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Anisotropic stochastic Pore Network generation algorithm with application to shale gas flow

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With climate change mitigation actions in place, Carbon Capture and Storage (CCS) is by far the most industrially efficient technology to reach net-zero carbon emissions (HM Government, 2018), with current annual capture capacity exceeding 40 million tonnes of CO2 world-wide (BP, 2020). While supercritical CO2 is stored in conventional reservoirs or saline aquifers, overlying mudrock formations create a structural trap, preventing CO2 leakage. Opalinus Clay is a perfect candidate for CCS research, with a large amount of existing data (Bossart and Milnes, 2017) and experimental work performed, allowing for good understanding of pore space processes. Upscaling properties such as absolute and relative permeabilities and capillary pressures are necessary for reservoir-scale modelling of CCS processes and caprock leakage assessment, but are difficult to obtain experimentally.

Pore Network Modelling (PNM) is a method used for estimating representative rock flow properties, and is significantly more computationally efficient than most other methods. In this work we created an algorithm, which generates a representative pore space model with pore sizes ranging from sub-nanometre to over a micron, while carefully calibrating pore geometry to match observed porosity and pore size distributions. Novel technique for representation of the shale pore space anisotropic behaviour, which allows for adjustment of the degree of orientation of pore throats with respect to the bedding plane, based on Small-angle X-Ray Scattering observations. Real gas and adsorption effects were accounted for following the method used in (Song et al., 2018) and using experimental high-pressure sorption data respectively. Single phase gas permeability was simulated at various conditions and verified against unsteady state plug permeability measurements, performed on Opalinus Clay.

Participation

In-Person

References

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