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Optimization of the CO2 injection location in heterogeneous siliciclastic reservoirs using graph theory

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Siliciclastic CO2 storage reservoirs often comprise lithological heterogeneity across different spatial scales. Consequently, the reservoirs could include high permeability pathways resulting in an unexpected migration of fluid. On the contrary, the presence of certain rock types which act as flow barrier, especially near the injection source, could block the flow of CO2 leading to reservoir pressure build-up. The latter is not desirable as it limits the CO2 injection rate. Identifying suitable injection locations away from flow barriers could require numerous high-fidelity numerical simulations due to the uncertainty resulting from the distribution of low-permeability rock types. This study presents a new computationally efficient approach for screening favourable locations for CO2 injection in heterogeneous reservoirs to minimise pressure build-up. The approach utilizes graph theory to identify the path of the least resistance to CO2 flow between the injection source and the top of the reservoir. Graph network models were synthetically created for 50 reservoirs to capture the variability in rock properties and their distribution. The paths of least resistance were determined for these reservoirs and their characteristics were found to correlate with injectivity indices determined from numerical simulations on the same models. The correlation was further used to derive a classification criterion for predicting a grid-cell scale injectivity index in heterogeneous siliciclastic reservoirs. Testing showed that the approach could accurately predict the spatial variability of injectivity index with a computational boost of up to 10,000 times compared to the conventional numerical simulation-based approach.

Participation

In-Person

References

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