The Potential Fault Instability Induced by Pore Pressure Changes Under the Strike-Slip Regime: Implications from 3-D Coupled Reservoir Geomechanical Modeling

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Abstract

Fault hydraulic behavior and mechanical instability in subsurface reservoirs is a sensitive issue for petroleum exploration, geothermal energy, CO2 storage and waste-disposal. We investigate the risk of shear slip of high-angle normal faults under the present-day strike-slip regime in the St. Lawrence Platform, Quebec that may be generated by pore pressure perturbations in deep saline aquifers of Paleozoic sedimentary basin, with implications for the assessment projects of CO2 storage and deep geothermal energy potential. Multiple runs of 3D coupled reservoir geomechanical modeling (Petrel-Visage-Eclipse) simulate several steps of increasing pore pressures by 4, 6, 8 and 15 MPa in sandstone reservoir in the footwall of the Yamaska Fault. Our results show that plastic shear deformations along the fault are initiated at the step of pore pressure increase by 8 MPa and a larger area slipped during the next injection stage. The non-linear geometry of the fault results in localization of plastic shear strain on the prominent fault segments optimally oriented, while other segments remain inactive. The shear slip occurs mostly at the depth level of the injection interval propagating laterally and upward in highly stressed fault segments. Our study helps to quantify the risk of fault reactivation induced by injection operations.

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