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Effects of geological barriers on the induced seismicity by fluid injection: geomechanical analysis of a compartmentalized reservoir

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The Val d'Agri Oilfield (Italy) has been affected by micro-seismicity since the inception of wastewater injection into a marginal portion of the reservoir. Such seismicity almost lasted for the first four years of injection, which is currently going on. The complex geological structural architecture of the reservoir has been recently re-defined on the basis of a dense set of 2D/3D seismic and borehole data. The induced seismicity which occurred very close to the injection point is mostly confined into the reservoir and characterized by normal faulting kinematic, even if principally aligned on an inherited back-thrust. Such structure belongs to a larger thrusts and back-thrusts system, favorably oriented within the current extensional stress field, probably kinematically inverted. A refined analysis of focal mechanisms of the induced seismicity also shows a minor strike-slip component, interpreted as connected to the concurrent reactivation of a previous transverse fault of the compressional system cutting the whole original fault sets.
Here we perform coupled fluid flow and geomechanical numerical simulations to understand the evolution of the stress field in the Val d'Agri Oilfield due to wastewater injection. We model the behavior of main faults involved in the induced seismicity process by frictional contacts in a finite element framework. The permeability into the thrusts and transverse fault zones are changed in order to understand the role of these structures either as fluid pathways or as efficient compartmentalization barriers for the pore pressure diffusion front associated to wastewater injection. Final aim is to have a more complete picture of the induced seismicity in Val d'Agri oilfield as a consequence of the pore pressure increase as well as its relationship with the original thrust and back-thrust system and the active stress field.