New Perspectives on Newport-Inglewood Fault Geometry

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Abstract

The Newport-Inglewood Fault is an active, right-lateral fault system that forms the southwestern edge of the Los Angeles Basin and passes through one of the most intensely urbanized regions of California. The southern portion of the fault ruptured in the 1855 Long Beach (Mw 6.4) earthquake, and the fault system poses high seismic hazard to the nearly 20 million people living in the greater metropolitan area. We revisit this urban fault and present new insights across its 3D geometry to depth, with an initial focus on the Long Beach and Seal Beach segments.

Following the approach of Riesner et al. (2017), we integrate 2D and 3D seismic reflection surveys, robust stratigraphic controls from decades of oil industry well records, and hypocenter and focal mechanism catalogs recently expanded through template-matching (Hauksson et al., 2012; Ross et al., 2019). We generate 3D fault geometry via an objective and reproducible method that treats these data as weighted interpolation constraints. Our initial 3D fault models highlight the complexity of the fault geometry, which includes multiple splays and complex linkage patterns at depth. Some portions of this fault system appear to reactivate Miocene-age normal faults, which have been rotated into near-vertical geometries that are conducive to strike-slip motion in the present transpressional regime. Overall, these models show similar levels of complexity to recent strike-slip earthquake ruptures (e.g., the 2019 M6.4 and M7.1 Ridgecrest sequence, Plesch et al., 2020), which has important implications for seismic hazard assessment.

Study Area and Data

Data covers a broad depth range: fault surface and shallow traces (~1-2 km), oil well control (~1-4 km), seismic reflection surveys (up to ~7 km), and seismological constraints (10km+). Faults and horizons are interpreted (see Figure 3 legend).

Figure 2: 3D view of key constraints in Seal Beach study area

Data covers a broad depth range: fault surface and shallow traces (~1-2 km), oil well control (~1-4 km), seismic reflection surveys (up to ~7 km), and seismological constraints (10km+). Faults and horizons are interpreted. Geologic unit tops from wells are marked with a yellow line. Faults are marked with a blue line. NIF trace is shown with a red line. Minimal structural relief is observed across fault in shallow units, consistent with nearly pure strike-slip motion. NIF has a near-vertical dip through shallow units, and shows complex, splayed geometry. Fault is non-planar: dip shallows to ~70° in Miocene units.

Discussion and Conclusions

1. A combination of seismologic, seismic reflection, oil well, and geologic data provides important constraints on the geometry of the active Newport-Inglewood (NI) strike-slip fault.
2. The NI fault is a complex, highly segmented strike-slip fault with a non-planar geometry and numerous splays.
3. We interpret the fault to dip to the northeast at depth in the Long Beach – Seal Beach segments.
4. Miocene growth strata in its hanging wall suggest an early phase of normal or transensional motion on the fault, followed by younger right-lateral strike slip motions.

References


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