Modeling Rock Cores Using MRST

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Introduction: The study of CO_2 sequestration and storage in rocks has significant applications in the fight against climate change. The goal of the present study was to create a visual model of core-scale rocks, which reside as an intermediate stage between pore and reservoir scale. The model was created and then modified to contain properties of specific rocks. It was also used to simulate certain experiments that are conducted in the lab, such as two-phase flow, so that a deeper understanding of the physical experiment can be achieved in observing the model.

Methods: All modeling and visualizations created in this research was conducted using the MATLAB Reservoir Simulation Toolbox (MRST), a free downloadable addition to the traditional MATLAB platform. Code was manufactured to create cylindrical and rectangular models with various rock properties, such as permeability, porosity, and lamination geometry. Modules in MRST were used to produce functions of one and two-phase flow that were applied to the model and helped produce graphs related to how each rock stores carbon. The single-phase flow solver (Figure 1) consists of boundary conditions with pressures that shift at either end of the model, while the two-phase model (Figure 2) focuses on oil and water as they move through the model with one another. The two-phase solver also produces density comparisons and relative permeability curves.

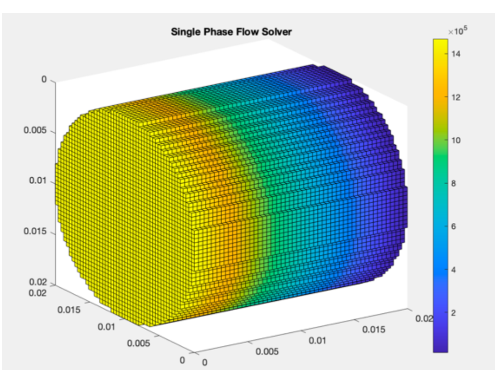

Figure 1: Pressure Gradient from Single-Phase Solver

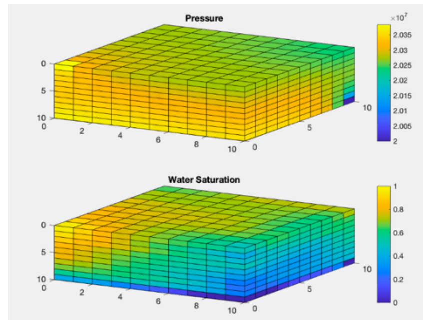

Figure 2. Pressure and Water Saturations from Two-Phase Flow

Results: The models and simulations allow users to draw conclusions between the experiments conducted using simulations and in-person. Their purpose in providing a visual aid to the carbon storage mechanisms that were occurring within the rock cores was successful.

Conclusions: This study evidences that the core-scale modeling of rocks and the experiments that are done on them are possible to conduct using MRST. They are indeed accurate enough in their visualizations to become an aid to people who wish to understand the physical processes behind in CO_2 storage in rock cores. Recommendations for future studies include extending the code to automatically calculate effective permeability values and the ability to map laminations to the model directly from a photo of a rock core.

References:

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