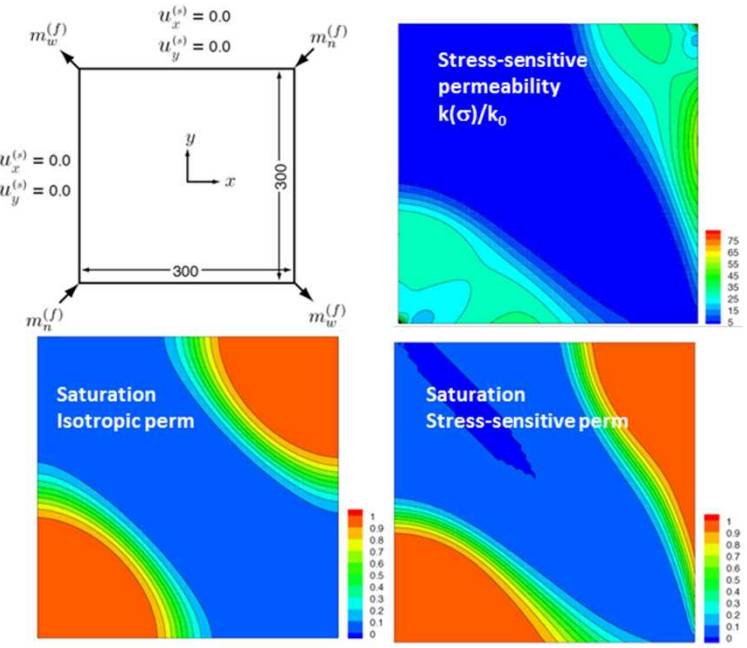
Models for Nonlinear Subsurface Flow and Geomechanics

SAND2015-1871PE



5-point flood into a homogeneous (lower left) and a stress-sensitive, heterogeneous (lower right) reservoir. Injection-pressure-induced stresses damage the reservoir thereby inducing increased, heterogeneous permeability (k/k0) and increased (decreased) water cut at lower right (upper left) production wells.

Turner, et al., 2014, Framework for coupling flow and deformation of a porous solid, Int. J. Geomech., DOI: 10.1061(ASCE)GM.1943-5622.0000416.

Scientific Achievement

Developed a generalized mathematical framework based on theory of interacting continua for coupled subsurface flow and geomechanics processes.

Significance and Impact

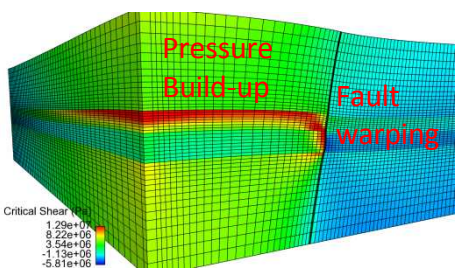
The framework facilitates modeling coupled physics in a conveniently implemented fashion.

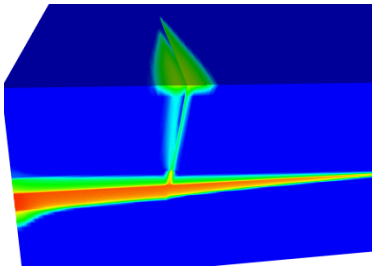
Research Details

- A generalized mathematical framework for coupled flow and geomechanics was developed.
- The interaction between fluid and solid appears in the form of a drag-like term.
- The framework enables modeling of stress-sensitive reservoirs to study injection pressurization effects on caprock integrity.
- The framework facilitates code development by placing the models into a generic continuum mechanics setting.
- The framework allows extension to model coupled reactive processes.

Models for Fluid-Induced Geomechanics Processes for Geologic Carbon Storage

Impact of faults on critical shear failure and leakage

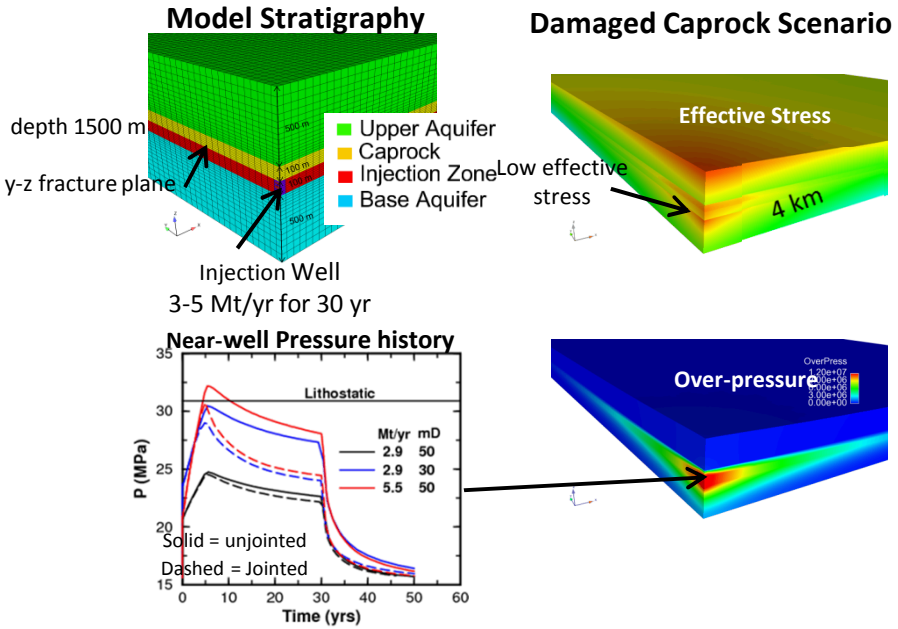




Low permeability fault impedes CO_2 injection and builds pressure behind the fault and inducing critical shear failure in both the caprock and fault.

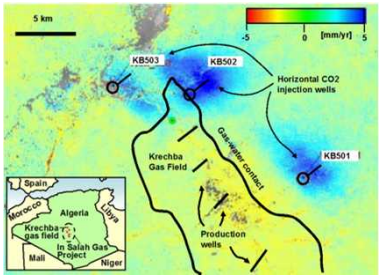
High permeability fault creates a pathway for leakage of CO_2 through the caprock.

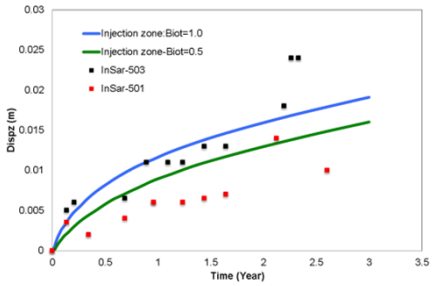
Jointed Rock Model



High injection rates and/or low storage aquifer permeability can lead to fracturing of the caprock, inducing leakage.

In Salah Application





Impact of geomechanical and hydrological properties on models for injection-induced uplift at InSalah

Bishop et al., ARMA 12-190 (2012)
MJ Martinez et al., Int. J. Greenhouse Gas Control, 17, 148-160 (2013)
Turner, et al., (2014) Int. J. Geomech., DOI: 10.1061(ASCE)GM.1943-5622.0000416.
Newell, et al., Systematic Investigation of the Influence of Geomechanical and Hydrogeological Properties on Surface Uplift at In Salah, (2015)submitted.

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