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Editorial

HIGHLIGHTS FROM THE FOURTH ISSUE OF INTERPORE JOURNAL

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I am delighted to introduce the latest issue of *InterPore Journal*. It's both rewarding and exciting to see this collection of papers come together. I extend my sincere gratitude to all the authors who have contributed their insightful research, the dedicated reviewers who offered their time and expertise, and the editorial team whose hard work and commitment made the publication of this new issue possible. Each of you has played an important role in upholding the quality and integrity of our journal. It is through these collective efforts that we continue to foster meaningful academic dialogue and advance knowledge in our field.

In this issue, in an invited commentary, Spurin et al. (1) explores the growing importance of understanding small-scale heterogeneity in porous media for modeling subsurface fluid migration, crucial for CO_2 and H_2 storage. It highlights three key factors: stricter permitting requirements for storage projects, different risk tolerances requiring long-term monitoring, and unique flow physics compared to traditional oil and gas extraction. The authors review how current models underestimate CO_2 plume spread, discuss relevant spatial scales for both CO_2 and H_2 storage applications, and suggest future research directions to improve storage modeling.

Danelon et al. (2) presents a model for nanoparticle-stabilized foam flow in porous media, incorporating particle retention and its effect on permeability. Their results show that when particle retention is neglected, the sweep efficiency improves compared to the case without nanoparticles, even at a low nanoparticle concentration. In contrast, when retention is accounted for, this enhancement is observed only at higher concentrations. The impacts of nanoparticle retention on pressure drop, permeability and foam's apparent viscosity are discussed in this paper highlighting the need to account for this phenomenon for an accurate process description.

Salter et al. (3) investigates enzyme-induced carbonate precipitation (EICP) as a promising technique to create low-porosity, low-permeability subsurface barriers, essential for CO_2 and H_2 storage, prevention of pollutant transport, and other subsurface flow challenges. High-speed lab x-ray computed tomography and flow modelling were used to study the mechanisms of reagent mixing and precipitation. This study reveals that crystallization starts uniformly on grain surfaces then localizes in pores with high enzyme concentrations. Simulations show that modeling the mixing as density-driven flow accurately predicts crystal distribution and permeability reduction. The validated model helps design tailored injection strategies, advancing the practical application of EICP for effective subsurface barriers.

Orujov et al. (4) explores the use of biosurfactants (specifically rhamnolipids) combined with bio-nanocrystals (cellulose nanocrystals, CNCs) to enhance foam stability for groundwater remediation. The effects of pH and CNC concentration on foam properties were examined through foam tests, rheological measurements, and sand pack flooding experiments. The results allowed the authors to recommend the mixture properties for creating an optimal, eco-friendly foam with maximum stability, foamability, and elasticity.

Wang et al. (5) analyzes published experimental hydrogen (H_2)/water relative permeabilities (RP) data used for simulating underground H_2 storage in aquifers. Fine-grid simulations of H_2 displacing water, using three widely cited RP datasets, showed stable fronts instead of the anticipated viscous fingering, which is a key indicator of correct input data used in the simulation given the viscosity ratio between water and H_2. The study attributes this to shortcomings of the conventional gas/liquid experimental methods used to obtain the RP functions. To address this, the authors propose a new set of viscous dominated "fingering RP functions". These new functions produce fully dispersed flow at the core scale. However, the viscous fingering emerges in horizontal flow as the length scale of the system increases, offering a more accurate approach for modeling H_2 storage behavior.

Krach et al. (6) employs Digital Rock Physics approach to retrieve the intrinsic permeability and its evolution in anisotropic porous materials, which are subjected to pore space alterations. A computational framework based on the finite difference method is developed to solve pseudo-unsteady Stokes equations for fluid flow in the pore scale. An efficient and parallelized implementation of this method is presented for large voxel-based datasets originating from various image-based experimental setups. Benchmarks investigations were conducted to demonstrate the solver's compatibility with large domain sizes generated by advanced imaging techniques. The study investigates two cases: an open-cell foam undergoing deformation and a microfluidic cell experiencing precipitation within its pore space.

Notably, two of the papers in this issue, by Salter et al. (5) and Danelon et al. (2), are also the first two recipients of the *Invited Student Paper Award*, based on outstanding presentations at the *InterPore2024* annual meeting last May. This award recognizes exceptional student contributions to the field, inviting nominees to submit their research for publication in *InterPore Journal*. The award is granted upon successful publication, ensuring that only the highest-quality work is recognized. All recipients from the *InterPore2024* conference will be officially announced at *InterPore2025*. More details about this award can be found here.

As we conclude this edition, I would like to express my deepest appreciation for the continued commitment and passion that fuels the success of the InterPore Journal. Your valuable contributions drive the ongoing evolution of our field, and I look forward to the innovative research you'll share in future issues. I hope this collection of papers offers you both new perspectives and inspiration for your own work. Happy reading!

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