SAND2013-7524C

CFSES InSalah Team Meeting

Joe Bishop, Pania Newell, Mario Martinez,
Hongkyu Yoon, Steve Bryant, Peter Eichhubl

Sept. 9, 2013
Albuquerque, NM

Sandia National Laboratories

Sandia National Laboratories is a multi-program laboratory managed and operated by Sandia Corporation, a wholly owned subsidiary of Lockheed Martin Corporation, for the U.S. Department of Energy's National Nuclear Security Administration under contract DE-AC04-94AL85000.

TEXAS

Questions to Answer

1. What science question is being addressed?
2. What is the impact on GCS?
3. What publications/new results anticipated by Dec. 2013?

Science Questions:

Can we accurately model injection-induced caprock deformation and damage?

Impact on GCS:

What leakage, if any, results from injection-induced caprock deformation?

Research Questions (from Feb.)

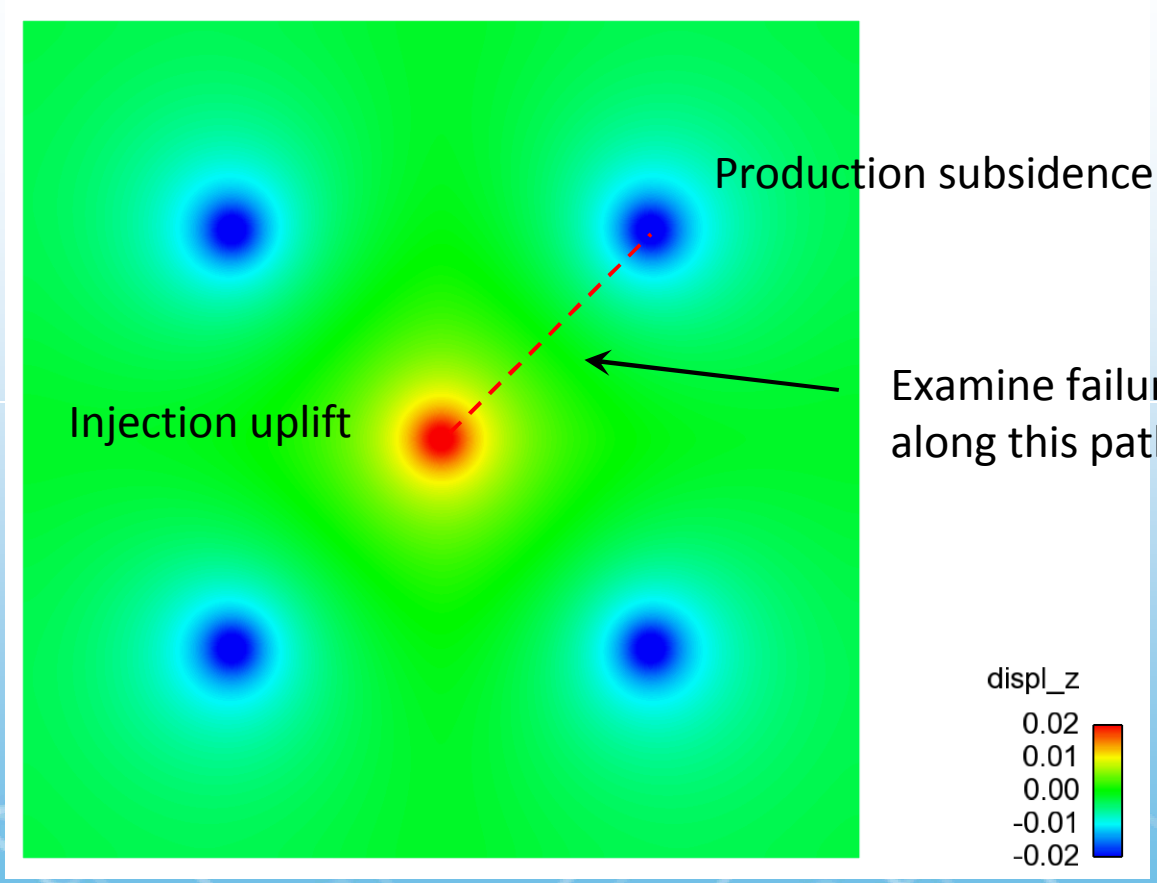
1. InSalah, what does it take to get the subsidence/injection shear failure?
2. Site stratigraphy, layer thickness, combination of phenomena
3. Change in mechanical properties at water/gas contact
4. Does pre-existence of joints/fractures facilitate lower failure threshold for this failure mode?
5. Evidence of caprock damage, stopped co2 injection but continued production; due to security, have since stopped all activities
6. Joint aperture or critical shear as a function of injection/production spacing
7. Is there a feedback mechanism?
8. Peter, are joints continuous through layers?
9. Is caprock MC less than injection MC? rock properties?
10. Is the fact that injection is ¼ of production a factor?
11. Initial stress state (compressional, extentional)
12. Injection well pattern with production, look at 2D idealization, variable spacing

Recent Work

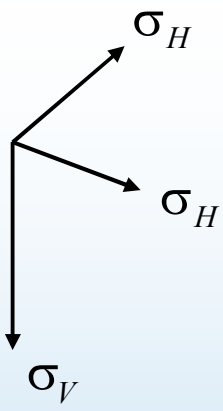
- Inverse Modeling (Hongkyu Yoon, Pania Newell)
- Emergent Failure Phenomena? (Is there a critical spacing between production and CO_2 injection wells for caprock failure?)

Critical Injection/Production Spacing?

Production/Injection Grid

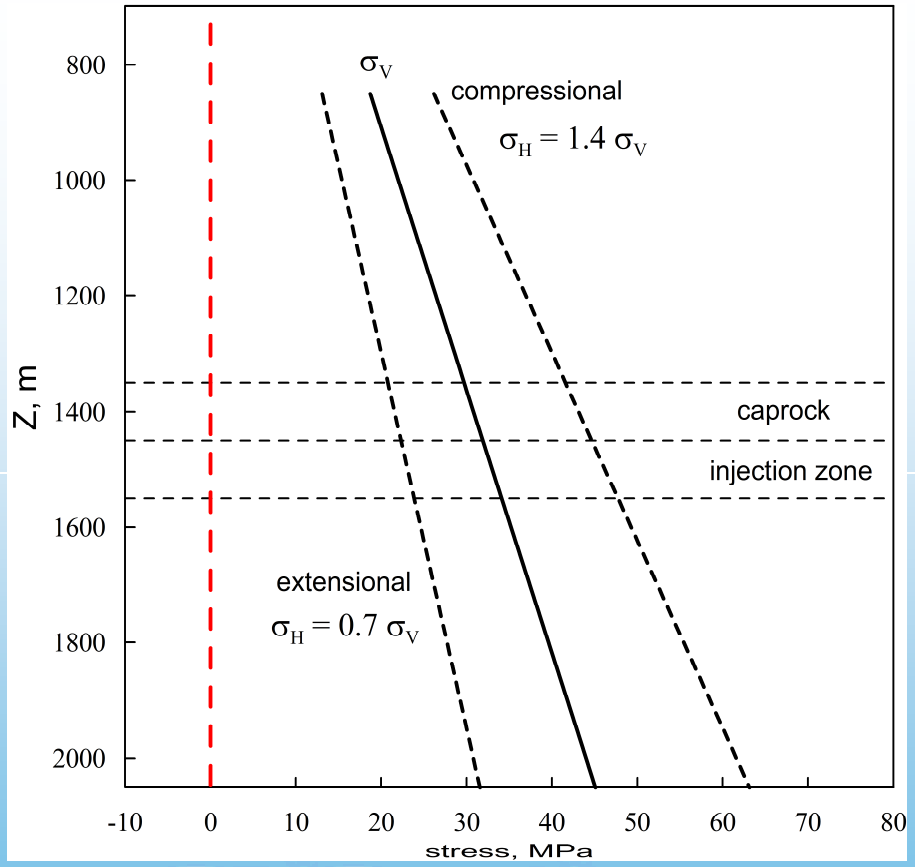


Initial Stress State

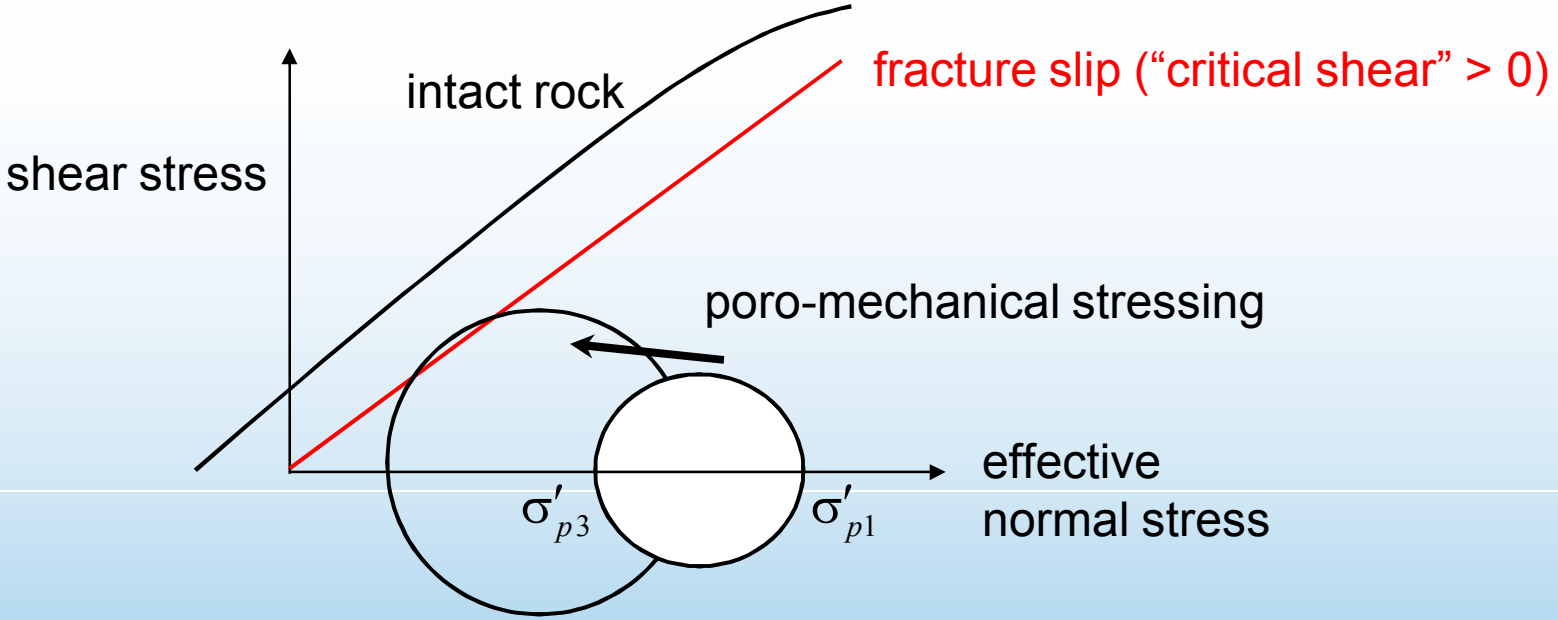


Look at two initial stress regimes

1. extensional $\sigma_H < \sigma_V$
2. compressional $\sigma_H > \sigma_V$



Mohr-Coulomb

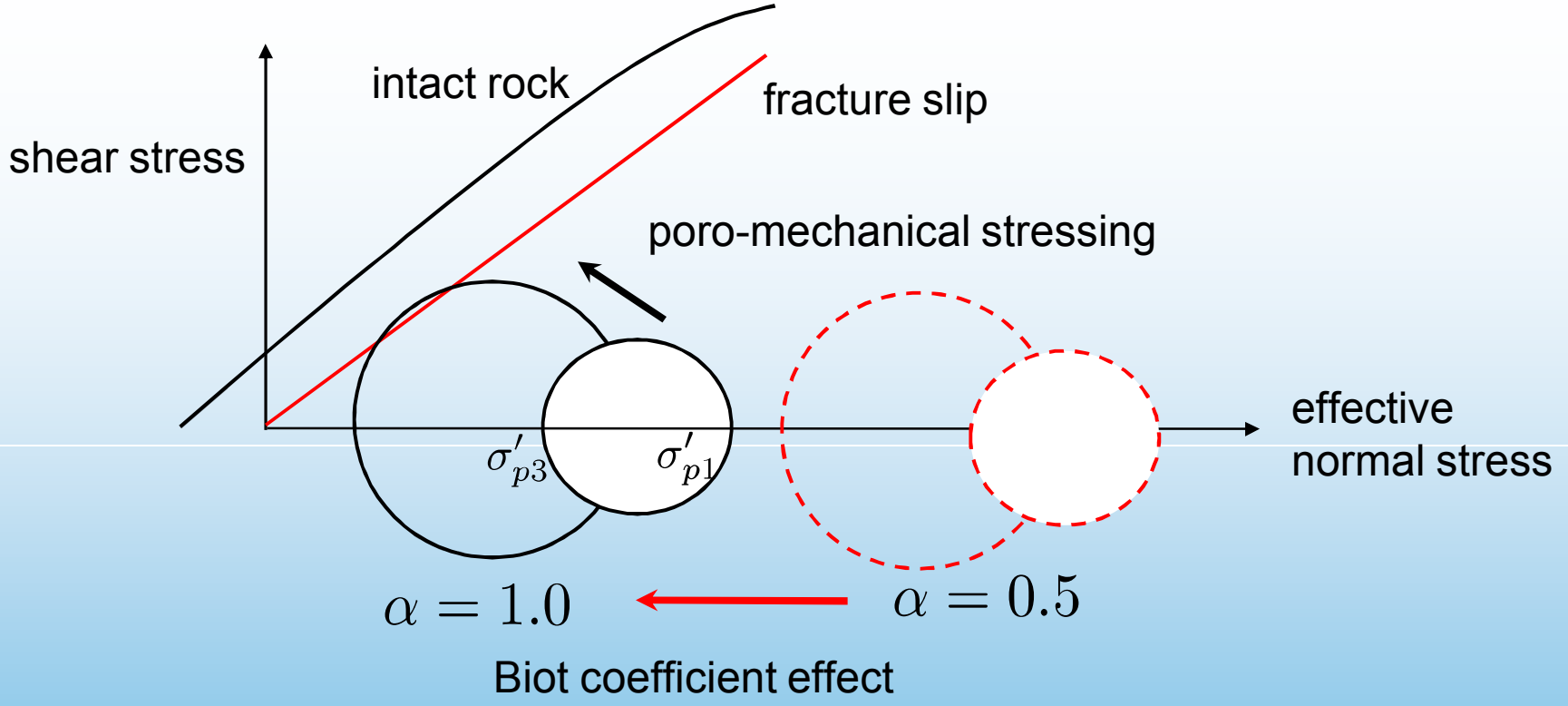


Linear Mohr-Coulomb

$$\tau = C + \mu(\sigma_n - p)$$ conservatively take $C = 0$, $\mu = 0.6$

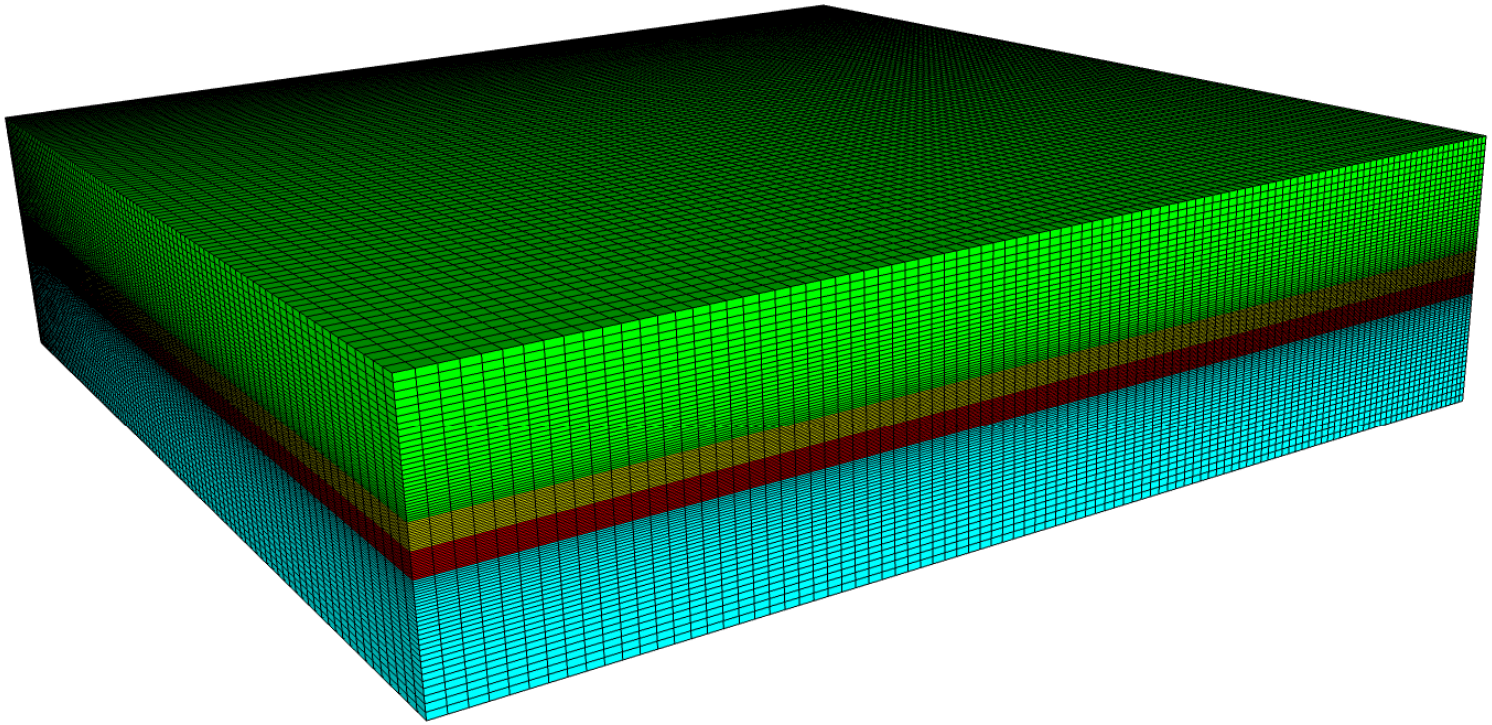
$$\sigma'_{p1} - 3\sigma'_{p3} > 0$$ call this “critical shear”

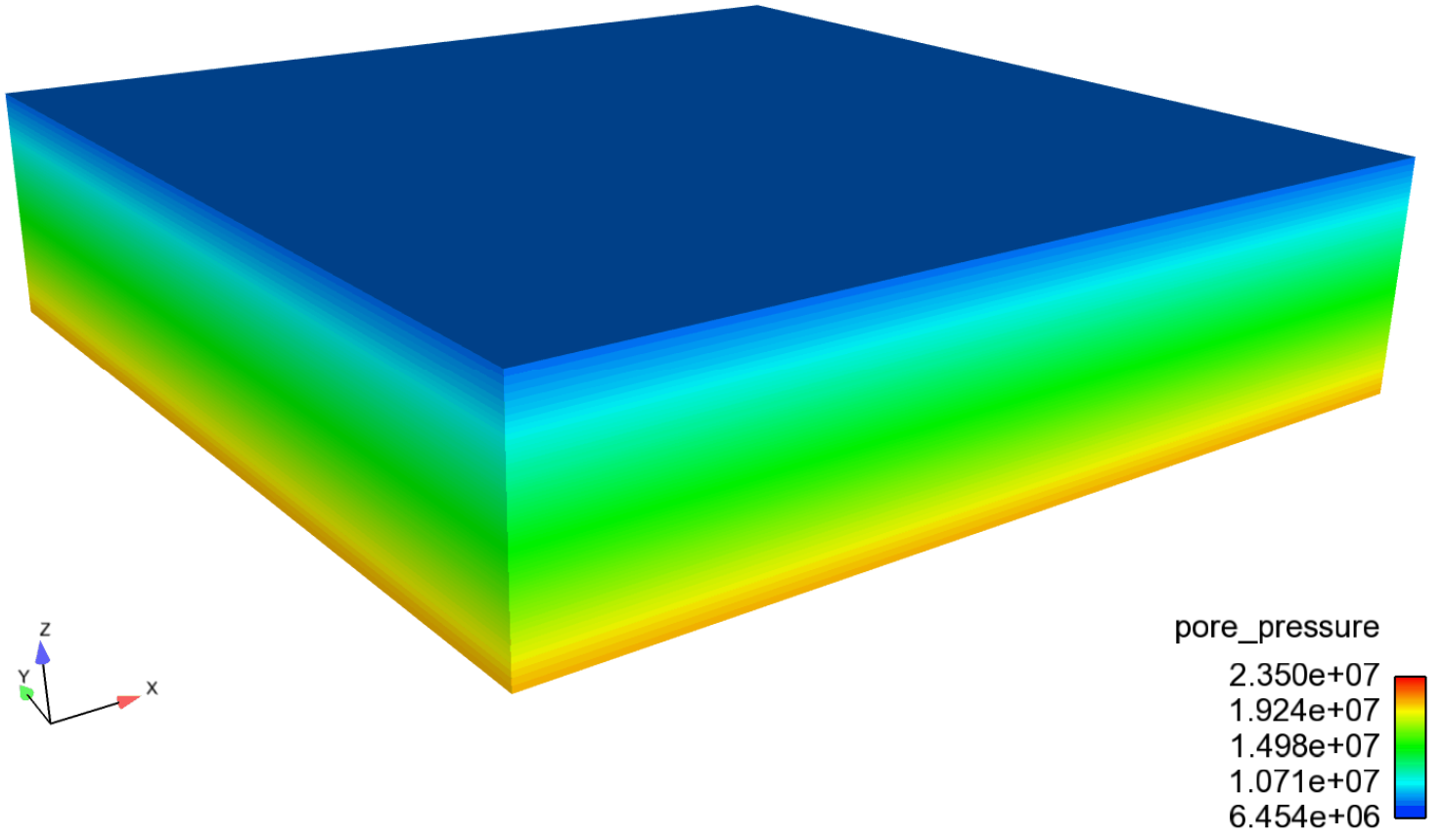
Mohr-Coulomb

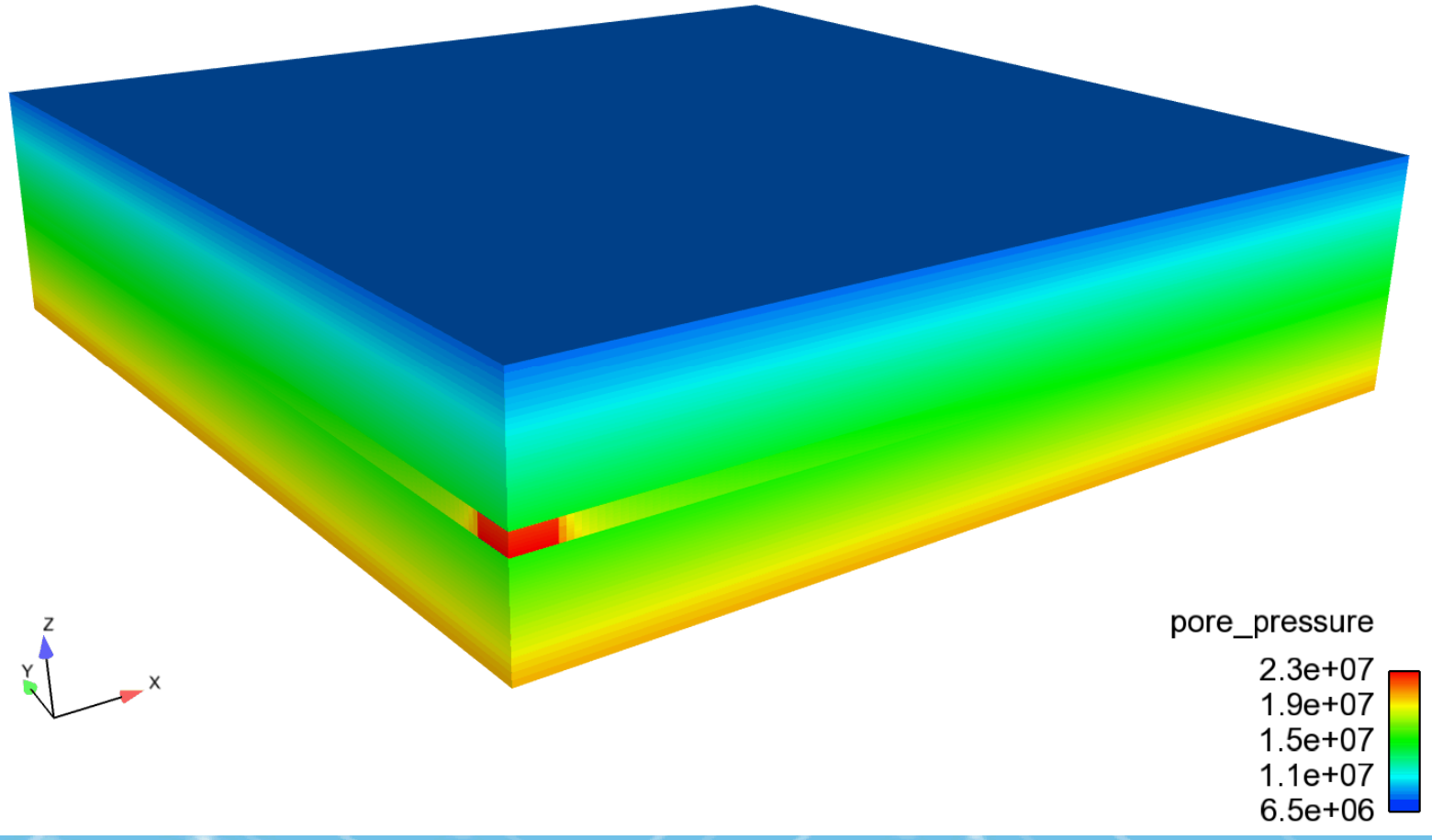


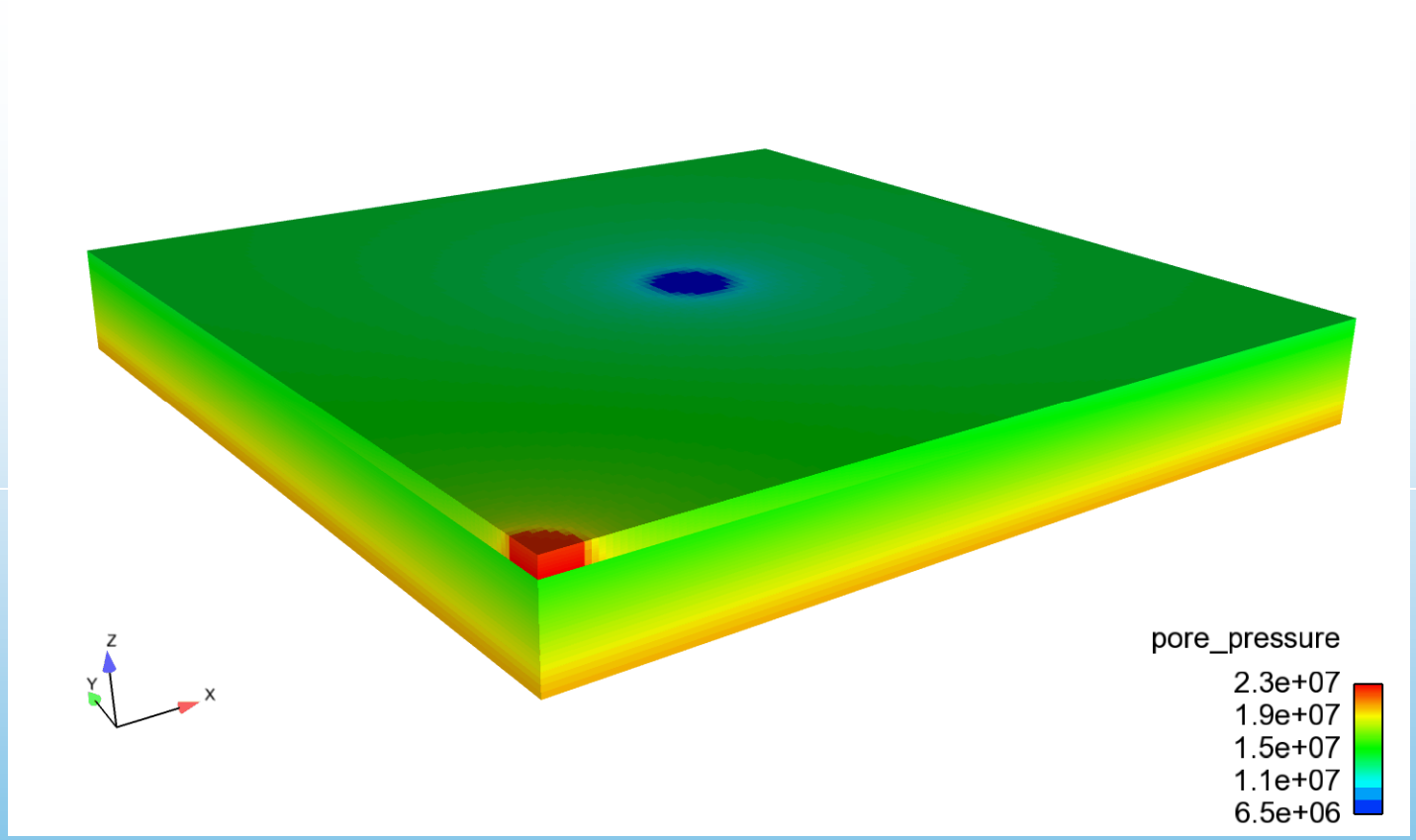
effective stress $\sigma'_{ij} = \sigma_{ij} + \alpha p \delta_{ij}$

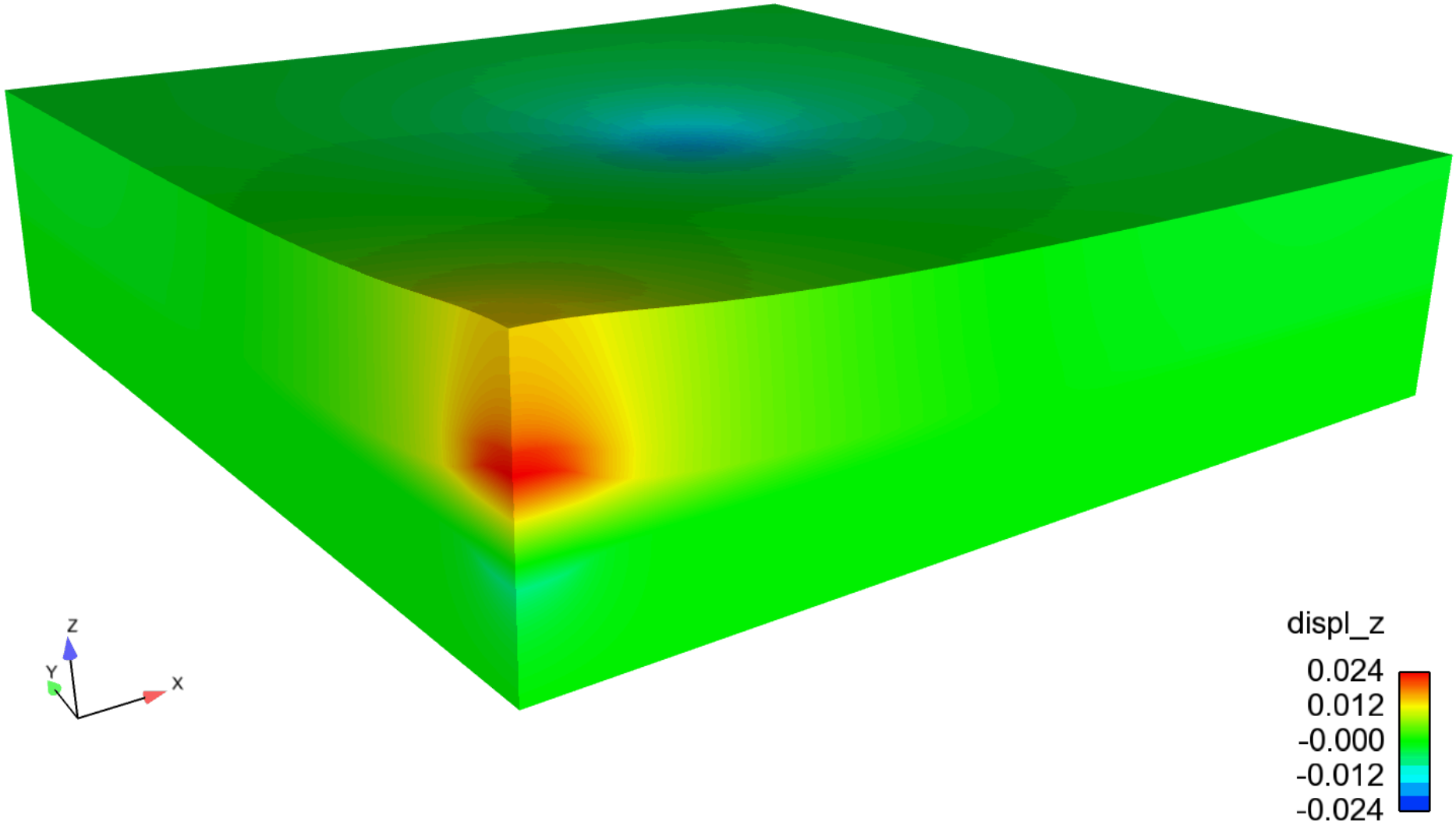
Biot coefficient

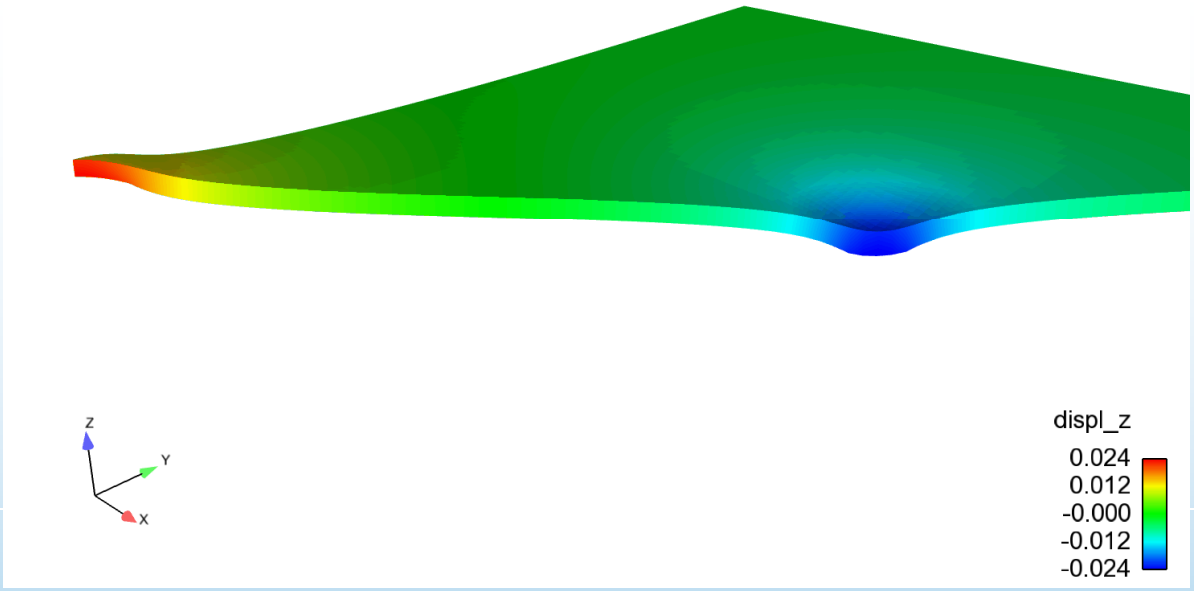


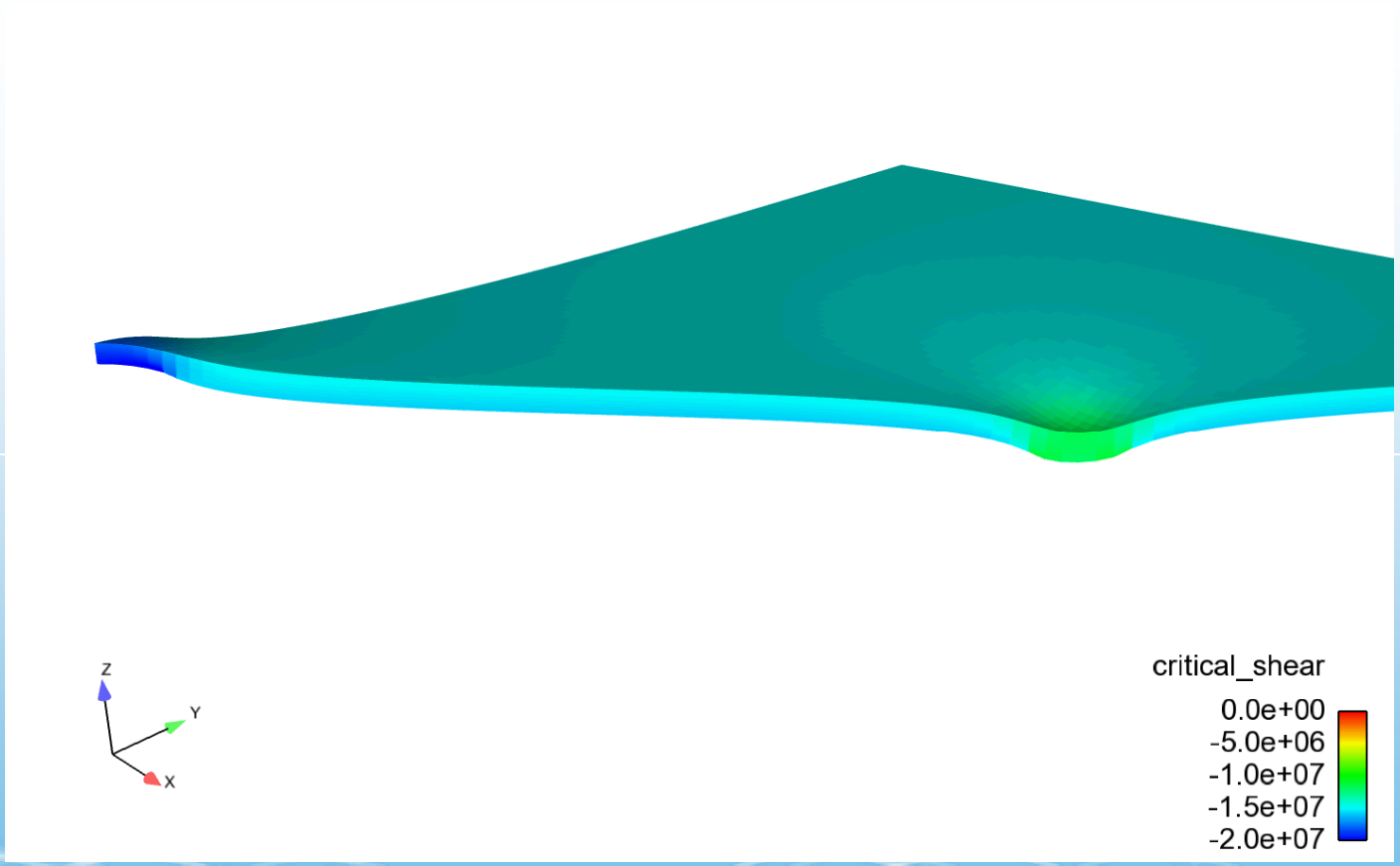

Z
Y
X
pore_pressure
2.350e+07
1.924e+07
1.498e+07
1.071e+07
6.454e+06


Z
Y
X
pore_pressure
2.3e+07
1.9e+07
1.5e+07
1.1e+07
6.5e+06


Z
Y
X
pore_pressure
2.3e+07
1.9e+07
1.5e+07
1.1e+07
6.5e+06


Z
Y
X
displ_z
0.024
0.012
-0.000
-0.012
-0.024


Z
Y
X
displ_z
0.024
0.012
-0.000
-0.012
-0.024


Z
Y
X
critical_shear
0.0e+00
-5.0e+06
-1.0e+07
-1.5e+07
-2.0e+07