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Geomechanical Response in Energy Transition Applications: Assessing its Role with Data Assimilation

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The subsurface is characterized by significant uncertainties that pose challenges for geothermal energy production, CO_2 sequestration, and hydrocarbon field development. To handle this uncertainty, engineers often use ensembles of models with different porosity and permeability distributions. In addition, history-matching procedures can further reduce uncertainty. However, traditional methods using well bottom hole pressures as observations can be challenging for geothermal or CO_2 sequestration projects with a limited number of wells. To overcome this limitation, additional observation data can be used. In this study, we propose using vertical displacements to evaluate the subsidence/uplift of the model. Pressure depletion, for example, leads to surface subsidence due to rock compaction. We suggest measuring subsidence during field development and using it as an objective function to minimize the difference from measured data. Our approach provides a more reliable and accurate way to evaluate the model's subsurface behavior, helping to reduce uncertainties in geothermal energy production, CO_2 sequestration, or hydrocarbon field development.

We used a state-of-the-art simulator called DARTS [1] to simulate fluid flow in the subsurface, and computed geomechanics response using a physics-based proxy. We then performed history matching using ensemble smoother with multiple data assimilation (ES-MDA) of the reservoir subsidence to better understand the reservoir properties, such as permeability [2]. Our workflow involved generating an ensemble of models with varying permeability and computing vertical displacements using the physics-based proxy model for geomechanics [3]. We then applied ES-MDA to find the model with permeability that fits best to the reference subsidence surface. Flow pattern in heterogeneous reservoir determines in-situ stress changes, which could induce seismicity in a presence of natural faults. We used fault slippage criteria for each scenario. Data assimilation procedure provide us history matched model, and, therefore, more reliable assessment of induced seismicity risk. We used 2.5D extruded mesh with heterogeneous permeability and uniform geomechanical properties.

Contributor statement

Writing – Original Draft: Ilshat Saifullin, Gabriel S.Seabra; Writing – Review and editing: Denis Voskov.
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