
Induced seismicity due to fluid injection in geological reservoirs: influence of pumping strategies

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R esum e

In the context of deep exploitation (gas storage, deep geothermal energy or wastewater disposal), there is the necessity to enhance the reservoir permeability before exploitation. To enhance the permeability, one way is to conduct stimulations by fluid injection which increase the pore pressure. However, this method can generate an increase of the seismic risk on distant faults. This is due to the fact that the overpressure provokes an effective normal stress decrease, leading to a potential rupture of critically stressed distant faults, known as induced seismicity. Induced seismicity potentially related to well operations has been observed in zone of oil and gas production, mining exploitation, fluid sequestration or in deep geothermal reservoirs.

The main goal of this work is to prevent induced seismicity from critically stressed distant faults by minimizing the pressure disturbances at distance of the well due to underground industrial operations while maintaining important pore pressure close to the well. Thus, we numerically study the diffusion of pressure disturbances due to well injection in a poro-elastic reservoir. We then use the diffusion of pressure disturbances to understand the evolution of the effective stress and to investigate the risks of induced seismicity.

A numerical model based on the finite difference method is developed to solve the pressure diffusion equation. The domain is assumed to be isotropic and homogeneous. The 2D domain represents the fault plane and permeable damaged zone embedded in a less permeable rock in 2D. We also perform simulations in the homogeneous sedimentary reservoir

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using 3D modeling.

The numerical model is validated by comparing the numerical distant pressure disturbances (at 5km from the injection/production wells) to analytical solutions developed from the Green's function of diffusion equation. The numerical model is then used to investigate the influence of a different fluid injection/production strategy (time-dependent injection) on the near-well and distant pressure disturbances. The performances of different pumping strategies are compared at an equivalent level of pressure close to the well in the region targeted for simulation. The results show that the oscillating pumping strategy has a significant potential in reducing the induced seismicity on distant faults. Further works including models of increasing complexity with more realistic fault geometries and operational conditions will be conducted for mitigation strategies.