Geomorphic evidence for the geometry and slip rate of the Southern San Cayetano fault: Implications for hazard assessment and fault interaction in complex tectonic environments

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We present surface evidence and displacement rates for a young, active, emergent reverse thrust fault in close proximity to major population centers in southern California (U.S.A.), the Southern San Cayetano fault (SSCF). Active faulting along the northern flank of the Santa Clara River Valley displaces young landforms, such as late Quaternary river terraces and alluvial fans. Geomorphic strain markers are examined using field mapping, high-resolution lidar topographic data, ^{10}Be surface exposure dating, and subsurface well data to provide evidence for a young, active, SSCF along the northern flank of the Santa Clara River Valley. Displacement rates for the SSCF are calculated over 10^3-10^4 year timescales with maximum slip rates for the central SSCF of 1.9 $^{+1.0}/_{-0.5}$ mm yr^{-1} between ~19-7 ka and minimum slip rates of 1.3 $^{+0.5}/_{-0.3}$ mm yr^{-1} since ~7 ka. Uplift rates for the central SSCF have not varied significantly over the last ~58 ka, with maximum values of 1.6 $^{+0.6}/_{-0.4}$ mm yr-1 since ~58 ka, down to 1.2 $^{+}/_{-}$ 0.3 mm yr^{-1} since ~7 ka. The SSCF is interpreted as a young, active, structure with onset of activity at some point after ~58 ka. Our structural interpretation suggests that the SSCF is connected to main San Cayetano fault in the subsurface at ~3 km depth. Consequently we suggest it highly likely that the SSCF ruptures in tandem with the main San Cayetano fault below ~3 km, but also potentially with the section of the main San Cayetano fault in the upper ~ 3km. Additionally, the SSCF could potentially act as a rupture pathway between the Ventura fault and the San Cayetano fault in large-magnitude multi-fault earthquakes in southern California. However, given structural complexities and varying Holocene displacement rates along-strike, further work is required to examine the exact mechanism, likelihood, and frequency of potential thoroughgoing ruptures along the Ventura/San Cayetano fault system.