Application of Existing Oil and Gas Approaches for Assesment of Induced Seismic Hazard

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Abstract

The vast increase in seismic activity in certain areas undergoing subsurface fluid injection has highlighted the need for better understanding of the system as a whole. The petroleum industry has a long history of modeling environments that feature a large degree of uncertainty, and has accumulated a breadth of expertise in producing realistic results, given limited input data. Similarly, a large repertoire of tools, workflows, and best practices have been developed for geophysical modeling, with generations of experience.

In this work, we use a generic, simulated example, representative of Oklahoma like subsurface conditions, and investigate the applicability of off the shelf tools toward modeling conditions likely to increase induced seismic hazard. Our base considers a characteristic subsurface disposal formation, with an injector positioned several kilometers horizontally from a fault. First, we address the pore pressure diffusion by running a multiphase fluid flow simulation. The resulting pore pressure changes are then introduced into an integrated geomechanical model to assess stress and strain changes at the fault.

We investigate the the influence of the distance between injector and fault, the permeability of both fault and target formation, and formation mechanical properties by means of sensitivity analysis. Initial modeling results suggest that increase in seismic related risk depends as much on rate and overall time of injection as the proximity of a critically stressed fault to an injector. The formation permeability may also serve as a temporal countdown for seismic hazard.

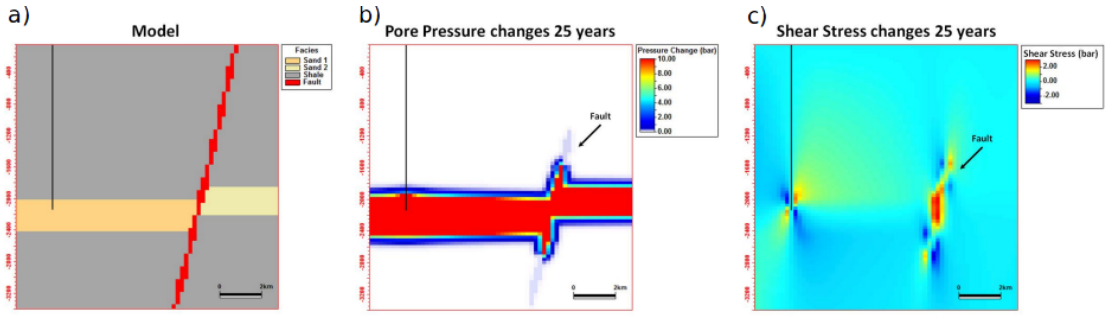

Figure 1: *Results from the fluid flow and geomechanical simulation. a) Model used for numerical analysis. b) Pore pressure changes following twenty five simulated years of injection. c) Shear stress changes from injection related pressure buildup.*