

# Geomechanical Behavior of Sandstone Reservoirs

## Scientific Achievement

Experiments using Mount Simon Sandstone lithofacies demonstrates range of new constitutive behaviors, and validates Kayenta Model for inclusion in FEM.

## Significance and Impact

Suggests best practices for pressure hazard assessment including induced seismicity, and wellbore damage prediction during CO<sub>2</sub> injection and brine withdrawal.

## Research Details

- Mount Simon heterogeneity yields a range of deformation styles from poro-elastic to elasto-plastic with coupling.
- Advanced constitutive model Kayenta is validated and includes non associative plasticity, kinematic hardening, elastic-plastic coupling, and nonlinear failure criteria.
- Linking static core-scale lab experimental (nonlinear) elastic moduli to dynamic moduli determined from well log and seismic data allows upscaling of results to reservoir scales.

Dewers, T., Newell, P., Broome, S., Heath, J., and Bauer, S. (accepted) *International Journal of Greenhouse Gas Control*



Mount Simon, Illinois Basin and CCS Injection Projects



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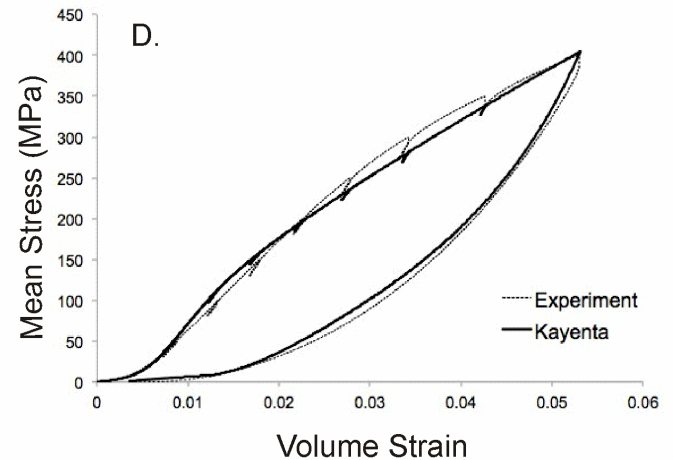
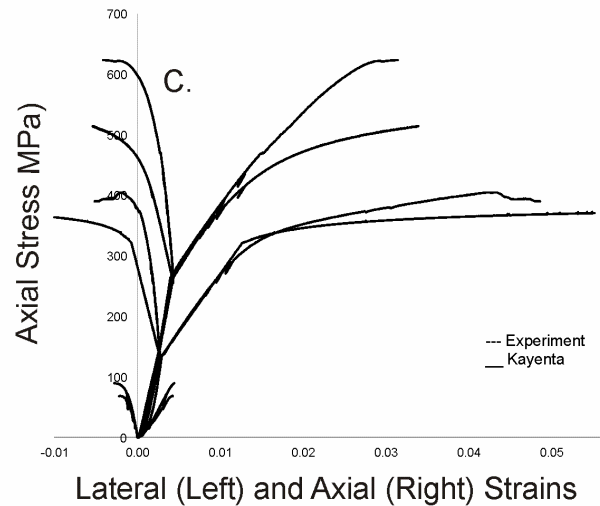
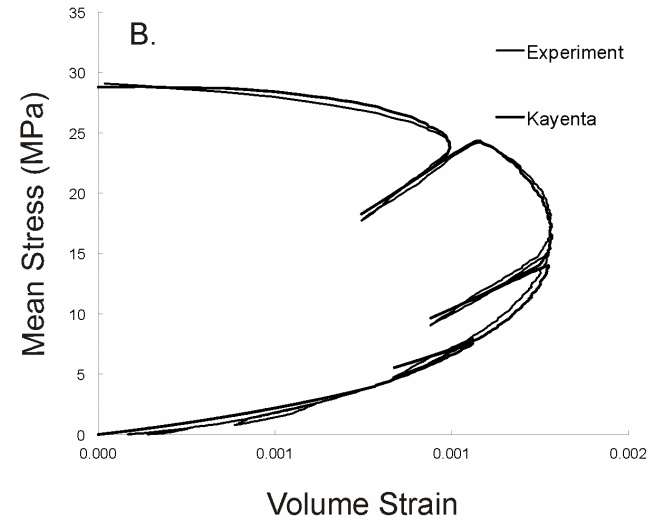
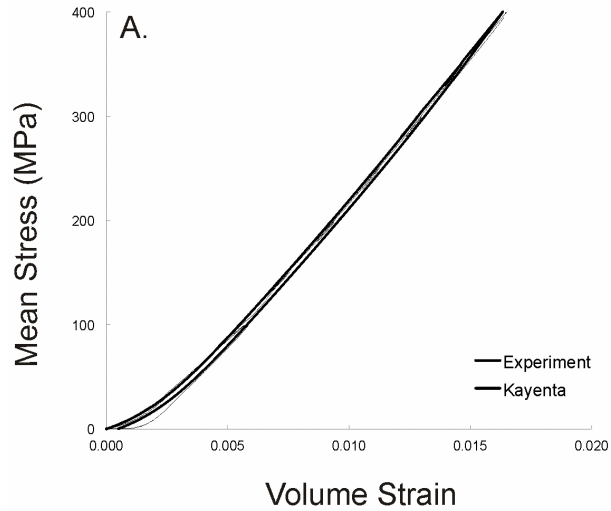
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# Kayenta Model Validation

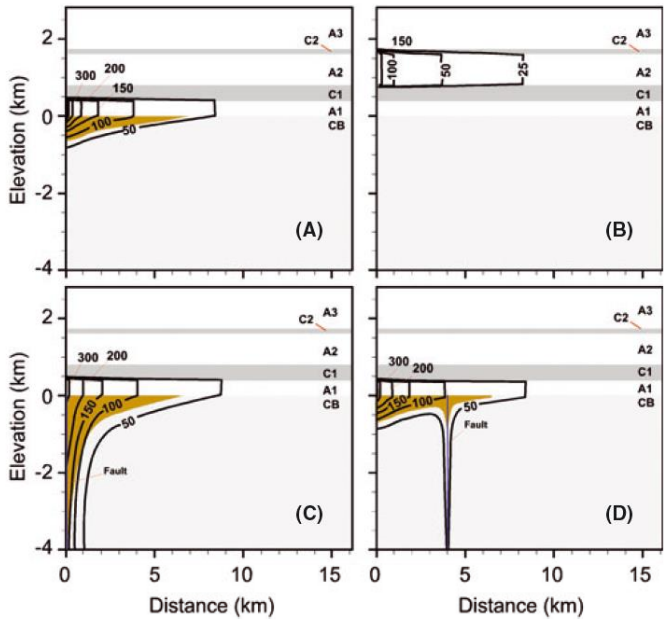
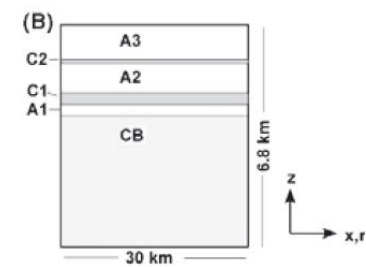
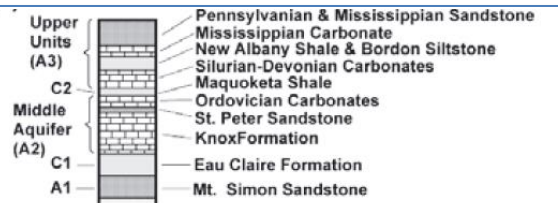
## Kayenta\* Includes:

- Non-Associative Plasticity
- Stress Invariant Dep. Failure
- Elliptical Cap Surface
- Kinematic Hardening
- Isotropic Hardening
- Nonlinear Elasticity
- Elastic-Plastic Coupling



\*Developed by Brannon et al. 2009

# Application: Induced Seismicity In Mt Simon Sandstone

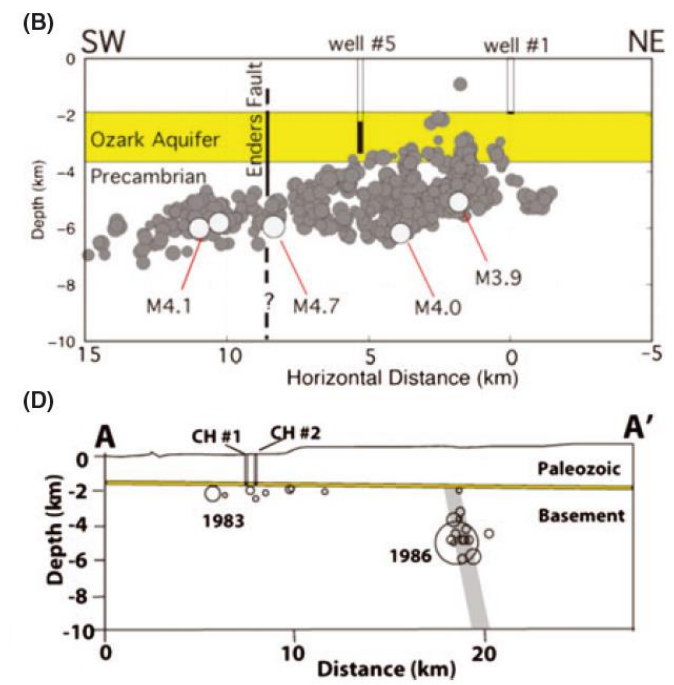


Simulated pore pressure during injection, with failure occurring within gold shaded regions

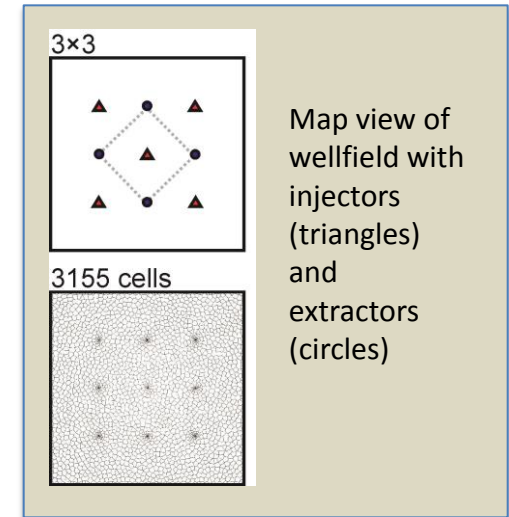
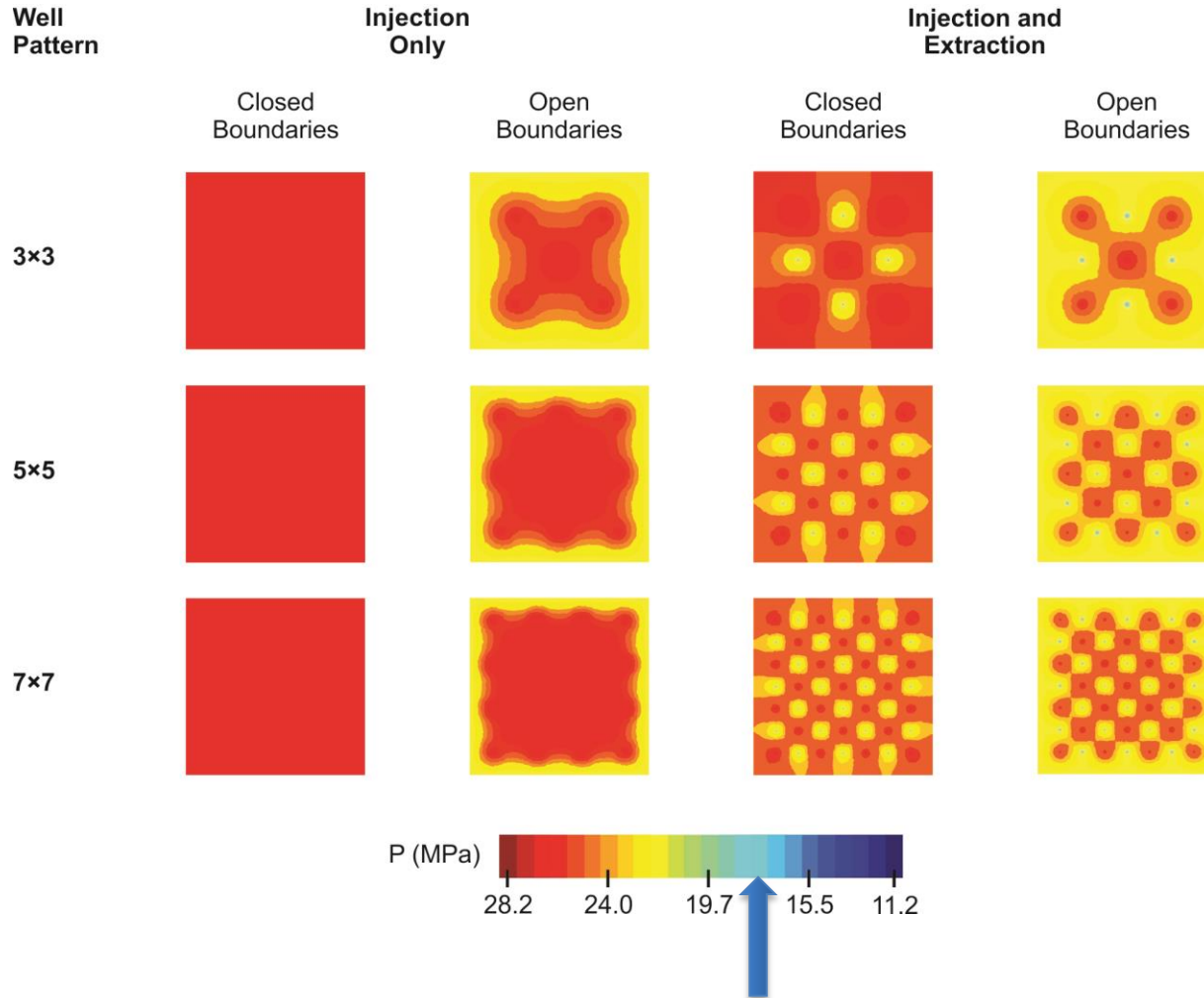


Site of Youngstown Ohio 2011 earthquakes thought to be triggered by fluid injection into the Mt Simon

Locations of earthquake epicenters (circles) and injection wells for Guy, Arkansas 2010-2011 and Lake, Ohio 1983-1986 earthquake swarms



## Map View of 16 km<sup>2</sup> Well Field Pressure Evolution



Drawdown at Mt Simon extraction wells can induce shear failure and wellbore damage

Threshold pressure for breakouts/well sanding determined experimentally