The borehole stations of the Earthscope Plate Boundary Observatory (PBO) are providing unprecedented observations of co-located pore pressure and strain measurements over time scales of seconds to years, and over wide geographic and tectonic environments. Water level fluctuations in response to tides are well documented and understood, however the response to earthquakes, especially at the dynamic co-seismic, and short-term post-seismic time scales is less well understood.

The pore pressure records of the Anza sites during the July 7th 2012 Collins Valley earthquake (M 5.4) illustrate the variation in well responses that can occur due to the same earthquake (Figure 1). These seismically induced pore pressure steps are compared to co-located strain observations and synthetics. We present mechanisms for describing pore pressure changes for several earthquakes in the Anza region, including aftershocks from the El Mayor-Cucapah earthquake (M 7.2) and the March 11th 2013 Toro Peak earthquake (M 4.7).

For each earthquake, the water table change is consistent with the co-seismic areal strain change, suggesting at least in part the influence of a static strain mechanism in each event. Each of the observed wells does not appear to have a preferential pore pressure response direction. A time domain method is used to detect changes in phase of tidal signals during and after the earthquakes, corresponding to a change in permeability of the rock layer. Using information from geophysical logs, the fracture orientation in boreholes is correlated with the principal strain of the earthquake (Figure 2). This correlation is then used to explain the magnitude and direction of the observed pore pressure responses.

Figure 1: Pore pressure observations from the M 5.4 Collins Valley earthquake. Shading represents a synthetic areal strain model calculated with Coulomb v3.

Figure 2: Borehole strain for PBO 88 during the Collins Valley earthquake. Displays fracture orientation along with max compression and extension for observed strain.