

InterPore2026



InterPore2026

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Report of Abstracts

Abstract ID : 10

Interfacial Effects of an Anionic Surfactant on Evaporation in a Porous Medium

Content

Evaporation in porous media plays a key role in many natural and industrial processes, such as drying of products, CO₂ sequestration, soil remediation and many more. Despite its significance, controlling evaporation at the pore scale remains challenging because it depends on several factors like wettability, pore geometry and fluid distribution. Surfactants are often used to alter liquid-gas interface properties in porous systems; however, their specific influence on evaporation at the pore scale is still not well understood.

We hypothesized that adjusting the surfactant mass fraction, particularly around the critical micelle concentration (CMC), would significantly influence how liquid evaporates in a porous medium. Therefore, we performed microfluidic experiments in a two-dimensional PDMS pore network. We compared pure water to sodium dodecyl sulfate (SDS) surfactant solutions at 0.10 wt.% (below the CMC), 0.23 wt.% (at the CMC), and 0.3 and 0.5 wt.% (above the CMC).

We recorded the evaporation process using an imaging technique (experimental setup shown in Figure 1) and used an image processing algorithm in Python to analyze the snapshots obtained. This allowed us to measure how liquid saturation changed, observe the movement of the liquid-air interfaces, and track how the contact angle changed as evaporation progressed.

Our results showed that surfactant mass fraction significantly influenced the evaporation dynamics. The fastest evaporation occurred at the critical micelle concentration (CMC) of SDS, which is 0.23 wt.%. At this optimum concentration, SDS reduced the surface tension from about 72.01 mN/m to 39.95 mN/m, thereby lowering the capillary pressure required for air entry and accelerating the evaporation process to complete roughly 47% faster than with pure water. Even at 0.10% (below CMC) air invaded pores more easily, speeding up the initial evaporation phase. At higher mass fractions above the CMC (0.30% and 0.50%), increasing the surfactant amount did not speed up the evaporation process; instead, the total evaporation time was slightly longer than at 0.23%. We believe this happened because the excess surfactant formed micelles, which may have slowed vapor transport and reduced the benefit of having a lower surface tension.

Our results demonstrate that adjusting the surfactant concentration is an effective way to control evaporation in porous media. By lowering surface tension and influencing how liquid distributes within the pore space, surfactant addition promoted more efficient liquid removal, confirming our initial hypothesis. These findings provide a foundation for developing more accurate evaporation models in porous materials and can inform the design of improved materials and processes for applications such as industrial drying and enhanced oil recovery.

References

Country

Germany

Green Housing & Porous Media Focused Abstracts

This abstract is related to Green Housing

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Track Classification: MS01 - (MS01) Porous Media for a Green World: Energy & Climate

Contribution Type: Oral Presentation

Submitted by **Dr BELLO, Ayomikun** <contactme@ayo-bello.com> on **Monday 17 November 2025**

Abstract ID : 29

Suspensions of Self-Organizing Synthetic Clays for Subsurface Hydrogen Containment

Content

This study investigates Laponite® suspensions as injectable, self-organizing flow barriers for subsurface hydrogen storage by linking rheology to pore-scale containment performance. Guided by the phase diagram, 2–3 wt% suspensions were prepared and rheologically characterized, revealing low initial viscosity followed by time-dependent increases in viscosity and elasticity; 3 wt% suspensions aged (gelled) too rapidly for practical injection, whereas 2–2.5 wt% formulations provided a workable sol–gel transition window. Injectability and sealing performance were evaluated in rock-patterned microfluidic devices emulating Berea sandstone, where 2 and 2.5 wt% suspensions were injected, aged at 20, 45, and 75 °C for prescribed periods, and then subjected to pressurized hydrogen in a custom high-pressure setup until breakthrough. Breakthrough pressures across 38.38 mm of porous media reached 105 psi for 2 wt% and 346 psi for 2.5 wt% suspensions after 18 days at 75 °C, demonstrating that appropriately aged 2.5 wt% suspensions form a robust, pressure-bearing in situ geobarrier. These results establish a direct link between aging rheology and containment performance and highlight the potential of Laponite® suspensions as engineered thixotropic geobarriers for subsurface containment and energy storage applications.

References

Country

USA

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Track Classification: MS01 - (MS01) Porous Media for a Green World: Energy & Climate

Contribution Type: Oral Presentation

Submitted by **Dr ARYANA, Saman** <saryana@uwyo.edu> on **Thursday 4 December 2025**

Abstract ID : 39

Assessing the impact of oxygen on rock mineralogy and fluid composition for subsurface biomethane storage in porous reservoirs

Content

Biomethane is an environmentally friendly alternative to natural gas and is regarded as a key energy source for aiding the decarbonization of the energy system. The urgent need to transition to clean energy has driven the demand for large-scale storage of alternative energy carriers, such as biomethane, in subsurface porous reservoirs. Biomethane typically contains oxygen as an impurity (up to 1%), yet the potential impact of oxygen on reservoir rock integrity and subsurface fluid composition during storage remains poorly understood. This study presents a comprehensive geochemical investigation, combining experimental and modelling approaches, to evaluate oxygen's impact on rock mineralogy and fluid composition at two potential subsurface storage sites with distinct rock properties and mineralogy.

Batch-reaction experiments were conducted under worst-case scenarios, including a high fluid-to-rock ratio and elevated oxygen partial pressures (~3%). Three different experiments were performed for each site: (1) oxygen-brine-rock, to directly evaluate oxygen-brine-rock reactions; (2) nitrogen-brine-rock, to isolate the influence of oxygen; and (3) oxygen-brine, to assess oxygen's impact on fluid composition alone. Fluid samples were collected regularly during the experiments and analysed alongside pre- and post-experimental fluids to assess changes in ion concentrations. Mineralogical analyses of pre- and post experimental rock samples were also performed to identify any changes in rock composition.

Fluid analysis shows relatively higher increases in potassium and iron concentrations in the oxygen-brine-rock experiments compared to the nitrogen-brine-rock experiments, suggesting slight dissolution of K^+ -bearing minerals. However, the changes were marginal considering the amount of these minerals present in the rock. Other ions, including Ca^{2+} , Mg^{2+} , Na^+ , and SO_4^{2-} , exhibit minimal changes, primarily attributed to brine-rock interactions rather than reactions involving oxygen.

Mineralogical analysis shows negligible changes in bulk rock composition, with major minerals such as quartz, calcite, and K-feldspar remaining stable. Minor changes in clay minerals, such as slightly increased kaolinite and decreased illite/smectite, were consistent across both gas-brine-rock experiments, indicating that oxygen does not cause significant mineralogical alterations. Geochemical modelling corroborated the experimental findings, showing that oxygen has no long-term negative impact on rock mineralogy.

These results demonstrate that the presence of oxygen in biomethane has a minimal effect on reservoir rock and fluid stability, supporting the geochemical feasibility of subsurface biomethane storage. Moreover, the findings suggest that existing regulatory oxygen limits could be slightly relaxed for subsurface biomethane storage, facilitating a smoother transition to this alternative energy source.

References

Country

UK

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Track Classification: MS01 - (MS01) Porous Media for a Green World: Energy & Climate

Contribution Type: Oral Presentation

Submitted by **JANGDA, Zaid** <zj21@hw.ac.uk> on **Tuesday 9 December 2025**

Abstract ID : 54

Achieving energy efficiency through Green buildings –a case study from India

Content

The world's efforts to avert catastrophic climate change are still far off track a decade after the Paris Agreement's adoption. This is not a failure of the Agreement's design, but it is a failure of collective ambition to match its aims. The Intergovernmental Panel on Climate Change has said that countries should cut their emissions much more rapidly, with a 60% drop from 2019 required by 2035 to limit warming to 1.5 °C. In this context, it is imperative to develop and promote alternative clean energy sources that can lead to the sustainability of the energy–environment system. India, as one of the major economies in the world, cannot abdicate its responsibility in fighting global warming and thus making use of renewable energy as a way to reduce greenhouse gas emissions, to decrease reliance on depleting reserves of fossil fuels and to mitigate climate change. Producing energy with minimum greenhouse gas emissions is, therefore, a major concern today. Located in a tropical region, India is blessed with abundant clean renewable energy resources, especially solar energy. Increasing the amount of renewable energy and improving energy efficiency within households and in buildings will be key to reducing greenhouse gas emissions from cities. As per the Leadership in Energy and Environmental Design (LEED), globally, buildings are responsible for at least 40% of energy use. In India, too, the energy consumption has seen an increase and would continue to rise unless suitable actions to improve energy efficiency are taken up immediately. Fast-growing cities can play an important role in this regard by mandating a certain percentage of the electricity consumption to come from renewable energy sources.

The Oil and Natural Gas Corporation (ONGC), a premier oil and gas company in India, has completed its first 'green building' called Green Hills at Dehradun, Uttarakhand, in 2013 (Fig.1). As per ONGC Limited's post, the Green Hills has a built up area of 14600 m², it is spread of five floors having capacity of 620 persons. It's a unique living green roof covered in native flora, featuring skylights for natural light, rainwater harvesting, and water conservation, making it a benchmark for sustainable architecture in India. Building design includes Heating, Ventilation, and Air Conditioning (HVAC) achieved by the solar panels over parking spaces that not only generated 7.5 per cent of total electrical load but also reduced heat by reflecting the sunlight. Registered with UNFCCC under the Clean Development Mechanism, it will generate 735 Certified Emission Reductions (CERs) every year landscaped Green Roof and an abundant bamboo plantation in the atrium of the building, conserving water up to 30 per cent through the use of an onsite sewage plant and low-flow sanitary fittings. It can conserve water up to 30 per cent through the use of an on-site sewage plant and low-flow sanitary fittings. Rainwater harvesting is also taken care of at the building. Turning his dream into reality, five ONGC green buildings are coming up at Delhi, Mumbai, Kolkata and Hyderabad, apart from the one commissioned at Dehradun.

References

The Pioneer, Saturday, 13 December 2025 Shrivastava, R: "The Way We Look at the Buildings Today, Green Hills, ONGC,-Case Study", International Journal of Emerging Technologies and Innovative Research, ISSN: 2349-5162, Vol.6, Issue 6, page no. pp51-70, June 2019

Country

India

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Track Classification: MS01 - (MS01) Porous Media for a Green World: Energy & Climate

Contribution Type: Oral Presentation

Comments:

Financial needs

Sir I shall be grateful if the organisers could kindly consider my request for possible financial help to meet the travel, registration and lodging expenses for the following reasons:

(a) I am a participant from a low-income and poor exchange rate country, India (1 Euro equals 107 Indian Rupee). The take-home salary is just sufficient to support my family of three. I do not have any other source of funding. Therefore, I'm unable to bear the conference expenses entirely on my own.

(b) It is a long distance from the domicile to the destination and will require a substantial financial expenditure, especially on travelling, registration and lodging.

© I'm left with only one choice: to request the organisers of the InterPore2026 for financial support to make my participation possible.

Hope I have explained my financial needs satisfactorily. Thanking you in anticipation

Submitted by **SHARMA, S.K.** <sks105@rediffmail.com> on **Sunday 14 December 2025**

Abstract ID : 67

Experimental study on integrity evaluation of formation-cement-casing system under CO₂ geological sequestration conditions

Content

This project aims to investigate the corrosion mechanisms of the formation-cement-casing system under CO₂ injection and storage conditions, with a particular focus on analyzing the evolution characteristics of wellbore wall fractures and the degradation behavior of the cement-formation interface, thereby providing a scientific foundation for developing an integrity assessment methodology for this system. Through the implementation of CO₂ corrosion experiments in conjunction with CT scanning and imaging technology, the following key insights have been obtained. The corrosive effect of CO₂ on the system is significantly influenced by environmental temperature and partial pressure, with corrosion severity increasing under elevated temperature and pressure conditions. Cement exhibits a dendritic corrosion network in the low-temperature condition, whereas molten-like damage is observed in the high-temperature condition. Under supercritical conditions, the expansion of karst cavities and the propagation of micro-cracks become more pronounced. The cemented surface tends to develop “erosion fracture canyons” in supercritical environments, with the corrosion front propagating in a stepwise manner over time. The porosity at the core end increased markedly, resulting in the formation of a multilevel pore system. CT scans indicate that prolonged exposure to CO₂ can lead to the expansion or regeneration of fractures along the wellbore wall, particularly under fluctuating temperature and pressure conditions. The corrosion process is governed by both chemical reactions and thermally activated mechanisms. Elevated temperature induces a transition in corrosion morphology from uniform penetration to the formation of directional channels, whereas increased pressure promotes the occurrence of layer cracking and enhances the diffusion rate of CO₂. The depth of corrosion increases over time, with a higher corrosion rate observed during the initial stage. Under prolonged exposure, a three-dimensional “tree-root” corrosion network develops. The corrosion and fracture evolution mechanism elucidated in this study holds significant scientific value for assessing the stability of sealed wellbores and mitigating the risk of CO₂ leakage.

References

- [1] Chen, B., R. Wang, Q. Li, Y. Zhou, Y. Tan, Q. Dai, Y. Zhang. Status and advances of research on caprock sealing properties of CO₂ geological storage. *Geological Journal of China Universities*, 2023, 29(1): 85-99. [2] Yu, E., Y. Di, H. Wu, X. Cao, Q. Zhang, C. Zhang. Numerical simulation on risk analysis of CO₂ geological storage under multi-field coupling: A review. *Chinese Journal of Theoretical and Applied Mechanics*, 2023, 55(9): 2075-2090.

Country

China

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Presenter: DONG, Huaimin (Chang'an University)

Track Classification: MS01 - (MS01) Porous Media for a Green World: Energy & Climate

Contribution Type: Online Presentation

Submitted by **DONG, Huaimin** <sdsddhm@chd.edu.cn> on **Wednesday 17 December 2025**

Abstract ID : 80

Geomechanical Response to Cyclic Hydrogen Storage in a Fault-Bounded Saline Aquifer

Content

The growing need for large-scale, flexible energy storage has increased the interest in using porous geological formations for hydrogen storage, but the associated geomechanical risks are still not well understood, particularly in structurally complex saline aquifers. This study presents a fully coupled hydro-geomechanical analysis of cyclic hydrogen injection and production in a fault-bounded reservoir, the Stuttgart Formation at Ketzin (North German Basin). It previously served for a successfully completed benchmark CO₂ storage pilot project. Using a compositional reservoir simulator (CMG-GEM), we evaluate the development of pore pressure, gas saturation, fault stress state, slip tendency and vertical displacement over multiple operational hydrogen injection cycles. The model incorporates facies-dependent elastic and strength properties, fault-specific mechanical behaviour and poroelastic coupling between pressure and deformation.

Simulation results show that pore pressure exhibits strong cyclic fluctuations near the well and attenuates towards the opening of the eastern fault, while the hydrogen plume remains largely confined between two bounding faults. Gas saturation is strongly influenced by facies-related permeability differences, with higher saturations in high-permeability sandy channel deposits and significantly reduced values in the lower-permeability floodplain facies. No evidence of uncontrolled plume migration or cross-fault leakage is observed.

The results indicate that the fault network remains geomechanically stable throughout all cycles. Slip-tendency values remain well below critical thresholds ($ST < 0.13$), and only minor stress redistribution is observed. Localised zones of increased shear stress occur at fault segments exhibiting a slight dip, demonstrating that geometric factors exert a strong control on resolved stresses. Time-series analysis shows that slip tendency increases during injection and decreases during production, driven primarily by pore-pressure-induced variations in effective normal stress. Results of the cyclic loading reveal that vertical displacements are small but measurable with magnitudes that fall well below typical detection thresholds and several orders of magnitude below levels known to affect infrastructure. The temporal evolution of displacement shows a consistent elastic response, with only a minor cumulative compaction trend (< 0.02 mm per cycle) near the well.

Overall, we could demonstrate that hydrogen storage at the Ketzin site under the tested operational conditions induces modest hydraulic and mechanical perturbations and poses a low risk of fault reactivation or significant deformation. However, we emphasise that uncertainties in fault friction, cohesion and stress-dependent permeability remain important and should be addressed through targeted laboratory testing and sensitivity analysis. The findings support the mechanical feasibility of underground hydrogen storage in structurally complex saline aquifers while underscoring the need for continued monitoring and evaluation of higher-pressure operating scenarios.

References

Country

Germany

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Track Classification: MS01 - (MS01) Porous Media for a Green World: Energy & Climate

Contribution Type: Oral Presentation

Submitted by **ECKEL, Anna-Maria** <eckel@gfz-potsdam.de> on **Wednesday 17 December 2025**

Abstract ID : 86

Hydrogen and Brine displacement processes in Clashach Sandstone: Relevance of Haine's jumps and Intermittent Flow

Content

Hydrogen (H₂) storage in underground porous media could support the energy transition by acting as an energy store to balance supply and demand in the renewable energy sector. Important unknowns to this technology include the H₂ fluid flow through a porous medium which affects the H₂ injectivity and recovery. We used time-resolved X-ray micro-computed tomography to image unsteady and steady-state injections of H₂ and brine (2 M KI) into a Clashach sandstone core at 5 MPa and ambient temperature (Clashach composition: ~96 wt.% quartz, 2% K-feldspar, 1% calcite, 1% ankerite).

During steady-state injections, initial entry of H₂ into the brine-saturated rock was within seconds, with H₂ dispersing into several discrete pores. Over time, some H₂ ganglia connected, disconnected and then reconnected (intermittent flow), indicating that the current anticipation of a constant connected flow pathway during multiphase fluid flow may be an oversimplification. Pressure oscillations at the core outlet during steady-state experiments were characterized as red noise, confirming observations of intermittent pore-filling. At higher H₂ fractional flow the H₂ saturation in the pore space increased from 20-22% to 28%. The average Euler characteristic was generally positive over time, indicating poorly connected H₂ clusters and little control of connectivity on the pore space H₂ saturation. During unsteady-state injections, H₂ displacement of brine included Haine's jumps.

Dynamic fluid rearrangements such as intermittent flow and Haine's jumps are outside the framework of Darcy's law extended to multiphase flow. However, the evolution of H₂ saturation with H₂ fractional flow could still be described using the conventional framework of relative permeability functions, suggesting that the large-scale movement of H₂ was not affected by intermittent flow. Yet, never previously has intermittent flow been documented at low capillary numbers of 4.7×10^{-9} . Due to the high viscosity ratio of the H₂-brine system intermittent flow may be relatively more important than for nitrogen or oil.

Our results suggest a lower H₂ storage capacity in sandstone aquifers with higher injection-induced hydrodynamic flow and suggest a low H₂ recovery. For more accurate predictions of H₂ storage potential and recovery, geological models should incorporate energy dissipating pore-scale processes such as Haine's jumps and intermittent flow.

References

Country

Spain

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Track Classification: MS01 - (MS01) Porous Media for a Green World: Energy & Climate

Contribution Type: Oral Presentation

Submitted by **THAYSEN, Eike** <eike.thaysen@idaea.csic.es> on **Thursday 18 December 2025**

Abstract ID : 100

Thermal Maturity and Stress Dependence of Gas Breakthrough Experiments in Fine Grained Sedimentary Rocks: A Case Study of Pliensbachian Claystones from the Hils Syncline, Germany.

Content

Hydrogen (H₂) containment in the subsurface is of growing importance for underground energy storage and is also relevant to nuclear waste disposal, where H₂ may be generated as a by-product, e.g. from radiolysis. Underground hydrogen storage will be done in reservoir formations sealed by low-permeability rocks, while engineered barrier systems for nuclear waste disposal are hosted within similarly low-permeability geological formations, including claystones. Gas accumulation may lead to elevated pore pressures that can trigger capillary failure and compromise barrier integrity, making the capillary sealing capacity of such formations critical. This capacity can be quantified by the capillary breakthrough pressure. Experimental data on hydrogen breakthrough in claystones are scarce, and most existing measurements do not explicitly account for the influence of stress. As breakthrough pressure is controlled by the smallest available pore throats, it is expected to depend strongly on confining pressure and on rock properties related to burial history, such as thermal maturity.

In this study, laboratory H₂ gas breakthrough experiments were conducted on fully water-saturated claystone samples to investigate the influence of confining pressure, thermal maturity and bedding anisotropy, on capillary sealing behaviour. Core plugs were prepared from intact Amaltheen Claystone cores obtained from boreholes in the Hils and Sack Synclines of the southern Lower Saxony Basin (northern Germany), a region characterized by a south–north increase in thermal maturity, with samples drilled both parallel and perpendicular to bedding to assess the influence of burial-related compaction and anisotropy on gas breakthrough behaviour.

Experiments were performed using a stepwise gas pressurization method, in which gas pressure was incrementally increased on the upstream side of the sample while monitoring the downstream pressure response. Gas breakthrough was identified by a distinct and sustained increase in downstream pressure, indicating the formation of a continuous gas pathway through the sample. These measurements were complemented by determinations of the effective gas permeability.

Preliminary results show a clear dependence of as breakthrough pressure on confining pressure, with progressively higher gas pressures required to initiate breakthrough as stress increased. Values increased from 0.75 to 3 MPa over a stress range of 5 to 20 MPa (relatively low mature sample; parallel to bedding). This behaviour is attributed to stress-induced pore compaction leading to increased capillary entry pressures. Effective permeabilities increased by up to one order of magnitude post-breakthrough.

Breakthrough pressure was also found to increase systematically with thermal maturity. As thermal maturity reflects the maximum burial depth experienced by the rock, this trend is interpreted to result from the development of tighter pore structures in more mature samples. Values increased from 3 MPa to 5.5 MPa for samples with vitrinite reflectance between 0.48 to 0.70 %VRr. In addition, breakthrough pressure differed between samples drilled parallel and perpendicular to bedding, demonstrating slight anisotropy in transport behaviour.

Overall, the results demonstrate that gas breakthrough in these mudstones is controlled by stress, burial-related compaction, and bedding anisotropy. These findings provide experimentally constrained bounds on gas pressures that claystone host rocks can sustain and contribute to risk assessment of sealing integrity.

References

Country

Germany

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Contribution Type: Poster Presentation

Submitted by **MBUI, Brian** <mutuma.mbui@emr.rwth-aachen.de> on **Friday 19 December 2025**

Abstract ID : 115

A Two-Step Screening Framework for Identifying Underground Hydrogen Storage Sites in Alberta's Depleted Gas Reservoirs

Content

To address long-term imbalances between the supply and demand of sustainable energy, excess energy can be converted into hydrogen and stored in subterranean porous formations. Alberta, Canada's largest energy-producing province, aims to make a large-scale transition to clean hydrogen deployment e.g. by combining steam methane reforming with carbon capture, utilization, and storage. Supporting this transition requires identifying the geological formations within the province that are most suitable for underground hydrogen storage (UHS). This study applies a two-step screening algorithm to reduce Alberta's large inventory of natural gas reservoirs to a shortlist of those with the highest UHS potential. Following guidelines established in the literature, the first step filters out reservoirs with low porosity, high pressure, or insufficient storage capacity. Reservoirs that pass this initial screening are then evaluated using a secondary scoring process. This second step includes five criteria—storage capacity, propensity for geochemical reactions, lithology, degree of depletion, and presence of existing natural gas storage infrastructure. Using a weighted scoring system in which capacity carries the greatest weight, each site was assigned a score from 0 to 5, with sites scoring above 3 considered suitable for UHS. Thus, we identify 40 target reservoirs, representing an overall hydrogen storage potential of approximately 624 PJ. To further assess storage security, the top-scoring reservoirs were evaluated based on salinity, pH, and formation depth to identify sites with minimal risk of biotic reactions and gas migration. Applying these additional constraints results in a list of 12 candidate formations that will undergo reservoir engineering evaluations to identify the top reservoir for pilot-scale design and study. The findings of this study highlight Alberta's strong potential for becoming a hydrogen storage hub.

References

Country

Canada

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Track Classification: MS01 - (MS01) Porous Media for a Green World: Energy & Climate

Contribution Type: Oral Presentation

Submitted by **RAHNAMAYBAHAMBARY, Khashayar** <krahnama@ualberta.ca> on **Saturday 20 December 2025**

Abstract ID : 143

Pore-scale dynamics of exsolution-driven multiphase flow during gas storage in heterogeneous porous reservoirs

Content

Underground gas storage involves periods of injection, production, and storage. During storage periods, the pressure equilibrates and the brine can become locally supersaturated with the gas. In addition, macro-scale rock heterogeneity leads to strong spatial variability in gas saturation, with localized zones of high gas saturation. To investigate pore-scale dynamics during storage under supersaturated conditions and in the presence of macro-scale heterogeneity, we conducted microfluidic storage experiments where macroscale heterogeneity was mimicked by connecting the chip outlet to a small gas reservoir. Experiments were performed for several pre-equilibrated gas/water systems (CO₂, H₂, and N₂). For the CO₂ experiments, a pH indicator was added to the water to visualize the concentration of dissolved gas. Our results show that for all studied gas/water systems, even slight supersaturation led to gas exsolution. This process locally depleted the water from gas, generating concentration gradients and leading to diffusive transport of dissolved gas from the outlet towards the inlet. This diffusive transport sustained continued exsolution at the inlet, leading to the formation of a pressure gradient and resulting in multiphase flow toward the outlet. However, the observed flow behavior differs between different gases: exsolved H₂ invades the porous media in a smooth way, while invasion via exsolved CO₂ happens much earlier and in bursts. These experiments show that, in contrast to homogeneous systems where Ostwald ripening drives redistribution, heterogeneous systems exhibit more complex redistribution behavior during storage.

References

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Track Classification: MS01 - (MS01) Porous Media for a Green World: Energy & Climate

Contribution Type: Oral Presentation

Submitted by **ZARGAR, Amir Reza** <amir-reza.zargar@mib.uni-stuttgart.de> on **Tuesday 23 December 2025**

Abstract ID : 145

Hydro-chemical Effects of Ammonia and Hydrogen Storage in Water-Saturated Porous Media

Content

With the growing importance of subsurface storage for clean fuels, hydrogen and ammonia have been proposed as promising candidates—hydrogen as a clean fuel and ammonia as a carbon-free energy carrier. A key concern, however, lies in the geochemical reactions that may occur between these injected fluids and host rocks in the presence of an aqueous phase. In particular, reactions with calcite can lead to carbonate dissolution and the formation of secondary phases such as CO_2 . Understanding these processes is essential for evaluating the long-term impacts of fluid injection into porous media and for optimizing energy storage systems. This study explicitly models surface-reaction kinetics at the pore-scale, addressing a critical knowledge gap regarding the suitability of carbonate formations for subsurface ammonia or hydrogen storage. Hydro-chemical simulations were performed to investigate interactions between ammonia/hydrogen and calcite. Numerical experiments focused on a single calcite grain exposed, in two separate scenarios, to continuous aqua-ammonia flow and to continuous dissolved hydrogen flow. Results indicate that, under identical boundary and hydrodynamic conditions, the grain–hydrogen system undergoes substantially more aggressive dissolution than the grain–ammonia system. This contrast arises from differing local chemical environments: in the ammonia–water system, strong alkaline conditions ($\text{pH} \approx 11\text{--}12$) develop, which suppress reaction rates and slow calcite dissolution, whereas in the water–hydrogen system, pH remains below 7, creating a more acidic environment that accelerates dissolution. A sensitivity analysis of ammonia injection rate further revealed that, although total calcite volume loss remains limited within the explored parameter range, higher injection rates lead to measurable increases in dissolution and associated microstructural changes.

References

Country

Iran

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Track Classification: MS01 - (MS01) Porous Media for a Green World: Energy & Climate

Contribution Type: Oral Presentation

Submitted by **MAHANI, Hassan** <hmahani@sharif.edu> on **Tuesday 23 December 2025**

Abstract ID : 161

Lab Evaluation of Long-Distance Propagation of CO₂ Foam for Deep Mobility Control

Content

Foam is a valuable tool for maximizing CO₂ sweep in subsurface applications. Maximizing sweep increases capillary and solution trapping of CO₂ in carbon sequestration and maximizes oil recovery in combined sequestration/enhanced oil recovery applications (Rossen et al., 2024), which improves the economics of the sequestration process. Long-distance CO₂-foam propagation is essential for maximizing CO₂ sweep. Long-distance propagation is challenging at the low velocities and low pressure gradients deep in a reservoir (Ashoori et al., 2012). We apply a multi-diameter coreflood method (left figure) to evaluate long-distance foam propagation. This technique allows determination of critical conditions governing CO₂-foam propagation in terms of minimum pressure gradients and velocity thresholds needed for foam generation, mobilization and stability maintenance (Yu et al., 2020). We also quantify the correlations between foam-propagation thresholds and influential factors for prediction of field behavior.

A multi-diameter coreflood approach allows determining the thresholds for foam generation, propagation and stability in place in different steps in the three sections of the core, following a particular injection-velocity sequence (Yu et al., 2020). In an increasing, or decreasing, velocity sequence, the sudden abrupt increase, or drop, in pressure gradient in one of the core sections indicates the critical pressure gradient and velocity required for foam generation, propagation or maintaining stability (right figure).

Foam propagation results from two processes: mobilizing bubbles behind the displacement front and bubble generation at the front, needed to compensate for bubble collapse there (Ashoori et al., 2012). Published data for N₂ foam show that long-distance N₂-foam propagation at deep reservoir velocity and pressure-gradient conditions is extremely challenging (Yu et al., 2020). This is because the minimum pressure gradient needed for N₂ foam mobilization, e.g. 33 bar/m in a 2.5-darcy Bentheimer core (right figure), and higher in lower-permeability formations, is not attainable far from an injection well. We find CO₂-foam propagation is much easier. In a 1052-mD core, the minimum pressure gradient needed for CO₂ foam generation is only 0.06 bar/m (easily attainable throughout a formation). The minimum for foam propagation is still problematic: 4.1 bar/m.

However, our data show that the minimum pressure gradients required for CO₂ foam generation and propagation are strongly affected by surfactant type. A surfactant that reduces CO₂-brine surface tension is expected to reduce the critical thresholds needed for foam generation and propagation. This would provide a direction for manipulating CO₂ foam generation and mobilization conditions to improve its long-distance propagation deep into reservoirs.

The multi-diameter coreflood approach provides a technique for evaluating field-scale long-distance foam propagation in the lab. This approach can be used to determine the critical velocity and pressure-gradient conditions for foam generation, propagation and stability maintenance. The measured quantitative critical thresholds reduce the uncertainty in the prediction of CO₂-foam propagation distance. The finding that a low-tension surfactant reduces the foam-propagation thresholds provides a way for extending CO₂-foam propagation for its deep applications in enhanced oil recovery.

References

Ashoori, E., Marchesin, D., and Rossen, W.R., "Multiple Foam States and Long-Distance Foam Propagation in Porous Media," SPE Journal 17, 1231-45 (2012). <https://doi.org/10.2118/154024-PA> / / / / /
Rossen, W. R., Farajzadeh, R., Hirasaki, G. J., and Amirmoshiri, M., 2024. "Potential and Challenges of Foam-Assisted CO2 Sequestration." Geoenergy Sci. Eng. 239: 212929 <https://doi.org/10.1016/j.geoen.2024.212929> / / / / /
Yu, G., Vincent-Bonnieu, S., and Rossen, W. R., "Foam Propagation at Low Superficial Velocity: Implications for Long-Distance Foam Propagation," SPE Journal 25 (06): 3457–3471 (2020). <https://doi.org/10.2118/201251-PA>

Country

Netherlands

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Presenter: ROSSEN, William (Delft University of Technology)

Track Classification: MS01 - (MS01) Porous Media for a Green World: Energy & Climate

Contribution Type: Oral Presentation

Comments:

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Submitted by **ROSSEN, William** <w.r.rossen@tudelft.nl> on **Friday 26 December 2025**

Abstract ID : 194

Water in clay nanochannels: electrodynamics, fluidics, and energy storage

Content

In this talk, I'll share experiments that reveal the electrodynamic properties of water at interfaces and in nanoscale confinement, focusing on proton conductivity and charging effects. I will discuss how ordinary clay materials can be transformed into periodic, interconnected channels that are accessible to water. These channels operate with interfacial water as if it were a distinct material with properties different from those of the bulk liquid. I will demonstrate that protons in water can be manipulated and stored in nanochannels, opening pathways for electric energy applications. These findings reveal previously overlooked interfacial phenomena and suggest new possibilities for water-driven (blue) nanofluidic devices, with applications ranging from filtration and separation to sustainable energy storage.

References

- [1] V. Artemov, *The Electrodynamic Properties of Water and Ice*, Springer-Nature, 2021
- [2] V. Artemov et al., *J. Phys. Chem. Lett.*, 2020, 11, 9, 3623–3628
- [3] V. Artemov et al., *J. Phys. Chem. Lett.*, 2023, 14, 20, 4796–4802
- [4] S. Melnik et al., *J. Phys. Chem. Lett.*, 2023, 14, 29, 6572–6576
- [5] V. Artemov et al., arXiv:2410.11983v3, 2025
- [6] A. Ryzhov et al., arXiv:2509.09462, 2025

References

Country

Germany

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Track Classification: MS01 - (MS01) Porous Media for a Green World: Energy & Climate

Contribution Type: Oral Presentation

Submitted by **ARTEMOV, Vasily** <vasily.artemov@tuhh.de> on **Monday 29 December 2025**

Abstract ID : 208

Machine Learning in Porous Media Research: A Review of Data-Driven and Physics-Integrated Approaches Across Scales

Content

The rapid growth of experimental data and imaging information and simulation results has led to increased adoption of machine learning (ML) techniques for studying porous media. The research evaluates current ML applications which analyze flow and transport and chemical reactions in porous and fractured media systems for CCUS and subsurface carbon mineralization and geothermal systems and hydrogen energy storage and remediation and unconventional resource recovery. The focus is exclusively on reviewing published approaches rather than proposing new algorithms or modeling strategies.

The review surveys at the pore scale demonstrate how ML techniques apply to image processing and digital rock physics and microstructure characterization. The research evaluates current deep learning and graph-based and unsupervised and self-supervised learning methods which analyze imaging data to detect pore-scale features and identify complex geometries and determine flow-related properties. The document presents a summary of ML applications which help speed up pore-scale simulations and help determine model parameters for upscaled models.

The review investigates ML-based surrogate models and proxy models and reduced-order representations which scientists use to create approximations of multiphase flow and reactive transport and flow-deformation coupling at bigger measurement sizes. The research investigates how these models have been integrated with modern physics-based simulation platforms which preserve their mass conservation features and their thermodynamic characteristics and physical significance. The research literature presents Physics-informed ML approaches which use governing equations and constraints to build learning formulations.

The review examines all published research which uses machine learning to merge data sets while it discusses the process of uniting experimental and field-based measurements and monitoring data analysis and simulation-data combination methods. The paper reviews applications which study mixing and dispersion and chemical reactions that occur in both homogeneous and broken rock formations while documenting the observed difficulties which stem from biased data and the need to move results between different rock types and fluid patterns and the process of quantifying uncertainties.

The review unites existing research data to show ML success while it shows its present difficulties and its position as an extra method which supports physics-based modeling in porous media research.

References

Country

United States of America

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Presenter: Dr MOUBARAK, Hesham (Terra Altai)

Track Classification: MS01 - (MS01) Porous Media for a Green World: Energy & Climate

Contribution Type: Oral Presentation

Submitted by **MOUBARAK, Hesham** <moubarak@terra-altai.com> on **Tuesday 30 December 2025**

Abstract ID : 214

Evaluation of the pore pressure influence on the acoustic velocities of Brazilian carbonate rocks

Content

Acoustic velocities of reservoir rocks are dependent on in-situ stresses and pore pressures. However, loading or unloading stages may also influence acoustic velocities in distinct ways (Wang and Wang, 2015). An important application of understanding the sensitivity to effective pressure for velocity is in modeling 4D response, which impacts oil and gas exploration (Cruz et al., 2021) and CO₂ storage monitoring (Lumley, 2010).

This work shows the results of lab experiments designed to measure acoustic velocities during pore pressure loading and unloading processes (Fig.1). Ultrasonic transmitted wave tests were performed on Brazilian pre-salt carbonate samples and Coquinas extracted from an outcrop of Morro do Chaves Fm. (NE Brazil). The core plugs were saturated with a high-salinity synthetic brine that aims to represent a typical Brazilian Formation Water (BFW) (Façanha et al., 2016). The experiments were performed using a triaxial system, which is composed of a pulse generator unit, three pairs of piezoelectric transducers: one P-wave (1.3 MHz) and two independent orthogonally polarized S-wave (900 kHz) at each vertical (Z-axis) and lateral (X and Y-axes) position, and an oscilloscope to detect the signal output. The measurements were performed by exploring a range of 10-25 MPa effective pressure and provided monitoring of P- and S-wave velocities in mean stress directions during different loading/unloading cycles (Fig. 2).

A velocity-pressure model (Wang & Wang, 2015) was also tested, yielding highly accurate predictions ($R^2 > 0.8$). Petroacoustic studies of complex carbonates addressing pressure sensibility are scarce in the literature. In the case of Brazilian carbonate rocks, it is even rarer. This way, this work aims to contribute to the understanding of velocity behavior in response to pressure variation. Such info is usually important for rock physics modeling of porous rocks with impacts to the mechanics and flow behavior.

References

- CRUZ, N.M., CRUZ, J.M., TEIXEIRA, L.M., COSTA, M.M., OLIVEIRA, L.B., URASAKI, E.N., BISPO, T.P., JARDIM, M.S., GROCHAU, M.X., MAUL, A. 2021. Tupi Nodes pilot: A successful 4D seismic case for Brazilian presalt reservoirs. *The Leading Edge*. 40, Issue 12, 886-896. December. <https://doi.org/10.1190/tle40120886.1>
- FACANHA, J., SOHRABI, M., DREXLER, S., COUTO, P. 2016. Experimental investigation of wettability for Brazilian pre-salt carbonates. October 2016. Rio Oil and Gas Conference. Rio de Janeiro, Brazil. Volume: 2016.
- LUMLEY, D. 2010. 4D seismic monitoring of CO₂ sequestration. *ASEG Extended Abstracts*, 2010:1, 1-4, DOI: 10.1081/22020586.2010.12041906
- WANG, Z., WANG, R. 2015. Pore pressure prediction using geophysical methods in carbonate reservoirs: Current status, challenges and way ahead. *J. Natural Gas Sci. and Eng.*, 27, 986-993. <http://dx.doi.org/10.1016/j.jngse.2015.09.032>

Country

Brazil

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Contribution Type: Poster Presentation

Submitted by **CEIA, MARCO** <marco@lenep.uenf.br> on **Tuesday 30 December 2025**

Abstract ID : 260

Elastic Anisotropy of the porous systems in the Pre-Salt carbonates by Thomsen parameters and numerical simulations

Content

Pre-salt layer carbonates are among the primary exploration targets in Brazil. However, their microstructural complexity presents significant challenges for geophysical characterization (Vasquez et al., 2019).

Elastic anisotropy is a critical property that influences the interpretation of seismic velocity, stress distribution, and fracture behavior. In pre-salt carbonates, complex pore geometries and diagenetic alterations lead to variable elastic responses, making laboratory characterization challenging (Martínez & Schmitt, 2013).

Digital rock physics (DRP), based on micro-computed tomography (μ CT), provides a framework for connecting microstructural and elastic domains, allowing for direct numerical simulations under controlled conditions (Lima Neto et al., 2023).

This study leverages the GeoDict software to analyze carbonate samples from the Barra Velha Formation in the Santos Basin, Brazil.

The objectives are:

- (a) Compute the effective stiffness matrix and directional VP and VS velocities from μ CT data samples - F90V and F92H, under a confining pressure of 22.1 MPa, 12.14 μ m voxel resolution, and 1.5”;
- (b) Extract the Thomsen anisotropy parameters (ϵ , δ , γ) to classify the magnitude of anisotropy (Thomsen, 1986);
- (c) Quantify deviations from elliptical anisotropy using non-ellipticity indicators, providing insight into the anisotropic character (Thomsen, 1986; Alkhalifah & Tsvankin, 1995);
- (d) Validate the applicability of VTI/HTI symmetry models and correlate the numerical results with laboratory data.

This work develops a digital workflow to analyze the elastic behavior of pre-carbonates, aiding in more precise reservoir characterization.

Figure 1 displays the deformation planes for samples F92H and F90V, illustrating the angular dependence of the elastic response obtained from GeoDict simulations. These diagrams show the magnitude of deformation as a function of propagation direction, providing a representation of the anisotropic behavior of each carbonate sample.

Sample F92H exhibits nearly circular contours at 70 GPa, indicating a weakly anisotropic that is consistent with a homogeneous pore distribution across the XY, XZ, and YZ planes. In contrast, F90V exhibits slightly elongated lobes along specific orientations in the XZ and YZ planes at pressures below 70 GPa. This pattern reveals directional mechanical anisotropy associated with preferential pore alignment and textural heterogeneity. In the XY plane, the pressure measurement reached 80 GPa.

The comparison of the two polar plots confirms that sample F90V displays a higher degree of elastic anisotropy. These results underscore the strong correlation between digital deformation fields and the microstructure that governs the elastic behavior of carbonate rocks.

Figure 2 illustrates the consistency between laboratory-measured and simulated wave velocities for F92H and F90V samples, demonstrating the reliability of the digital simulation results in reproducing elastic properties and anisotropic trends.

Table 1 shows that the simulation model produces higher velocities than those physically mea-

sured in the lab, with performance varying depending on the specific sample and wave type. Figure 3 shows the Thomsen parameters for the analyzed carbonate samples under 22.1 MPa, measured in the laboratory. Thomsen parameters' digital values for F92H ($\epsilon = -0.0058$, $\gamma = -0.0052$) and F90V ($\epsilon = -0.0320$, $\gamma = -0.0191$) reveal weak and moderate anisotropies, confirming the laboratory results.

References

Alkhalifah, T., & Tsvankin, I. (1995). Velocity analysis for transversely isotropic media. *Geophysics*, 60(5), 1550-1566. Lima Neto, I., Ceia, M., Misságia, R., Oliveira, L., Santos, V., & Moreira, J. (2023). Anisotropic elastic moduli of presalt carbonates from Santos Basin, Brazil. In *SEG International Exposition and Annual Meeting* (pp. SEG-2023). SEG. Martínez, J. M., & Schmitt, D. R. (2013). Anisotropic elastic moduli of carbonates and evaporites from the Weyburn-Midale reservoir and seal rocks. *Geophysics Prospect*, 61(2), 363–379. Thomsen, L. (1986). Weak elastic anisotropy. *Geophysics*, 51(10), 1954–1966. Vasquez, G. F., Morschbacher, F. M., Anjos, C. W. D., Silva, M. P., Madrucci, V., & Justen, J. C. R. (2019). Petroacoustics and composition of presalt rocks from Santos Basin. *The Leading Edge*, 38(5), 322–416.

Country

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Track Classification: MS01 - (MS01) Porous Media for a Green World: Energy & Climate

Contribution Type: Poster Presentation

Submitted by **MARCHEZI MISSAGIA, Roseane** <rose@lenep.uenf.br> on **Friday 2 January 2026**

Abstract ID : 270

Fluid Migration in Sedimentologically Heterogeneous Reservoirs: Implications for ISL Uranium Mining, South Tortkuduk deposit, Chu-Sarysu basin, South Kazakhstan

Content

Fluid transport in porous media is commonly predicted using petrophysical properties derived from geophysical well logs, which provide indirect proxies for porosity, permeability, and fluid saturation at the reservoir scale. In many sedimentary reservoirs, these log-derived properties form the basis for static and dynamic modeling workflows. However, in sandstone-hosted uranium deposits extracted by In-Situ Leaching (ISL), standard logging techniques such as resistivity and gamma-ray logs, often prove inadequate in lithologically heterogeneous parts of the reservoirs. The study investigates a Paleocene–Eocene fluvial, uranium-bearing succession at the South Tortkuduk ISL mine in Kazakhstan. By analyzing cores and coeval outcrop analogues, we identify sedimentary facies and intra-formational reservoir architecture that cannot be deduced from log responses alone. Features such as inclined heterolithic strata (IHS) and paleo-chute channel deposits play a significant role in controlling hydraulic connectivity, but are often overlooked in log-based interpretations.

Reservoir-scale numerical simulations of fluid migration are performed to evaluate the impact of sedimentologically constrained permeability distributions on fluid flow. Simulation results show that log-based models and uniform categorization of poro-perm properties overestimate hydraulic connectivity and underestimate flow anisotropy within sand-dominated intervals. In contrast, models that incorporate sedimentological controls better reproduce restricted vertical flow, preferential lateral transport, and localized bypassed zones.

The results demonstrate that integrating sedimentological interpretation in reservoir-scale simulation significantly improves prediction of fluid migration in heterogeneous sedimentary porous media and provides a more reliable basis for ISL flow and reactive transport modeling. This improvement, in turn allows for more effective development and production optimization strategies. This study is logistically and financially supported by KATCO JV LLP.

References

Country

Kazakhstan

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Contribution Type: Oral Presentation

Submitted by **SMAGAMBETOV, Bekzhan** <bekzhan.smagambetov@nu.edu.kz> on **Saturday 3 January 2026**

Abstract ID : 298

From silicate solutions to colloidal gels: dynamic NMR relaxometry to probe water dynamics and structural evolution in porous media

Content

In the context of energy- and climate-related challenges involving porous materials, understanding water dynamics across different states of porous matter, from reactive mineral solutions to consolidated colloidal gels, is essential for describing transport, aging, and stability in silicate-based and bio-inspired systems. However, capturing these processes under non-equilibrium conditions and across relevant length and time scales remains experimentally challenging. In this work, we develop and apply a dynamic low-field NMR relaxometry framework to investigate water dynamics and structural evolution in silicate systems, spanning the transition from alkaline silicate solutions to deformable porous gels.

We first investigate aqueous alkali silicate solutions using NMR relaxometry to quantify changes in water mobility and interfacial interactions as a function of hydroxide concentration and alkali nature. Transverse relaxation measurements reveal marked and systematic variations in relaxation behavior, reflecting modifications of solution speciation and mesoscale organization prior to gelation. These results demonstrate that NMR relaxometry provides a sensitive, non-destructive probe of structural evolution in reactive silicate solutions [1].

The approach is then extended to the drying of colloidal and aluminosilicate gels, where water transport is intrinsically coupled to deformation, gradient formation, and particle-network reconfiguration. Using a dynamic relaxometry methodology that follows transverse relaxation times (T_2) as a function of saturation rather than time, and combining global measurements with one-dimensional spatial water profiles, we identify robust power-law relationships linking relaxation efficiency to desaturation. These relationships reveal distinct drying regimes and allow a clear discrimination between ideal homogeneous drying and non-ideal scenarios governed by physical instabilities such as gradients and incomplete network reorganization [2].

To rationalize these observations, a minimal numerical framework is introduced, enabling the separation of the respective contributions of hydric gradients, macroscopic contraction, and particle-network reconfiguration. Additional relaxometry measurements performed at different magnetic fields further support the interpretation of relaxation mechanisms and interfacial water dynamics.

Overall, this work establishes dynamic NMR relaxometry as a unifying and quantitative methodology to continuously follow water dynamics from reactive solutions to porous gels, providing physically grounded descriptors relevant for transport, aging, and stability in porous materials, with direct implications for the understanding and control of water-related processes in energy-efficient and climate-resilient porous systems.

Keywords: Low-field NMR, NMR relaxometry, variable-field relaxometry, water dynamics, silicate solutions, colloidal gels, drying, porous media, non-equilibrium processes

References :

[1] Poulesquen, A.; Sidi-Boulouar, R. et al. submitted —Comprehensive structural and dynamical study of alkali silicate solutions, *Journal of Colloid And Interface Science*, 2025.

[2] Maillet, B.; Sidi-Boulouar, R.; Coussot, P. Dynamic NMR Relaxometry as a Simple Tool for Measuring Liquid Transfers and Characterizing Surface and Structure Evolution in Porous Media. *Langmuir* 2022, 38 (49), 15009–15025. <https://doi.org/10.1021/acs.langmuir.2c01918>.

References

[1] Poulesquen, A.; Sidi-Boulenouar, R. et al. submitted —Comprehensive structural and dynamical study of alkali silicate solutions, *Journal of Colloid And Interface Science*, 2025. [2] Maillet, B.; Sidi-Boulenouar, R.; Coussot, P. Dynamic NMR Relaxometry as a Simple Tool for Measuring Liquid Transfers and Characterizing Surface and Structure Evolution in Porous Media. *Langmuir* 2022, 38 (49), 15009–15025. <https://doi.org/10.1021/acs.langmuir.2c01918>.

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Contribution Type: Oral Presentation

Submitted by **Dr SIDI-BOULENOUAR, Rahima** <rahima.sidi-boulenouar@univ-eiffel.fr> on **Saturday 3 January 2026**

Abstract ID : 299

Chemo-Mechanical Characterisation of Effects and Working Dynamics of Nanosilica in Wellbore Cement Sheath for Advanced Application

Content

The leakage of CO₂ from Portland cement has recently attracted significant research interest, particularly in the context of geologic carbon capture and sequestration. Portland cement is considered susceptible to degradation in the presence of CO₂ due to the reaction between the wellbore cement sheath, formation water, and CO₂. In the last decade, several studies on wellbore cementing have focused primarily on the strength-enhancing capacity of Nanosilica, despite its potential to address other wellbore cementing issues. The approach employed in this study is predicated on the pre-defined operational mechanism of CO₂-induced cement degradation to develop a more resistant Portland cement sheath. The study explores chemical and mechanical analysis sets geared towards efficient and effective performance characterisation. Two sets of samples were prepared for the uncarbonated and carbonated batches. The slurries were prepared with 0%, 1.0%, and 1.5% Nanosilica by weight of cement, free of conventional additives, for representative characterisation. X-ray Diffraction, Thermogravimetry, and mechanical and petrophysical analysis show that the addition of Nanosilica enhanced the cement sheath's chemical resistance, mechanical strength and petrophysical properties. The addition of 1% nanosilica demonstrated consistent, optimal performance across all evaluation parameters. The study outcome provides a holistic effect characterisation and determination of the working mechanism of Nanosilica in cement sheath as well as its proficiency in new functionalities in the presence of CO₂, and thus, contributes to the future advancement of performance and mechanism-based hybrid composite development suitable for a variety of subsurface conditions as well as Geologic carbon capture and sequestration.

References

Country

United Kingdom

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Contribution Type: Oral Presentation

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Abstract ID : 302

Double Diffusive Convection in Aquifer Thermal Energy Storage (ATES) Systems

Content

Aquifer thermal energy storage (ATES) system is a sustainable energy storage technology for long-term recovery of stored heat and has the potential of reducing global carbon emissions. Across the globe, many low-temperature aquifer thermal energy storage (LT-ATES) systems with injected water temperatures of less than 60°C have been engineered for direct applications in building heating during adverse thermal conditions [1]. However, due to their low-temperature delivery, LT-ATES are often coupled with ground-source heat pumps (GSHPs) to mitigate their deficiencies. High-temperature aquifer thermal energy storage (HT-ATES) is an advancement on the low-temperature storage, where hot water with temperatures exceeding 60°C is injected into aquifers to store seasonal thermal energy and recover it later. Across literature, they have been reported to potentially deliver high thermal energy recovery during extraction and can be directly deployed at industrial scales, in addition to building heating applications. However, only a few pilot projects exist alongside theoretical studies, which report that free thermal convection is one of the major impediments to harnessing the potential of HT-ATES [2]. Injected hot water, being less dense than the native aquifer fluid, flows farther distances due to buoyant convection, which is further enhanced in the case of HT-ATES, leading to a drastic loss in the recovery efficiency. To reduce thermal energy losses, van Lopik et al. (2016) suggest adding salinity to eliminate the density disparity between the injected and native fluids, thereby reducing buoyant convection [3]. In their numerical analysis, they demonstrate a more vertical fluid-fluid interface that preserves the injected fluid near the injection well, while also reducing diffusive losses between the injected and native fluids, as well as between the injected fluid and the surrounding rocks. They report a recovery efficiency of 69%, which is a significant increase from the non-salinity counterparts of the efficiency of about 45% [2, 3].

While the distinct diffusive behaviours of salt and heat lead to a transient change in the density of the injected fluid, they also lead to the onset of double-diffusive instabilities. Based on the injection conditions and the relative concentration of the two species, flow is influenced by either fingering instability or layered convection (see Figure 1) [4]. A common metric used to define this type of convection is the Stability ratio $N = \beta \Delta C / \alpha \Delta T$, which dictates layered convection for $N > 1$ and fingered convection for $N < 1$. Such double-diffusive effects may alter the energy dynamics of an ATES system, thereby demonstrating efficiencies different from those reported in the literature. In our study, we investigate the double-diffusive convection in both LT-ATES and HT-ATES to assess its potential impact on thermal energy recovery. We approach the problem by simulating a small-scale injection-storage-recovery model, which enables us to understand the dynamics of flow and energy resulting from the varying thermohydraulic properties of the aquifers and the injection-recovery methods. We decompose the total injected energy into kinetic and potential components and include additional loss terms, scaled to quantify their relative influence on the thermal recovery efficiency [5].

References

1. Fleuchaus, P., Godschalk, B., Stober, I., & Blum, P. (2018). Worldwide application of aquifer thermal energy storage – A review. *Renewable and Sustainable Energy Reviews*, 94, 861–876. <https://doi.org/10.1016/J.RSER.2018.06.057>.
2. Molz, F. J., J. G. Melville, A. D. Parr, D. A.

King, and M. T. Hopf (1983), Aquifer thermal energy storage: A well doublet experiment at increased temperatures, *Water Resour. Res.*, 19(1), 149–160, doi:10.1029/WR019i001p00149.

3. van Lopik, J.H., Hartog, N. & Zaadnoordijk, W.J. The use of salinity contrast for density difference compensation to improve the thermal recovery efficiency in high-temperature aquifer thermal energy storage systems. *HydrogeolJ* 24, 1255–1271 (2016). <https://doi.org/10.1007/s10040-016-1366-2>.

4. Huppert HE, Turner JS. Double-diffusive convection. *Journal of Fluid Mechanics*. 1981; 106:299-329. doi:10.1017/S0022112081001614.

5. Necker F, Härtel C, Kleiser L, Meiburg E. Mixing and dissipation in particle-driven gravity currents. *Journal of Fluid Mechanics*. 2005; 545:339-372. doi:10.1017/S0022112005006932.

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Presenter: JAIN, Tarun (University of Alberta, Canada)

Track Classification: MS01 - (MS01) Porous Media for a Green World: Energy & Climate

Contribution Type: Poster Presentation

Submitted by **JAIN, Tarun** <tkjain@ualberta.ca> on **Sunday 4 January 2026**

Abstract ID : 310

Design Strategies for Enhancing Gas Separation with High-Performance Mixed Matrix Membranes

Content

In response to the urgent need for efficient carbon dioxide (CO₂) capture techniques from industrial processes, membrane-based gas separation has emerged as a promising approach due to its cost-effectiveness, safety, environmental benefits, and energy efficiency. Among the various materials employed, polymeric membranes have attracted considerable attention because of their suitability for large-scale deployment. However, despite the successful commercialization of polymeric membranes, they suffer from an inherent permeability–selectivity trade-off.

A promising strategy to overcome this limitation involves the use of mixed matrix membranes (MMMs), which integrate porous fillers within a polymer matrix. MMMs combine the processability of polymers with the superior selectivity and permeability of porous materials. The development of efficient MMMs depends on several critical factors, including membrane morphology, polymer type, filler particle characteristics, particle dispersion, plasticization, and physical aging. Performance enhancements can also be achieved through modifications such as optimizing filler size, shape, and loading, adding additives, and implementing surface modifications on fillers.

In this presentation, I will share our recent findings on how geometrically optimized fillers can significantly improve the efficiency of MMMs designed for gas separation. In the first part of the presentation, I will discuss how Platonic-shaped fillers influence the design criteria for optimal membranes using a computational approach. The evaluation considers both single- and binary-gas transport to assess permeability and selectivity. The second part of the presentation focuses on the design of MMMs by identifying the sources of incompatibility that prevent achieving ideal membrane performance and on developing effective strategies to overcome these challenges.

References

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Track Classification: MS01 - (MS01) Porous Media for a Green World: Energy & Climate

Contribution Type: Oral Presentation

Submitted by **GHASEMI, Mehdi** <mehdi.ghasemi@manchester.ac.uk> on **Sunday 4 January 2026**

Abstract ID : 312

Optimal Cushion Gas for Underground Hydrogen Storage: A Thermodynamic Perspective

Content

The purity of recovered hydrogen from geological storage is controlled by persistent interactions between the injected hydrogen and the cushion gas. Here, we present the first thermodynamic analysis of hydrogen-cushion gas interactions under reservoir conditions. By quantifying changes in Helmholtz free energy associated with mixing, we show that hydrogen recovery purity depends on the combined effects of the thermodynamic driving force for mixing and the molar density contrast between hydrogen and cushion gas. This thermodynamic framework consistently explains numerical predictions based on experimentally measured diffusion coefficients. Among the representative cushion gasses examined, nitrogen and methane exhibit similar behavior and yield higher hydrogen purity than carbon dioxide, although the differences diminish with increasing depth. This indicates that field-scale storage performance is fundamentally governed by intrinsic thermodynamic tendencies.

References

Country

China

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Track Classification: MS01 - (MS01) Porous Media for a Green World: Energy & Climate

Contribution Type: Oral Presentation

Submitted by **Dr WANG, Yuhang** <wangyuhang17@cug.edu.cn> on **Sunday 4 January 2026**

Abstract ID : 322

Insights for screening of abandoned oil and gas wells for geothermal development

Content

Continued reliance on fossil fuels as the primary energy source poses severe environmental risks. Geothermal energy, characterized by its low carbon footprint, has been utilized for electricity generation since the early 20th century [1]. These systems exploit the elevated temperatures of subsurface formations as the principal energy source. Nevertheless, the substantial costs associated with drilling to economically viable depths remain a major constraint to large-scale deployment. Recently, the repurposing of abandoned oil and gas wells has been proposed as a more cost-effective alternative [2]. The efficiency of geothermal heat extraction—and the viability of a given well—depends critically on the thermal properties of the wellbore and surrounding formation, as well as on operational parameters. This study builds upon a comprehensive sensitivity analysis examining the influence of well-screening factors, fluid thermal and hydraulic properties, installation configurations, and operational parameters [3]. A proxy model was developed to establish correlations between key input features and evaluation metrics. Particular attention was given to assessing the role of insulation in system efficiency. In this study, a coefficient of performance (COP) equal to 1 was adopted as the threshold for defining marginal efficiency in geothermal energy harvesting. Statistical analysis of screening factors indicates that without effective insulation of the inner pipe, the viability of the energy harvesting system can only be justified within a narrow range of conditions. Wells with depths below 3500 m have only a 22% probability of achieving this COP threshold, whereas wells between 3500 and 5000 m exhibit a 42% probability. When effective insulation is applied, the likelihood of marginal efficiency increases substantially, reaching approximately 70% for wells within the 3500 and 5000 m depth range. A comparable methodology was employed to identify favorable geothermal gradients and reservoir rock thermal conductivity values. The findings of this study are helpful for performance appraisal and optimization of geothermal energy harvesting projects.

References

[1] Volkan Ediger, Sertaç Akar (2023) Historical Pattern Analysis of Global Geothermal Power Capacity Development, Geothermal Rising Conference Reno, Nevada October 1-4. [2] S. Pan, Y. Kong, C. Chen, Z. Pang, J. Wang (2020) Optimization of the utilization of deep borehole heat exchangers, *Geotherm. Energy* 8 (6). [3] Y. Ahmadpour, M. Sajjadi, M. Emami Niri (2025) Repurposing of abandoned oil and gas wells as geothermal power plants: A comprehensive sensitivity analysis and AI based performance prediction, *Renewable Energy* 253, 123510.

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Contribution Type: Oral Presentation

Submitted by **SAJJADI, Mozhdeh** <sajjadi.mozhdeh@ut.ac.ir> on **Sunday 4 January 2026**

Abstract ID : 343

Thermo–hydro–mechanical modeling of hydrogen storage in saline aquifers with Ostwald ripening effects

Content

Hydrogen storage in saline aquifers can be used to mitigate fluctuations in the energy supply from renewable sources and to support low-carbon emission goals. Estimating the hydrogen recovery factor and evaluating the thermo–hydro–mechanical (THM) response of the reservoir are critical for the economic feasibility and safety assessment of such projects. The multi-scale, multiphase, and multi-physics nature of this process makes it challenging to analyze and requires appropriate coupling between phenomena occurring at different scales.

One microscopic process that can significantly influence reservoir-scale behavior is Ostwald ripening. During hydrogen injection, shut-in, and production phases, a portion of the gas becomes trapped within the pore space. At the microscale, smaller trapped gas bubbles exhibit higher curvature and, consequently, higher capillary pressure. At the same time, hydrogen solubility in brine increases with pressure. As a result, smaller gas bubbles are more soluble than larger gas ganglia and tend to dissolve into the brine. Through diffusion, the dissolved hydrogen migrates and accumulates in larger bubbles, leading to their growth.

These micro-scale changes in bubble size and morphology alter capillary pressure and relative permeability relationships. In this study, the impact of Ostwald ripening on reservoir-scale responses is investigated within a coupled thermo–hydro–mechanical (THM) modeling framework. The results are analyzed using both qualitative observations of gas plume evolution and quantitative metrics, including pressure, stress, and hydrogen recovery factor.

Across different reservoir conditions—varying permeability, pressure, temperature, and stress fields—Ostwald ripening significantly increases the hydrogen recovery factor while having a negligible effect on other THM responses of the system. Based on these simulation results, incorporating the effects of Ostwald ripening into capillary pressure and relative permeability hysteresis models is essential. Neglecting this process may lead to a substantial underestimation of the hydrogen recovery factor.

References

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Contribution Type: Oral Presentation

Submitted by **Dr MAHMOODPOUR, Saeed** <mahmoodpour.saeed@gmail.com> on **Sunday 4 January 2026**

Abstract ID : 364

The use of mobile $\delta^{13}\text{C}$ measurements for CO₂ leak detection at the Salt Wash Fault System, Utah

Content

Geological storage of CO₂ requires monitoring techniques capable of detecting and characterising potential surface leakage. This study evaluates the reliability of carbon isotopic composition ($\delta^{13}\text{C}$) as a leakage indicator using mobile wavelength-scanned cavity ring-down spectroscopy (WS-CRDS) data collected at the Salt Wash fault system, Utah, an established natural analogue for geological CO₂ leakage. Spatially continuous measurements were acquired across bubbling springs and areas of diffuse seepage, producing a high-resolution dataset of CO₂ concentration and $\delta^{13}\text{C}$ variability. Atmospheric background conditions were characterised by relatively stable CO₂ concentrations (370 - 420 ppm) and mean $\delta^{13}\text{C}$ values of -8.49‰ , providing a baseline for leakage detection. Both bubbling springs produced repeatable, high-magnitude concentration anomalies confirming active surface leakage. In contrast, isotopic responses during direct vent encounters were highly variable. Keeling plot analysis constrained the apparent isotopic composition of seep-derived CO₂ to a narrow range of 0.60 - 2.36 ‰, indicating a source signature that is isotopically heavier than atmospheric CO₂, consistent with measurements of near-surface dissolved inorganic carbon in waters and interaction with deep carbonate formations during subsurface migration for the same site. As a result of the proximity of the isotopic signatures for leaking and atmospheric CO₂, Keeling mixing relationships demonstrate that isotopic discrimination is rapidly lost as leaking CO₂ is diluted by atmospheric air. At concentrations below approximately 700 - 740 ppm, the $\delta^{13}\text{C}$ values fall within the natural background range, limiting the effectiveness of $\delta^{13}\text{C}$ as a stand-alone leakage detection method. In contrast, CO₂ concentration anomalies provide a clear and reliable indicator of leakage across the survey area. These results highlight the strong site dependence of isotopic monitoring and emphasise the need to integrate concentration-based detection with complementary approaches in geological CO₂ storage monitoring.

References

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Track Classification: MS01 - (MS01) Porous Media for a Green World: Energy & Climate

Contribution Type: Oral Presentation

Submitted by **CAI, Hull** <hc1622@ic.ac.uk> on **Sunday 4 January 2026**

Abstract ID : 370

Laser-Etched Glass Microfluidic Device Facilitates Visualizing CO₂ Hydrate Film Propagation in Porous Media

Content

Gas hydrates are crystalline solids in which guest molecules are trapped within cages formed by water molecules under high-pressure and low-temperature conditions. They show great potential for submarine CO₂ storage in shallow seabed sediments. This approach involves injecting liquid CO₂ beneath the hydrate stability zone (HSZ). As the CO₂ migrates upward into the HSZ, a hydrate layer forms and acts as a seal, confining the mobile liquid CO₂ beneath it. Studying the formation and propagation dynamics of CO₂ hydrates in porous media is essential for understanding the time-dependent evolution of hydrate saturation in host sediments. This knowledge is critical for predicting the mechanical strength of hydrate-bearing sediments and for designing safe and effective CO₂ injection strategies. Microfluidics is an effective approach for visualizing the phase-transition behavior associated with hydrate formation and has been widely used in hydrate research. However, for dense hydrate formers such as liquid CO₂, the initial hydrate film formation stage is difficult to capture using traditional acid-etched glass micromodels with smooth inner surfaces. In contrast, laser-etched glass micromodels introduce controlled surface roughness, which facilitates the visualization of fine hydrate nuclei and enables direct observation of rapid hydrate film propagation during the early stages of formation. In this study, we employ a laser-etched glass micromodel to investigate hydrate formation processes involving both light phases (gaseous CH₄ and gaseous CO₂) and a dense phase (liquid CO₂). Two distinct stages of hydrate formation are identified: rapid hydrate film growth occurring within seconds, followed by hydrate thickening. In particular, we compare liquid CO₂ hydrate formation in laser-etched and acid-etched glass micromodels, confirming the superior capability of the laser-etched micromodel in capturing early-stage hydrate dynamics. Finally, the effects of subcooling, temperature, additives, and gas saturation on hydrate formation behavior are systematically examined. This work advances microfluidic hydrate research and supports the development of hydrate-based CO₂ storage technologies.

References

Country

Saudi Arabia

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Track Classification: MS01 - (MS01) Porous Media for a Green World: Energy & Climate

Contribution Type: Oral Presentation

Submitted by **YU, Wei** <wei.yu@kfupm.edu.sa> on **Sunday 4 January 2026**

Abstract ID : 372

The Role of Microporosity During H₂ Storage in Carbonate Reservoirs

Content

Hydrogen energy is expected to play a significant role in the energy transition, with geological storage poised to be one of the few economically viable options for enabling a large-scale hydrogen economy. However, there is a critical lack of research in H₂ storage in carbonate rocks, particularly regarding the role of microporosity (<10 μm) and pore connectivity in residual trapping during imbibition.

The limitations in studying the role of microporosity arise from the low spatiotemporal resolution of lab-based micro-CT scanners in addition to the heterogeneous nature of carbonate pore systems. Analogous research considering proxy fluids indicate that microporous phases can significantly stratify flow paths into complex geometries due to their hydrophilicity and high capillary entry pressure. These regions –when water-wet –can lower non-wetting phase residual saturations and boost wetting-phase relative permeabilities to aid recovery during waterflooding (Reynolds et al., 2017; Gao et al., 2019). Furthermore, the complexity of micro-porous carbonates is further exacerbated when wettability is considered. This is coupled with contact angle hysteresis which is typically accentuated in smaller pore sizes and heterogeneous systems (e.g., van Rooijen et al., 2022).

To bridge the gap, pre-characterization work was conducted prior to high-resolution synchrotron X-ray imaging using lab-based X-ray micro-CT scanner to develop a null hypothesis and highlight regions of interest. An Estailades carbonate mini-plug was imaged during two cycles of drainage and imbibition at reservoir conditions (10 MPa and 50 °C). During drainage, H₂ pore occupancy pre-dominantly lies in the largest pores (macropores) with microporous phases acting as barriers that increase flow tortuosity unless their capillary entry pressure can be exceeded. However, during imbibition, we find that microporous phases may affect the phase connectivity, enhance brine flow and affect the residual saturation distribution. This is evidenced by the increase in residual saturation around a microporous-rich band where micro-macro links are greater and macroporous connectivity is reduced. Subsequent experiments conducted under synchrotron radiation will enable the visualization of H₂-brine phase flow paths during drainage and imbibition to understand the dynamics of flow through heterogeneous carbonate pore systems.

References

- Bultreys, T., Stappen, J.V., Kock, T.D., Boever, W.D., Boone, M.A., Hoorebeke, L.V. and Cnudde, V. 2016. Investigating the relative permeability behavior of microporosity-rich carbonates and tight sandstones with multiscale pore network models. *Journal of Geophysical Research: Solid Earth*. 121(11), pp.7929–7945.
- Burchette, T.P. 2012. Carbonate rocks and petroleum reservoirs: a geological perspective from the industry. Geological Society, London, Special Publications. 370(1), pp.17–37.
- Gao, Y., Raeini, A.Q., Blunt, M.J. and Bijeljic, B. 2019. Pore occupancy, relative permeability and flow intermittency measurements using X-ray micro-tomography in a complex carbonate. *Advances in Water Resources*. 129, pp.56–69.
- Reynolds, C.A., Menke, H., Andrew, M., Blunt, M.J. and Krevor, S. 2017. Dynamic fluid connectivity during steady-state multiphase flow in a sandstone. *Proceedings of the National Academy of Sciences*. 114(31), pp.8187–8192.
- Van Rooijen, W., Hashemi, L., Boon, M., Farajzadeh, R. and Hajibeygi, H. 2022. Microfluidics-based analysis of dynamic contact angles relevant for underground hydrogen storage. *Advances in Water Resources*.

164, p.104221.

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Presenter: AL MANDHARI, Mohammed (Heriot-Watt University)

Track Classification: MS01 - (MS01) Porous Media for a Green World: Energy & Climate

Contribution Type: Oral Presentation

Submitted by **AL MANDHARI, Mohammed** <mzaa2000@hw.ac.uk> on **Sunday 4 January 2026**

Abstract ID : 385

Durability and microstructural evolution of low carbon concrete for marine and offshore structures

Content

The microstructural evolution of cementitious materials strongly governs their durability and transport properties. In marine environments, these properties are of particular importance for the long-term durability of reinforced concrete structures, particularly for floating offshore wind turbines (FOWTs). Concrete used for FOWTs is expected to enable long service lives with reduced maintenance requirements in aggressive marine environments compared to steel support structures. Moreover, concrete foundations offer opportunities for incorporating low-carbon and supplementary cementitious materials. However, the long-term performance of such materials in continuous seawater exposure remains insufficiently understood, particularly with respect to microstructural evolution and transport mechanisms.

In this context, this study investigates the influence of curing medium (freshwater and seawater) on pore structure development and ionic transport in cement-based materials. It focuses on decoupling the effects of extended curing time from chloride exposure in seawater. The studied concrete mixture was prepared with Portland cement, limestone and calcined clay in line with low carbon construction objectives. Mercury intrusion porosimetry was employed to characterize pore size distribution and total porosity starting from early age (7 days) to long term.

The results reveal a specific evolution of porosity and microstructure with hydration time: a relatively constant porous volume and a significant refinement of the pore network. For both curing conditions, modal pore diameter shifts toward smaller size between 7 and 28 days indicating progressive filling of capillary pores thanks to pozzolanic reaction. However, samples exposed to seawater exhibit a shift toward finer pores compared to freshwater cured specimens. This behavior suggests that different solid phases are formed in marine environment. It is attributed to the combined effects of hydration advancement and interaction with seawater ions. The latter promotes the precipitation of secondary phases and partial pore blocking leading to reduce pore connectivity and to form less permeable microstructure. These analyses were confirmed by additional microstructural investigations using thermogravimetric analysis and X-ray diffraction.

In addition, complementary transport measurements reveal a pronounced decrease in the diffusion coefficient over time accompanied with an increase in electrical resistivity. Meanwhile, variations in water porosity remain limited. Collectively, these changes contribute to a time dependent modification of transport properties involved in chloride induced corrosion of concrete structure exposed to seawater.

References

Country

France

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Contribution Type: Oral Presentation

Submitted by FARHAT, Walaa <walaa.farhat@ec-nantes.fr> on **Sunday 4 January 2026**

Abstract ID : 397

Comparative System Analysis of Geological Hydrogen Produced from Natural Accumulation versus Engineered Stimulation

Content

Naturally occurring, geologically sourced hydrogen has recently emerged as a promising low-carbon energy resource, prompting growing exploration and evaluation efforts across regions including North America, Australia and European Union. Despite this momentum, current cost and greenhouse gas (GHG) assessment approaches rely heavily on retrospective field data, limiting their applicability for early-stage project screening, system design, and policy alignment.

In this study, we present a simulation-informed, system-level analysis framework that explicitly couples subsurface reservoir behavior with surface production and processing configurations. By integrating techno-economic analysis (TEA) and life cycle assessment (LCA) within a unified modeling platform, we simultaneously quantify the levelized cost of hydrogen (LCOH) and associated GHG emission intensity (GHG EI) for both naturally accumulated hydrogen resources and engineered stimulation-based production pathways.

Results indicate that hydrogen production from natural accumulations can achieve an LCOH of approximately US\$0.95 per kilogram with a corresponding GHG EI of ~0.34 kg CO_{2e} per kilogram when accounting for incentives such as the U.S. 45V hydrogen production tax credit. In contrast, stimulation-driven pathways exhibit substantially higher costs and emissions, driven primarily by increased energy and material demands required to induce serpentinization reactions.

Overall, this work addresses a critical gap in early-stage geological hydrogen evaluation and provides a decision-oriented analytical framework to support technology developers, policymakers, and investors in assessing the viability and climate performance of geological hydrogen within the evolving hydrogen economy.

References

Country

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Track Classification: MS01 - (MS01) Porous Media for a Green World: Energy & Climate

Contribution Type: Poster Presentation

Submitted by **MA, Haoming** <haoming.ma@uwyo.edu> on **Monday 5 January 2026**

Abstract ID : 399

Coreflooding without flooding: Buoyancy-based multiphase-flow core analysis for H₂/CO₂ storage sites

Content

Achieving large-scale underground hydrogen storage and carbon-dioxide sequestration is central to the energy transition and climate-neutrality goals. Reliable prediction of multiphase flow in geological formations is essential for the design and safety of such systems and largely relies on accurate estimation of fluid-rock properties. However, conventional coreflooding approaches for determining permeability and relative permeability suffer from some significant drawbacks such as pressure measurement errors, end effects, gravity override and rock damage, and yield rate-dependent relative permeability curves that are not intrinsic to the rock–fluid system. Furthermore, small-scale sub-core heterogeneity should be considered in the property estimation studies and gravity-capillary driven flow should be a focal point, as it prevails in H₂/CO₂ storage far from wells or after injection and production has been terminated, leaving the fluids to migrate due to buoyancy and capillary forces.

We present a new buoyancy-based method for estimating three-dimensional permeability ($k(x,y,z)$) and intrinsic relative-permeability curves (k_r) of core samples, without imposing external flow. The approach focuses on gas-water redistribution in a sealed vertical core due to gravity and capillary forces. The method inverts transient and equilibrium saturation fields obtained during the flow using imaging to recover both $k(x,y,z)$ and k_r . Synthetic tests on numerical simulations of H₂-water flow are conducted and show that the permeability field is reconstructed with an error below 4% for almost all cases. Intrinsic k_r curves are also accurately recovered using the new method, with some errors observed for highly nonlinear curves. Parametric analyses shows that the method is generally robust and accurate, providing insight on the unique gravity-capillary driven core-flow. The new approach has numerous advantages over conventional coreflooding and could establish a pathway for more reliable characterization of geological hydrogen and CO₂ storage sites.

References

Country

Israel

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Contribution Type: Oral Presentation

Submitted by **RABINOVICH, Avinoam** <avinoamr@tauex.tau.ac.il> on **Monday 5 January 2026**

Abstract ID : 415

Time-Dependent Pore-Scale Evolution of Petrophysical Properties and In-Situ Resistivity During CCS and CCUS in Permian Basin Carbonates

Content

Understanding time-dependent petrophysical and geophysical responses during carbon capture and storage (CCS) is critical for reliable monitoring and long-term storage assessment. This study investigates the evolution of in-situ electrical resistivity and associated pore-scale alterations in carbonate core samples from the Permian Basin under CO₂ storage-relevant conditions. Four core samples, two (S06465, S06468) obtained from the Bureau of Economic Geology (BEG) and two (H3, H4) from Department of Energy (DOE) repositories, were analyzed to quantify changes in porosity, permeability, and pore structure resulting from CO₂-brine-rock interactions.

The experimental workflow was applied to four core samples: H3, H4, S06465, and S06468. Sample H3 was collected from depths of 10,673.5–10,674 ft, H4 from 10,721–10,721.5 ft, S06465 from 9,742 ft, and S06468 from 9,652 ft. Initial petrophysical characterization included helium porosity, Archimedes porosity, gas permeability, and liquid permeability measurements. A 20 wt% NaCl brine was used to represent formation salinity. Nuclear magnetic resonance (NMR) measurements, including quick porosity, T₂, and T₁ analyses, were conducted before CO₂ exposure.

Pore combination modeling was performed using PLS400 equipment to characterize pore structure before and after exposure to supercritical CO₂ (scCO₂). In-situ resistivity measurements were conducted under both 100% brine saturation and partial saturation conditions, where approximately 30% brine saturation and 70% scCO₂ saturation were maintained. Measurements were performed at an elevated temperature (120 °C) to simulate reservoir conditions. Resistivity was continuously monitored for 10 days at 3,500 psia. Following the resistivity experiments, pore-combination modeling was developed using the experimental data to quantify pore-scale changes. Additional characterization techniques, including thin-section analysis, micro-CT imaging, and advanced image segmentation, were employed to evaluate changes in pore structure, including vuggy and matrix porosity, as well as permeability evolution.

Results indicate clear time-dependent petrophysical changes, with an initial increase in porosity observed after 10 days of scCO₂ exposure. However, liquid permeability decreased, likely due to the dissolution and alteration of connected pore pathways. One of the studied samples exhibits low permeability, with values of approximately 0.04 mD. These findings provide one of the first laboratory-scale observations of short-term porosity and permeability evolution in Permian Basin carbonate samples under CCS-relevant conditions.

In-situ resistivity monitoring proved to be an effective tool for developing scalable models applicable to CCUS, CO₂-enhanced oil recovery (CO₂-EOR), and Foam CO₂ huff-and-puff processes. The results support improved oil recovery strategies and contribute to economic feasibility under U.S. Section 45Q tax incentives for CCUS technologies. This integrated and novel workflow enhances pore-scale understanding of mineralization, precipitation, and dissolution mechanisms, providing valuable insights into pore-scale processes that control both hydrocarbon recovery and long-term CO₂ storage capacity. Ongoing experiments extend exposure durations to three months to compare short- and long-term storage behavior relevant to CCS and CO₂-EOR applications, which will be further investigated through detailed pore-scale geochemical modeling using PetraSim/TOUGHREACT.

References

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Contribution Type: Oral Presentation

Submitted by **KHAN, Muhammad Noman** <mkhan101@uh.edu> on **Monday 5 January 2026**

Abstract ID : 450

Protein-based mineral foams: validation of a pre-foaming method

Content

Mineral foams represent a new category of materials that are attracting considerable interest in sustainable construction. They can be formed by combining an aqueous foam produced with a biobased foaming agent (protein) and a cement paste [1]. The internal structure of these mineral foams is characterized by highly controlled porosity. The size, distribution, and connectivity of the pores determine physical properties. Notably, they are characterized by low density and good thermal and acoustic performances [2]. These characteristics make them ideal for use as a lightweight eco-friendly insulation material and fire resistant. Mineral foams behaviour depends on the intrinsic properties of the aqueous foam and of the cementitious matrix [3], as well as the manufacturing process. In this context, this work focuses on the validation of a method for mineral foam production based on the pre-foaming concept [4, 5]. This method involves producing a cement paste and an aqueous foam separately with a dedicated machine, then mixing them to obtain a mineral foam avoiding foam collapse [6]. The formulations are defined according to the target apparent density of the hardened foam, which is calculated as a function of the air and foaming solution flow rates, paste volume, water-to-cement ratio (W/C), setting accelerator, and specific densities of the components. The calculation is based on the following hypotheses: the volume of the aqueous foam corresponds to the total volume of air and foaming solution introduced in the machine; mineral foam volume corresponds to the combined volume of the cement paste and the aqueous foam; the cement paste density is calculated without considering potential air entrainment during mixing; and the hardened cement paste density considers only the water required for the cement hydration. To validate our pre-foaming process, multiple formulations were used to produce aqueous foam by adjusting the air and foaming solution flow rates. The objective is to fix the foaming solution flow rate and change the air flow rate to produce aqueous foam at a targeted apparent density. Then, this density was compared to the theoretically calculated one. For the selected flow rates, the density results were identical to the theoretical ones, meaning that all the injected air volume was totally retained in the aqueous foam. In the case of mineral foam production, the flow rates of the cement paste and the setting accelerator are also adjusted according to the theoretical values. The measured apparent density of the mineral foam was again identical to the theoretical value showing lack of the collapse during process. Therefore, the flow rates imposed on the machine perfectly control the volumetric fraction of the product obtained at the final stage of the foaming process. Large range of targeted mineral foam densities are then reachable managing the process parameter.

References

- [1] Amran Y.H.M., Farzadnia N., & Abang Ali A.A., (2015). Properties and applications of foamed concrete; a review. *Construction and Building Materials* 101, 990–1005. <https://doi.org/10.1016/j.conbuildmat.2015.10.112>
- [2] Batool F., & Bindiganavile V., (2017). Air-void size distribution of cement-based foam and its effect on thermal conductivity. *Construction and Building Materials* 149, 17–28. <https://doi.org/10.1016/j.conbuildmat.2017.05.050>
- [3] Auriol M., (2016). Influence des interactions physico-chimiques entre particules et composés organiques sur la stabilité de mousses minérales. PhD thesis in Physical Chemistry of Condensed Matter, University of Bordeaux.
- [4] Chandni T.J., & Anand K.B., (2018). Optimization of foam volume in foam concrete. *Journal of Building Engineering* 19, 154–160. <https://doi.org/10.1016/j.jobbe.2018.04.032>

[5] Xu T., & Garrecht H., (2024). Effects of Mixing Techniques and Material Compositions on the Compressive Strength and Thermal Conductivity of Ultra-Lightweight Foam Concrete. *Materials* 17, 2640. <https://doi.org/10.3390/ma17112640> [6] Mortada N., (2021). *Mousses Minérales: Développement, Structure Porale et Propriétés d'usage*. PhD thesis in Civil Engineering, University of Rennes.

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Contribution Type: Online Presentation

Submitted by **EL KHIRAOUI, Ali** <ali.el-khiraoui@etudiant.univ-rennes.fr> on **Monday 5 January 2026**

Abstract ID : 456

Measurement and interpretation of low CO₂ relative permeability

Content

Quantifying pore-scale fluid displacement mechanisms in CO₂/brine system is critical for predicting multiphase flow behavior and trapping efficiency during geological CO₂ storage. In this study, we image steady-state two-phase flow of brine and CO₂ in a water-wet Bentheimer sandstone under reservoir conditions. An experimental approach utilizing differential X-ray imaging was developed to investigate pore-scale CO₂ behavior during drainage conditions. This methodology enabled direct measurement of relative permeability and capillary pressure, as well as characterization of gas ganglia evolution within the pore space across a range of fractional flows under capillary-dominated conditions.

The measured CO₂ relative permeability remains low during early stages of drainage over a wide saturation range, increasing to 0.24 only at 100% CO₂ injection, corresponding to a gas saturation of 0.57. Image analysis reveals that CO₂ initially occupies the largest pores and throats as small, disconnected ganglia, with fragmentation promoted by Roof snap-off. With increasing CO₂ fractional flow, invasion extends into smaller pores and throats, allowing individual ganglia to coalesce and form a connected flow pathway. Gaussian curvature distribution exhibits a slightly positive mean curvature, consistent with positive capillary pressure and confirming a water-wet system. Capillary pressure estimated from interfacial curvature are in agreement with independent porous-plate measurements reported in the literature, demonstrating that curvature-based analysis provides reliable pore-scale capillary pressure estimates despite inherent uncertainties.

Overall, the results indicate that the low gas relative permeability observed in CO₂/brine systems is an inherent feature governed by capillary-dominated displacement processes and frequent snap-off events. These mechanisms result in a poorly connected CO₂ phase, yielding flow behavior that deviates from predictions based on invasion percolation models.

References

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Contribution Type: Poster Presentation

Submitted by **AL ZARAFI, Anfal** <a.al-zarafi23@imperial.ac.uk> on **Monday 5 January 2026**

Abstract ID : 470

Impact of fluvial reservoir heterogeneities on underground hydrogen storage operations

Content

Large-scale energy storage achieved by underground hydrogen storage (UHS), e.g. in caverns or porous media, will likely play an important role in the low-carbon future. Especially for hydrogen storage in porous media, geological heterogeneities, such as in fluvial depositional environments, can influence UHS operations. In reservoirs with large-scale heterogeneities, hydrogen flow paths, plume shape and gas-saturation distribution can be impacted –all key factors, which affect UHS performance. In this UHS study, we examine the flow behaviour of hydrogen in fluvial depositional environments. Realistic fluvial reservoir systems are generated with a process-based tool FLUMY [1], where different characteristics such as the channel depth, width, and net-to-gross ratio, are varied to create an ensemble of geological realisations.

The numerical simulations of cyclical injection and production of hydrogen in these geological models is carried out using the multiphase flow simulator TOUGH3 [2]. We evaluate the impact of fluvial heterogeneities on UHS in terms of operational efficiency, hydrogen losses due to trapping with and without hysteresis and unwanted brine production. Results are presented for various geological configurations to highlight their implications for UHS design and optimization.

References

[1] FLUMY™, Process based channelized reservoir models, Copyright © MINES PARIS PSL / ARMINES, <https://flumy.minesparis.psl.eu> [2] Jung, Y., G. Pau, S. Finsterle, C. Doughty, TOUGH3 User's Guide, Version 1.0, Report LBNL-2001093, Lawrence Berkeley National Laboratory, Berkeley, Calif., January 2018.

Country

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Contribution Type: Oral Presentation

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Abstract ID : 492

Effect of permeability contrast on Rayleigh-Taylor instability in layered porous media

Content

Geological carbon dioxide (CO₂) sequestration in deep saline aquifers is a promising strategy for mitigating the impacts of anthropogenic CO₂ emissions on global climate change \cite{Huppert2014,Sahu_Neufeld_2023}. The effectiveness of CO₂ sequestration relies on efficient mixing of CO₂ with resident brine, which can be investigated through the study of gravity-driven flow or Rayleigh–Taylor instability in stratified porous media. While numerous studies \cite{Rapaka2008, MUSUUZA2009796, MUSU-UZA2011417, PhysRevLett.106.104501, EMAMIMEYBODI2015238, Hewitt_2022} have examined density-driven flows in single-layer porous media to predict the onset of convective instability and the subsequent evolution of mass transport, natural aquifers and many engineered systems are inherently stratified, comprising layers with distinct permeabilities and porosities. Such heterogeneity can fundamentally modify both the onset of convective instability and the ensuing flow patterns, yet its influence remains poorly understood.

In this study, we investigate gravity-driven flow of a dense fluid in a two-layered porous media

The post-onset flow dynamics are further analyzed in terms of the growth rate and frequency

References

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Contribution Type: Oral Presentation

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Abstract ID : 499

Pore-Scale Controls on Capillary Entry Pressure in Underground Hydrogen Storage

Content

Capillary trapping and hydrogen recovery efficiency in underground hydrogen storage (UHS) systems are governed not only by fluid properties and wettability but also by the detailed geometry of pore spaces. We hypothesise that the onset of capillary entry pressure is controlled by a critical pore diameter—referred to as the effective pore throat—below which interfacial forces increase sharply and dominate gas–liquid displacement. To test this hypothesis, a series of single tapered-capillary experiments were performed to simulate two-phase gas–brine displacement under controlled conditions. The experimental variables included capillary diameter, gas type (H_2 , CO_2 , N_2 , CH_4 , air, He), brine composition (deionised water, NaCl, $CaCl_2$), and CO_2 equilibration of the aqueous phase. Pressure evolution and dynamic contact angles were measured to decouple the effects of pore geometry, fluid composition, and interfacial properties. The results demonstrate that capillary entry pressure becomes significant only when the pore diameter falls below a critical threshold, confirming the relevance of the effective pore throat concept. Gas type exerted minimal influence on capillary behaviour due to comparable gas–water interfacial tensions. In contrast, brine chemistry—particularly the presence of divalent cations—and CO_2 equilibration substantially reduced capillary pressures, thereby enhancing hydrogen mobility. These findings provide a mechanistic framework for improving pore-scale modelling, optimising injection strategies, and tailoring brine conditions to enhance hydrogen recovery in UHS applications.

References

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Abstract ID : 508

Interplay of Multiphysics Processes for Reliable CO₂ Storage Design in Chalk Reservoirs

Content

Reliable CO₂ storage design in deep geological formations demands a comprehensive understanding of coupled Thermo-Hydro-Mechanical-Chemical (THMC) processes. Using a real depleted chalk reservoir in the Danish North Sea, we demonstrate how these interplays govern injectivity, containment, and long-term integrity. Our multiphysics simulations reveal that cold CO₂ injection significantly influences pressure evolution and stress paths, where neglecting mechanical compaction leads to substantial overestimation of storage capacity. Thermal effects, though localized, alter storage capacity, while geochemical interactions remain spatially constrained but critical for caprock sealing over geological timescales. The results underscore that safe and efficient CO₂ storage cannot rely on single-physics assumptions; instead, integrated THMC modeling is essential for predicting fault stability, optimizing injection strategies, and ensuring containment. This work provides a validated framework for designing CO₂ storage in chalk reservoirs and offers practical guidance for scaling similar approaches to other similar systems, accelerating the deployment of secure subsurface storage as part of global carbon management strategies.

References

Hosseinzadeh, Behzad, et al. "Validated thermo-hydro-mechanical modeling framework for CO₂ storage in chalk reservoirs: A case study from the Harald East field." *International Journal of Greenhouse Gas Control* 146 (2025): 104426.; Amour, Frédéric, et al. "Accounting for chemical impacts on mechanical properties in coupled simulations of CO₂ injection into a depleted chalk field." *International Journal of Greenhouse Gas Control* 141 (2025): 104324.; Nick, H. M., et al. "Site-Specific Assessment of CO₂ Storage Potential in Chalk: The Harald East Experience." *SPE*, 2025.

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Contribution Type: Oral Presentation

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Abstract ID : 524

Osmotic Compression–Driven Zeolite Formation: In Situ Monitoring of Gel-to-Crystal Transition by ^1H NMR Relaxometry

Content

Zeolites are crystalline aluminosilicates with high porosity and tunable surface properties, widely used as catalysts, adsorbents, and ion exchangers. Their conventional hydrothermal synthesis, however, is energy-intensive and poorly suited for real-time monitoring of the gel-to-crystal transition [1]. In this work, we introduce an alternative, low-energy approach for zeolite synthesis based on osmotic compression of aluminosilicate gels.

By applying a controlled osmotic pressure gradient using polyethylene glycol (PEG) solution across a semi-permeable membrane, water is extracted from the gel, inducing gel shrinkage and subsequent crystallization at room temperature [2]. To probe the kinetics of water transport and gel-to-crystal transformation, we developed a non-invasive time resolved in situ monitoring strategy using ^1H NMR relaxometry.

A custom-designed, 3D-printed miniaturized osmotic cell compatible with NMR measurements enables the real-time acquisition of the transversal relaxation time T_2 relaxation distributions [3]. These distributions provide quantitative information on water populations (free vs. bound) and their evolution during osmotic stress. Our results reveal a clear correlation between gel shrinkage, T_2 decay, and zeolite formation, confirming that proton NMR relaxation is a sensitive probe of structural evolution during osmotic compression.

This methodology establishes a novel, energy-efficient, and physically insightful route for zeolite synthesis and opens prospects for monitoring and controlling phase transitions in colloidal or gel-based materials under osmotic confinement.

Keywords: Low-field NMR, NMR relaxometry, variable-field relaxometry, water dynamics, silicate solutions, colloidal gels, drying, porous media, non-equilibrium processes.

References

- [1] Rodrigues, D.; Keshavarz, B.; Courtois, N.; Ilavskij, J.; McKinley, G.; Poulesquen, A.; Aluminosilicate colloidal gels: from the early age to the crystallization of zeolite. *Soft Matter*, 2024, 20, pp.5538. <https://doi.org/10.1039/d4sm00181h>. [2] Keita, C.; Yannick, H.; Salmon, J.B.; Microfluidic osmotic compression of a charge-stabilized colloidal dispersion: Equation of state and collective diffusion coefficient. *Physical Review E*, 2021, 104 (6), <https://doi.org/10.1103/PhysRevE.104.L062601>. [3] Maillet, B.; Sidi-Boulenouar, R.; Coussot, P. Dynamic NMR Relaxometry as a Simple Tool for Measuring Liquid Transfers and Characterizing Surface and Structure Evolution in Porous Media. *Langmuir* 2022, 38 (49), 15009–15025. <https://doi.org/10.1021/acs.langmuir.2c01918>.

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Contribution Type: Oral Presentation

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Abstract ID : 525

Methane Cracking in Metal Porous Media via Electromagnetic Induction Monolithic Heating

Content

Methane Cracking in Metal Porous Media via Electromagnetic Induction Monolithic Heating
Zhuoran Wei, Qinwen Deng, Yong Shuai, Ruming Pan *School of Energy Science and Engineering, Harbin Institute of Technology, Harbin, 150001, China* Corresponding author: ruming.pan@hit.edu.cn

Methane cracking is a promising route for low-carbon hydrogen production, as it avoids direct CO₂ emissions associated with conventional steam reforming. However, its practical implementation is constrained by inefficient heat transfer and high pressure drop in high-temperature reactors. Metal porous media combined with electromagnetic induction heating offer a potential solution by enabling volumetric, contactless heating and enhanced heat transfer. This work presents methane cracking in metal porous media under electromagnetic induction monolithic heating, with an emphasis on coupled heat transfer and flow behavior.

An equivalent porous-medium modeling framework is developed to describe the multiphysical interactions in induction-heated metal foams. Figure 1 shows that electromagnetic induction heating provides a more uniform temperature distribution compared to conventional boundary heating. This work provides a general tool for induction-heated porous reactors applied to methane cracking and related high-temperature chemical vapor deposition processes.

References

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Contribution Type: Oral Presentation

Submitted by 魏, 卓然 <2938208125@qq.com> on **Monday 5 January 2026**

Abstract ID : 532

Hysteresis, Trapping, and Wettability Effects in Underground Hydrogen Storage: A Pore-to-Field-Scale Comparative Study

Content

Underground hydrogen storage (UHS) in porous geological formations is emerging as a critical technology for balancing renewable energy supply and demand. Although hydrogen storage shares operational similarities with natural gas storage, hydrogen's distinct physical properties lead to fundamentally different multiphase flow behaviour, particularly with respect to capillary trapping and relative permeability hysteresis. Hydrogen losses due to residual trapping during cyclic injection and withdrawal remain a major source of uncertainty in storage efficiency, yet most field-scale simulations rely on conventional hysteresis models that assume strongly water-wet conditions and monotonic trapping behaviour.

In this study, we present a complete and reproducible pore-scale-to-field-scale implementation workflow for the wettability-dependent relative permeability hysteresis model proposed by Spiteri et al., enabling systematic assessment of hydrogen trapping across a wide range of wettability conditions. The model is implemented within the Open Porous Media (OPM) hysteresis framework and integrated into the OPM Flow reservoir simulator, with additional verification performed using the QASR simulator. Numerical formulations are adapted to ensure stability and smooth transitions during repeated flow reversals typical of seasonal hydrogen storage operations.

Model parameters are calibrated using pore-network simulations based on high-resolution micro-CT images of Berea sandstone. Gas-water injection cycles are simulated under strongly water-wet, weakly water-wet, and mixed-wet conditions to derive initial-residual saturation relationships and scanning relative permeability curves. The calibrated Spiteri parameters capture non-monotonic trapping behaviour observed at the pore scale, which cannot be reproduced using conventional Land-based hysteresis models.

Field-scale simulations are conducted using a heterogeneous aquifer model derived from the PUNQ-S3 sector model. Four hysteresis scenarios—no hysteresis, Killough, Carlson, and Spiteri—are evaluated over multiple injection-withdrawal cycles. Results show that wettability exerts a first-order control on hydrogen trapping and recovery. Traditional hysteresis models fail to represent residual trapping under weakly water-wet and mixed-wet conditions, whereas the Spiteri model reproduces the non-monotonic trapping trends identified in pore-scale simulations.

This work bridges pore-scale physics and reservoir-scale performance, providing practical guidance for hysteresis model selection in UHS simulations. By enabling wettability-dependent hysteresis within open-source reservoir simulators, the study improves the predictive capability of UHS assessments and supports more reliable design and operation of large-scale hydrogen storage projects.

References

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Track Classification: MS01 - (MS01) Porous Media for a Green World: Energy & Climate

Contribution Type: Oral Presentation

Submitted by **ALOB Aidan, Ibrahim** <ibrahim.alobaidan@hotmail.com> on **Monday 5 January 2026**

Abstract ID : 557

Pore-scale investigation of steady-state relative permeability of hydrogen and carbon dioxide in water-wet carbonate rocks

Content

High-resolution three-dimensional X-ray microtomography was employed to investigate the steady-state relative permeability and pore-scale flow behavior of hydrogen (H_2) and carbon dioxide (CO_2) in a water-wet reservoir carbonate rock under subsurface conditions. This study extends previous pore-scale investigations of gas distribution, connectivity, and rearrangement by directly quantifying relative permeability using a steady-state fractional flow approach while simultaneously imaging fluid configurations within the same pore system.

The experiment was conducted using a steady-state fractional flow methodology at a pressure of 8 MPa and a temperature of 50 °C, representative of subsurface reservoir conditions. Brine and gas were co-injected under capillary-dominated flow across a wide range of fractional flow states, from single-phase brine injection to gas-dominated flow. A contrast-enhanced brine was used to enable accurate phase identification, and three-dimensional images were acquired at steady state for each fractional flow condition. Relative permeability was calculated from measured pressure gradients and flow rates, while segmented images were analyzed to quantify phase saturation, pore occupancy, gas connectivity, ganglia size distribution, and capillary pressure derived from interfacial curvature.

The results reveal systematic differences in the relative permeability behavior of H_2 and CO_2 . For both gases, gas relative permeability remained low over most of the fractional flow range, reflecting strong capillary control and limited gas mobility in the water-wet carbonate pore space. However, H_2 exhibited slightly higher gas mobility at low water fractional flow compared to CO_2 , consistent with its lower density and viscosity.

Pore-scale imaging demonstrated that both gases preferentially occupied larger pores and throats during steady-state flow. Nevertheless, H_2 formed more connected gas pathways, whereas CO_2 was distributed in more stable but less connected configurations. Capillary pressure measurements derived from interfacial curvature were consistent with these observations, highlighting reduced remobilization of CO_2 relative to H_2 .

These findings provide a direct pore-scale comparison of steady-state relative permeability and flow behavior of H_2 and CO_2 in carbonate rocks. The enhanced mobility and connectivity of H_2 support efficient gas withdrawal during cyclic underground hydrogen storage, while the reduced mobility of CO_2 are favorable for long-term geological sequestration. The results offer important pore-scale constraints for reservoir-scale simulations and contribute to the design and optimization of subsurface gas storage strategies relevant to energy transition and climate mitigation.

References

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Presenter: ALZAABI, Ahmed

Track Classification: MS01 - (MS01) Porous Media for a Green World: Energy & Climate

Contribution Type: Oral Presentation

Submitted by **ALZAABI, Ahmed** <ahmedalzaabi99@hotmail.com> on **Monday 5 January 2026**

Abstract ID : 571

Influence of diagenesis on reservoirs rock parameters and extent of H₂-rock reaction during subsurface storage: Insights from petrophysical and geochemical laboratory experiments.

Content

To meet the forecast demand for underground hydrogen storage, additional storage capacity in salt caverns and porous rock-formations will be needed (IEA, 2023). The reactivity of molecular hydrogen can trigger different geochemical processes in porous storage formations, for example the reduction of Fe(III) in hematite (Fe₂O₃) to Fe(II) (Hydrogen-TCP, 2023). Due to the heterogeneous nature of porous rock formations uncertainty regarding the impact of these processes remains. Here we present results of detailed petrophysical and petrographic characterization and geochemical laboratory experiments of Triassic sandstones from a former gas reservoir and underground gas storage site in Germany. The mainly red-brown colored sandstone is primarily composed of quartz grains and subordinate feldspar grains, both with hematite coatings, and partly pore-filling cements and clay cutans. But within the investigated 5 m reservoir section, some decimeter scale intervals are bleached to grey-beige as a result of different diagenetic influences. The aim of the study is to characterize the transport and storage properties as well as to quantify the extent of hydrogen-rock reactions for these two distinctly different appearances within the formation. Petrophysical results show different poro-perm characteristics between the red-brown and the bleached sandstone. Samples of the red-brown sandstone show higher porosity but lower permeability than samples from the bleached sections. Batch experiments with powdered sandstone samples from both intervals, synthetic saline formation water and hydrogen at a partial pressure of 10 MPa at 120°C and 20 MPa confining pressure show significant, but minor amounts of H₂ being oxidized during the 14 days experiment for both the red-brown and bleached sandstone. This was counterintuitive as we expected to see more H₂ oxidation by the hematite-rich red-brown sandstone. Petrographic investigations combined with Raman analyses revealed that iron-bearing grain coatings in the red-brown sandstone are mostly overgrown with quartz and plagioclase cements. These results indicate that, diagenetic bleaching, probably caused by migration of reducing fluids (Aehnelt et al., 2021), led to improved permeability while porosity was reduced, e.g. due to cement precipitation. The presence of reactive Fe(III) in the unbleached facies does not increase H₂-mineral reactions, indicating that the quartz overgrowth of hematite-coatings protects Fe(III) from reacting with hydrogen. Thus in the studied formation, accessibility to reactive mineral surfaces (here hematite) is a controlling factor that can limit H₂-rock reactions.

References

- IEA (2023) Global Hydrogen Review 2023. Available at: <https://www.iea.org/reports/global-hydrogen-review-2023>
- Hydrogen-TCP-Task-42 (2023) Underground Hydrogen Storage: Technology Monitor Report. International Energy Agency - Hydrogen TCP, p. 153. Available at: https://www.ieahydrogen.org/wpfd_file/2023_report_task-42_technology-monitor-report-underground-hydrogen-storage_h2tcp/.
- Aehnelt, M. et al. (2021) "On the origin of bleaching phenomena in red bed sediments of Triassic Buntsandstein deposits in Central Germany," *Geochemistry*, 81(2), p. 125736. Available at: <https://doi.org/10.1016/j.chemer.2020.125736>.

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Track Classification: MS01 - (MS01) Porous Media for a Green World: Energy & Climate

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Submitted by **WENIGER, Philipp** <philipp.weniger@bgr.de> on **Monday 5 January 2026**

Abstract ID : 610

Assessing geothermal reservoir deformation and hydro-mechanical behavior through numerical modeling informed by borehole pressure and injection data

Content

Geothermal energy represents a clean, renewable, and sustainable source of power that relies on heat stored at depth within the earth. The safe and efficient exploitation of geothermal resources requires a detailed understanding of subsurface fluid flow, pressure evolution, and the associated mechanical response of the reservoir and surrounding geological structures.

This study focuses on the Geoven geothermal project, a deep geothermal system located north of Strasbourg, France, which exploits heat from the Robertsau fault zone. However, operations were suspended by regulatory authorities following a sequence of induced seismic events that occurred during well activities, highlighting the need for improved understanding of the coupled processes governing pressure evolution, deformation, and seismic response within the reservoir.

The objective of this work is to develop a robust numerical model capable of capturing the dynamic response of the Geoven geothermal reservoir during injection and pumping operations. The modeling approach integrates pressure and flow-rate time-series data collected during operation into a coupled numerical framework that accounts for fluid flow, reservoir deformation, and injection-induced variations in hydro-mechanical properties. The model is designed to describe how pressure perturbations propagate through the reservoir and how geological factors, such as spatial variations in rock permeability and fault-related processes, influence system behavior.

The modeling strategy begins with a simplified representation assuming homogeneous reservoir properties, which successfully reproduces a large portion of the observed pressure response. The framework is then progressively refined by incorporating spatial heterogeneity in hydraulic properties away from the wells, reflecting more realistic subsurface conditions. In addition, the model considers the influence of seismic and post-seismic processes, represented through additional pressure contributions that affect transient pressure evolution within the system.

The results demonstrate that even a relatively simple numerical model can reliably reproduce observed pressure behavior during injection. The analysis further indicates that accounting for pressure sources associated with seismic and post-seismic effects is essential for accurately matching the measured pressure signals. These processes play a significant role in controlling the short and long term pressure response of the geothermal reservoir.

Overall, this work enhances the understanding of coupled hydro-mechanical processes in fault-controlled geothermal systems and contributes to the development of more reliable geothermal reservoir models. The findings support improved reservoir characterization, risk assessment, and operational planning, thereby facilitating the safe and sustainable deployment of geothermal energy resources.

References

Country

France

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Track Classification: MS01 - (MS01) Porous Media for a Green World: Energy & Climate

Contribution Type: Oral Presentation

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Abstract ID : 614

Consequences of Low Gas Relative Permeability on Field-Scale CO₂ Storage and Oil Recovery

Content

In the presence of mobile water, recent experimental results and pore-scale analysis have suggested that the gas relative permeability in gas–oil systems can be very low in mixed-wet or oil-wet rocks. In this study, we investigate how three-phase relative permeability affects field-scale behavior. We show that the use of different relative permeability models provide significantly different predictions of multiphase flow properties, which in turn affects both oil recovery and CO₂ storage capacity. We demonstrate that using physically-valid low gas relative permeabilities improves the predicted storage capacity and that the injection of water is not needed to trap or immobilize CO₂.

References

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Track Classification: MS01 - (MS01) Porous Media for a Green World: Energy & Climate

Contribution Type: Oral Presentation

Submitted by **ARIYARIT, Oranan** <oranan.ariyarit14@imperial.ac.uk> on **Monday 5 January 2026**

Abstract ID : 620

Gas diffusion and permeability in dry and partially saturated industrial concrete

Content

Gas production is expected in radioactive-waste disposal structures as a result of metal corrosion, leading to a slow increase in gas pressure within engineered barriers. It is essential to investigate gas migration mechanisms at low pressures. In this study, gas permeability and gas diffusion coefficients of an industrial concrete considered for radioactive-waste repository were measured. Diffusion tests were conducted on dry samples using a dedicated experimental device, and diffusion coefficients were directly determined with the use of Fick's first law. The relative contributions of diffusion- and permeation-driven gas flow were evaluated. The results clearly show that gas diffusion in dry samples dominates gas transfer at very low pressure gradient, whereas permeation becomes predominant once the gas pressure exceeds a moderate value. Tests on partially saturated samples further indicate that gas transport is no longer governed solely by the pressure gradient, but is also influenced by the degree of saturation and capillary effects.

References

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Contribution Type: Oral Presentation

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Abstract ID : 621

Impact of pore size distribution in the membrane of polymer electrolyte fuel cells (PEMFCs) on its pressure drop, and mass transport

Content

Recently, proton exchange membrane fuel cells (PEMFCs) have attracted increasing attention due to their potential for sustainable energy production [1]. PEMFCs are considered a compelling choice due to their rapid start-up, high energy conversion efficiency, and minimal environmental impact [2]. However, to promote their usability, careful thermal and water management is necessary to sustain their performance and durability [3]. The membrane, typically composed of Nafion, exhibits a porous nanostructure where the pore size distribution (PSD) plays a critical role in governing coupled heat and mass transport [4].

Several studies have focused on modeling of water transport and diffusivity in porous media of PEMFC. Chaudhary et al. [5] modeled water uptake in the membrane of PEMFC, considering a two-phase flow of water and water vapor, using two different approaches for water uptake. Dou et al. [6] modeled water distribution in the cathode catalyst layer (CCL) of PEMFC. The results showed a significant effect of wetting conditions on the distribution of condensed water, with the hydrophilic CCL being more susceptible to flooding. Song et al. [7] reconstructed a pore-scale model to study interparticle transport and electrochemical reactions in CCL. At high Nafion concentration, the distribution of proton current density at the Pt/Nafion interface is adequate and even. Zhang et al. [8] conducted a pore network modeling (PNM) study on GDL. The results indicate that porosity significantly affects fluid transport, whereas water inlet pressure is primarily influenced by wettability.

In this work, we employ transient, single-phase computational fluid dynamics (CFD) modeling to analyze the effect of pore size variations on the mass transport in the Nafion membrane. To this end, three different synthesized porous media structures with varying pore-size distributions will be prepared as representative volume elements (RVE). Then, the mass transfer inside such a medium will be examined, using the Navier-Stokes equations. The model considers water transfer inside the porous media with varying pore sizes and inlet fluid velocity. In addition, the pressure drops as the fluid moves in this region will be examined.

Results will include a correlation between the PSD and liquid-phase transfer. Additionally, the analyses will elucidate the relationships among PSD, inlet velocity, and pressure drop within the membrane. Intuitively, the pressure drop would be directly proportional to the inlet velocity, meaning that higher inlet velocities correspond to larger pressure drops. We believe that larger pores can promote water diffusivity, and a broader PSD may be more preferred for mass transfer in the membrane section of PEMFCs. These findings will highlight the potential trade-off between PSD and the pressure drop in PEM membranes and provide design guidelines for engineering next-generation membranes with tailored pore architectures. The study will establish a framework for modeling porous polymer electrolytes, enabling optimization of structural parameters to balance durability and performance in PEMFC applications.

References

- [1] M. Rayhani, C. Jian, A review of molecular dynamic simulation on polymer electrolyte membrane fuel cell, *J Power Sources* 657 (2025) 238143. <https://doi.org/https://doi.org/10.1016/j.jpowsour.2025.238143>.

- [2] H. Zhang, X. Shao, Z. Zhan, M. Sarker, P.-C. Sui, P.-Y.A. Chuang, M. Pan, Pore-Scale Modeling of Microporous Layer for Proton Exchange Membrane Fuel Cell: Effective Transport Properties, *Membranes (Basel)* 13 (2023) 219. <https://doi.org/10.3390/membranes13020219>. [3] A. Kopanidis, A. Theodorakakos, M. Gavaises, D. Bouris, Pore scale 3D modelling of heat and mass transfer in the gas diffusion layer and cathode channel of a PEM fuel cell, *International Journal of Thermal Sciences* 50 (2011) 456–467. <https://doi.org/https://doi.org/10.1016/j.ijthermalsci.2010.11.014>. [4] T. Berning, On the nature of electro-osmotic drag, *Energies (Basel)* 13 (2020). <https://doi.org/10.3390/en13184726>. [5] S. Chaudhary, V.K. Sachan, P.K. Bhattacharya, Two dimensional modelling of water uptake in proton exchange membrane fuel cell, *Int J Hydrogen Energy* 39 (2014) 17802–17818. <https://doi.org/https://doi.org/10.1016/j.ijhydene.2014.09.187>. [6] S. Dou, L. Hao, H. Liu, Effects of liquid water on the pore structure and transport coefficients in the cathode catalyst layer of PEM fuel cells, *Int J Hydrogen Energy* 47 (2022) 41138–41153. <https://doi.org/https://doi.org/10.1016/j.ijhydene.2022.09.187>. [7] H. Song, X. Shao, H. Zhang, P. Jiang, X. Wen, Z. Zhan, Effects of Nafion content in the catalyst layer of PEMFC on the transport phenomenon among nanoscale particles, *Int J Hydrogen Energy* 67 (2024) 282–293. <https://doi.org/10.1016/J.IJHYDENE.2024.01.014>. [8] N. Zhang, W. Chen, H. Zhou, Q. Deng, B. Chen, Pore-scale modeling of gas diffusion layers: Investigation of gas-liquid two-phase transport properties, *Int J Heat Mass Transf* 230 (2024) 125775. <https://doi.org/https://doi.org/10.1016/j.ijheatmasstransfer.2024.125775>.

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Contribution Type: Oral Presentation

Submitted by **RAYHANI, Mahsheed** <mah6iid@yorku.ca> on **Monday 5 January 2026**

Abstract ID : 635

CO₂ Migration and Trapping in Deep-Marine Fan Systems

Content

Deep-marine basin floor systems are promising candidates for geological CO₂ storage due to their large capacity and complex stratigraphy. On the Norwegian Continental Shelf, several exploration licenses for CO₂ storage target such systems, including complex fan systems serving as a key stratigraphic trap. These systems consist of layers of sand deposited by underwater channels and lobes that shifted over time; one example of this is the Frigg-Heimdal reservoir system in the North Sea. Uncertainty in sedimentary architecture, facies distribution, and connectivity poses challenges for predicting plume migration and trapping efficiency, as well as in understanding how depositional heterogeneity influences CO₂ migration and trapping.

To address these uncertainties, we employ high-fidelity reservoir simulations using an analogue model derived from the Karoo outcrop. This approach enables systematic investigation of how depositional heterogeneity influences CO₂ migration and trapping. We define scalable concepts to describe migration patterns and trapping efficiency and evaluate simplified modeling approaches.

Our analysis demonstrates the important impact of depositional heterogeneity in CO₂ storage performance. Variations in facies properties and capillary behavior influence plume migration, and the results highlight the relevance of fine-scale heterogeneity for predicting migration patterns in complex fan systems. Through systematic evaluation of different configurations and parameter sensitivities, we identify relationships that can inform simplified modeling approaches and accelerate simulation workflows.

This work provides insights into heterogeneity controls on CO₂ storage and establishes concepts that support scalable modeling strategies for complex geological settings. The findings contribute to improved uncertainty management and the development of robust workflows for predicting storage security in deep-marine depositional systems.

References

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Track Classification: MS01 - (MS01) Porous Media for a Green World: Energy & Climate

Contribution Type: Oral Presentation

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Abstract ID : 638

The combined effects of pressure decline and gas withdrawal in underground hydrogen storage: A pore-scale experimental study

Content

We investigate how pressure decline interacts with displacement at the pore scale in a water-wet Bentheimer sandstone at 4 MPa and 23 °C, representing underground hydrogen storage in saline aquifers. Brine was injected at 0.01 and 0.05 ml/min while a programmed outlet pressure decline rate of 1 kPa/min was applied. Two initial states were tested: high hydrogen gas saturation ($S_g = S_{gi}$), representative of regions above the gas-water contact (GWC), and residual gas saturation ($S_g = S_{gr}$), representative of conditions below the GWC. We used micro-CT imaging at 9.6 $\mu\text{m}/\text{voxel}$ to analyse the gas distribution and connectivity at different pressure drops, and to determine the pore scale displacement type when pressure decline is combined with a constant brine influx.

The results show that capillary pressure increased during withdrawal, leading to drainage displacement at the pore scale, even though brine was injected. We observed an increase in gas saturation by expansion, where the capillary pressure increased due to the reduction in brine pressure. Large ganglia were connected to the outlet and produced by expansion. When pressure decline began at S_{gr} , the gas saturation increased approximately in proportion to the pressure drop (e.g., 8% saturation increase for a pressure drop of 7.5% pressure). Starting pressure decline at S_{gi} resulted in larger residual gas clusters and a higher degree of connectivity. When large gas clusters were connected to the outlet, the expanded volume fraction was notably lower than the fractional pressure drop because part of the gas was produced by expanding towards the outlet. The maximum gas saturation reached was 0.55, and no apparent gas pathway was connected from the inlet to the outlet. No displacement of the gas via imbibition was seen during pressure decline despite the high gas saturation.

These observations suggest that under continuous pressure decline, local capillary pressure can increase, preventing imbibition displacement of gas by water. This makes the interpretation of laboratory experiments to find the critical gas saturation challenging. Gas production occurs primarily through expansion-driven drainage rather than through normal displacement.

References

- Al-Masri, W., & Shapiro, A. (2021). Experimental determination of relative permeabilities and critical gas saturations under solution-gas drive. *Journal of Petroleum Science and Engineering*, 202. <https://doi.org/10.1016/j.petrol.2021.108509>
- Alobaidan, I. A., Bijeljic, B., & Blunt, M. J. (2025). Drive mechanisms and hydrogen recovery in underground storage: a material balance and simulation approach. *International Journal of Hydrogen Energy*, 146. <https://doi.org/10.1016/j.ijhydene.2025.06.081>
- Al-Yaseri, A., Esteban, L., Yekeen, N., Giwelli, A., Sarout, J., & Sarmadivaleh, M. (2023). The effect of clay on initial and residual saturation of hydrogen in clay-rich sandstone formation: Implications for underground hydrogen storage. *International Journal of Hydrogen Energy*, 48(13), 5175–5185. <https://doi.org/10.1016/j.ijhydene.2022.11.059>
- Andrew, M., Bijeljic, B., & Blunt, M. J. (2014). Pore-scale contact angle measurements at reservoir conditions using X-ray microtomography. *Advances in Water Resources*, 68, 24–31. <https://doi.org/10.1016/j.advwatres.2014.02.014>
- Bagudu, U., McDougall, S. R., & Mackay, E. J. (2018). Network modelling analysis of a depressurization experiment on a North Sea reservoir core sample. *Journal of Petroleum Science and Engineering*, 162, 63–75. <https://doi.org/10.1016/j.petrol.2017.11.036>
- Baldwin, C. A., Sederman, A. J., Mantle, M.

- D., Alexander, P., & Gladden, L. F. (1996). Determination and characterization of the structure of a pore space from 3D volume images. *Journal of Colloid and Interface Science*, 181(1), 79–92. <https://doi.org/10.1006/jcis.1996.0358>
- Berg, S., Gao, Y., Georgiadis, A., Brussee, N., Coorn, A., Van der Linde, H., Dietderich, J., Alpak, F. O., Eriksen, D., Mooijer-van den Heuvel, M., Southwick, J., Appel, M., & Wilson, O. B. (2020). Determination of Critical Gas Saturation by Micro-CT. *Petrophysics –The SPWLA Journal of Formation Evaluation and Reservoir Description*, 61(2), 133–150. <https://doi.org/10.30632/PJV61N2-2020a1>
- Brown, K., Schlüter, S., Sheppard, A., & Wildenschild, D. (2014). On the challenges of measuring interfacial characteristics of three-phase fluid flow with x-ray microtomography. *Journal of Microscopy*, 253(3), 171–182. <https://doi.org/10.1111/jmi.12106>
- Caglayan, D. G., Weber, N., Heinrichs, H. U., Linßen, J., Robinius, M., Kukla, P. A., & Stolten, D. (2020). Technical potential of salt caverns for hydrogen storage in Europe. *International Journal of Hydrogen Energy*, 45(11), 6793–6805. <https://doi.org/10.1016/j.ijhydene.2019.12.161>
- Dokhon, W., AlZaabi, A., Bijeljic, B., & Blunt, M. J. (2025). Micro-CT imaging of drainage and spontaneous imbibition for underground hydrogen storage in saline aquifers. *Advances in Water Resources*, 204, 105064. <https://doi.org/10.1016/j.advwatres.2025.105064>
- Dokhon, W., Goodarzi, S., Alzahrani, H. M., Blunt, M. J., & Bijeljic, B. (2024). Pressure decline and gas expansion in underground hydrogen storage: A pore-scale percolation study. *International Journal of Hydrogen Energy*, 86, 261–274. <https://doi.org/10.1016/j.ijhydene.2024.08.139>
- Drummond, A., Fishlock, T., Naylor, P., & Rothkopf, B. (2001). An Evaluation of Post-Waterflood Depressurisation of the South Brae Field, North Sea. <http://onepetro.org/SPEATCE/proceedings-pdf/01ATCE/All-01ATCE/SPE-71487-MS/2937088/spe-71487-ms.pdf/1>
- Egermann, P., & Vizika, O. (2000). Critical gas saturation and relative permeability during depressurization in the far field and the near-wellbore region. *SPE Annual Technical Conference and Exhibition*. Gao, Y., Sorop, T., Brussee, N., Linde, H. van der, Coorn, A., Appel, M., & Berg, S. (2023). Advanced Digital-SCAL Measurements of Gas Trapped in Sandstone 1. *Petrophysics*, 64(3), 368–383. <https://doi.org/10.30632/PJV64N3-2023a4>
- Heinemann, N., Alcalde, J., Miocic, J. M., Hangx, S. J. T., Kallmeyer, J., Ostertag-Henning, C., Hassanpouryouzband, A., Thaysen, E. M., Strobel, G. J., Schmidt-Hattenberger, C., Edlmann, K., Wilkinson, M., Bentham, M., Stuart Haszeldine, R., Carbonell, R., & Rudloff, A. (2021). Enabling large-scale hydrogen storage in porous media-the scientific challenges. In *Energy and Environmental Science* (Vol. 14, Issue 2, pp. 853–864). Royal Society of Chemistry. <https://doi.org/10.1039/d0ee03536j>
- Higgs, S., Da Wang, Y., Da, Sun, C., Ennis-King, J., Jackson, S. J., Armstrong, R. T., & Mostaghimi, P. (2024). Direct measurement of hydrogen relative permeability hysteresis for underground hydrogen storage. *International Journal of Hydrogen Energy*, 50, 524–541. <https://doi.org/10.1016/j.ijhydene.2023.07.270>
- Jangda, Z., Menke, H., Busch, A., Geiger, S., Bultreys, T., Lewis, H., & Singh, K. (2023). Pore-scale visualization of hydrogen storage in a sandstone at subsurface pressure and temperature conditions: Trapping, dissolution and wettability. *Journal of Colloid and Interface Science*, 629, 316–325. <https://doi.org/10.1016/j.jcis.2022.09.082>
- Kamath, J., & Boyer, R. (1995). Critical Gas Saturation and Supersaturation in Low-Permeability Rocks. *SPE Formation Evaluation*, 247–253. <http://onepetro.org/FE/article-pdf/10/04/247/2604468/spe-26663-pa.pdf/1>
- Krevor, S., Blunt, M. J., Benson, S. M., Pentland, C. H., Reynolds, C., Al-Menhali, A., & Niu, B. (2015). Capillary trapping for geologic carbon dioxide storage - From pore scale physics to field scale implications. *International Journal of Greenhouse Gas Control*, 40, 221–237. <https://doi.org/10.1016/j.ijggc.2015.04.006>
- Lackey, G., Freeman, G. M., Buscheck, T. A., Haeri, F., White, J. A., Huerta, N., & Goodman, A. (2023). Characterizing Hydrogen Storage Potential in U.S. Underground Gas Storage Facilities. *Geophysical Research Letters*, 50(3). <https://doi.org/10.1029/2022GL101420>
- Miocic, J., Heinemann, N., Edlmann, K., Scafidi, J., Molaei, F., & Alcalde, J. (2023). Underground hydrogen storage: a review. *Geological Society, London, Special Publications*, 528(1), 73–86. <https://doi.org/10.1144/sp528-2022-88>
- Moghadasi, R., Foroughi, S., Goodarzi, S., Zhang, Y., Bijeljic, B., Blunt, M. J., & Niemi, A. (2025). Trapping and remobilization during geological CO₂ storage: A pore-scale imaging and modeling study. *Advances in Water Resources*, 205. <https://doi.org/10.1016/j.advwatres.2025.105092>

Mwakipunda, G. C., Franck Kouassi, A. K., Ayimadu, E. T., Komba, N. A., Nadege, M. N., Mgimba, M. M., Ngata, M. R., & Yu, L. (2025). Underground hydrogen storage in geological formations: A review. In *Journal of Rock Mechanics and Geotechnical Engineering*. Chinese Academy of Sciences. <https://doi.org/10.1016/j.jrmge.2025.02.014>

Peksa, A. E., Wolf, K. H. A. A., Slob, E. C., Chmura, L., & Zitha, P. L. J. (2017). Original and pyrometamorphical altered Bentheimer sandstone; petrophysical properties, surface and dielectric behavior. *Journal of Petroleum Science and Engineering*, 149, 270–280. <https://doi.org/10.1016/j.petrol.2016.10.024>

Peksa, A. E., Wolf, K. H. A. A., & Zitha, P. L. J. (2015). Bentheimer sandstone revisited for experimental purposes. In *Marine and Petroleum Geology* (Vol. 67, pp. 701–719). Elsevier Ltd. <https://doi.org/10.1016/j.marpetgeo.2015.06.001>

Petersen, E. B., Agaev, G. S., Palatnik, B., Ringen, J. K., Øren, P. E., & Vatne, K. O. (2004). Determination of critical gas saturation and relative permeabilities relevant to the depressurization of the Statfjord Field. *Raeesi, B., Morrow, N. R., & Mason, G. (2014). Capillary Pressure Hysteresis Behavior of Three Sandstones Measured with a Multistep Outflow–Inflow Apparatus. Vadoso Zone Journal*, 13(3), 1–12. <https://doi.org/10.2136/vzj2013.06.0097>

Ruprecht, C., Pini, R., Falta, R., Benson, S., & Murdoch, L. (2014). Hysteretic trapping and relative permeability of CO₂ in sandstone at reservoir conditions. *International Journal of Greenhouse Gas Control*, 27, 15–27. <https://doi.org/10.1016/j.ijggc.2014.05.003>

Sun, X., Zhang, Y., Wang, S., Song, Z., Li, P., & Wang, C. (2018). Experimental study and new three-dimensional kinetic modeling of foamy solution-gas drive processes. *Scientific Reports*, 8(1). <https://doi.org/10.1038/s41598-018-22669-z>

Talukdar, M., Blum, P., Heinemann, N., & Miocic, J. (2024). Techno-economic analysis of underground hydrogen storage in Europe. *IScience*, 27(1). <https://doi.org/10.1016/j.isci.2023.108771>

Zhu, Z., Cao, Y., Zheng, Z., & Chen, D. (2022). An Accurate Model for Estimating H₂ Solubility in Pure Water and Aqueous NaCl Solutions. *Energies*, 15(14). <https://doi.org/10.3390/en15145021>

Zivar, D., Kumar, S., & Foroozesh, J. (2021). Underground hydrogen storage: A comprehensive review. *International Journal of Hydrogen Energy*, 46(45), 23436–23462. <https://doi.org/10.1016/j.ijhydene.2020.08.138>

Zuo, L., Krevor, S., Falta, R. W., & Benson, S. M. (2012). An Experimental Study of CO₂ Exsolution and Relative Permeability Measurements During CO₂ Saturated Water Depressurization. *Transport in Porous Media*, 91(2), 459–478. <https://doi.org/10.1007/s11242-011-9854-2>

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Presenter: Mr DOKHON, Waleed (Imperial College of London)

Track Classification: MS01 - (MS01) Porous Media for a Green World: Energy & Climate

Contribution Type: Oral Presentation

Comments:

While the work does not address housing materials directly, it investigates hydrogen flow and trapping in porous media relevant to large-scale underground hydrogen storage. Such storage is a key enabling technology for low-carbon energy systems that support green housing and sustainable residential energy supply.

Submitted by **DOKHON, Waleed** <waleed.dokhon21@imperial.ac.uk> on **Monday 5 January 2026**

Abstract ID : 643

Pore-Scale Experimental and Pore Network Modeling Study of CO₂ Injection in Microfluidic Porous Media

Content

The increasing rate of CO₂ emissions into the atmosphere as a result of energy production and consumption raises global concerns for climate stability and human well-being. For this reason, actions to mitigate gas emissions have attracted the attention of global organizations and are becoming increasingly relevant in view of their potential positive impacts on the planet's climate. Among the techniques capable of reducing net carbon emissions related to human activities, Carbon Capture and Storage (CCS) involves capturing the CO₂ resulting from the activity before it is released into the atmosphere and storing it in geological formations, typically saline aquifers, where it remains trapped for long periods.

In this work, we compare experimental results of CO₂ injection with numerical predictions obtained from a Pore Network Model (PNM) representation of the experimental setup. The experiment considers a microfluidic device initially saturated with brine. During the injection process, high-pressure CO₂ is introduced into the device, displacing its brine content. Invasion order, capillary trapping and relative permeability curves are analyzed and compared between experimental observations and PNM simulations.

The results demonstrate the capability of the PNM to accurately reproduce the key physical mechanisms governing two-phase flow during CO₂ injection in microfluidic porous media. This agreement highlights the potential of pore-scale modeling as a reliable tool for interpreting experimental results and improving the understanding of CO₂ sequestration processes relevant to CCS applications.

References

Country

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Contribution Type: Oral Presentation

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Abstract ID : 653

Multicomponent Gas Ripening and Redistribution during Underground Hydrogen Storage

Content

During underground hydrogen storage in aquifers and depleted gas fields, hydrogen commonly coexists with methane used as a cushion gas. In this context, it is important to understand how the distribution of the gas phase composition evolves over time in the reservoir, as this affects the recovery efficiency of the stored hydrogen. In these systems, the methane and hydrogen trapped in the system may still redistribute over time, due to gradual dissolution and diffusion of the gas components in the aqueous phase. This process, known as Ostwald ripening, alters the connectivity of the trapped gas phase, and typically leads to the dissolution of smaller gas bubbles and the growth of larger ones. Previous studies have extensively examined the Ostwald ripening of single-component gases in porous media; however, the behavior of multicomponent gas systems remains poorly understood [1], [2].

In this study, we investigate multicomponent gas ripening at the pore scale, by imaging the long-term redistribution of a trapped gas mixture in sandstone samples using time-lapse X-ray micro-CT imaging. Since characterizing the behavior of a methane-hydrogen gas mixtures in opaque porous media is challenging due to their limited contrast in X-ray imaging, we employ krypton and helium as proxy gases for which the composition can be quantified with X-ray micro-CT. At the start of the experiments, a 50–50% mixture of krypton and helium is prepared based on partial pressures and equilibrated with 25% KI brine in a reactor at pressure-temperature conditions which represent hydrogen storage in shallow aquifers (4 MPa, 25–35°C). The gas mixture then is trapped within the porous medium through sequential drainage and imbibition cycles using the prepared gas mixture and brine, after which the sample is shut in and allowed to equilibrate. This experimental approach enables direct visualization of gas-phase composition evolution within the pore space under supercritical conditions and allows analysis of redistribution kinetics using helium as a proxy gas with diffusive properties similar to hydrogen.

Preliminary results confirm the suitability of helium as a representative for hydrogen and indicate a gradual, capillary-driven mass transfer process in which smaller gas bubbles dissolve and diffuse toward larger gas ganglia, ultimately leading to an equilibrium state. These findings provide new insights into long-term dynamics of gas-mixture following entrapment in porous media. The results are particularly relevant for natural gas reservoirs repurposed for hydrogen storage, and contribute to a better understanding of gas distribution, transport properties, and recovery efficiency in such systems.

References

- [1] S. Goodarzi, Y. Zhang, S. Foroughi, B. Bijeljic, and M. J. Blunt, 'Trapping, hysteresis and Ostwald ripening in hydrogen storage: A pore-scale imaging study', *Int. J. Hydrog. Energy*, vol. 56, pp. 1139–1151, Feb. 2024, doi: 10.1016/j.ijhydene.2023.12.029. [2] N. Bueno, L. Ayala, and Y. Mehmani, 'Ostwald ripening of multi-component bubbles in porous media: A theory and a pore-scale model of how bubble populations equilibrate', *Adv. Water Resour.*, vol. 182, p. 104581, Dec. 2023, doi: 10.1016/j.advwatres.2023.104581.

Country

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Track Classification: MS01 - (MS01) Porous Media for a Green World: Energy & Climate

Contribution Type: Oral Presentation

Submitted by **YOUNESIAN FARID, Hossein** <hossein.younesianfarid@ugent.be> on **Monday 5 January 2026**

Abstract ID : 677

Numerical Modeling of Natural Hydrogen Production in Porous Media

Content

Natural hydrogen, also referred to as white hydrogen, has recently gained attention as a low-carbon energy resource generated by geological processes in the subsurface. Field observations indicate that hydrogen-rich systems are commonly associated with ultramafic rocks, active fluid circulation, and serpentinization reactions. However, quantitative tools capable of linking hydrogen generation, transport, and accumulation in porous media remain limited. In this work, we present a numerical model that couples fluid flow, reactive transport, and evolving rock properties to investigate natural hydrogen production in serpentinizing systems.

The model represents a porous domain in which water reacts with olivine-bearing rocks at depth. Molecular hydrogen is generated through temperature-dependent oxidation of ferrous iron during serpentinization and subsequently migrates upward driven by buoyancy and pressure gradients. Hydrogen transport is described by advection, molecular diffusion, and mechanical dispersion, while fluid flow follows Darcy's law under a Boussinesq approximation to account for density variations induced by dissolved hydrogen.

A central aspect of the model is the dynamic coupling between geochemical reactions and the physical structure of the porous medium. As serpentinization progresses, consumption of reactive minerals leads to an increase in porosity, which in turn modifies permeability following a Kozeny–Carman relationship. This feedback mechanism directly affects flow pathways, reaction rates, and hydrogen migration efficiency, allowing the model to capture key hydro-chemo-mechanical interactions inherent to serpentinizing systems.

The governing equations are solved numerically with physically consistent boundary conditions representing axial symmetry, hydrostatic pressure at depth, and free hydrogen flux at the surface. Parametric studies explore the influence of temperature, initial porosity and permeability, reaction zone geometry, grain size, and kinetic parameters on hydrogen production rates and surface fluxes.

This computational framework provides a numerical tool for evaluating hydrogen production potential in serpentinization systems and can support exploration strategies for natural hydrogen resources. Future applications include scenario testing for different geological settings and integration with field data from known hydrogen-producing regions.

References

McCollom, T.M., Klein, F., et al. (2016). Temperature trends for reaction rates, hydrogen generation, and partitioning of iron during experimental serpentinization of olivine. *Geochimica et Cosmochimica Acta*, 181, 175-200. Klein, F., Bach, W., & McCollom, T.M. (2013). Compositional controls on hydrogen generation during serpentinization of ultramafic rocks. *Lithos*, 178, 55-69. Okamoto, A., Kataoka, K., & Matsumoto, K. (2021). Porosity evolution and hydrogen production during olivine-serpentine-magnetite reactions. *Earth and Planetary Science Letters*, 570, 117076. Maiga, O., Deville, E., et al. (2023). Characterization of the spontaneously recharging natural hydrogen reservoirs of Bourakebougou in Mali. *Scientific Reports*, 13(1), 11876.

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Abstract ID : 688

Influence of Local pH Gradients on Carbonate Precipitation in Multiphase Water-scCO₂ Systems: A microfluidic reactor study

Content

We investigate the combined influence of scCO₂-brine and mineral interfaces on local pH gradients and carbonate precipitation under diffusive conditions using microfluidic flow cells in a pressure reactor. The controlled studies will yield relationships for reactive transport modeling of scCO₂-driven precipitation in vesicular basalts and other reactive media. We hypothesize dissolution and diffusion of CO₂ in pore water will generate local pH gradients as a function of pore morphology and water saturation, especially in poorly-connected vesicles where snap-off phenomena trap bubbles and advective transport is minimal. Hence, in these dual-porosity systems there are pore-scale regions at a certain distance from scCO₂-brine interfaces and metal ion-sourcing mineral interfaces where pH is ideal for carbonate formation. In those regions, the concentration of dissolved CO₂ ions is high enough to form carbonate, but, critically, low enough to not over-acidify the fluid, rendering carbonates soluble. This hypothesis, termed “Goldilocks Zone”, was introduced by Shen et al. (ES&T, 2025) in pore-scale modeling of scCO₂ injection in sidewall cores from the Wallula Basalt CO₂ Injection Project conducted by PNNL.

To test this hypothesis, we isolate the impacts of scCO₂ diffusion and metal ion sourcing on spatial pH and mineralization behavior with diagnostic single-outlet microfluidic devices with embedded MgO crystal inclusions. The devices feature a simple Archimedean spiral channel or isolated reaction chambers bonded to a polished crystal substrate and are filled with buffered “formation fluid” and pressurized to 90 bars in a Parr vessel. The chamber headspace is filled with scCO₂, creating a scCO₂/brine interface at the channel’s entrance. Across the interface, CO₂ dissolves and diffuses down the channel, reacting with MgO and forming magnesium carbonates in hours to days.

We investigate precipitation behavior under different pH regimes by varying the initial buffering capacity of the fluid and determine pH computationally with 1D diffusion-reaction models in PHREEQC using reaction coefficients from literature. Post-reaction, the volume, morphology, and mineralogy of carbonate precipitants is analyzed with μ CT and microscopy as well as XRD, SEM, and Raman. Our results show a spatial preference of carbonate growth midway into the channel achieved through local pH-driven precipitation and re-dissolution of Mg-carbonates in different reaction stages, which supports our Goldilocks Zone hypothesis. The findings from this work will enhance the understanding of how flow regimes can be used to optimize precipitation behaviors in reactive reservoirs to enhance in situ mineralization or separations or to maintain accessibility.

References

Multiphase Flow Regime Controls Carbonate Precipitation Morphologies during CO₂ Injection in Subsurface Basalts. *Environ. Sci. Technol.* 2025, 59 (38), 20345–20356. <https://doi.org/10.1021/acs.est.5c03397>.

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Abstract ID : 700

Susceptibility analysis of underground CO₂ storage and its implications for aquifers, case study: Middle Magdalena Valley

Content

Carbon capture and sequestration (CCS) is a key strategy for mitigating climate change through the capture and long-term storage of carbon dioxide (CO₂), the most significant greenhouse gas, accounting for approximately 74.5% of global emissions. CCS projects involve the storage of CO₂ in both onshore and offshore geological formations and are being implemented worldwide, particularly in regions where the oil and gas industry plays a major economic and political role. In Colombia, CCS remains in a research and assessment stage, requiring preliminary evaluations of potential storage sites and their implications for groundwater resources.

Despite the country's abundance of surface water, its limited water quality increases the strategic importance of groundwater as a freshwater source. Consequently, assessing aquifer vulnerability to potential CO₂ leakage represents a critical component of CCS feasibility studies. The Middle Magdalena Valley (MMV) is one of Colombia's most productive hydrocarbon regions and hosts extensive groundwater systems associated with thick sedimentary deposits of the Magdalena River. In 2025, the MMV produced more than six million barrels of oil.

In this study, a simplified numerical model was implemented to simulate the migration of injected CO₂ over a 10-year period under a hypothetical storage scenario within a productive formation of the MMV. The model was designed as a first-order approximation to explore dominant flow behavior rather than to reproduce site-specific operational conditions. Results indicate a predominantly horizontal CO₂ migration pattern controlled by formation properties.

To evaluate potential impacts on groundwater, a susceptibility index was developed using raster map algebra. The susceptibility equation was constructed by integrating a subset of hydrological, hydrogeological and geological parameters identified in established CCS site characterization guidelines, selected based on data availability in the study area. The resulting susceptibility map classifies groundwater contamination vulnerability into distinct ranges, highlighting zones of increased vulnerability relevant for local water use and future CCS screening efforts.

References

- Agencia Nacional de Hidrocarburos. (2024). Co₂ Storage atlas in Colombia. Bogota: Agencia Nacional de Hidrocarburos. Retrieved from https://www.anh.gov.co/documents/29510/Atlas_CO2_Ingles_Interactivo.pdf
- Agencia Nacional de Hidrocarburos. (n.d.). Datos y estadísticas. Retrieved from Agencia Nacional de Hidrocarburos: <https://www.anh.gov.co/es/operaciones-y-regal%C3%ADas/datos-y-estadisticas/>
- Crippa, M., Guizzardi, D., Pagani, F., Banja, M., Muntean, M., Schaaf, E., . . . Pekar, F. (2025). GHG emissions of all world countries. Publications Office of the European Union. doi:<https://data.europa.eu/doi/10.2760/9816914>
- IEA Greenhouse Gas R&D Programme. (2009). CCS Site Characterisation Criteria. IEA Greenhouse Gas R&D Programme.

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Abstract ID : 709

Time-Resolved Pore-Scale Multiphase Flow Dynamics for CO₂ and Hydrogen Storage Using 4D Synchrotron Imaging

Content

Understanding pore-scale fluid dynamics is fundamental to optimising CO₂ and hydrogen geological storage strategies. Here, we present a comprehensive pore-scale investigation of reactive and non-reactive multiphase flow dynamics using 4D synchrotron X-ray imaging coupled with high-resolution microscale core-flooding experiments, enabling direct, time-resolved visualization of fluid displacement and pore-structure evolution within real rock samples.

In reactive transport experiments, CO₂ injection into carbonate rocks reveals dynamically evolving mineral dissolution, leading to pronounced pore-scale structural alteration and significant modification of capillary trapping behaviour. Time-resolved 3D imaging demonstrates that trapping efficiency in reactive environments is strongly controlled by the dynamic evolution of pore geometry, rather than by static rock properties alone.

For non-reactive two-phase flow, we systematically explore flow-regime transitions with increasing flow rate, progressing from classical Darcy-linear behaviour to a non-linear intermittent regime and, at higher velocities, to a previously unidentified near-linear intermittent flow regime. Despite persistent pore-scale intermittency, 4D synchrotron observations reveal an apparent re-linearisation of the macroscopic pressure–flow relationship, arising from changes in the spatiotemporal statistics of intermittent displacement events. Our experiments provide the first direct pore-scale visualization and quantitative characterization of this near-linear intermittent state.

These findings challenge the common assumption that non-linearity in two-phase porous media flow increases monotonically with flow rate and highlight limitations of conventional Darcy-based models under realistic storage conditions. By resolving both reactive pore evolution and non-reactive flow intermittency in four dimensions, this work advances fundamental understanding of multiphase transport and provides critical insights for improving predictive models and enhancing the safety and efficiency of subsurface CO₂ and hydrogen storage.

References

Country

United Kingdom

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Contribution Type: Oral Presentation

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Abstract ID : 711

Reactive Transport in Underground Gas Storage: Dissolution Patterns and Effective Reaction Rates in Single-Mineral, Multi-Mineral and Multiphase Media

Content

Reactive transport and multiphase flow in porous media are encountered in several important environmental applications such as carbon storage, hydrogen storage and use, and contaminant transport in hydrocarbon spills. Understanding of flow, transport and reaction processes in the subsurface has been transformed by the advances in X-ray imaging, image analysis and pore-scale modelling. It is an accurate experimental description of solid and fluid(s) distributions in the pore space along with the ability to study dynamics of multi-phase flow and reactive transport that has helped better grasp fundamental physics of these processes.

Traditional framework for prediction of dissolution patterns and reaction rates by Pe-Da diagrams (e.g. Golfier et al.(2003), Battiato and Tartakovsky (2011)) has been expanded by recognising the impact of (i) flow (hence transport) heterogeneity quantified by velocity and probability displacement distributions (Bijeljic et al, 2013) and (ii) injection rate in single-mineral media (Menke et al., 2016; Al-Khulaifi et al., 2018); (iii) mineral content and (iv) mineral distribution in multi-mineral media (Al-Khulaifi et al., 2019, Adedipe et al., 2025); and (v) hydrocarbon phase distribution and (vi) hydrocarbon phase remobilization in multiphase media (Ma et al., 2025). These determinants for dissolution patterns will be discussed in mass transfer limited and reaction limited regimes for which the impact of heterogeneity is the most profound, and illustrated by reservoir conditions experiments of supercritical CO₂ acidic brine injection into carbonate rock.

Novel concepts including: (i) Screening for Pore-scale Imaging and Modelling developed to determine and classify heterogeneity signatures (Al-Khulaifi et al. 2018), and (ii) Mineral Proximity Distributions (Al-Khulaifi et al. 2019) to fast flow channels developed to characterize coupled flow and reaction dynamics will be highlighted.

Furthermore, the significance of this work lies in expanding the knowledge on the scale dependence of mineral reaction rates (e.g. White and Brantley, 2003); Maher 2010). The effective reaction rates are found to be orders of magnitude lower than the corresponding intrinsic batch rates due to mass transfer limitations. Moreover, the changes in porosity, permeability, velocity field and transport behaviour as characterised by distributions, explain the impact of transport heterogeneity, mineral spatial distribution and presence of hydrocarbon phase on the effective dissolution rates in carbon-dioxide storage in aquifers and hydrocarbon reservoirs.

A further example that focuses on reactive flow coupling will show the measurements of steady-state relative permeability in presence of chemical reaction with the host rock (Chai et al. (2025). Both dissolution and precipitation can alter pore space thus altering the absolute and relative permeability characteristics of the medium.

Overall, the novel experimental and image analysis methodologies allowed us to study the next level of complexity including multimineral media and coupling of reactive transport and multiphase flow processes, which have now been the subjects for future work..

References

Golfier, F., Zarcone, C., Bazin, B., Lenormand, R., Lasseux, D., & Quintard, M. (2002). On the ability of a Darcy-scale model to capture wormhole formation during the dissolution of a porous medium. *Journal of fluid Mechanics*, 457, 213-254. Battiato, I., & Tartakovsky, D. M. (2011). Applicability regimes for macroscopic models of reactive transport in porous media. *Journal of contaminant*

hydrology, 120, 18-26. Bijeljic, B., Raeini, A., Mostaghimi, P., & Blunt, M. J. (2013). Predictions of non-Fickian solute transport in different classes of porous media using direct simulation on pore-scale images. *Physical Review E—Statistical, Nonlinear, and Soft Matter Physics*, 87(1), 013011.

Menke, H. P., Andrew, M. G., Blunt, M. J., & Bijeljic, B. J. C. G. (2016). Reservoir condition imaging of reactive transport in heterogeneous carbonates using fast synchrotron tomography—Effect of initial pore structure and flow conditions. *Chemical Geology*, 428, 15-26.

Al-Khulaifi, Y., Lin, Q., Blunt, M. J., & Bijeljic, B. (2018). Reservoir-condition pore-scale imaging of dolomite reaction with supercritical CO₂ acidified brine: Effect of pore-structure on reaction rate using velocity distribution analysis. *International Journal of Greenhouse Gas Control*, 68, 99-111.

Al-Khulaifi, Y., Lin, Q., Blunt, M. J., & Bijeljic, B. (2019). Pore-scale dissolution by CO₂ saturated brine in a multimineral carbonate at reservoir conditions: Impact of physical and chemical heterogeneity. *Water Resources Research*, 55(4), 3171-3193.

Adedipe, O. A., Al-Khulaifi, Y., Foroughi, S., Lin, Q., Blunt, M. J., & Bijeljic, B. (2025). Impact of Mineral Spatial Distribution on CO₂ Dissolution Rates in Multimineral Carbonate Rocks. *Authorea Preprints*. Ma, Q., Chai, R., Foroughi, S., Wang, Y., Blunt, M. J., & Bijeljic, B. (2025). Pore-Scale Dynamics of Multiphase Reactive Transport in Water-Wet Carbonates under CO₂-Acidified Brine Injection: Dissolution Patterns and Reaction Rates. *arXiv preprint arXiv:2509.18907*.

White, A. F., & Brantley, S. L. (2003). The effect of time on the weathering of silicate minerals: why do weathering rates differ in the laboratory and field?. *Chemical Geology*, 202(3-4), 479-506.

Maher, K. (2010). The dependence of chemical weathering rates on fluid residence time. *Earth and Planetary Science Letters*, 294(1-2), 101-110.

Chai, R., Ma, Q., Goodarzi, S., Yow, F. Y., Bijeljic, B., & Blunt, M. J. (2025). Multiphase Reactive Flow During CO₂ Storage in Sandstone. *Engineering*.

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Contribution Type: Oral Presentation

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Submitted by **BIJELJIC, Branko** <b.bijeljic@imperial.ac.uk> on **Tuesday 6 January 2026**

Abstract ID : 713

Hydrogen Wettability of Peridotite under Various Brine Compositions and Temperatures: Implications for Natural Hydrogen Accumulation and Underground Hydrogen Storage

Content

Natural hydrogen, as a clean and carbon-free energy carrier, plays an important role in the global energy transition and the low-carbon development of modern industries. However, the location of natural hydrogen reservoirs is difficult to predict, due to the lack of a targeted theoretical framework for exploration. Peridotite serpentinization serves as the primary mechanism for natural hydrogen generation. Given the extremely low solubility of hydrogen in brine, a rock-hydrogen-brine three-phase system readily forms. Consequently, the generation, migration, and accumulation of natural hydrogen in formations are directly controlled by the wettability of the peridotite surface.

In this study, the contact angles of hydrogen bubbles onto peridotite in brine were measured. The impacts of brine compositions (i.e., NaCl, KCl and CaCl₂ with different concentrations) and temperature in the range of 300-580 K are investigated. The results show that there is an alteration of wetting tendency in NaCl solution at temperatures ranging from 400 to 430 K: a maximum hydrophilicity is observed within this temperature range while showing less hydrophilicity below and above this temperature range. In DI water, this transition temperature occurs around 480 K. However, a monotonic trend is observed for the hydrogen wettability in CaCl₂ and KCl solution as the temperature increases, separately. We propose a theoretical model, on the basis of Young-Laplace equation, to demonstrate the maximum accumulation/storage of the hydrogen under formation conditions of 5 MPa pressure, approximately 403 K temperature, and 5 wt% NaCl brine. The capillary resistance may prevent a hydrogen column with height of 224.8 m from migration and escaping from the formation. Within a 1 km × 1 km formation area, this corresponds to a hydrogen storage potential of approximately 1.33×10^4 t. This study provides implications for the optimum formation environments (i.e., pressure, temperature, salinity and salt types) for the accumulation/storage of hydrogen in subsurface.

References

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Track Classification: MS01 - (MS01) Porous Media for a Green World: Energy & Climate

Contribution Type: Oral Presentation

Submitted by **Prof. DING, Boxin** <boxin.ding@cup.edu.cn> on **Tuesday 6 January 2026**

Abstract ID : 717

Pore-Scale Insights into CO₂ Hydrate Kinetics

Content

Geological storage of carbon dioxide (CO₂) is a pivotal strategy for mitigating anthropogenic greenhouse gas emissions. During CO₂ injection, hydrate formation driven by Joule-Thomson cooling presents critical challenges to reservoir injectivity and long-term storage integrity due to pore blockage and permeability reduction. However, the kinetics and morphology of hydrate at the pore scale, particularly under varying pore geometries and pressure perturbations, remain insufficiently understood.

This study employs a high-resolution microfluidic experimental platform combined with image analysis to systematically investigate CO₂ hydrate formation and dissociation dynamics under controlled thermodynamic and hydrodynamic conditions. Five systematic experiments explore hydrate dynamics across varying pore geometries, CO₂ phases (gas and liquid), water saturations, and transient pressure perturbations. Nine distinct hydrate morphologies are directly captured and quantified, including pore-filling, grain-coating, worm-like, banded-like, laminated-like, and capillary films, which are strongly influenced by pore geometry and pressure fluctuations. Results indicate that liquid-phase CO₂ and transient pressure disturbances significantly accelerate hydrate nucleation and growth rates, producing more stable and extensive hydrate clusters compared to gas-phase conditions.

The study finds a stochastic nature of hydrate nucleation influenced by local water-gas distribution and highlights hysteresis behavior during hydrate dissociation influenced by pore confinement and capillary forces. Furthermore, we observed the pore-scale Joule-Thomson cooling and its effect on the hydrate behaviour, especially the significant local temperature reduction and the hydrate streams inside the pore network. These findings provide novel insights into microscale hydrate kinetics, which emphasize the critical roles of pore structure and dynamic pressure in governing hydrate formation

References

Country

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Track Classification: MS01 - (MS01) Porous Media for a Green World: Energy & Climate

Contribution Type: Oral Presentation

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Abstract ID : 733

Pore-to-Core Scale Assessment of Nanofluid-Assisted CO₂ Storage Using Surrogate Fluids in Sandstone Reservoirs

Content

Geological CO₂ storage efficiency in saline aquifers is commonly limited by residual brine saturation, pore-scale accessibility, and restricted injectivity, particularly in low-permeability formations. While nanofluids have been proposed as a promising method to enhance CO₂ storage performance, a systematic linkage between pore-scale mechanisms and core-scale storage outcomes remains insufficiently understood.

In this study, silica nanofluids were evaluated as a means to enhance surrogate supercritical CO₂ (scCO₂) storage across pore-to-core scales under controlled wettability and salinity conditions. Microfluidic visualization experiments were conducted using sandstone-representative pore networks to directly quantify changes in residual wetting-phase saturation following nanofluid treatment. Complementary core-flooding experiments were performed on high-permeability Bentheimer sandstone and low-permeability Torry Buff sandstone to assess the scalability of pore-scale observations.

Microfluidic results show that nanofluid treatment reduced residual surrogate brine saturation by up to 10.8% in strongly water-wet systems and 16.0% in mid-wet systems, indicating a substantial increase in accessible pore volume for surrogate scCO₂. Under saline conditions, storage enhancement persisted but decreased with increasing salinity. Core-flooding experiments corroborated these trends, yielding a modest recovery increase (~4% absolute) in Bentheimer cores and a pronounced enhancement in Torry Buff cores, where recovery increased from ~17% to ~39%. Measurements of interfacial tension and static wettability indicate that in strongly water-wet systems, the observed improvements arise primarily from interfacial flow-dynamic modification rather than classical wettability alteration, whereas in mid-wet and low-permeability systems additional contributions consistent with wettability strengthening and flow redistribution are observed.

These results demonstrate that silica nanofluids can reproducibly enhance CO₂ storage efficiency by increasing pore-scale accessibility and improving sweep efficiency, with the dominant mechanism governed by initial wettability, salinity, and permeability. The combined pore-to-core approach provides new insight into the scalability of nanofluid-assisted CO₂ sequestration in porous media.

References

Country

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Track Classification: MS01 - (MS01) Porous Media for a Green World: Energy & Climate

Contribution Type: Online Presentation

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Abstract ID : 735

Underground Hydrogen Storage: A Data-Driven Approach to Site Selection and Performance Optimisation

Content

Hydrogen is widely recognised as a cornerstone of global decarbonisation and a critical component of the pathway to net-zero emissions. By enabling the conversion of renewable electricity into chemical energy, a process known as Power-to-X, it offers a robust solution to the temporal and spatial mismatches in renewable generation, effectively tackling the intermittency of wind and solar power. In the UK, for instance, the transition strategy is supported by a strategic “twin-track” roadmap, targeting a production capacity of 10 GW, approximately 4.88 million kg/day. With current natural gas consumption exceeding 444,000 GWh annually, transitioning this massive demand requires infrastructure capable of managing regional imbalances.

Underground hydrogen storage (UHS) provides the essential temporal balancing required to absorb surplus renewable energy, preventing curtailment and preserving value for industry, transport, and heating. However, the success of this infrastructure depends on identifying efficient and reliable geological storage sites. Traditionally, site screening has been dominated by assessing static parameters, which remain constant over time, such as rock properties. While essential, these assessments overlook dynamic factors that evolve over time and in response to operating conditions, including pressure changes and hysteresis in flow functions. These dynamic processes are critical for determining realistic storage capacity and operational efficiency. This study addresses the current gap by integrating static and dynamic screening approaches, enabling more accurate evaluation of potential storage sites and advancing underground hydrogen storage readiness. A significant barrier to dynamic screening has historically been the lack of detailed reservoir input data required for reliable simulations. To address this, machine learning is utilised to develop reservoir-specific relative permeability correlations for hydrogen flow in porous media, derived directly from experimental data. These data-driven correlations supply the missing parameters needed to model complex fluid dynamics, enabling a comprehensive assessment of trapping mechanisms.

To operationalise the findings, we conduct a UK-specific study that advances dynamic screening by simulating various reservoirs under diverse operational conditions driven by UK regional supply and demand. By incorporating specific limiting factors, such as the steady baseload requirements of UK industrial clusters versus the intermittent hydrogen surpluses, the model predicts reservoir behaviour under realistic operating conditions. This framework facilitates the identification of bottleneck scenarios and allows for the selection of top storage options for each major UK cluster, matching geological candidates to local infrastructure needs.

The initial results underscore the risks of relying solely on static models. Numerical simulations show that ignoring hysteresis can lead to an overestimation of hydrogen recovery by up to 20%. Furthermore, in geological models featuring high-permeability layers, flow instabilities reduced recovery rates by an additional 10%. By capturing these key dynamic processes, our research provides a vital tool for enhanced site screening and candidate selection, ensuring that the UK's storage infrastructure is developed with the efficiency and reliability required for a low-carbon future.

References

A. Jahanbakhsh, A. Louis Potapov-Crighton, A. Mosallanezhad, N. Tohidi Kaloorazi, M.M. Maroto-

Valer, Underground hydrogen storage: A UK perspective. *Renewable and Sustainable Energy Reviews* 189 (2024) 114001. <https://doi.org/10.1016/j.rser.2023.114001>. Department for Energy Security and Net Zero. (2023). Sub-national gas consumption statistics 2022. GOV.UK. G.O. Taiwo, O.S. Tomomewo, B.A. Oni, A comprehensive review of underground hydrogen storage: Insight into geological sites (mechanisms), economics, barriers, and future outlook. *Journal of Energy Storage* 90 (2024) 111844. <https://doi.org/10.1016/j.est.2024.111844>. HM Government. (2022). British energy security strategy. London: HM Government. J.O. Abe, A.P.I. Popoola, E. Ajenifuja, O.M. Popoola, Hydrogen energy, economy and storage: Review and recommendation. *International Journal of Hydrogen Energy* 44 (2019) 15072. <https://doi.org/10.1016/j.ijhydene.2019.04.068>.

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Track Classification: MS01 - (MS01) Porous Media for a Green World: Energy & Climate

Contribution Type: Poster Presentation

Comments:

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Submitted by **MOSALLANEZHAD, Abdolali** <am3053@hw.ac.uk> on **Tuesday 6 January 2026**

Abstract ID : 736

Physicochemical Characterization of CO₂-Activated Colloidal Silica Gels for Adaptive Subsurface Sealing

Content

The large-scale deployment of Carbon Capture and Storage (CCS) is a critical pillar in global strategies to achieve net-zero emissions and mitigate climate change. However, the long-term viability of geological storage depends on the containment of CO₂ within reservoir structures, requiring advanced technologies to ensure seal integrity and prevent buoyant migration through fractures or compromised wellbores. Colloidal silica gels are a promising adaptive solution, as they can be injected as low-viscosity fluids and triggered in situ to form stable barriers. However, their activation by CO₂ rather than traditional chemical agents remains under-characterized regarding the dynamic parameters that govern deployment. This study presents an experimental characterization of colloidal silica gels activated exclusively by CO₂, focusing on the fundamental link between time-dependent gas uptake and the resulting mechanical evolution.

The CO₂ uptake kinetics were investigated across varying particle sizes and concentrations using high-precision pressure-decay measurements in closed isochoric systems. Application of real gas equations of state to the measured pressure and temperature profiles enabled the quantification of the cumulative moles of CO₂ consumed by the suspension in real-time. These profiles were benchmarked against pure water baselines to isolate the excess CO₂ demand associated specifically with colloidal destabilization and silanol buffering, distinguishing between simple physical dissolution and reaction-driven consumption, and quantifying the buffering capacity that dictates the time prior to the onset of gelation.

To link these chemical triggers to physical performance, rheometry was conducted within a high-pressure cell, tracking structural evolution under a constant CO₂ pressure. We characterized the induction period, defined as the timeframe during which the fluid remains injectable, by monitoring viscosity as a function of CO₂ exposure time under isobaric conditions. The sol-gel transition was identified through the crossover of storage (G') and loss (G'') moduli, which are correlated with the molar uptake data to estimate the saturation level required for gel network formation. Dynamic frequency sweeps were used to characterize the final stiffness and viscoelastic damping of the mature gel to confirm mechanical integrity under sustained pressure. Complementing these bulk measurements, Scanning Electron Microscopy (SEM) provided qualitative insight into the morphology and particle connectivity of the formed gels.

Thus, this work provides a characterization of these sealing agents by prioritizing rate-dependent parameters over idealized equilibrium chemistry. The findings demonstrate the viability of CO₂-responsive colloidal silica as an adaptive smart fluid that utilizes leaking or in-situ CO₂ as its own activator, offering a robust foundation for enhancing the safety and efficiency of geological carbon storage in complex subsurface environments.

References

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Abstract ID : 739

Studying the use of deep underground environments using multi-scale laboratory experimental approaches

Content

The use of the geologic underground, either to extract natural resources (water, heat, gases, useful mineral substances, etc.) or to inject / store resources (water, heat, hydrogen) or undesirable compounds (industrial waters and brines, CO₂, etc.) requires the knowledge and control of reactive transport processes in porous and fractured geological media in various scales of time and space. However, to date, little is known and control concerning the understanding of the physico-chemical and kinetic mechanisms at the interfaces at the origin of the mass transfers between phases (minerals - biology - water - gas). Indeed, several key questions and scientific lock limit the exploitation of the current knowledge, and prevent from any generalization of the available theoretical approaches to be able to model the future of these systems under influence of the human utilization.

Being able to investigate at lab scale the combined effects of thermodynamics, hydrodynamics, geo- and biochemical processes occurring in such deep geological environment is still challenging to address these topics. However, over the last fifteen years, new types of transparent high-pressure micro- and millifluidics reactors have been developed. It is based on the idea of combining the advantages of micro-fluidics (size reduction, rapid screening, in situ analysis, reproducibility, control of hydrodynamics, improvement of thermal and material transfers, low consumption of reagents during optimization phases, etc.) with the properties of the fluid systems used in high pressure and high temperature conditions (implementation of hydro- and solvothermal processes, studies of geofluid flows in model porous media, biology under extreme conditions, supercritical fluids, etc.). These tools allow to study more precisely the phenomena taking place at small scales and are complementary to the classical approaches using either macroscopic batch reactors or diamond anvil cells.

In this presentation, we will first detail the technologies available for the fabrication of high-pressure micro and millifluidics reactors, and then we will discuss their use in several applications related to the use of deep geological environments such as: (i) the geological storage of CO₂ (fluid flows, carbonation processes, solubility measurements, etc.), (ii) the effect of deep underground microorganisms on gas storage (CO₂, H₂) along with possible biochemical reactions (in particular methanogenesis), (iii) the production of hydrogen from iron and iron-bearing minerals in subsurface conditions in link with CO₂ storage and (iv) the use of microfluidic reactors to investigate clogging mechanisms in the case of geo-thermal energy recovery.

References

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Contribution Type: Online Presentation

Submitted by **MARRE, Samuel** <samuel.marre@icmcb.cnrs.fr> on **Tuesday 6 January 2026**

Abstract ID : 745

Investigating the effect of operational and petrophysical parameters on salt precipitation and injectivity loss

Content

Geological storage of carbon dioxide in deep saline aquifers is widely recognized as a critical component of global decarbonization strategies. Achieving the large-scale injection rates required to meet climate targets depends strongly on maintaining well injectivity over long operational times. One of the most persistent challenges to injectivity during CO₂ injection is salt precipitation caused by brine evaporation into the dry CO₂ phase, particularly in the near-well region. Salt accumulation can significantly reduce porosity and permeability, leading to injectivity impairment and increased operational costs.

In this study, we present a comprehensive numerical investigation of salt precipitation processes during CO₂ injection, with a specific focus on the role of capillary-driven flow. Simulations are conducted at the core and near-well scales using the TOUGH simulator suite, employing the ECO2N_V2 formulation to capture multiphase flow, phase behavior, evaporation, and salt precipitation.

To quantify fluid redistribution mechanisms, dimensionless metrics are introduced to characterize water backflow. These metrics enable systematic comparison of capillary- and gravity-driven transport across different reservoir configurations and flow regimes. The numerical framework allows detailed examination of where and when salt precipitation develops relative to evaporation fronts, flow pathways, providing insight into the physical controls governing salt localization.

This work aims to establish a mechanistic understanding of how operational and petrophysical factors interact to control salt precipitation patterns and injectivity behavior. The simulation results are synthesized into predictive charts that map operational regimes associated with differing risks of localized precipitation and injectivity impairment. These charts are intended as practical tools to support injection design and operational decision-making.

Overall, this study contributes to improving predictive capability for injectivity management in geological CO₂ storage by systematically isolating and quantifying the governing physical processes under realistic reservoir and operational conditions.

References

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Track Classification: MS01 - (MS01) Porous Media for a Green World: Energy & Climate

Contribution Type: Oral Presentation

Submitted by **Mr SHOKRI, Javad** <mohammadjavad.shokriafra@manchester.ac.uk> on **Wednesday 7 January 2026**

Abstract ID : 783

Estimation of the dissolution rate during CO₂ storage in deep aquifer with variable permeability

Content

The carbon geological storage (CGS) remains one of the most valuable practical means for the mitigation of global warming problem. Since the beginning of the pioneering industrial pilot on CO₂ storage in deep saline aquifer (DNA, [1]), the gas injection and related trapping mechanisms have become one of principal targets of the related research fields [2].

The estimation of CGS-related risks and its efficiency are often based on numerical analysis making use of dedicated dynamic reservoir models. Among other information these models incorporate a lot of realistic data about reservoirs structure and properties controlling the subsurface CO₂ migration and trapping. Without taking this into consideration the assessment of the CO₂ plume evolution characteristics is hardly possible [3,4]. The main objective of our work is the determination of permeability heterogeneity impact on dynamic CO₂ dissolution rate at reservoir scale which is an important factor in the description of the CO₂ plume dynamics and its geometry.

Taking advantage of a recently gained understanding of CO₂-dissolved single-phase mixing dynamics in homogeneous media, the large-scale consideration of the typical heterogeneity cases and its impact on conventional scenarios and general behavior of the fingers pattern from the onset to the late shut-down stage, have been tried, cf. [5]. In particular, the adaptation of known approaches for corresponding permeability variations has been done. As it could be expected, the differences of the convective dissolution (CD) behavior in homogeneous and some heterogeneous reservoirs may incorporate various scenarios of global CD rate evolution with numerous onset, steady-state (SS) or even shut-down (SD) stages for the latter case, reflecting the dynamic interaction between global concentration field and CO₂-rich layer. The list above can include some other CO₂ dissolution regimes not presented in homogeneous media.

The results of numerical analysis revealed that the properly shaped reference homogeneous medium scaling of the dissolution rate (this includes also properties anisotropy and some other features, cf. [5,6]) may serve as a basis for the realization and assessment of the dissolution rate in case of some continuous permeability variations with depth.

The introduction of key characteristics of the heterogeneous permeability field into relevant stability criteria and numerical models turned out to be a challenge for current research. Methodological aspects of large-scale dynamic simulation of CO₂ dissolution in heterogeneous aquifers related to the impact of local properties variation on the global dissolution rate, are first presented and illustrated using most recent results of numerical simulation.

Then the large-scale examples of the dissolution rate upscaling for different characteristics of the continuous permeability variation and corresponding generalized description of the global CD rate evaluation, are considered and discussed. Some details of the upscaling methodology are illustrated in order to specify its possible applicability and generalization on other types of properties heterogeneity.

Considerations of such a kind can provide a valuable information for adaptation of design and monitoring strategy to potential CGS sites.

References

[1] Ringrose, Ph. S., Furre, Anne-Kari, Gilfillan, Stuart M.V., Krevor, S., Landrø, M., Leslie, R,

Meckel, T., Nazarian, B., and A. Zahid (2021) Storage of Carbon Dioxide in Saline Aquifers: Physicochemical Processes, Key Constraints, and Scale-Up Potential, *Annu. Rev. Chem. Biomol. Eng.* 2021,12:1,471-494. [2] Emami-Meybodi E., H. Hassanzadeh, C. P. Green, J. Ennis-King (2015) Convective dissolution of CO₂ in saline aquifers: Progress in modeling and experiments. *Int. J. Greenhouse Gas Control* 40, 238. <https://doi.org/10.1016/j.ijggc.2015.04.003>. [3] Simmons, C. T. (2005). Variable density groundwater flow: From current challenges to future possibilities. *Hydrogeology Journal*, 13, 116-119. [4] Leslie, R., Cavanagh, A. J., Haszeldine, R. S., Johnson, G., Gilfillan, S. M. (2021). Quantification of solubility trapping in natural and engineered CO₂ reservoirs. *Petroleum Geoscience*, 27(4), petgeo2020-120. [5] Bogdanov, I., Blondeau, C. (2024) Simulation of Dynamic CO₂ Dissolution During Geological Storage in Heterogeneous Aquifers. GHGT-17 Conference, Available at SSRN 5068926. [6] Erfani, H., Babaei, M., Berg, C. F., et al. Scaling CO₂ convection in confined aquifers: Effects of dispersion, permeability anisotropy and geochemistry. *Advances in Water Resources*, 2022, 164: 104191.

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Track Classification: MS01 - (MS01) Porous Media for a Green World: Energy & Climate

Contribution Type: Poster Presentation

Submitted by **BOGDANOV, Igor** <igor.bogdanov@univ-pau.fr> on **Saturday 10 January 2026**

Abstract ID : 786

Advancing Carbonation in Cement: Balancing CO₂ Uptake and Structural Performance

Content

This study presents a novel strategy to enhance CO₂ uptake in cement systems by incorporating 1,6-hexamethylenediamine (HMDA) as a water-soluble additive. Conventional CO₂ curing approaches are constrained by the low solubility of CO₂ in cement pore solutions and the associated reduction in alkalinity, which can hinder cement hydration. To overcome these limitations, HMDA was introduced into CO₂-saturated water to chemically bind dissolved CO₂ via carbamate formation while maintaining a pH favorable for hydration.

Cement pastes were prepared using four mixing solutions: tap water (W1), carbonated water (W2), and carbonated water containing 0.1% and 0.6% HMDA (W3 and W4). A comprehensive characterization program was employed, including total inorganic carbon (TIC) measurements, pH analysis, X-ray diffraction (XRD), micro-computed tomography (μ CT), Fourier-transform infrared spectroscopy (FTIR), mechanical testing, and pore structure analysis.

The results demonstrate that HMDA markedly increased CO₂ uptake, rising from 0.74 g/L in carbonated water (W2) to 8.2 g/L in the HMDA-rich system (W4) at a water-to-cement ratio of 0.5. While HMDA-modified samples exhibited reduced early-age strength, they achieved superior long-term mechanical performance. At 28 days, W3 showed the highest compressive strength of 113.8 MPa at a water-to-cement ratio of 0.3, along with increased stiffness and elastic modulus.

XRD and FTIR analyses confirmed enhanced calcite formation and reduced portlandite content, indicating deeper and more controlled carbonation. μ CT and pore size distribution analyses revealed decreased total porosity and refined pore structures, particularly in W3 and W4. These microstructural improvements underpin the observed gains in long-term mechanical properties.

Overall, the HMDA-based approach provides a dual benefit of significantly enhanced CO₂ sequestration and improved cement performance. This method offers a scalable and cost-effective pathway for carbon utilization in cement production, contributing to the development of high-performance, low-carbon construction materials.

References

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Contribution Type: Oral Presentation

Submitted by **Dr YASERI, Ahmed** <ahmed.yaseri@kfupm.edu.sa> on **Sunday 11 January 2026**

Abstract ID : 787

From Pore to Core: Multi-Scale Evidence of Underground Hydrogen Storage Stability After Three Months of Hydrogen Exposure Under Reservoir Conditions

Content

Underground hydrogen storage (UHS) is a cornerstone technology for net-zero energy systems, offering terawatt-hour capacity to buffer renewable intermittency. Although many experiments have been reported on hydrogen flow in porous rocks, robust evidence for long-duration reactions and impact on transport under combined high temperature and high pressure remains limited, leaving a critical uncertainty around reservoir stability during seasonal storage.

Here we provide firm, multi-scale pre/post experimental constraints on two major onshore UK candidate aquifers—the Triassic Sherwood Sandstone Group and the Cretaceous Lower Greensand Group—after ~3 months exposure to H₂ at simulated in-situ conditions deep underground, 50 °C and 150 bar. We integrate X-ray computed tomography (3D pore–grain architecture and bulk phase fractions), optical petrography (fabric/facies), SEM imaging (micro-textures and fines), and XRD (mineralogy) to resolve hydrogen impacts across scales. We also performed dynamic synchrotron images of hydrogen flows in the porous rocks to investigate the reaction impact on the transport. We performed systematically investigations on the pore networks, grain framework, or mineralogy, porosity and permeability. The results show the pore network changes varied by <5%, consistent with measurement uncertainty. Only a single localised fines-migration feature (likely pyrite grain displacement) was detected, without associated dissolution/precipitation signatures. Quartz-dominated frameworks (>~65 wt%) appear inert under these conditions, while facies-scale heterogeneity governs pore connectivity and is expected to dominate injectivity and withdrawal behaviour. These results reduce a key uncertainty for UHS in silicate-rich sandstones, support prioritising connected macro-porous facies in site screening and well placement, and provide a transferable workflow for rapid hydrogen–rock interaction assessment and monitoring. Future work should extend to potentially more reactive lithologies, cyclic operation, longer exposure, and bio-active systems, in order to complete risk evaluation for large-scale seasonal storage.

References

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Contribution Type: Oral Presentation

Submitted by **MA, Lin** <lin.ma@manchester.ac.uk> on **Sunday 11 January 2026**

Abstract ID : 794

Environmentally Sustainable CO₂ Sequestration via Gas Hydrates in Marine Clay Sediments

Content

Anthropogenic CO₂ emissions are the primary driver of climate change and ocean acidification, necessitating scalable and secure carbon capture and sequestration (CCS) approaches. CO₂ sequestration in marine sediments in the form of gas hydrates represents a promising long-term storage option due to high volumetric capacity and enhanced stability under deep-sea pressure and temperature conditions. In deep-sea Sediments, hydrate formation can immobilise CO₂ and reduce leakage risks relative to dissolved or free CO₂ phases, leveraging natural hydrate stability zones in marine sediments. However, most laboratory studies have focused on idealised systems using deionised water or synthetic saline and model sands, leaving critical gaps in understanding hydrate formation kinetics in natural seawater and clay-rich subsea sediments. In this work, CO₂ hydrate formation kinetics were investigated in natural Krishna–Godavari Basin (KGB) sediments and seawater using pure CO₂ gas at pressures of 3.0–7.0 MPa and ~274.5 K, with and without biocompatible kinetic promoters (amino acids). Bentonite clay suspensions (0–7 wt.%) were used to approximate clay-dominated marine sediment environments.

Results demonstrate a strong dependence of hydrate formation on both clay content and the presence of promoters. Gas-to-hydrate (G-H) and water-to-hydrate (W-H) conversions increased with bentonite & KGB sediments concentration up to an optimum of 3 wt.%, rising from baseline seawater values of 20.21% to 52.82% and 14.64% to 27.88%, respectively. Beyond this concentration, conversion efficiencies declined, likely due to mass-transfer limitations and pore blockage. Combined KGB sediments-bentonite-amino acid systems also showed significant enhancements, with gas uptake increases up to 220% relative to bulk seawater.

This study provides the first comprehensive kinetic analysis of CO₂ hydrate formation in seawater containing natural clay minerals and environmentally benign promoters, offering insights into the sustainable deployment of hydrate-based CCS in clay-rich marine sediments.

Keywords: CO₂ hydrate, Biodegradable promoters, Marine sediments, Sequestration, CCS

References

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Contribution Type: Oral Presentation

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Abstract ID : 799

Impact of Flow Rate and Salt Zonation on Porosity–Permeability Evolution During CO₂ Storage in Saline Aquifers

Content

Injection of CO₂ into saline aquifers can induce capillary-driven drying of residual brine in the near-wellbore region, leading to salt precipitation and a potential reduction in injectivity. This phenomenon represents a key operational risk for geological CO₂ storage, particularly under conditions where drying and precipitation processes are strongly coupled to local flow behaviour. Previous experimental and numerical studies have demonstrated that CO₂ injection rate plays an important role in controlling whether salt precipitation becomes spatially localised or more uniformly distributed within the pore space [1–7]. Despite these advances, for realistic storage formations the injection rate at which precipitation behaviour transitions between different spatial regimes remains poorly understood. Moreover, it is still unclear how such rate-dependent transitions should be incorporated into porosity–permeability relationships commonly used in reservoir-scale simulations of injectivity evolution.

In this study, we examine the existence of a threshold CO₂ injection rate governing salt precipitation behaviour in a representative UK sandstone storage formation. The investigation is based on CO₂ coreflooding experiments conducted under controlled conditions. These experiments are complemented by high-resolution three-dimensional micro-CT imaging, enabling direct pore-scale characterisation of salt precipitation patterns formed under different flow regimes. This combined experimental approach allows precipitation behaviour to be assessed in a physically realistic pore structure representative of saline aquifer storage sites.

To bridge pore-scale observations with larger-scale modelling needs, pore-scale modelling is employed to evaluate flow behaviour and to establish a porosity–permeability evolution framework associated with salt precipitation during CO₂ injection. Rather than focusing on specific quantitative outcomes, the emphasis is placed on developing a generalised modelling approach that captures rate-dependent effects while remaining suitable for upscaling to reservoir-relevant conditions.

The integrated experimental and numerical framework in the present work provides a systematic basis for identifying transitions in precipitation behaviour associated with changes in injection rate and for formulating porosity–permeability relationships applicable to CO₂ storage scenarios. The outcomes of this work are intended to support injectivity modelling and inform injection strategy design in saline aquifers, particularly in the near-wellbore region where salt precipitation may influence operational performance. More broadly, the study highlights the importance of explicitly accounting for flow-rate-dependent processes when representing coupled pore-scale and reservoir-scale behaviour during geological CO₂ storage.

References

- [1] Ott, H., de Kloe, K., Marcelis, F., & Makurat, A. (2011). Injection of supercritical CO₂ in brine saturated sandstone: pattern formation during salt precipitation. *Energy Procedia*, 4, 4425-4432.
- [2] Ott, H., de Kloe, K., Van Bakel, M., Vos, F., Van Pelt, A., Legerstee, P., ... & Makurat, A. (2012). Core-flood experiment for transport of reactive fluids in rocks. *Review of Scientific Instruments*, 83(8).
- [3] Ott, H., Snippe, J., De Kloe, K., Husain, H., & Abri, A. (2013). Salt precipitation due to

sc-gas injection: Single versus multi-porosity rocks. *Energy Procedia*, 37, 3319-3330. [4] Roels, S. M., Ott, H., & Zitha, P. L. (2014). μ -CT analysis and numerical simulation of drying effects of CO₂ injection into brine-saturated porous media. *International Journal of Greenhouse Gas Control*, 27, 146-154. [5] Ott, H., Roels, S. M., & De Kloe, K. (2015). Salt precipitation due to supercritical gas injection: I. Capillary-driven flow in unimodal sandstone. *International Journal of Greenhouse Gas Control*, 43, 247-255. [6] Ji, T., Haghi, A. H., Jiang, P., Chalaturnyk, R., & Xu, R. (2025). Capillary-Driven transport and precipitation of salt in heterogeneous structures during carbon sequestration. *Geophysical Research Letters*, 52(13), e2024GL114388. [7] Chen, X. S., Hu, R., Zhou, C. X., Xiao, Y., Yang, Z., & Chen, Y. F. (2024). Capillary-driven backflow during salt precipitation in a rough fracture. *Water Resources Research*, 60(3), e2023WR035451.

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Abstract ID : 805

Mesoscale simulations for modeling clay swelling due to completion fluids in CCS

Content

Clay swelling is a critical concern for Carbon Capture and Storage (CCS) projects, as brine-based completion fluid (injected before CO₂ injection) with different salinity than that of the formation water can trigger clay swelling, which can lead to permeability reduction and formation damage and in the worst case wellbore instabilities or even total abandonment of the well. Numerous studies have investigated the effects of adding different cations in the injected brine on mitigating the permeability reduction due to clay swelling. Recent micromodel experiments have provided clear evidence of this phenomenon at the pore-scale.[1] Recent advances in imaging have led to detailed pore-scale investigations of this phenomenon with microCT imaging conducted during core-flooding experiments.[2] These experiments reveal that besides the composition of the injected brine and the type of clay present in the reservoir, there are a number of factors affecting clay swelling such as the size, shape and distribution of grains and clays. We perform mesoscale simulations to study these various factors affecting clay swelling. We generate synthetic grain-packs of different shapes and sizes with different spatial distributions of clay and different extent of clay swelling and then perform Multiple Relaxation Time Lattice Boltzmann Method (MRTLBM) simulations to study the impact of clay swelling on permeability reduction. Our results show that the same amount of clay distributed differently in the form of interstitial pellets vs grain coatings can lead to different extents of permeability reduction. While this synthetic geometry gives us lots of degrees of freedom to play with and see the effect of various factors affecting clay swelling, we also validate our simulation methodology with experimental data of microCT scans performed during core-flooding experiments.

References:

- [1] Mehdizad et al., JPSE 214 2022, 110561.
- [2] Aksu et al., GeoResJ 7 2015, 1, 1-3.

References

- [1] Mehdizad et al., JPSE 214 2022, 110561., [2] Aksu et al., GeoResJ 7 2015, 1, 1-3.

Country

India

Green Housing & Porous Media Focused Abstracts

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Track Classification: MS01 - (MS01) Porous Media for a Green World: Energy & Climate

Contribution Type: Oral Presentation

Submitted by **AHUJA, Vishal** <vishal.ahuja@shell.com> on **Monday 12 January 2026**

Abstract ID : 815

From Molecular Design to Pore-Scale Flow: A Chemo-Selective Guar Biopolymer Blend for Sustainable Enhanced Oil Recovery

Content

Enhanced oil recovery (EOR) technologies are essential for maximizing hydrocarbon production from mature and depleted reservoirs. Within porous media systems, inefficient displacement during conventional waterflooding leaves a substantial fraction of oil trapped in complex pore networks, requiring advanced flow-control technologies to enhance energy efficiency and minimize environmental impact. Polymer flooding is a widely adopted chemical EOR technique; however, the long-term sustainability and reservoir compatibility of conventional synthetic polymers remain significant challenges. This study reports the development of a novel, chemo-selectively engineered biopolymer blend composed of acetylated guar gum (aGG) and guar gum (GG), designed to enhance multiphase flow behaviour within porous media. Among the investigated compositions, the GG:aGG (4:1) polymer blend exhibited the lowest crystalline nature and highest thermodynamic stability, as supported by electrode potential measurements and Gibbs free energy analysis. Fourier transform infrared spectroscopy (FTIR) confirmed successful esterification and polymer integration through characteristic ester (1733 cm⁻¹) and hydroxyl (3467-3600 cm⁻¹) absorption bands. Rheological investigations demonstrated synergistic pseudoplastic and viscoelastic behaviour of the polymer blend, which are critical for effective mobility control and sweep efficiency in porous media. The optimized polymer blend showed enhanced sweep efficiency, reduced interfacial tension (27.0 dyne/cm), and acceptable injection pressure (2700 Pa). Wettability alteration studies indicated a significant shift toward water-wet conditions, reducing the contact angle to 61.1°, thereby facilitating improved oil displacement through pore constrictions. Emulsification studies further revealed the formation of small, densely packed oil-water droplets, indicative of enhanced transport through heterogeneous pore networks. Oil Reservoir Simulating Bioreactor (ORSB) experiments confirmed the effectiveness of the polymer blend under reservoir-simulated conditions, resulting in a significant improvement in oil recovery and demonstrating strong potential to achieve the targeted incremental recovery exceeding 10% of the original oil in place.

Keywords: Polymer Flooding, Porous Media Flow, Enhanced Oil Recovery, Wettability Alteration, Interfacial Tension

“Chemo-Selective Biopolymer Blending for Stable and Efficient Oil Displacement”

References

Country

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Track Classification: MS01 - (MS01) Porous Media for a Green World: Energy & Climate

Contribution Type: Oral Presentation

Submitted by **Mr TYAGI, Abhishek** <abhityagi12141@gmail.com> on **Monday 12 January 2026**

Abstract ID : 829

Reducing the risk of deformation of the earth's surface during the decomposition of gas hydrates

Content

Natural gas hydrates occur as clusters formed within the pores of coarse-grained sedimentary rocks or as lenses interbedded with low-permeability fine-grained and clayey sediments. According to geological exploration conducted as part of the Integrated Ocean Drilling Program (IODP), gas hydrates are widespread throughout the world's oceans where a seafloor source of methane exists and pressure-temperature conditions ensure the stability of gas hydrates. These areas include all continental slopes. Researchers estimate that methane resources in gas hydrates are several times greater than known reserves of conventional gas.

The mechanisms and relationships between the permeability of hydrate-containing formations and pressure-temperature conditions during gas hydrate decomposition have been studied, minimizing the risks associated with changes in the mechanical properties of the formations and subsidence of the Earth's surface. The mechanisms of gas hydrate decomposition in sandstone reservoirs with cryogenic pore-type gas hydrates are studied. The primary focus is on the use of reservoir pressure reduction.

The permeability of bulk models is determined as a function of porosity and average particle diameter.

3D printed models are used to account for the effect of effective pressure on permeability. The mechanical properties of the printed models and their anisotropy are studied depending on the printing angle and load vector direction.

Based on microstructural analysis using X-ray computed microtomography, a method for determining changes in the permeability of model porous gas hydrate rocks due to mechanical loading is developed.

This research was funded by the Ministry of science and higher education of the Russian Federation (Project № FSNM-2024-0008)&

References

1. Khimulia, V.; Karev, V.; Kovalenko, Y.; Barkov, S. Changes in Filtration and Capacitance Properties of Highly Porous Reservoir in Underground Gas Storage: CT-Based and Geomechanical Modeling. *J. Rock Mech. Geotech. Eng.* 2024, 16, 2982–2995. <https://doi.org/10.1016/j.jrmge.2023.12.015>.
2. Ouyang, Q.; Pandey, J.S.; von Solms, N. Microfluidic Insights: Methane Hydrate Dynamics in Distinct Wetttable Confined Space. *Chem. Eng. J.* 2023, 474, 145567. <https://doi.org/10.1016/j.cej.2023.145567>.
3. Mudugamuwa, A.; Roshan, U.; Hettiarachchi, S.; Cha, H.; Musharaf, H.; Kang, X.; Trinh, Q.T.; Xia, H.M.; Nguyen, N.; Zhang, J. Periodic Flows in Microfluidics. *Small* 2024, 20, e2404685. <https://doi.org/10.1002/sml.202404685>.
4. Liu, W.; He, H.; Yuan, F.; Liu, H.; Zhao, F.; Liu, H.; Luo, G. Influence of the Injection Scheme on the Enhanced Oil Recovery Ability of Heterogeneous Phase Combination Flooding in Mature Waterflooded Reservoirs. *ACS Omega* 2022, 7, 23511–23520. <https://doi.org/10.1021/acsomega.2c02007>.
5. Ma, Z.; Qi, L.; Dai, Z.; Yang, Z.; Ma, Y.; Wang, D.; Carroll, K.C.; Soltanian, M.R. Impact of Multiscale Heterogeneous Sediments and Boundary Conditions on Dispersivity Spatial Variations. *Water Resour. Res.* 2025, 61, e2024WR039151. <https://doi.org/10.1029/2024WR039151>.
6. Manga, M.; Beresnev, I.; Brodsky, E.E.; Elkhoury, J.E.; Elsworth, D.; Ingebritsen, S.E.; Mays, D.C.; Wang, C.Y. Changes in Permeability Caused by Transient Stresses: Field Observations, Experiments, and Mechanisms. *Rev. Geophys.* 2012, 50, RG2004. <https://doi.org/10.1029/2011RG000382>.

7. Jung, J.; Cao, S.C.; Shin, Y.-H.; Al-Raoush, R.I.; Alshibli, K.; Choi, J.-W. A Microfluidic Pore Model to Study the Migration of Fine Particles in Single-Phase and Multi-Phase Flows in Porous Media. *Microsyst. Technol.* 2018, 24, 1071–1080. <https://doi.org/10.1007/s00542-017-3462-1>.
8. Kozhevnikov, E.; Turbakov, M.; Riabokon, E.; Gladkikh, E.; Guzev, M.; Panteleeva, A.; Ivanov, Z. Rock Permeability Evolution during Cyclic Loading and Colloid Migration after Saturation and Drying. *Adv. Geo-Energy Res.* 2024, 11, 208–219. <https://doi.org/10.46690/ager.2024.03.05>.
9. Wang, L.-B.; Sun, Y.-F.; Bu, Y.-H.; Xu, Z.-B.; Sun, X.; Shao, H.-F.; Sun, C.-Y.; Chen, G.-J. Temperature-Pressure Field Evolution of Hydrate-Bearing Sediments: A Comparative Study of Depressurization Strategies for Gas Recovery Using a Novel Fan-Shaped Simulator. *Gas Sci. Eng.* 2026, 145, 205802. <https://doi.org/10.1016/j.jgsce.2025.205802>.
10. Liu, Y.; Wang, S.; Zhao, W.; Yan, H.; Guo, P.; Zhang, J.; Bai, Z.; Wang, Z.; Ou, L. Multi-Dimensional Experimental Study of Hydrocarbon Gas-Assisted Gravity Drainage. *Arab. J. Sci. Eng.* 2023, 48, 17031–17048. <https://doi.org/10.1007/s13369-023-08333-3>.
11. Ma, Z.; Dai, Z.; Zhang, X.; Zhan, C.; Gong, H.; Zhu, L.; Wallace, C.D.; Soltanian, M.R. Dispersivity Variations of Solute Transport in Heterogeneous Sediments: Numerical and Experimental Study. *Stoch. Environ. Res. Risk Assess.* 2022, 36, 661–677. <https://doi.org/10.1007/s00477-021-02040-x>.
12. Dogan, M.; Van Dam, R.L.; Liu, G.; Meerschaert, M.M.; Butler, J.J.; Bohling, G.C.; Benson, D.A.; Hyndman, D.W. Predicting Flow and Transport in Highly Heterogeneous Alluvial Aquifers. *Geophys. Res. Lett.* 2014, 41, 7560–7565. <https://doi.org/10.1002/2014GL061800>.
13. Feia, S.; Dupla, J.-C.; Canou, J.; Ghabezloo, S.; Sulem, J.; Chabot, B.; Aubry, E.; Mainguy, M. An Experimental Setup with Radial Injection for Investigation of Transport and Deposition of Suspended Particles in Porous Media. *Geotech. Test. J.* 2017, 40, 1115–1124. <https://doi.org/10.1520/GTJ20160032>.
14. Vavra, E.; Bai, C.; Puerto, M.; Ma, K.; Mateen, K.; Hirasaki, G.J.; Biswal, S.L. Effects of Pressure Oscillations on Foam Transport in Porous Media. *Transp. Porous Media* 2025, 152, 48. <https://doi.org/10.1007/s11242-025-02172-6>.
15. Eikehaug, K.; Haugen, M.; Folkvord, O.; Benali, B.; Bang Larsen, E.; Tinkova, A.; Rotevatn, A.; Nordbotten, J.M.; Fernø, M.A. Engineering Meter-Scale Porous Media Flow Experiments for Quantitative Studies of Geological Carbon Sequestration. *Transp. Porous Media* 2024, 151, 1143–1167. <https://doi.org/10.1007/s11242-023-02025-0>.
16. Guo, Y.; Nouri, A.; Nejadi, S. Effect of Slot Width and Density on Slotted Liner Performance in SAGD Operations. *Energies* 2020, 13, 268. <https://doi.org/10.3390/en13010268>.
17. Kotb, O.; Haftani, M.; Nouri, A. An Investigation into Current Sand Control Testing Practices for Steam Assisted Gravity Drainage Production Wells. *Eng* 2021, 2, 435–453. <https://doi.org/10.3390/eng2040027>.
18. Feia, S.; Sulem, J.; Canou, J.; Ghabezloo, S.; Clain, X. Changes in Permeability of Sand during Triaxial Loading: Effect of Fine Particles Production. *Acta Geotech.* 2016, 11, 1–19. <https://doi.org/10.1007/s11440-014-0351-y>.
19. Chen, L.-T.; Li, N.; Sun, C.-Y.; Chen, G.-J.; Koh, C.A.; Sun, B.-J. Hydrate Formation in Sediments from Free Gas Using a One-Dimensional Visual Simulator. *Fuel* 2017, 197, 298–309. <https://doi.org/10.1016/j.fuel.2017.02.034>.
20. Sun, H.; Chen, B.; Pang, W.; Song, Y.; Yang, M. Investigation on Plugging Prediction of Multiphase Flow in Natural Gas Hydrate Sediment with Different Field Scales. *Fuel* 2022, 325, 124936. <https://doi.org/10.1016/j.fuel.2022.124936>.
21. De Carlo, L.; Farzamian, M.; Turturro, A.C.; Caputo, M.C. Time-Lapse ERT, Moment Analysis, and Numerical Modeling for Estimating the Hydraulic Conductivity of Unsaturated Rock. *Water* 2023, 15, 332. <https://doi.org/10.3390/w15020332>.
22. Bogena, H.R.; Huisman, J.A.; Oberdörster, C.; Vereecken, H. Evaluation of a Low-Cost Soil Water Content Sensor for Wireless Network Applications. *J. Hydrol.* 2007, 344, 32–42. <https://doi.org/10.1016/j.jhydrol.2007.06.032>.
23. Lima, F.; Hall, S.A.; Engqvist, J.; Tudisco, E.; Woracek, R.; Athanasopoulos, S.; Vestin, P. Investigating Apparent Deviations from Darcy's Law in Heterogeneous Rocks: Insights from Neutron Imaging. *Transp. Porous Med.* 2025, 152, 46. <https://doi.org/10.1007/s11242-025-02185-1>.
24. Riabokon, E.; Gladkikh, E.; Turbakov, M.; Kozhevnikov, E.; Guzev, M.; Yin, Q.; Wu, J.; Startsev, D. Acoustic Vibration Restoration of Rock Permeability While Crude Oil Filtration Containing Paraffins. *Geoenergy Sci. Eng.* 2024, 238, 212865. <https://doi.org/10.1016/j.geoen.2024.212865>.
25. Kozhevnikov, E.V.; Turbakov, M.S.; Gladkikh, E.A.; Riabokon, E.P.; Poplygin, V.V.; Guzev, M.A.; Qi, C.; Jing, H. Colloid-Induced Permeability Degradation Assessment of Porous Media. *Géotechnique Lett.* 2022, 12, 217–224. <https://doi.org/10.1680/jgele.22.00017>.
26. Turbakov, M.S.; Kozhevnikov, E.V.; Riabokon, E.P.; Gladkikh, E.A.; Poplygin, V.V.;

Guzev, M.A.; Jing, H. Permeability Evolution of Porous Sandstone in the Initial Period of Oil Production: Comparison of Well Test and Coreflooding Data. *Energies* 2022, 15, 6137. <https://doi.org/10.3390/en15176137>.

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Track Classification: MS01 - (MS01) Porous Media for a Green World: Energy & Climate

Contribution Type: Oral Presentation

Submitted by **TURBAKOV, Mikhail** <msturbakov@pstu.ru> on **Monday 12 January 2026**

Abstract ID : 835

Hydrate-Based Kinetic Investigation of CO₂ Sequestration in Subsea Clayey Sediments Using Sustainable Promoters

Content

Carbon dioxide (CO₂) emissions are a major driver of global warming, prompting growing interest in carbon capture and storage (CCS) technologies. Among emerging approaches, sequestering carbon into marine sediments has gained attention, as it enables the formation of gas hydrates that can securely store CO₂. Despite its potential, the effectiveness of this method strongly depends on the kinetics of hydrate formation and hydrate stability, especially in marine clay sediments. In particular, variations in salinity within marine environments can significantly influence hydrate behaviour, making a detailed understanding of these kinetic processes essential for the safe and efficient implementation of hydrate-based CO₂ storage strategies in marine sediments. In this study, hydrate formation kinetics and stability were analysed in marine sedimentary conditions using Krishna-Godavari (K-G) basin clay sand media by mimicking actual subsea parameters. The effects of various environmentally friendly additives, specifically amino acids (AA), as well as the synergistic kinetic promotion of gas hydrate formation by combined amino acids (AA) and 1,3-dioxolane, were systematically investigated. Investigation demonstrates that both methionine and tryptophan enhances hydrate formation kinetics than seawater and seawater+clay system and nearly 2 and 1.4 times improvement in gas hydrate conversion have been observed. Tryptophan slightly (3-5 %) outperform methionine in terms of kinetic promotion and humic acid potassium salt decreases overall kinetics of hydrate formation. The combine DIOX+AA systems demonstrated nearly 10-15% improvement in overall gas uptake in hydrate with KG clayey sand. The ex-situ morphological analysis shows porous, muddy morphologies with tryptophan and methionine and porous granular morphology with clay alone system. Furthermore, higher hydrate stability and inhibited hydrate dissociation kinetics have been observed in all clayey systems. The findings of this study is crucial and have potential to replace toxic chemical additives with low-environmental-footprint bio promoters, enabling enhanced hydrate formation kinetics and stability for long-term CO₂ storage in subsea sediments.

References

1. Eti Pagar, Sai Kiran Burla, Vimal Kumar, Hari Prakash Veluswamy, Influence of amino acids on gas hydrate formation and dissociation kinetics using flue gas (CO₂ + N₂ mixture) in silica sand under saline/non-saline conditions for CO₂ sequestration, Applied Energy, Volume 367, 2024, 123460.

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Track Classification: MS01 - (MS01) Porous Media for a Green World: Energy & Climate

Contribution Type: Poster Presentation

Comments:

Submission of full abstract for conference

Submitted by **KUMAR, Yogendra** <mishrayogendrabet@gmail.com> on **Monday 12 January 2026**

Abstract ID : 837

Improving Ground Ice Segmentation in Permafrost Cores Using X-ray CT

Content

Ground ice strongly controls how permafrost responds to warming, influencing thaw settlement, thermokarst development and drainage changes. For predicting thaw settlement and designing resilient infrastructure to expected climate conditions, ice content estimates must be accurate and comparable across cores and sites. X-ray Computed Tomography (CT) is a practical non-destructive tool for measuring ice distribution, but the standard practice of segmenting ice using fixed Hounsfield Unit (HU) thresholds often fails in heterogeneous permafrost because sediment, organic matter, and ice can overlap in apparent density and mixed voxels are common. These effects can bias inferred ice volumes and, in turn, assessments of thaw vulnerability.

We evaluate how segmentation choices affect ice quantification using a 164 cm long permafrost core from a Yedoma upland in north-eastern Siberia spanning variable cryostructures and sediment compositions. We compare (i) conventional HU thresholding, (ii) automated thresholding methods (including Otsu and adaptive histogram-based approaches), and (iii) machine-learning models (random forests and convolutional neural networks) that incorporate texture and morphological context in addition to intensity. CT-derived ice content and bulk density estimates are validated against independent laboratory measurements to quantify bias and uncertainty across core intervals rather than relying on visual agreement alone.

Results show that no single method is robust for all materials. Threshold-based workflows can perform adequately in simpler intervals but become unstable where partial-volume effects and phase overlap are strong. Automated and learning-based approaches reduce some of these errors, but their performance depends on parameter choices, training data, and transferability between contrasting textures. We summarize strengths and limitations across cryostructures and provide guidance for selecting segmentation workflows when the end use is climate- and hazard-relevant ice quantification. The study supports standardized, non-destructive CT-derived datasets needed for comparing permafrost cores and improving projections of thaw impacts in rapidly changing Arctic regions.

References

Country

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Track Classification: MS01 - (MS01) Porous Media for a Green World: Energy & Climate

Contribution Type: Oral Presentation

Submitted by **ROUSTAEI, Mahya** <mroustae@ualberta.ca> on **Monday 12 January 2026**

Abstract ID : 842

Experimental and Theoretical Analysis of CO₂ Transport and Capture in Metal-Modified MOF-5 Porous Media

Content

Rising atmospheric CO₂ concentrations resulting from industrial activity and fossil fuel consumption present an urgent challenge for climate mitigation, underscoring the need for efficient capture technologies based on advanced porous materials. Metal organic frameworks (MOFs), characterized by their highly ordered pore networks, large internal surface areas, and tunable chemical functionality, offer a versatile platform for investigating CO₂ transport and adsorption in crystalline porous media.

In this study, we present a coupled experimental and theoretical investigation of CO₂ transport and capture in transition metal modified MOF-5. Density Functional Theory (DFT) calculations are employed to elucidate pore scale adsorption mechanisms by quantifying CO₂ binding energies, metal framework stability, and charge transfer at distinct adsorption sites within the modified MOF-5 structure. These simulations provide molecular level insight into the influence of metal doping on CO₂ solid interactions and adsorption. The experimental work, including material synthesis, structural and chemical characterization, equilibrium gas adsorption measurements, and dynamic breakthrough experiments, is conducted to evaluate the adsorption performance, transport behavior, and stability of the metal modified MOF-5 under relevant conditions. By integrating molecular-scale modeling with macroscopic adsorption and transport measurements, this study demonstrates how transition metal incorporation enhances CO₂ uptake and modifies transport phenomena within the porous framework. The results contribute to a multiscale understanding of CO₂ capture in engineered porous media and highlight the role of tailored pore chemistry in optimizing adsorption driven separation processes.

References

Lei, R., Shen, W., Yang, Z., Jin, H., Chai, W., Guo, X., Ge, H. and Jin, D., Enhanced Co₂ Adsorption in Cux-Mof-5: Optimal Doping and Regeneration Performance.

Country

India

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Contribution Type: Poster Presentation

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Abstract ID : 848

Flow–Reactivity Interactions during Impure CO₂ Storage in Carbonate Reservoirs

Content

Carbonate reservoirs in depleted oil and gas fields are widely considered suitable candidates for geological CO₂ storage due to their high porosity and extensive subsurface distribution. In the Danish North Sea, many prospective storage formations consist predominantly of chalk and other carbonate lithologies. However, the calcite-rich composition and typically low permeability of these rocks make them highly sensitive to geochemical reactions triggered by CO₂ injection. This sensitivity is further amplified when the injected CO₂ stream contains reactive impurities such as SO₂, NO₂, and H₂S, which may be present at trace concentrations in industrial capture streams. Despite their potential importance, the coupled effects of CO₂ stream impurities on geochemical reactivity, multiphase flow behavior, and storage efficiency in carbonate porous media remain insufficiently constrained.

This contribution examines the influence of CO₂ stream composition on flow–reactivity interactions in carbonate reservoir rocks using a combined experimental and modeling approach. Dynamic core-flooding experiments are conducted on reservoir carbonate samples under representative subsurface conditions (100 bar, 35 °C). Pure methane serves as a non-reactive reference fluid, while additional experiments involve pure CO₂ and CO₂ mixtures containing CH₄, SO₂, NO₂, or H₂S. Alternating injections of gas and formation water are applied to reproduce transient multiphase flow conditions representative of advancing CO₂ plume fronts and cyclic gas–water displacement processes encountered during storage operations.

Geochemical reactions are assessed through analysis of effluent fluid compositions using ion chromatography, enabling evaluation of carbonate dissolution and potential secondary mineral reactions. To support interpretation of the experimental observations and to isolate impurity-specific effects, a one-dimensional kinetic reactive transport model is developed. The modeling framework facilitates systematic analysis of reaction pathways and their interaction with multiphase flow at the core scale, providing insight into process coupling relevant to porous media behavior.

The combined experimental–numerical framework highlights how variations in CO₂ stream composition influence both geochemical response and flow behavior in carbonate porous media. In addition to modifying carbonate reactivity, impurities affect gas–water displacement characteristics and residual gas trapping, which are critical parameters for storage efficiency and security. While geochemical reactions act at the pore scale, their short-term impact on bulk petrophysical properties remains limited under the investigated conditions, emphasizing the dominance of flow-controlled mechanisms during early stages of CO₂ storage.

Overall, this work underscores the importance of accounting for realistic CO₂ stream compositions when investigating coupled flow and reactive transport processes in carbonate CO₂ storage reservoirs and contributes to improved understanding of impurity effects in porous media relevant to carbon storage applications.

References

Country

Denmark

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Presenter: FEILBERG, Karen (Danish Hydrocarbon Research and Technology Centre)

Track Classification: MS01 - (MS01) Porous Media for a Green World: Energy & Climate

Contribution Type: Oral Presentation

Comments:

Oral presentation preferred but can also do a poster presentation

Submitted by **FEILBERG, Karen** <klfe@dtu.dk> on **Monday 12 January 2026**

Abstract ID : 849

Vertical-Equilibrium Modelling of CO₂ Migration in Depleted Reservoirs

Content

CO₂ storage in geological formations requires the understanding of multiphase multi-component flow over large reservoir-scale domains, where fully resolved three-dimensional simulations become computationally expensive and impractical for large-scale studies. Vertical-equilibrium (VE) modelling provides an efficient alternative for such systems. When vertical pressure equilibration is fast compared to lateral flow, the vertical structure of the flow is governed primarily by hydrostatic balance. The governing equations can then be integrated over the vertical direction, reducing the three-dimensional problem to a two-dimensional formulation based on vertically integrated variables while preserving mass conservation and buoyancy-driven dynamics. VE modelling has been widely developed and applied for CO₂ storage in saline aquifers.

In this work, we develop a three-phase VE framework for gravity-dominated flow of CO₂, methane, and brine in porous media, motivated by CO₂ injection into depleted gas reservoirs. The model extends conventional two-phase VE formulations by introducing a third mobile phase and representing the system in terms of vertically segregated phase layers. CO₂, methane, and brine are treated as separate phases within a black-oil-type formulation, enabling efficient simulation while aiming to preserve first-order displacement physics. Brine is treated as incompressible, while CO₂ and methane are compressible. Pressure-dependent density and viscosity variations are derived from the Peng–Robinson equation of state and approximated using low-order analytical expansions, yielding mass-consistent vertically integrated properties without resolving fine-scale vertical structure.

Model behaviour is evaluated through comparison with high-resolution compositional simulations for a gravity-segregated anticline system. The VE model reproduces key porous-media flow characteristics observed in the fine-scale reference solutions, including buoyant rise of the injected phase, lateral migration under structural control, stable three-phase ordering, and evolution of gas–water contacts. Notably, plume extent, migration pathways, and final trapping locations are captured with good accuracy.

From a computational perspective, the VE approach reduces simulation time by more than two orders of magnitude compared to full compositional modelling, enabling rapid parameter studies, uncertainty analysis, and scenario screening that are impractical at fine scale. The results highlight the effectiveness of VE modelling as a physics-based upscaling strategy for gravity-dominated multiphase flow in porous media.

References

- Andersen, O., Gasda, S. E., & Nilsen, H. M. (2015). Vertically Averaged Equations with Variable Density for CO₂ Flow in Porous Media. *Transport in Porous Media*, 107, 95–127. <https://doi.org/10.1007/s11242-014-0427-z>
- Ghanbari, S., Mackay, E. J., Heinemann, N., Alcalde, J., James, A., & Allen, M. J. (2020). Impact of CO₂ mixing with trapped hydrocarbons on CO₂ storage capacity and security: A case study from the Captain aquifer (North Sea). *Applied Energy*, 278. <https://doi.org/10.1016/j.apenergy.2020.115634>
- Lie, K.-A. (2019). *An Introduction to Reservoir Simulation Using MATLAB/GNU Octave: User Guide for the MATLAB Reservoir Simulation Toolbox (MRST)*. Cambridge University Press. <https://doi.org/DOI:10.1017/9781108591416>
- Moyner, O. (2024). *JutulDarcy.jl - a Fully Differentiable High-Performance*

Reservoir Simulator based on Automatic Differentiation. ECMOR 2024, 2024(1), 1–37. <https://doi.org/10.3997/2214-4609.202437111> Nordbotten, J., & Celia, M. (2011). Geological Storage of CO₂: Modeling Approaches for Large-Scale Simulation. Geological Storage of CO₂: Modeling Approaches for Large-Scale Simulation, i–ix. <https://doi.org/10.1002/9781118137086.fmatter>

Country

United Kingdom

Green Housing & Porous Media Focused Abstracts

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Presenter: TELVARI, Saeid (Heriot-watt University)

Track Classification: MS01 - (MS01) Porous Media for a Green World: Energy & Climate

Contribution Type: Oral Presentation

Submitted by **TELVARI, Saeid** <st4014@hw.ac.uk> on **Monday 12 January 2026**

Abstract ID : 862

Micro-mechanical Study of Hydro-mechanical Coupling at the Interfaces of Raw Earth Masonry

Content

The use of bio or geo-sourced materials is a sustainable solution to reduce the carbon footprint in the building sector. Among these, raw earth materials stand out thanks to its reversibility, local availability, and remarkable hygrothermal properties. Nevertheless, this material sometimes exhibits unpredictable mechanical responses due to its high sensitivity to water [1], which hinders a more widespread adoption. Raw earth is a composite material whose clay and silt particles, once hydrated, act as a binder for the granular skeleton. The cohesion of this porous medium and its mechanical properties are therefore strongly correlated with its hydric state [2]. During the construction of masonry structures, earth bricks are placed in contact with wet earth mortar, leading to water exchange through capillary flow (imbibition process) and evaporation (drying process) at the brick/mortar interfaces. This results in swelling and shrinkage of the material, which can induce significant local micro-cracking and severely affect cohesion. The extent of these micro-mechanisms is expected to be controlled by the microstructure and, in particular, by the properties of the pore network.

In this work, we characterize the hydromechanical coupling that leads to the cohesion between earth bricks and mortar to explain the counterintuitive observation that walls built with denser bricks, featuring better mechanical strength, thinner pores and higher capillary forces, may exhibit worse strength than looser bricks with worse mechanical strength, larger pores and lower capillary forces. The response of raw earth structures, including masonry, has primarily been studied at macroscopic and phenomenological levels. To our knowledge, no full-field micro-mechanical study of hydromechanical coupling at interfaces exists, despite the need to understand and quantify these processes at the local scale due to the material's strong heterogeneity. In our study, we track the evolution of raw earth microstructures (samples of dimensions $\varnothing \times h = 20 \times 40$ mm) during imbibition and drying tests using 3D operando measurements in a laboratory micro-tomograph as well as the multi-modal neutron+X-ray imaging platform NeXT at the institut Laue-Langevin [3]. The combined use of neutron and X-ray tomography allows us to characterize the hydro-mechanical behavior of brick-mortar interface during these processes by locally relating deformation and micro-cracking (visible through X-rays to the saturation rate visible with Neutrons). We are also studying the impact of the microstructure on this hydro-mechanical coupling by testing raw earth with different porosity levels, as well as different grain size distributions and mineralogical compositions.

References

- [1] Hall M, Djerbib Y Moisture ingress in rammed earth: part 1—the effect of soil particle-size distribution on the rate of capillary suction. *Constr Build Mater* 18:269–280. (2004) [2] Chauhan, P., El Hajjar, A., Prime, N., & Plé, O. Unsaturated behavior of rammed earth: Experimentation towards numerical modelling. *Construction and Building Materials*, 227, 116646 (2019). [3] Tengattini, A., Lenoir, N., Andò, E., Giroud, B., Atkins, D., Beaucour, J., & Viggiani, G. NeXT-Grenoble, the Neutron and X-ray tomograph in Grenoble. *Nuclear Instruments and Methods in Physics Research Section A: Accelerators, Spectrometers, Detectors and Associated Equipment*, 968, 163939 (2020).

Country

France

Green Housing & Porous Media Focused Abstracts

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Track Classification: MS01 - (MS01) Porous Media for a Green World: Energy & Climate

Contribution Type: Oral Presentation

Comments:

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Submitted by **GEORGES, David** <georgesdavid27@gmail.com> on **Monday 12 January 2026**

Abstract ID : 869

Pore-Scale Modelling of Wormhole Formation in Fractured Salt-Bearing Reservoir Rock

Content

Wormhole formation in salt deposits threatens containment integrity in geological disposal facilities (GDF) by creating preferential pathways for radionuclide migration. While continuum models predict invasion patterns, they fail to capture formation timescales due to inadequate representation of pore-scale heterogeneity and pre-existing fractures. Pore-scale reactive transport modelling can address these limitations by explicitly resolving dissolution dynamics at the pore level. We performed simulations using GeoChemFoam, an open-source OpenFOAM-based employing a micro-continuum approach. Flow is governed by the Darcy-Brinkman-Stokes equations, with local permeability following a Kozeny-Carman relationship, while advection-diffusion equations describe reactive transport of dissolved species. Dissolution kinetics at solid-fluid interfaces were handled using the improved Volume of Solid (iVoS) approach with a fully implicit reaction solver. Simulations were conducted on micro-CT imaged fractured halite samples. Results reveal two dissolution regimes: uniform face dissolution at the inlet and localized wormhole formation at fracture intersections. Fractures concentrate flow, establishing a positive feedback cycle - increased reactant delivery accelerates dissolution, increasing permeability and further concentrating flow. Multi-fold porosity increases near the inlet propagate along wormholes, creating localized mechanical weakness. Observed dissolution patterns demonstrate the necessity of pore-scale reactive flow-based upscaling approaches.

References

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United Kingdom

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Contribution Type: Poster Presentation

Submitted by **RAMACHANDRAN, Hariharan** <h.ramachandran@hw.ac.uk> on **Monday 12 January 2026**

Abstract ID : 875

Beyond Oil: A Comparative Assessment of Computational Methods for Flow Prediction in Porous Media for CO₂ and H₂ Storage Applications

Content

Accurate prediction of fluid flow in porous media underpins the safe and efficient utilization of subsurface resources. While computational methods for porous media flow have traditionally been developed and validated within the context of oil and gas recovery, the subsurface is now increasingly envisioned as a critical asset for carbon dioxide (CO₂) sequestration and hydrogen (H₂) storage applications that impose fundamentally different physical, chemical, and operational constraints. Variations in fluid properties, multiphase interactions, transport mechanisms, geochemical coupling, and leakage risk necessitate a re-evaluation of the suitability and limitations of existing modeling approaches.

This study presents a systematic comparison of widely used computational methods for flow prediction in porous media, including continuum-scale approaches based on Darcy and extended Darcy formulations, pore-scale methods such as lattice Boltzmann and direct numerical simulations, and hybrid and data-driven techniques integrating physics-based models with machine learning. The strengths, assumptions, and computational trade-offs of each approach are critically assessed with respect to their applicability across oil recovery, CO₂ geostorage, and H₂ subsurface storage scenarios.

By benchmarking these methods against key performance criteria i.e. accuracy, scalability, representation of heterogeneity, and capability to capture multiphase and reactive transport, this work highlights gaps in current modeling frameworks and identifies pathways for next-generation predictive tools. It underscores that reliable flow prediction is not merely a reservoir engineering challenge but a foundational requirement for the long-term integrity, safety, and scalability of subsurface energy and climate solutions.

References

Country

India

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Contribution Type: Oral Presentation

Submitted by **Mr AGARWAL, Akshit** <akshit.agarwal@chemical.iitd.ac.in> on **Monday 12 January 2026**

Abstract ID : 880

Coreflood Evidence of Connectivity-Controlled CO₂ Breakthrough and Residual Trapping

Content

Reliable prediction of CO₂ trapping in subsurface formations requires an improved understanding of how pore structure governs multiphase flow irreversibility at the core scale. While pore connectivity is widely recognized as a key controlling factor, experimental evidence linking connectivity to residual CO₂ trapping under controlled flow conditions remains limited. This study investigates the influence of effective pore connectivity on CO₂-brine displacement behavior using coreflood experiments in water-wet sandstone cores with comparable porosity and permeability but contrasting connectivity characteristics. Primary drainage and secondary imbibition experiments were performed under capillary-dominated flow conditions at low injection rates to minimize viscous effects. Effective pore connectivity is quantified using macroscopic proxies, including formation factor and flow zone indicators. Measured responses include CO₂ breakthrough time, differential pressure evolution, and residual gas saturation. The results reveal systematic differences in breakthrough behavior and trapped CO₂ saturation that correlate strongly with connectivity proxies, while exhibiting weak sensitivity to injection rate within the tested regime. The observed flow irreversibility and trapping trends indicate that effective pore connectivity exerts a dominant control on residual CO₂ immobilization at the core scale. These findings provide experimentally grounded constraints for incorporating connectivity effects into continuum-scale flow models and have direct implications for the design and assessment of geological CO₂ storage operations.

References

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Contribution Type: Oral Presentation

Submitted by **BARDHAN, Anirudh** <anirudhb@iitb.ac.in> on **Monday 12 January 2026**

Abstract ID : 881

Experimental Investigation of Horizontal versus Vertical CO₂ Plume Migration in Porous Reservoir Media Using Core Flooding with Variable Core Thickness

Content

Understanding the migration behavior of injected CO₂ within subsurface reservoirs is critical for the safe and efficient deployment of carbon capture and storage (CCS) technologies. While most laboratory-scale studies assume predominantly one-dimensional flow, actual reservoirs exhibit complex plume dynamics driven by buoyancy, permeability anisotropy, and vertical–horizontal connectivity. This study presents a systematic experimental investigation of horizontal versus vertical CO₂ plume movement using a high-pressure core flooding apparatus and reservoir cores cut with varying thicknesses and orientations. By comparing flow behavior in horizontally and vertically oriented cores, the experiments isolate the relative influence of gravitational segregation, viscous forces, and capillary effects on CO₂ migration. Measurements of pressure drop, saturation evolution, and breakthrough behavior are used to quantify directional differences in plume advancement and spreading. The results demonstrate how core geometry and orientation strongly influence CO₂ mobility and plume stability, providing insights into vertical leakage risks, lateral plume extent, and storage efficiency. This work bridges the gap between idealized laboratory experiments and field-scale reservoir behavior, enabling improved interpretation of CO₂ injection tests and more reliable prediction of plume evolution in heterogeneous formations.

References

Country

India

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Track Classification: MS01 - (MS01) Porous Media for a Green World: Energy & Climate

Contribution Type: Oral Presentation

Submitted by **BARDHAN, Anirudh** <anirudhb@iitb.ac.in> on **Monday 12 January 2026**

Abstract ID : 895

Surrogate Models for Structure–Property Relationships in Amorphous Porous Materials

Content

Amorphous porous materials play a central role in energy and environmental technologies, including direct air capture of CO₂ and heterogeneous catalysis. Their performance is governed by strong local heterogeneity at the atomic scale, where variations in coordination, topology, and chemical environment control adsorption, reaction energetics, and transport. Capturing these effects with atomistic simulations is challenging, as amorphous systems exhibit large statistical variability and require extensive sampling to obtain meaningful structure–property relationships.

We present a multiscale, data-driven framework that addresses this challenge by constructing surrogate models linking local atomic structure to key quantities of interest. Atomistic simulations are used to generate representative ensembles of amorphous configurations, from which local atomic environments are described using physically motivated descriptors. Supervised learning techniques, in particular partial least squares (PLS), are employed to identify low-dimensional representations that retain the dominant correlations between structure and material response.

These reduced descriptors serve as inputs to surrogate models based on Gaussian process regression (GPR/kriging), enabling fast prediction of properties such as adsorption energies, grafting energies of metal dopants, or energy barriers along selected catalytic pathways. Importantly, the probabilistic nature of these surrogates provides uncertainty estimates, which are exploited through active-learning strategies to guide additional atomistic calculations and systematically improve model accuracy at minimal computational cost.

By replacing expensive brute-force sampling with uncertainty-aware surrogate models, the proposed framework enables efficient exploration of heterogeneous amorphous materials while preserving physical interpretability. The approach provides a practical route to quantify structure–property relationships in disordered porous media and supports the rational design of materials for energy and climate-relevant applications.

References

Country

Switzerland

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Track Classification: MS01 - (MS01) Porous Media for a Green World: Energy & Climate

Contribution Type: Oral Presentation

Submitted by **LUNATI, Ivan** <ivan.lunati@empa.ch> on **Monday 12 January 2026**

Abstract ID : 906

Finite Element Modeling of CO₂-Brine Flow with Thermal Effects in Saline Aquifers

Content

Reliable simulation of CO₂ injection into deep saline aquifers requires numerical frameworks capable of consistently coupling multiphase flow and heat transport in porous media. Such coupling is essential to correctly represent the interaction between pressure, phase distribution, advective transport, and temperature evolution, particularly in the presence of strong injection-driven gradients. This work presents a finite element modeling framework designed to accurately resolve these coupled processes with numerical consistency.

Multiphase flow is described using a two-phase formulation based on overall-composition variables, considering a CO₂-brine system within a simplified yet physically consistent framework designed to isolate the dominant mechanisms of injection-driven multiphase transport. This formulation provides a coherent representation of phase behavior and establishes a suitable foundation for future extensions toward reactive transport. Thermal effects are modeled through an energy conservation equation and includes pressure-temperature coupling terms (Joule-Thomson Effect).

The governing equations are discretized using the finite element method and implemented in Python using the Firedrake framework. Distinct approximation spaces are employed for each field variable to ensure numerical stability and robustness. Pressure is solved implicitly, velocities are subsequently derived from the pressure field, saturation is advanced explicitly using the current time-step pressure solution, and the temperature field is solved implicitly using the updated pressure, velocity, and saturation.

The model is verified with respect to numerical robustness, physical coherence of the response, and correctness of implementation through a sequence of numerical experiments and benchmark tests employing different geometrical representations relevant to reservoir and near-wellbore analysis, including 1D/2D Cartesian and 1D/3D radial domains. The results demonstrate the stability and flexibility of the proposed formulation and provide a consistent basis for future coupling with geochemical models aimed at evaluating salt precipitation and injectivity loss.

References

Country

Brazil

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Track Classification: MS01 - (MS01) Porous Media for a Green World: Energy & Climate

Contribution Type: Oral Presentation

Submitted by **PEIXOTO, Daniel** <danielh_peixoto@hotmail.com > on **Tuesday 13 January 2026**

Abstract ID : 927

A comparative analysis of miscible and immiscible CO₂-flooding in a heterogeneous porous media for CO₂-enhanced oil recovery

Content

Pore-scale multiphase investigations for enhanced oil recovery (EOR) and underground gas storage determine macroscale permeability and injection efficiency. The displacement dynamics at microporous media are characterised by fluid-fluid and fluid-rock interactions along with momentum balance equations. This study presents pore-scale numerical investigations under varying reservoir properties to elucidate carbon dioxide (CO₂) enhanced oil recovery and trapping mechanisms. Multiple reservoir scenarios, ranging from 6 to 30 MPa pressure, were considered, which show a transition from immiscible to miscible flow regimes. Additionally, the role of fluid rock interactions was evaluated through numerical simulations.

For immiscible regimes, a three-phase volume of fluid (VOF) model was simulated with distinct interfacial tension (IFT) between the phases. However, to model the miscible flow dynamics, the species transport equation is coupled with the VOF multiphase model.

The hydrodynamic simulations show that mass diffusivity under high-pressure miscible conditions reduces capillary pinning, increasing oil recovery and decreasing residual brine significantly inside the porous domain. Furthermore, the study captures the sensitive analysis of the displacement dynamics for varying wettability and capillary number scenarios. CO₂ trapping mechanisms, snap-off events for different cases, were discussed. The study highlights optimisation of oil recovery and CO₂ sequestration in complex three-phase porous reservoir systems.

References

Country

India

Green Housing & Porous Media Focused Abstracts

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Contribution Type: Oral Presentation

Submitted by **Mr DEHURY, Rajat** <ch21d014@smail.iitm.ac.in> on **Tuesday 13 January 2026**

Abstract ID : 932

TIME-RESOLVED SYNCHROTRON INVESTIGATION OF ACID-INDUCED MINERAL DISSOLUTION IN RIO BONITO SANDSTONES: IMPLICATIONS FOR CO₂ STORAGE

Content

Understanding the mineralogical and structural responses of reservoir rocks to acidic fluids is essential for predicting the long-term stability of geological CO₂ storage sites. In this study, the dissolution mechanisms within Rio Bonito Formation sandstones were systematically investigated under acidic conditions using a multi-technique, time-resolved synchrotron approach. X-ray microtomography (4D μ -CT), time-resolved X-ray diffraction (TR-XRD), and time-resolved X-ray fluorescence (TR-XRF) were employed to characterize porosity evolution and mineral reactivity across a range of pH conditions relevant to CO₂ sequestration scenarios. Experiments were conducted at the Brazilian Synchrotron Light Laboratory (LNLS) utilizing custom-designed sample environments to enable real-time fluid injection during imaging and spectroscopy. Acid solutions of varying pH were injected through the samples while continuously acquiring datasets. 4D μ -CT revealed a front-like dissolution pattern, primarily affecting cement-rich regions. These regions dissolved preferentially before the acid infiltrated the intrinsic pore structure, leading to early-stage heterogeneity in porosity evolution. Under higher pH conditions, designed to simulate CO₂-rich brines at reservoir conditions, complete dissolution of cement phases was observed, destabilizing the rock matrix. This behavior is attributed to the acid volume exceeding the buffering capacity of the cement minerals, preventing early saturation and promoting continued dissolution. TR-XRD and TR-XRF analyses confirmed the progressive dissolution of key mineral phases such as calcite and microcline, with concurrent release of Ca²⁺, Al³⁺, and K⁺ ions. The quartz framework remained largely inert, maintaining the mechanical stability of the porous matrix as reactive phases dissolved. The dissolution rate demonstrated an approximately exponential decrease with increasing pH, consistent with theoretical predictions and previous flow-through experiments in carbonate-bearing rocks. The findings reinforce that mineral reactivity is strongly governed by pH, spatial distribution of reactive phases, and fluid accessibility. Comparative analysis with prior studies supports that such exponential behavior is expected during acid-rock interactions in real-world scenarios. While direct HCl injection used here differs from the gradual acidification expected in CO₂-brine systems, it effectively simulates a wide range of pH conditions, providing critical insights into reactive transport phenomena. Overall, this work highlights the effectiveness of time-resolved synchrotron techniques in capturing the dynamic processes of mineral dissolution and offers a framework for future studies under reservoir-relevant pressure and temperature conditions. The results contribute to a better understanding of CO₂ mineralization pathways and underscore the importance of mineralogical buffering in the mechanical and chemical stability of geological storage sites.

References

Country

Brazil

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Track Classification: MS01 - (MS01) Porous Media for a Green World: Energy & Climate

Contribution Type: Oral Presentation

Submitted by **JOSE SALVADOR, Aluizio** <salvadoraluizio@gmail.com> on **Tuesday 13 January 2026**

Abstract ID : 942

Microwave Assisted Synthesis of bimetallic Ni-based MOFs for High Performance CO₂ Capture from Humid Flue Gas: Experimental and Process Modelling

Content

Highly crystalline and ultra-microporous Nickel based metal organic frameworks (Ni-MOFs) were synthesized via conventional heating and microwave-assisted methods for efficient CO₂ capture from humid flue gas streams. The MOFs synthesized through microwave-assisted route exhibited large surface areas (up to 1346 m²/g) and high micropore volume (up to 0.51 cm³/g). CO₂ adsorption capacities of 5.18 mmol g⁻¹ was recorded for Ni-based framework (NB-mw). Upon introduction of Cu into the framework (NCB-mw), the CO₂ uptake increased to 6.61 mmol/g at 298 K and 1 bar. The bimetallic integration decreased the pore size due to reduction in M-O bond lengths, facilitating CO₂ diffusivity of 2.86×10^{-9} m²/s. The utilization of a single, small ligand enhanced MOFs shelf life and stability under humid conditions. And NCB-mw retained its structural integrity and adsorption efficiency over 20 consecutive adsorption-desorption cycles. The CO₂/N₂ selectivity and isosteric heat of adsorption for NCB-mw were evaluated to be 167 and 42.7 kJ/mol, respectively. Furthermore, a DFT study identified the preferential adsorption sites and their affinity towards CO₂ molecules. In addition to experimental investigations, process modelling was conducted to assess the energy consumption and scalability of NCB-mw for post-combustion CO₂ capture via temperature vacuum swing adsorption (TVSA) simulation. The analysis included fixed-bed adsorption modelling, system-level performance parameters and energy estimation to evaluate both material suitability and process integration.

Keywords: Metal Organic Framework, Microwave Synthesis, CO₂ adsorption, Density Functional Theory, Process Modelling

References

Country

India

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Track Classification: MS01 - (MS01) Porous Media for a Green World: Energy & Climate

Contribution Type: Poster Presentation

Submitted by **YADAV, Anshika** <anshika.neeri22j@acsir.res.in> on **Tuesday 13 January 2026**

Abstract ID : 945

Pore-Scale Comparison of Continuous CO₂ Injection and SAG Processes in a Rock Micromodel

Content

In carbon capture and storage (CCS), CO₂ injection behavior in porous media is governed not only by injection rate and fluid composition but also by the interaction between injection strategy and pore-network structure, leading to inherently nonlinear displacement dynamics at the pore scale. In this study, we used a physical rock micromodel CO₂ displacement under continuous injection and surfactant-alternating-gas (SAG) injection through quantitative metrics and image-based analysis.

Continuous-injection tests were conducted over 0.001–0.1 mL/min, whereas SAG tests were performed over 0.005–0.5 mL/min with 0.5–2 injected pore volumes (PV). Experiments were carried out at NaCl concentrations of 0 M and 0.599 M using aqueous solutions of SDBS (0.01 wt%) and Glucopon (0.01 wt%). Under continuous injection, displacement efficiency increased with injection rate for both surfactant systems. At NaCl 0 M, efficiency in the SDBS system increased from 45.7% at 0.001 mL/min to 76.2% at 0.1 mL/min, while the Glucopon system increased from 59.1% to 78.0% over the same rate range. At NaCl 0.599 M, the Glucopon system reached approximately 81% efficiency at 0.1 mL/min. Image observations showed comparatively stable and continuous displacement fronts at higher injection rates for both systems.

In contrast, SAG injection did not produce a monotonic dependence of efficiency on injected PV. For example, at NaCl 0 M in the SDBS system at 0.05 mL/min, continuous injection yielded an efficiency of approximately 78.8%, whereas SAG efficiencies at 0.5 PV, 1 PV, and 2 PV were 56.4%, 61.0%, and 58.3%, respectively, demonstrating non-monotonic fluctuations with alternating injection. Pore-scale images further indicated repeated pathway reconfiguration during phase switching, including simultaneous disconnection of established flow paths and localized invasion into previously unoccupied pore bodies.

Image-based pore-network analysis showed that the micromodel exhibits a structurally constrained network, with an average pore-body connectivity of approximately 3–4 and many pore bodies connected through a limited number of throats. During SAG, CO₂ invasion preferentially occurred through relatively well-connected pore bodies and larger throats, whereas low-connectivity pore bodies were repeatedly bypassed or became locally isolated. As a result, increasing injected PV altered the spatial distribution of invaded regions but did not drive the overall efficiency toward a single direction or convergence.

In the Glucopon system, continuous injection already produced reduced fingering and a relatively uniform front, and the additional impact of SAG on pore-scale pathways was limited. Under SAG at 0.05 mL/min, efficiencies were in the range of approximately 54–59%, without a clear improvement relative to the continuous-injection case. These results indicate that the influence of alternating injection is governed less by injected PV or surfactant identity per se than by the degree of residual capillary control established under continuous injection and by connectivity- and throat-size-controlled accessibility within the pore network.

Overall, our results provide quantitative and image-based evidence that non-steady injection strategies can reconfigure pore-scale pathway selection in structurally constrained porous media, but the resulting displacement response is non-monotonic and strongly condition-dependent. This highlights the need to interpret SAG and related strategies from a pore-scale flow-mechanism perspective rather than relying solely on efficiency-based performance metrics.

References

Country

Republic of Korea (South Korea)

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Track Classification: MS01 - (MS01) Porous Media for a Green World: Energy & Climate

Contribution Type: Oral Presentation

Submitted by **JUNG, Jongwon** <jjung@chungbuk.ac.kr> on **Wednesday 14 January 2026**

Abstract ID : 946

Functionalization of Micromodels Using Olivine Sand for Investigation of Geologic Hydrogen Production from Serpentinization

Content

Serpentinization of ultramafic rocks offers a promising carbon-negative pathway for in-situ geologic hydrogen generation. By reacting water with magnesium-rich minerals like olivine, this process yields molecular hydrogen (H_2) and can simultaneously sequester carbon dioxide through mineral carbonation. However, the pore-scale mechanisms governing fluid–mineral interactions, mineral expansion, and gas phase evolution remain poorly understood due to the lack of high-resolution spatial and temporal data. This study presents a novel micromodel platform enabling real-time visualization of serpentinization and hydrogen evolution under controlled laboratory conditions.

The experimental platform utilizes a silicon wafer etched with a complex sandstone-inspired flow pattern through photolithography. To replicate the mineralogy of ultramafic reservoirs, the etched channels were functionalized with olivine sand, creating a reactive “fracture-on-a-chip.” The micromodel was sealed with borosilicate glass and mounted in a custom-engineered aluminum holder designed to withstand temperatures up to 250°C and pressures up to 560 psi. The system was integrated with a high-precision ISCO pump and a back-pressure regulator to inject pre-degassed brine. A rigorous degassing protocol was implemented to ensure that any observed gas phases resulted from chemical reactions rather than liberated dissolved air.

Moving beyond initial 80°C proof-of-concept tests, experiments conducted at 110°C and 655 kPa (approx. 95 psi) provided critical insights into reaction kinetics and phase behavior. Under these elevated conditions, real-time reflected light microscopy captured the emergence of visible bubbles within the olivine-functionalized pores. These bubbles, a direct observation of gas evolution, were seen nucleating at mineral-fluid interfaces and coalescing within the flow channels. This phenomenon is vital for understanding how hydrogen gas might migrate or become trapped within the subsurface.

To quantify these dynamics, the machine learning tool Ilastik was employed for image segmentation. While the software was highly effective at identifying olivine grains and tracking the morphological evolution of the micromodel structure, it faced challenges in distinguishing gas bubbles from liquid brine in deeper or shadowed channels. Post-experimental characterization provided definitive evidence of the serpentinization reaction. Scanning Electron Microscopy (SEM) analysis of the olivine grains recovered from the 110°C tests revealed the development of secondary mineral phases. The SEM imagery showed the formation of wave-like structures consistent with proto-serpentine formation. These structures were found coating the original olivine surfaces, confirming that the micromodel platform successfully facilitates and captures the chemical transformation of ultramafic rock.

These results inform improvements for future tests, including the use of fluorescent imaging or micro-computed tomography (micro-CT) to map chemical changes and gas production in situ. By providing high-resolution data on mineral precipitation and gas evolution, this micromodel platform enables mechanistic investigations of natural hydrogen systems. Furthermore, the measured fluid and rock properties serve as critical inputs for pore- and reservoir-scale simulations, helping project collaborators identify the optimal conditions for carbon-negative hydrogen production in global ultramafic reservoirs.

References

Country

United States

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