PRELIMINARY REVISED ALQUIST-PRIOLO EARTHQUAKE FAULT ZONE MAP FOR THE WHITTIER FAULT, YORBA LINDA 7.5' QUADRANGLE, ORANGE COUNTY, CALIFORNIA

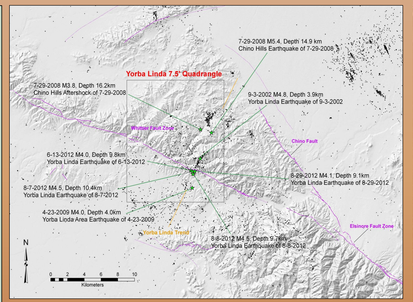
Janis L. Hernandez
California Geological Survey
888 S. Figueroa Street, Suite 475, Los Angeles, CA 90017
Janis.Hernandez@conservation.ca.gov

The California Geological Survey (CGS) first evaluated the Whittier Fault for potential fault zoning in 1977. A revised evaluation was prepared in 1979, concluding segments of the Whittier Fault Zone were "sufficiently active and well defined" to be included within an Alquist-Priolo Earthquake Fault Zone (APEFZ), and in 1980, an Earthquake Fault Zone map was issued for the Yorba Linda 7.5' quadrangle. Since 1980, much urban development has taken place within the cities of Brea, Yorba Linda, and in the County of Orange accompanied by a number of geotechnical and fault studies within the mapped fault zone. Here we summarize the results of our current re-evaluation.

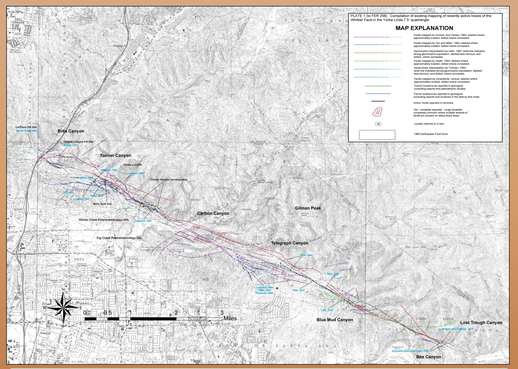
The Whittier Fault is a major structural element in the eastern Los Angeles basin. It is the longer of two northern extensions of the active Elsinore Fault Zone, the other being the Chino Fault. The Whittier Fault is a complex, segmented, left-stepping transpressional feature with predominately right lateral slip (Gath et al., 1992). Primary sense of movement along this complex fault zone is right-lateral strike-slip, trending about N70^{0}W, with dips ranging from 65 to 80^{0}NE. The Whittier fault is believed to have begun as a normal fault in the mid to late Miocene, probably with a right lateral component, but is now dominantly a right-lateral fault. Right laterally deflected drainages associated with small streams and canyons, and large displacements of the major canyons support a tectonic interpretation and late Quaternary strike-slip displacement (Gath, 1997, Rockwell and others, 1988).

Detailed paleoseismic studies have revealed complex fault characteristics at the Olinda Oil Field and Olinda Ranch (Fig Creek) sites. Gath et al. (1992) report the Whittier Fault consists of three active fault strands at Olinda Creek: the northern, central and southern strand. The central and southern strands form a positive flower structure: southern strand dipping northeast, central strand dipping southwest, with an elevated pressure ridge between the two faults. Work by Leighton and Associates reveals similar complex faulting relationships within Olinda Ranch. Patterson and Rockwell (1993) report Holocene sense of displacement is nearly pure strike-slip at Olinda Oil Field (Fig Creek). Gath (1997) prepared a tectonic strip map along the entire length of the Whittier Fault Zone, noting several geomorphic features indicative of active faulting, including an abundance of right-laterally deflected stream channels.

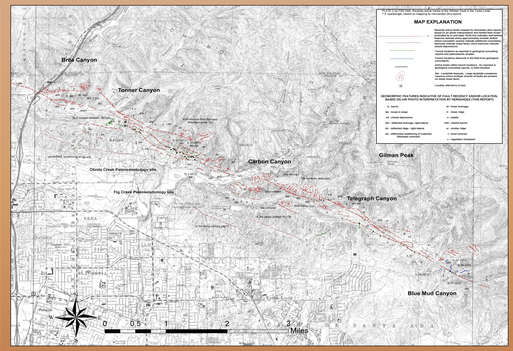
Detailed observations, made in these new studies and by CGS, provide a better understanding of the characteristics of active strands of this fault, which help with classification of geomorphic features recognized in other locations along the fault zone. CGS' revision of this zone map is prompted by the abundance of new geologic data that identify locations of "sufficiently active and well defined" fault segments located outside previously designated zone boundaries.



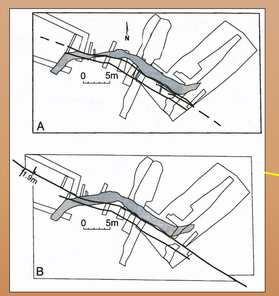
Recent seismicity in the vicinity of the Whittier Fault (data from Hauksson and others, 2012). Green stars indicate significant magnitude earthquakes, including the 2012 Yorba Linda events.



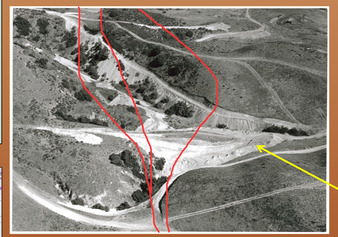
A. Digital compilation of existing mapping, technical studies, and trench data from consulting reports.



B. Aerial photo interpretation of geomorphic features annotated using several sets of historical stereo-pair air photographs. The photos were scanned and geo-referenced using ArcGIS software to existing cultural features on 2009 NAIP (National Agriculture Imagery Program) digital imagery. Fault trench data from observed trenches (blue lines) and reviewed on file (green lines) is shown here.

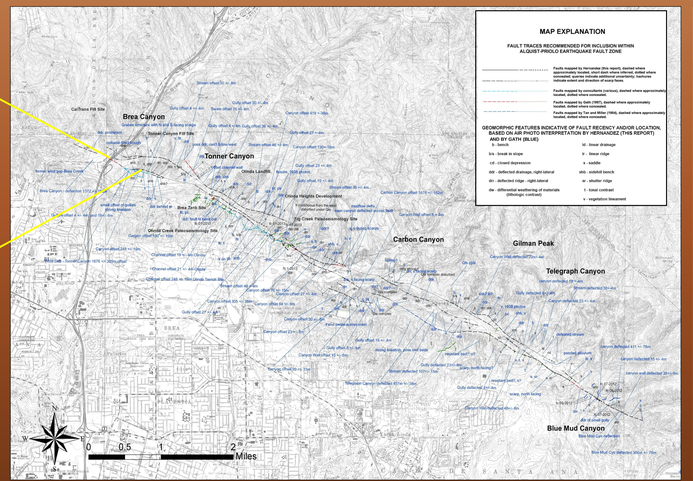


At Fig Creek, plan view of faults (thick lines), buried channel Q4 (shaded pattern), and trenches excavated across the Whittier Fault. **(A)** Present geometry of buried channel Q4. The channel is only offset at far left. **(B)** Restored geometry of buried channel Q4 before the latest fault displacement, based on channel margins as piercing points. Total restored dextral slip is 1.9m right lateral (modified from Weldon, McCalpin, and Rockwell, 1996)

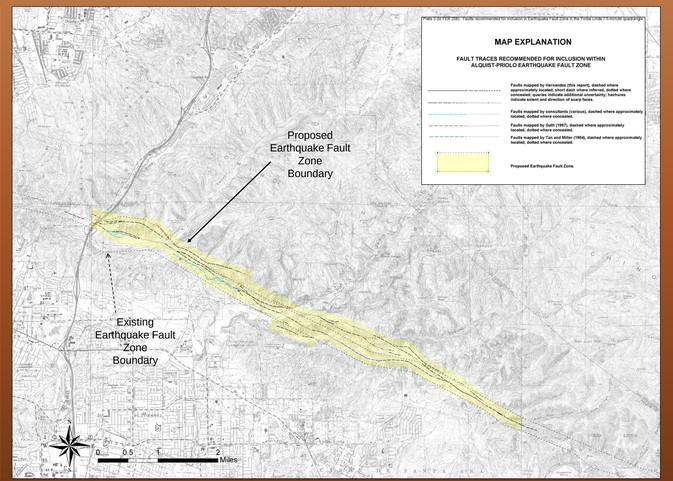


Air photos taken in 1970 prior to Tonner Canyon fill placement from cut materials derived from grading of State Route 57 Freeway alignment. Whittier Fault Zone consists of three steeply northeast dipping traces in this location (in red). Photo courtesy of Robert E. Tepel

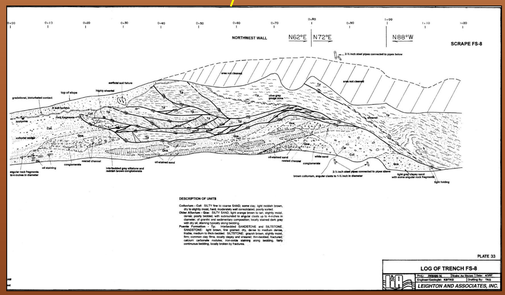
Photos taken in 1970 during initial canyon cleanout operations prior to Tonner Canyon fill placement. Views looking west at northeast-dipping Whittier Fault . Photos courtesy of Robert E. Tepel



C. Composite map showing active faults recommended for zoning, trench locations, and geomorphic interpretation of active faulting by this author (in black), and tectonic geomorphic strip map prepared by Gath, 1997(in blue).



D. Map showing existing EFZ boundary (1980), based on mapping by Miller et al., 1977. Proposed EFZ boundary (in yellow) with sources of active faulting indicated by color.



Studies by Leighton and Associates (1997), profile view of FS-8 roadcut scrape across the southern fault strand. FS- 8 profile features a series of near-horizontal fault splays that have primarily a thrust component of displacement. Fault dip is to the northeast.

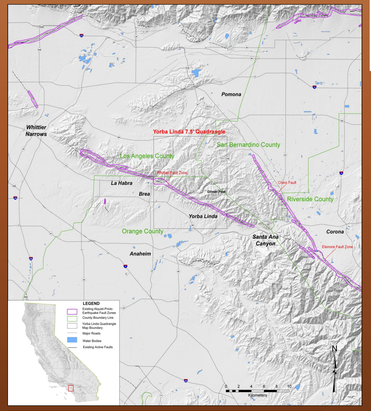


Figure 1: Study area map with index to location within southern California.

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Gath, E.M., Gonzalez, T., and Rockwell, T.K., 1992, Evaluation of the Late Quaternary rate of slip, Whittier fault, Southern California: U.S. Geological Survey Final Technical Report-Contract No. 14-08-0001-G1696, September 4, 1992.

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