Coupled DDM-FEM solution applied to fault reactivation assessment in CO_2 sequestration

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The amount of CO_2 in the environment has increased due to widespread industrial activities, fossil fuel utilization, as well as deforestation. Carbon sequestration and geological storage are the most used and promising techniques to mitigate carbon emissions [1]. Alternatively, carbon storage can also be utilized for enhanced oil recovery, improving reservoir permeability and reducing CO_2 emissions from petroleum activities. However, the capture capacity and long-term safety in geological deposits must be ensured since CO_2 leakage through geological faults can potentially contaminate the soil and groundwater surrounding the storage site.

This work proposes using a Displacement Discontinuity Method (DDM) and Finite Element Method (FEM) coupling scheme to investigate fault reactivation due to Co2 injection in a pre-salt reservoir. The coupling approach adopts the finite element methods to solve the fluid flow through the porous media associated with the Displacement discontinuity method to solve the mechanical behavior [2]. The geological faults are modeled using a zero-thickness interface element associated with the Mohr-Coulomb plastification criterion to evaluate the fault reactivation process [3].

The influence of the in-situ stress and the fault orientation on the reactivation potential are analyzed. The simulation also investigates the optimum injection pressure to maximize CO_2 storage and critical reservoir pressure to avoid fault reactivation. The simulation indicates that reactivation can increase the storage capacity, in other cases, it can result in corridors for leakage of injected CO_2. Furthermore, the depleted petroleum reservoir overlayed with salt caprock could be suitable for long-term and safe carbon capture and storage in geological formations.

The numerical results show that the coupled DDM-FEM approach can be an attractive alternative to simulate fault reactivation in CO_2 storage process with good accuracy and low computational effort.

References

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