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Visualisation of microbial activities in reservoirs during UHS based on real-rock micromodels

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Hydrogen, converted from renewable energy sources, provides a feasible route map to balance the daily up to seasonal fluctuation between renewable energy supply and consumer demand. However, storing such a large volume of hydrogen (G-TWh) safely and economically remains a big challenge for achieving net-zero emission targets for the future. The concept of underground hydrogen storage (UHS) in porous formations is promising since depleted hydrocarbon reservoirs and aquifers are widespread worldwide. Unlike underground natural gas (mainly methane) storage, hydrogen is the perfect electron donor for microbes, and thus microbial metabolisms can consume and convert hydrogen into other molecules, e.g., methanogenesis, H2 + CO2 to methane, causing the loss and contamination of hydrogen. Another concept is geo-bio-methanation, converting hydrogen to methane directly in the subsurface for stable long-term storage. Both concepts need a thorough understanding of microbial activities in porous rocks. Questions, including, 1) does microbial growth reduce reservoir performance? 2) is there any effect of minerals and pore microstructures on microbial activities? 3) how do static and flow conditions affect microbe distribution? need to be better elucidated. In this study, we develop an unconventional real-rock micromodel configured with a thin rock layer in a transparent microfluidic chip to visualise microbial growth under a fluorescence microscope. The real-rock micromodels will fill the drawback of the lack of mineral difference and real pore structures. This workflow and platform may hence open new possibilities in studying microbial metabolism in geo-materials and the potential interactions.