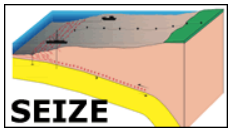
Modeling of Earthquake-Related Pore Pressure Changes and Fluid Flow in Subduction Zones



Award: 02-41565 (May 2003)

E. Screaton[1], S. Ge[2]

[1]University of Florida; [2] University of Colorado

Analytical and numerical modeling were used to evaluate the hydrodynamic response of subduction zones to fault movement.

- Coseismic head perturbations were superposed on large-scale quasi-steady state pore pressure distributions from Nankai and Costa Rica subduction zones to examine fluid flow following a slip event. Although simulated coseismic pore pressure changes would be large enough to be observed through borehole monitoring, the overall impact on the flow field was short-lived.
- A previously developed model of deformation and fluid flow was modified to simulate hydraulic head changes resulting from coseismic slip using heterogeneous properties. This model indicates significant differences using a heterogeneous mechanical properties rather than a homogeneous model (see Figure).
- An analytical solution for head changes due to slip was combined with a fluid flow model to simulate propagating thrust slip. Results illustrate that pore pressure changes through time during propagating slip events are very distinct from single slip events, and that fluid flow may modify the pore pressure signals if sediments have high permeability .

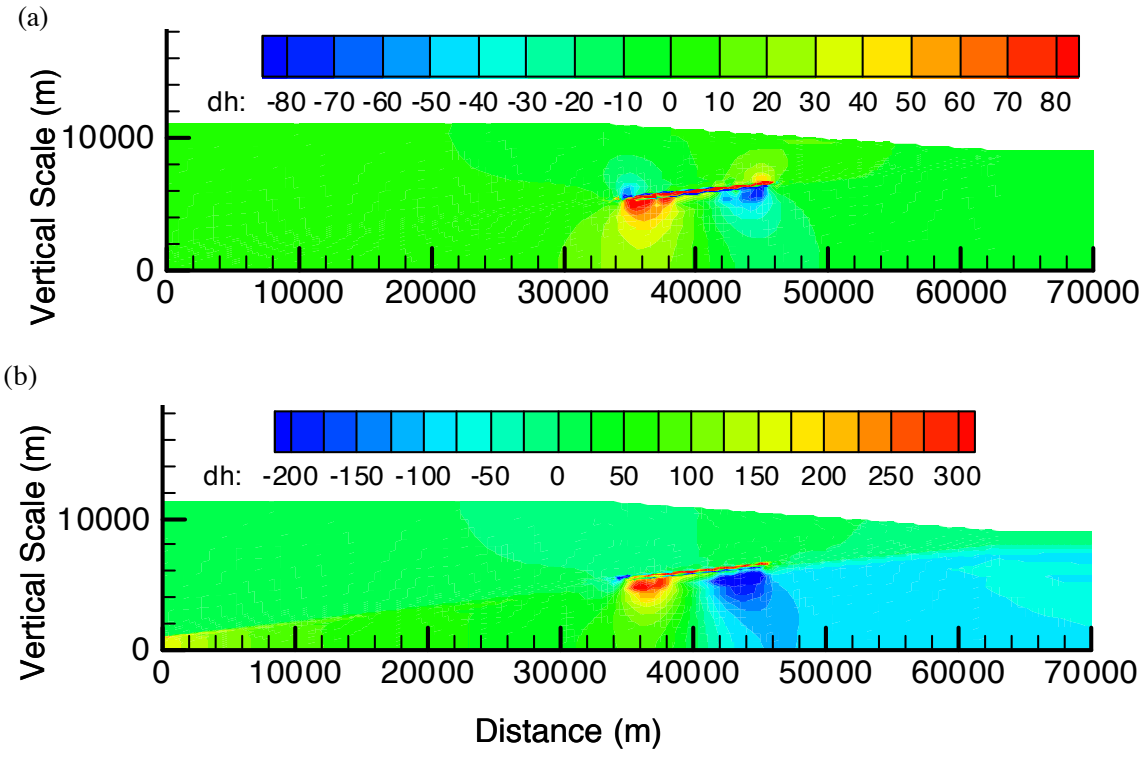


Figure: Co-seismic hydraulic head change in meters for a) the homogeneous mechanical and hydrogeologic property case and (b) the heterogeneous property case-a stiffer crust and softer sediment case.

Cutillo, P.A., S. Ge, and E. Screaton, 2006, Hydrodynamic response of subduction zones to seismic activity: A case study for the Costa Rica Margin, Tectonophysics, 426, 167-187.

Gamage, K., and E. Screaton, 2006, Characterization of excess pore pressures at the toe of the Nankai accretionary complex, Ocean Drilling Program sites 1173, 1174, and 808: Results of one-dimensional modeling, J. Geophys. Res., 111, B04103, doi:10.1029/2004JB003572.

Ge. S., and Screaton, E., 2005, Modeling seismically induced deformation and fluid flow in the Nankai subducion zone, Geophysical Research Letters, vol. 32, L17301, doi:10.1029/2005GL023473, 4 pp.

Screaton, E.J. and S. Ge, 2007, Modeling of the effects of propagating thrust slip on pore pressures and implications for monitoring, Earth and Planetary Science Letters, 258 (3), 454-464.