Temporal variation of S-wave splitting measurements before and after the M6 2014 Napa earthquake

Hongru Hu and Aibing Li,

Department of Earth and Atmospheric Sciences, University of Houston

Stress increase before a major earthquake could be a reliable precursor if it can be robustly detected. It is reflected in temporal variations of seismic anisotropy in the upper crust, which can be determined from S-wave splitting (SWS) analysis. The challenge of this approach is the lack of enough stations and foreshocks in general. In this study, we utilize seismic data from the Northern California Seismic Network to analyze SWS before and after the 2014 M6 earthquake that occurred in south Napa, Northern California (122.32W and 38.23N) on August 24th. Earthquakes in the area of 38N to 38.5N and 122W to 122.6W (Figure 1) from 08/01/2013 to 08/24/2014 are used to obtain SWS parameters, fast S wave polarization direction and delay time.

SWS measurements are determined at four stations in the area for 14 foreshocks, the mainshock, and 9 aftershocks. We examine S waves with the incidence angle of less than 35 degree, which is determined by maximizing P-wave energy in the ray direction (L component). We then rotate the data from ENZ to LQT (Q for radial and T for transverse component) system. The resulted fast direction in the LQT system is projected back into the ENZ system. The fast polarization directions vary from station to station but are mostly consistent at each station and show no significant change with time. On the other hand, the delay times reflect an evident temporal variation with the maximum values from the mainshock. Before the mainshock, delay times also show a trend of increase towards the mainshock time. The delay time difference between the closest foreshocks(08/05/2014) and the mainshock is significantly large at two nearby stations NHC and N016 and is almost same at a relative far station (CVS). These observations evidence that stress increases rapidly and significantly before a major earthquake and the delay time of SWS is a promising precursor of large earthquakes.

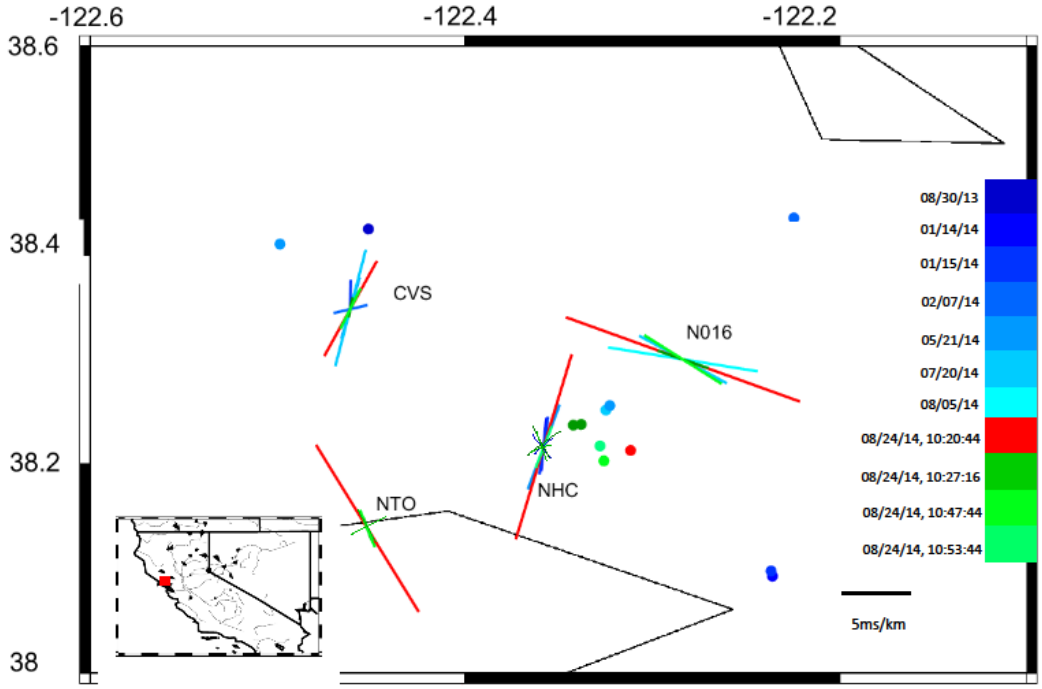

Figure 1. SWS results in Northern California before and after the 2014 Napa earthquake (red dot). The study area is indicated as a red block in the inset. The bars at each station are parallel to fast polarization directions and scaled by the delay time (normalized by distance). Crosses are for null measurements. Solid dots are the locations of the earthquakes and color coded based on event time. Blue colors are for earthquakes before the mainshock and green colors for aftershocks. The bars are color coded in the same way as the earthquakes.