As a numerical experiment, an existing Explicit Finite Element Discontinuum tool used in non-linear analysis for open pit slope and underground hydromechanical problems was modified to allow simulation of additional phases and used to simulate oil extraction and fluid injection between multiple wells across a faulted, folded and expansive multi-layered oil and gas deposit. The main benefit is that the existing FE tool is powerful and can efficiently handle complex geometries, sophisticated programmable constitutive behaviour, large numbers of faults and is parallelised for rapid results computation.

In the example, the conventional equations governing fluid and gas flow and pore pressure were solved simultaneously with the equations for deformation and damage inside the 3D field scale FE (non-linear) models. A relationship between permeability and rock damage was also defined and acts as a solution constraint. Discontinuities were handled explicitly and the different hydrogeological domains were mapped with the geological domains, or as separate volumes.

The test simulated a theoretical long term extraction and injection schedule across a large number of wells and was able to generate a simulation of important phenomena:

- Well dislocation and subsidence
- Energetic fault slip associated with very high seismic potential
- Contamination of the overlying gas layers with oil after plastic damage to the rock mass separating the layers
- Premature recovery of the injected fluid in place of oil

Model results, interpretation and a proposed workflow for application to real problems are discussed.