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Quick estimation of capillary pressure barrier of fractured caprocks.

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An ideal CO2 storage site needs to be able to contain a large volume of CO2 without any significant leakage through the caprock seal. Aside from legacy wells, (sub-seismic) faults and associated fractured damage zones form a potential containment risk. A well-connected fracture network can increase the permeability and decrease the capillary barrier of the caprock, rendering them to be potential pathways for CO2 leakage. Therefore, for a successful identification of sequestration sites, quick screening of fault-related leakage risks is needed. In this work we present a workflow to quickly estimate the capillary pressure barrier of a fault related fracture network under different stress conditions using percolation algorithms on two different scales, the single fracture scale, and the fracture network scale.

For the fracture scale we generate several synthetic fracture surfaces with different roughness values and calculate the resulting aperture field. This aperture field informs a capillary entry pressure field via the Young-Laplace equation. The proposed algorithm determines if a percolation of CO2 from one boundary of the fracture to another occurs for specific fluid pressure values at the inlet. The fluid pressure at percolation is then defining the upscaled capillary entry pressure of the fracture. This procedure is repeated for a range of stress boundary conditions acting on the fracture walls, that is for different average fracture apertures, to obtain the stress sensitive capillary entry pressure relationship for fractures with different roughness properties.

On the fracture network scale, we apply a similar upscaling procedure on various statistical realisations of a fault related fracture network. Different stress values on the fracture network boundaries determine the stresses acting on each individual fracture of the network. Using these stress values and the corresponding upscaled capillary entry pressures from the previous step informs a heterogeneous capillary pressure field of the whole network that then can be used to obtain the uncertainty envelope for the overall fracture network capillary pressure barrier.

Low values of capillary pressure barrier would indicate higher leakage risk associated with that site. High values on the other hand, could identify a potential storage site that needs further investigations to determine its 'quality'. The proposed algorithms are computationally very efficient and thus provide with a powerful tool for rapid screening of potential CO2 sequestration sites.

Time Block Preference

Time Block C (18:00-21:00 CET)

References

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