Coulomb Stress Analysis for
29 July 2008 Mw 5.4 Chino Hills, California Earthquake

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We calculate Coulomb stress changes imparted by the July 29. 2008 Chino Hills earthquake on the Chino and Whittier faults. Using Wells & Coppersmith (1994) empirical relations for rupture dimensions, we choose a source fault 5.23 km long and 4.15 km wide with 0.16 m left lateral slip and 0.15 m reverse slip, which produces a seismic moment of 1.49e+024 dyne cm (Mw=5.3). We use the USGS epicenter (33.953°N, 117.761°W) and a depth of 13.6 km as the centroid of the rupture. The focal mechanism is from Hauksson et al (2008) and has the rupture plane striking 43° and dipping 58° with a rake of 43°.

A fault of similar orientation to the rupture plane is located southwest of the epicenter in the California fault database (Ludington et al, 2007). This may be the causative fault (Figure 1).

The epicenter is located in a wedge between two right-lateral faults: the Chino fault, which dips 65° to the southwest, and the Whittier fault, which dips 75° to the northeast according to 2002 National Seismic Hazard Maps fault parameters. A simple model assuming both faults are vertical shows a stress increase of 0.2 bars on each fault and a stress decrease of 0.2 bars on some sections of the Whittier fault (Figure 2). We also calculate stress on both fault planes by using their dip angle. In this case, the Chino fault experienced a Coulomb stress increase of 0.1 bars above 7.5 km depth and 0.2 bars between 7.5 km and 15 km depth (Figure 3). We also see a Coulomb stress increase of 0.2 bars on the section of the Whittier fault closest to the rupture (Figure 4).

Aftershocks mostly accumulated in two clusters where Coulomb stress change is positive nearby the Whittier and the Chino faults. Seismicity is approximately 5 km away from the Chino fault surface trace because of its relatively larger dip angle of 65°. We find that aftershock locations are generally consistent with areas of increased Coulomb stress (Figure 5).

References:

Hauksson E., Hutton K., Given, D. California Integrated Seismic Network report version 01:2:40 pm 29 July 2008.

Steve Ludington, Barry C. Moring, Robert J. Miller, Paul A. Stone, Arthur A. Bookstrom, David R. Bedford, James G. Evans, Gordon A. Haxel, Contstance J. Nutt, Kathryn S. Flyn and Melanie J. Hopkins, Preliminary integrated geologic map databases for the United States, 2007 *http://pubs.usgs.gov/of/2005/1305/*

Wells, D.L., and Coppersmith, K.J., 1994, New empirical relationships among magnitude, rupture length, rupture width, and surface displacements: Bulletin of the Seismological Society of America, v. 84, p. 974-1002.

U.S. Geological Survey and California Geological Survey, 2006, Quaternary fault and fold database for the United States, accessed Jan 9, 2006, from USGS web site: http//earthquake.usgs.gov/regional/qfaults/.

A geomorphic feature with the same orientation of the rupture plane that may be the causative fault

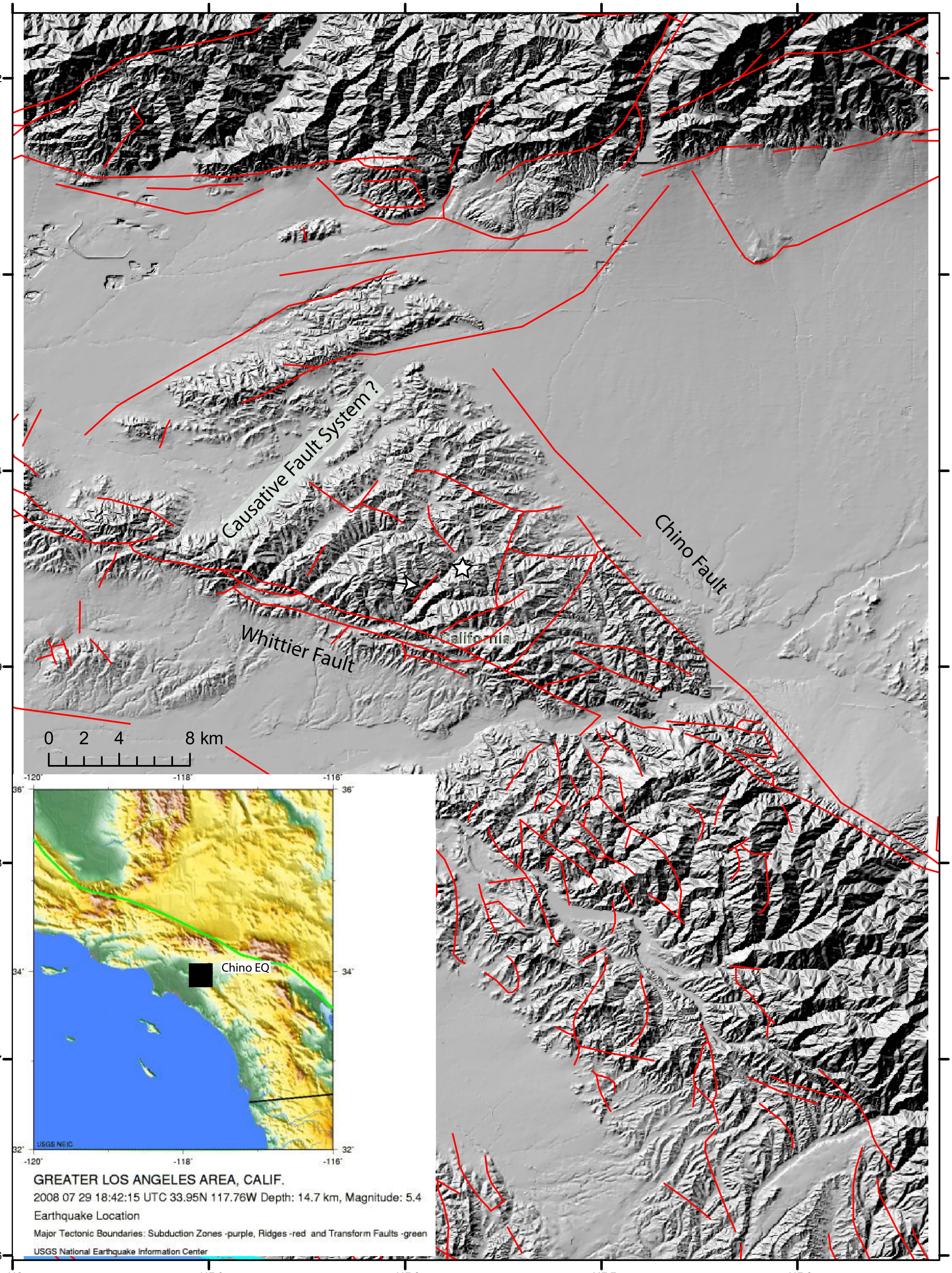

Figure 1

Parts of Whittier & Chino faults brought closer to Coulomb failure by Chino earthquake

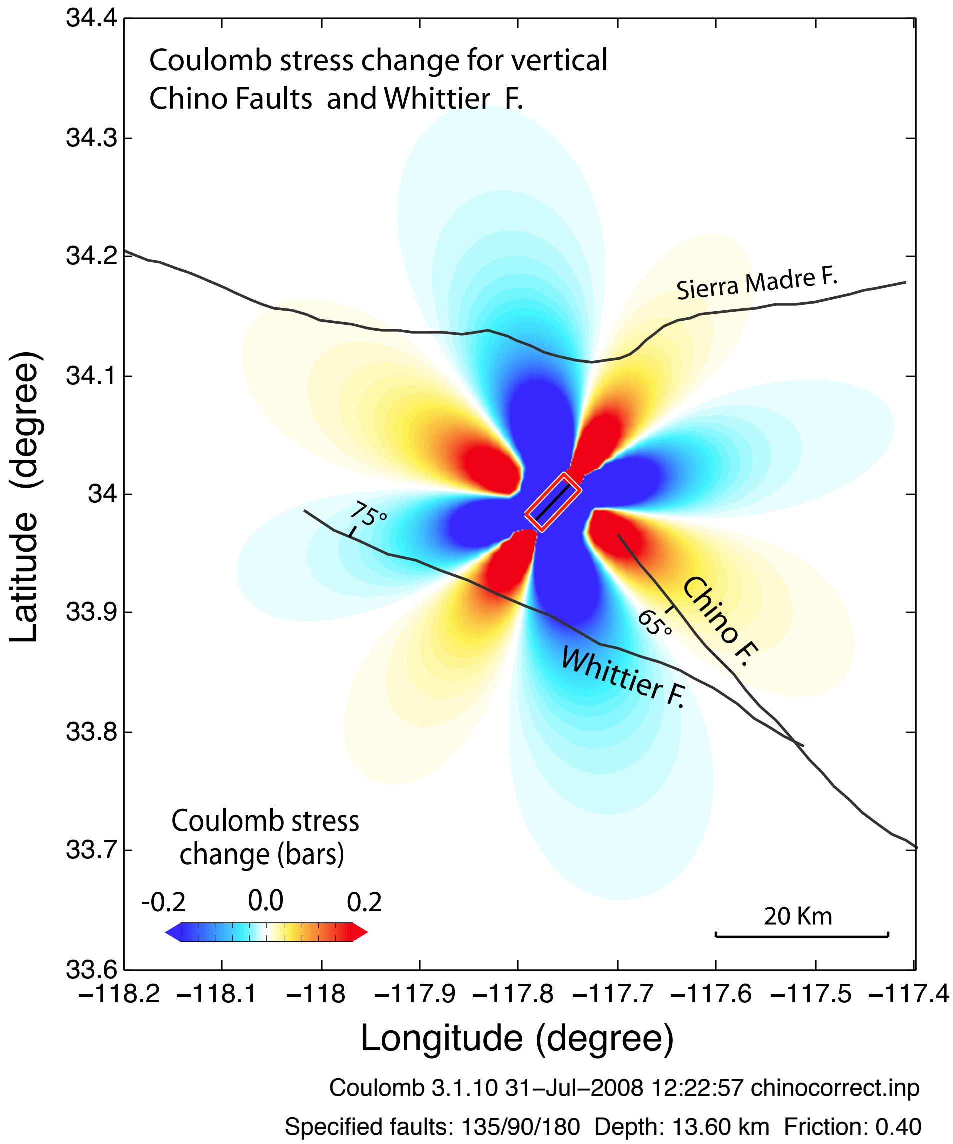

Figure 2

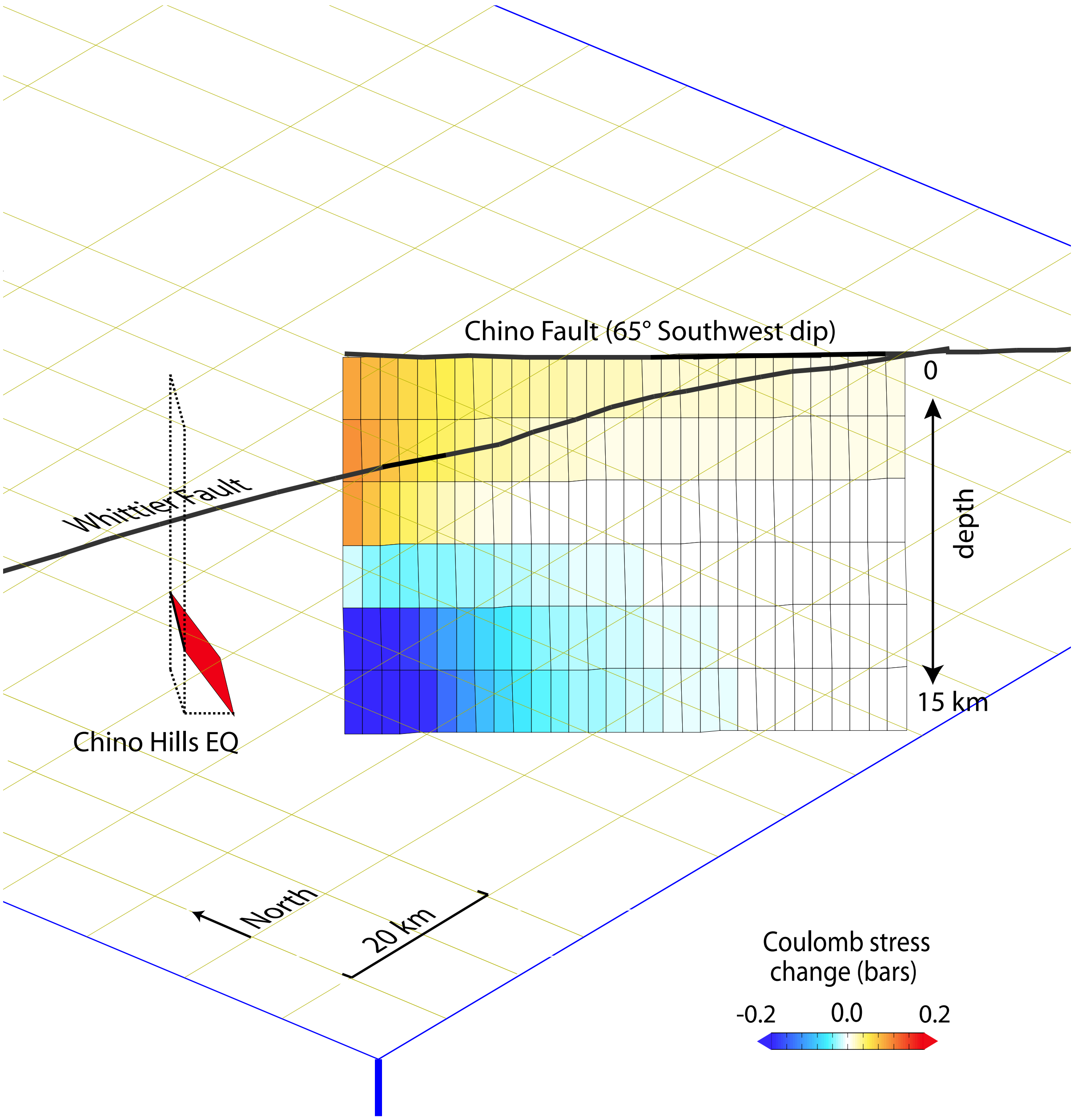
Chino Fault (65° Southwest dip)
0
depth
15 km
Whittier Fault
Chino Hills EQ
North
20 km
Coulomb stress
change (bars)
-0.2
0.0
0.2

Figure 3

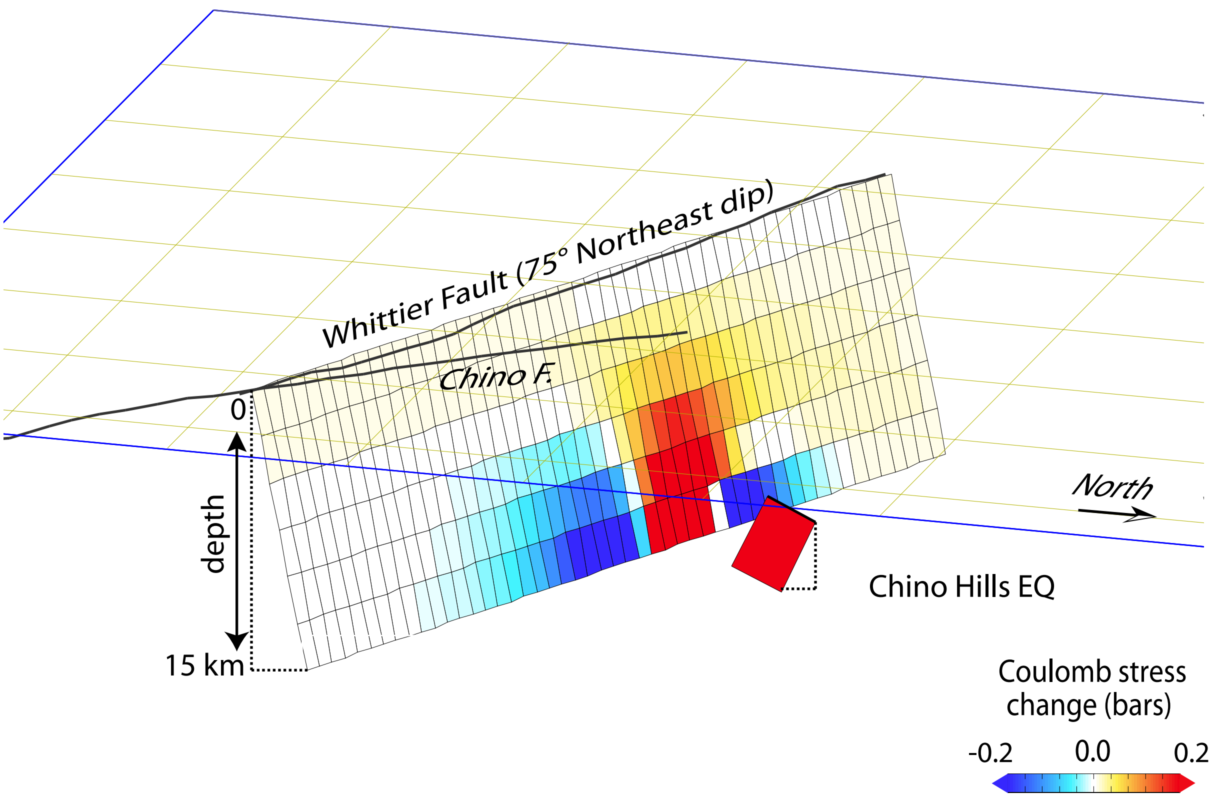
Whittier Fault (75° Northeast dip)
Chino F.
0
depth
15 km
North
Chino Hills EQ
Coulomb stress
change (bars)
-0.2
0.0
0.2

Figure 4

Seismicity is consistent with the maximum positive Coulomb stress change resolved on the Whittier and Chino faults at depths of 13-20 km
(Receiver fault orientation is Str=135°, Dip=90°, Rake=180°)

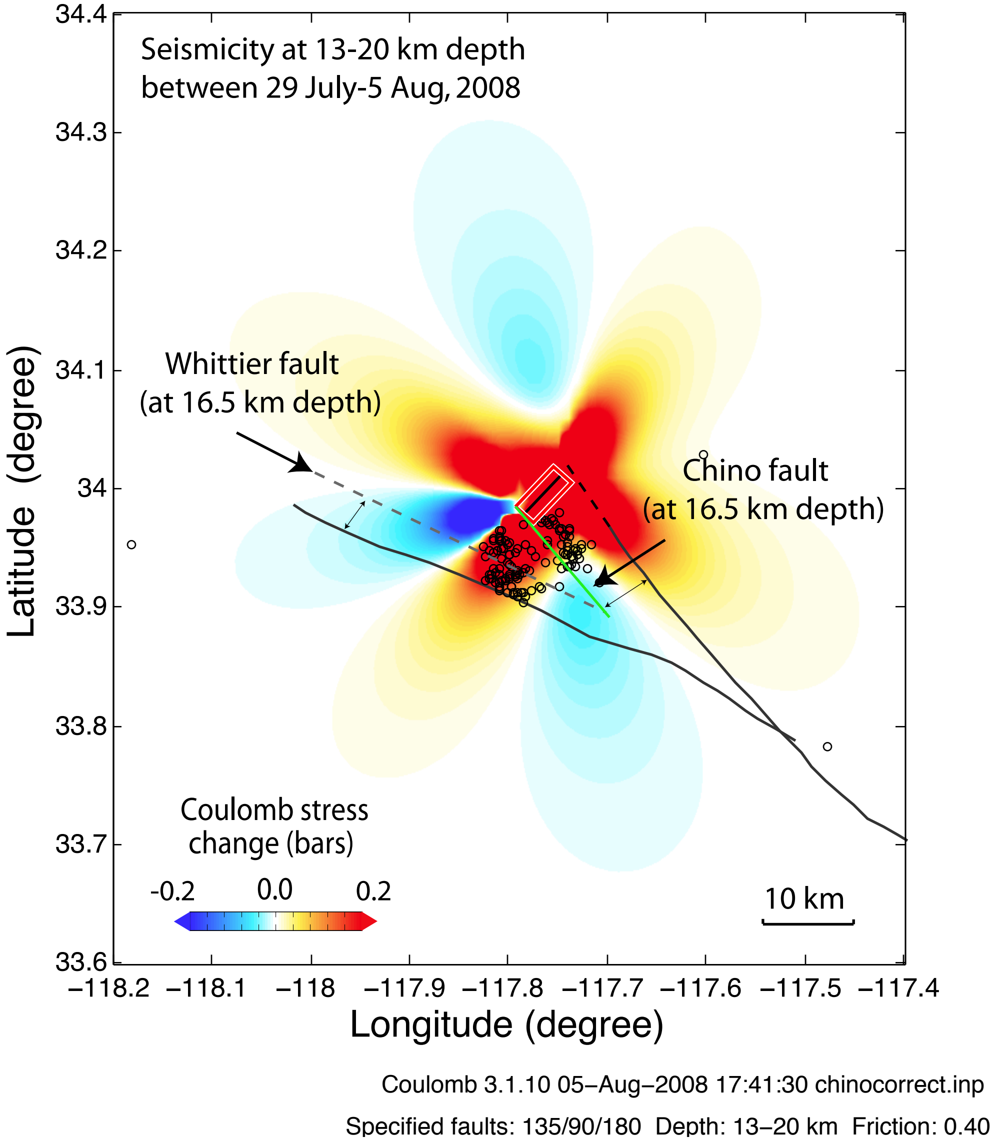

Figure 5