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On the conceptual role of permeability contrasts within sandstone utilised for underground hydrogen storage

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Numerical modelling with commercial software (CMG) was used to analyse of the effect of contrasting permeabilities on fluid flow and hydrogen plume development in subsurface, porous media employed in underground hydrogen storage. Increasing heterogeneities were introduced to reservoir-scale simulations, based upon the Navajo sandstone, Utah in an aquifer-supported system. Initial investigations into the effects of well placement on reservoir pressure, cumulative hydrogen and water production in a homogeneous and heterogeneous model were used as baseline simulations to benchmark the performance of scenarios containing further permeability contrasts.

The results show, in terms of well placement, that production well placement at the top of the reservoir is the most important factor to maximise hydrogen production, due to the buoyancy of hydrogen. The relationship between permeability and viscosity in Darcy's equation of flow provides a rudimentary guide to the behaviour of hydrogen in relation to contrasting permeabilities. However, reservoir heterogeneities affect fluid pathways, linking the effects of previous permeabilities, creating compartments and impacting upon the flow of other fluids. These characteristics, coupled with hysteretic effects, affect local pressure gradients, the other variable in Darcy's equation, and determine the hydrogen migration. As a result, forecasts of plume development and reservoir performance need to consider the whole system.

Participation

In-Person

References

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