Source Faults in the Puente Hills and Vicinity: Contribution to the Community Fault Model

Robert S. Yeats, Eldon M. Gath, Rene Perez, Chris Walls, Tania Gonzalez, and Tom Rockwell
Earth Consultants International
150 El Camino Real, Suite 212
Tustin, CA 92780

We combine surface mapping, including fault evaluation reports by Jerry Treiman of CGS, trench excavations by ECI and other firms, subsurface geology based on well data, and tectonic geomorphic expression to show surface and blind faults that are part of the network of earthquake sources that are hazards to metropolitan Los Angeles. The Elsinore fault has a right-lateral strike-slip rate of 5.3-5.9 mm/yr and a total right slip of 8-9 and no more than 12 km, indicating that it could achieve its total displacement at that rate in about 2 m.y. The Elsinore fault splits into two faults. The Chino fault, dips 60° SW and, together with the adjacent Mahala anticline and Ridge syncline, dies out NW in Los Serranos, a suburb of Chino Hills. Its long-term slip rate is 0.7-2 mm/yr based on the age of affected drainage basins and 0.36-0.51 mm/yr for the Holocene based on a trench. Its maximum net oblique slip is 850-1525 m based on offset facies of the Sycamore Canyon Member of the Puente Formation, consistent with the same age of initiation as the Elsinore fault. The Whittier fault splits from the Elsinore fault at a low angle and changes from south side up in the Santa Ana Mountains to north side up in the Puente Hills. Its slip rate is 2-3 mm/yr in Santa Ana Canyon and about 2 mm/yr at Olinda Creek. Its total displacement of Paleogene facies is 8-9 km, which would require about 4 m.y. to accumulate at present slip rates. At Whittier Narrows, the fault turns NW and becomes the East Montebello fault with a slip rate of 0.2 ± 0.1 mm/yr on one strand with the fault scarp marking the other strand untrenched. This fault dies out south of Interstate 10, with its displacement taken up by the Montebello and Elysian Park anticlines.

Blind faults include the Puente Hills thrust generating the Coyote Hills with a slip rate of 1.3 ± 0.5 mm/yr based on dislocation modeling, consistent with slip rates at Santa Fe Springs determined by Shaw et al. (2003). This structure, which includes the Richfield and Kraemer anticlines and intersects the Whittier fault near Santa Ana Canyon, accounts for part of the slip rate difference between the Elsinore and Whittier faults. Folds in the footwall of the Whittier fault in Whittier, Sansinena, and Brea-Olinda oil fields account for some north-south shortening, although Holocene displacement is almost pure strike slip. Farther north, the Walnut anticline and underlying blind thrust die out eastward. The San Jose Hills are uplifted on the partly-blind San Jose reverse fault, which may have a left-lateral component farther east based on a ground-water barrier that may be the source fault for the 1988 and 1990 Upland earthquakes. The San Jose, Walnut, and Whittier faults may merge downward with the Puente Hills fault. The San Jose and Walnut folds terminate westward against a ground-water barrier named the Walnut Creek fault, which may be a left-lateral mirror image counterpart of the right-lateral East Montebello fault at the western end of the San Gabriel Valley.

Because the slip rate of the Whittier fault is known, the age of formation of the Puente Hills is determined as 700-1,200 ka based on the age of offset drainage basins;

uplift rate is 0.4 mm/yr. The northern Santa Ana Mountains are being uplifted at 0.31 mm/yr starting at about 3.6 Ma along a previously-unmapped north-verging blind reversse fault. All of these structures taken together can account for the slip rate budget between the Elsinore fault and the south boundary of the San Gabriel Mountains. The Holocene and late Pleistocene slip rates on some of these structures are still poorly known, however.

Publications

Myers, D.J., Nabelek, J.L., and Yeats, R.S., 2003, Dislocation modeling of blind thrusts in the eastern Los Angeles Basin, California*: Jour. Geophys. Research., v. 108*, no. B9, 2443, doi:10.1029/2002JB002150, SCEC Contribution 481.

Yeats, R.S., 2003, Tectonics of the San Gabriel Basin and surroundings, southern California, submitted to *Bulletin, Geological Society of America*.