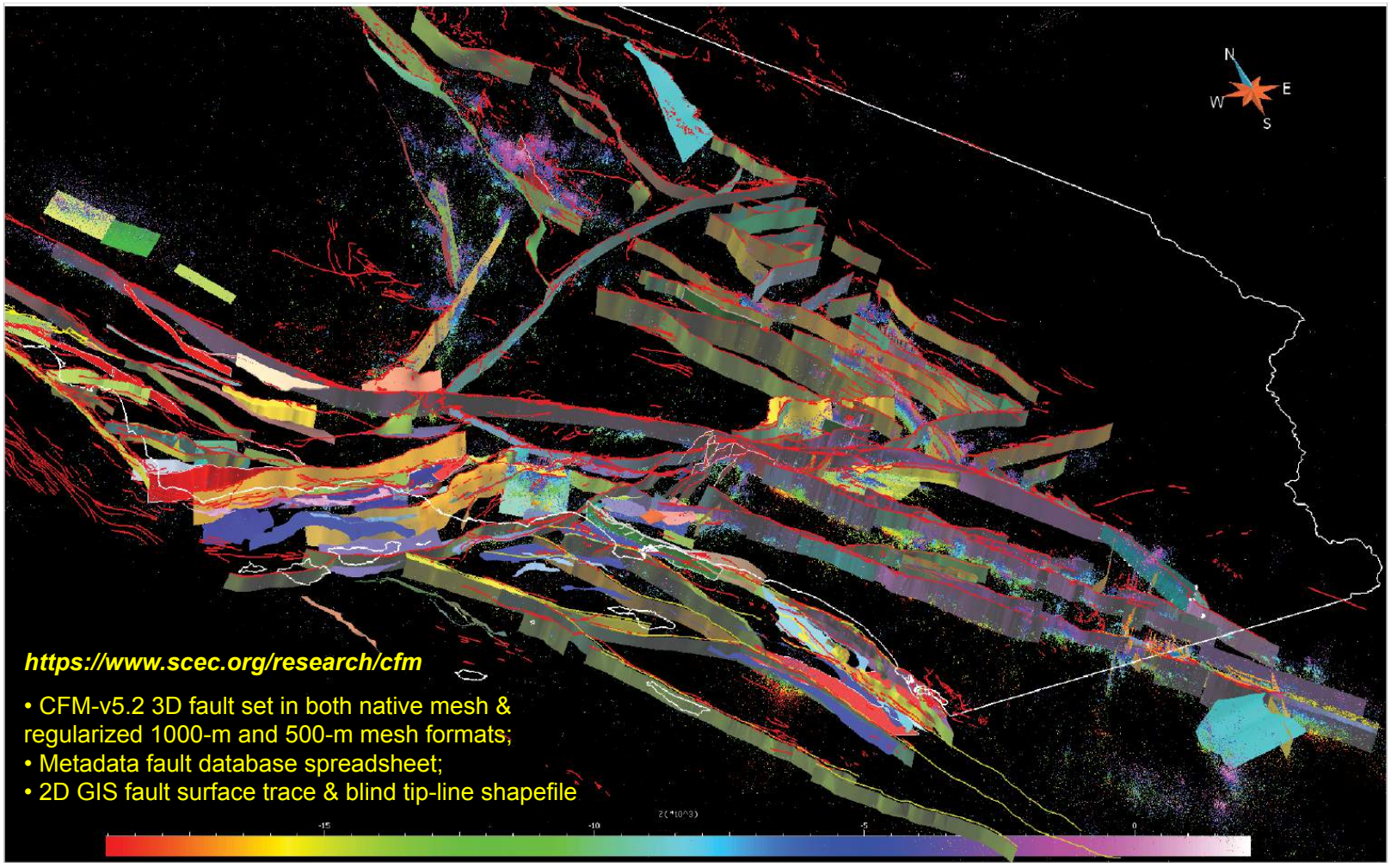
SCEC

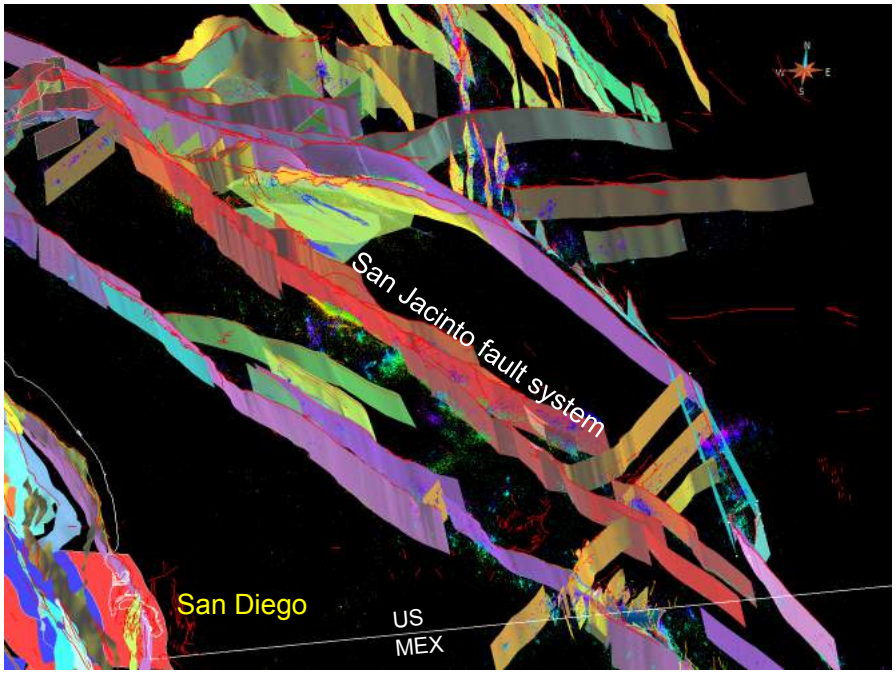
Southern California Earthquake Center

The Updated SCEC CFM-v5.2 3D Fault Set for 2018



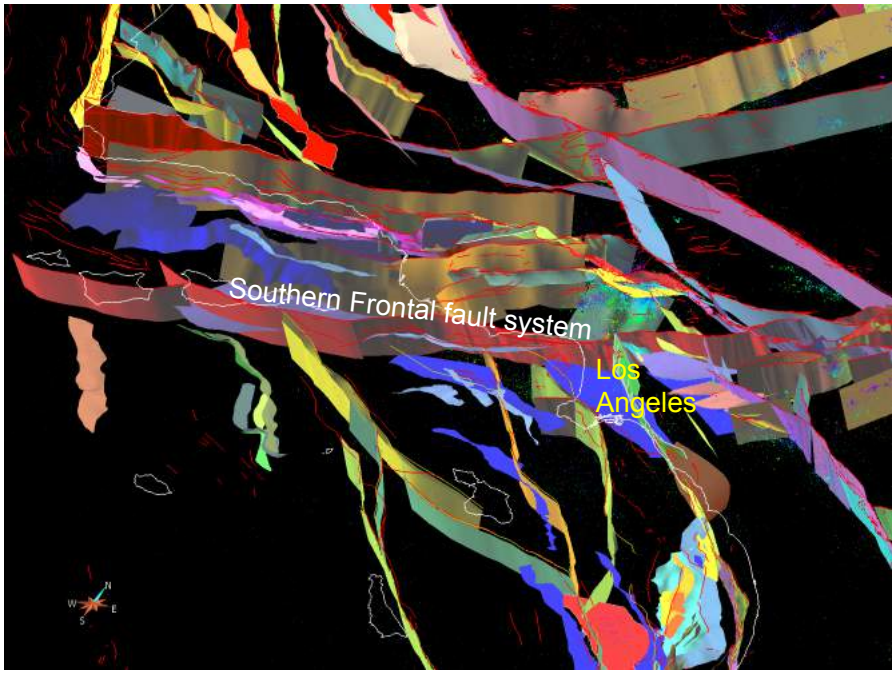
Hierarchical Organizational Scheme for CFM Fault Systems

San Jacinto Fault System



Includes: Glen Helen, San Jacinto, Lytle Creek, Claremont, Loma Linda, Rialto-Colton, Casa Loma, Hot Springs, Clark, Buck Ridge, Coyote Creek, Superstition Hills, Superstition Mountain, Dixieland, Weinert-El Centro and West Mesa faults

Southern Frontal Fault System



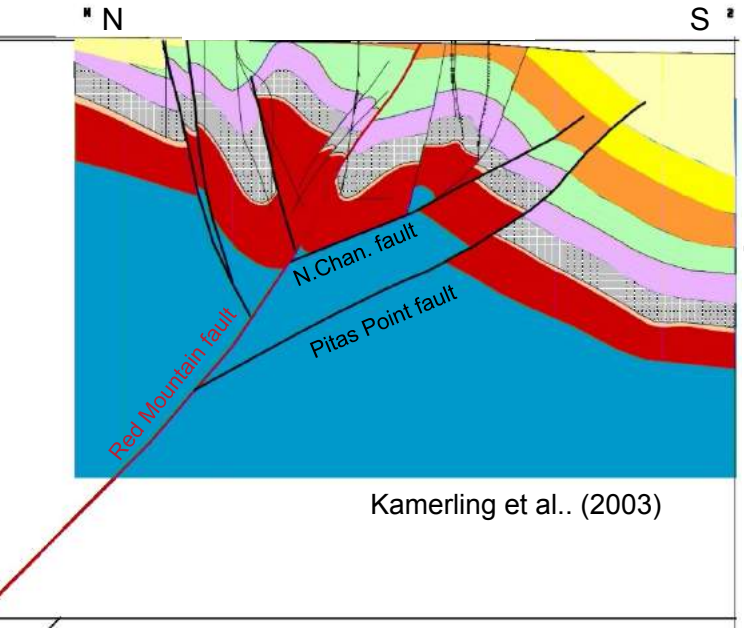
Includes: Raymond, Hollywood, Santa Monica, North Salt Lake, Malibu Coast, Santa Cruz Island, and Santa Rosa Island faults

How is CFM 3D Fault Geometry Determined?

Step 1: Integration of industry well, seismic reflection and correlated subsurface horizons

Example: North Channel-Pitas Point-Red Mountain fault system, Santa Barbara-Ventura Area

Industry well data and subsurface structure maps & cross sections



Kamerling et al.. (2003)

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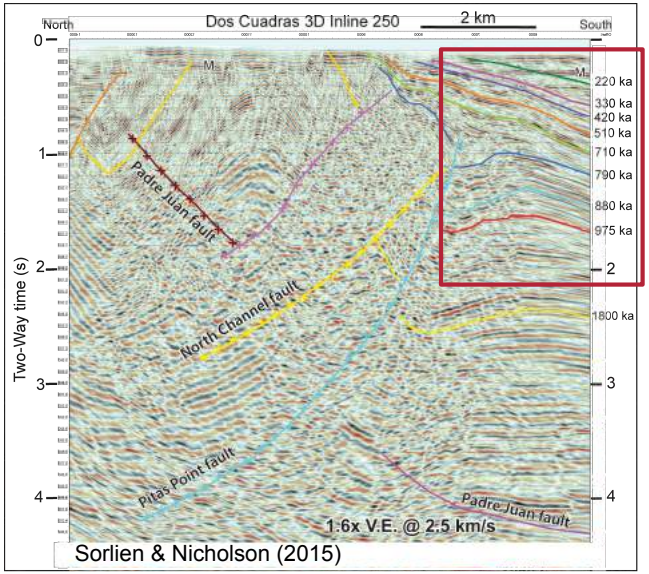
Industry 2D & 3D seismic reflection data and dated reference horizons



Sorlien & Nicholson (2015)

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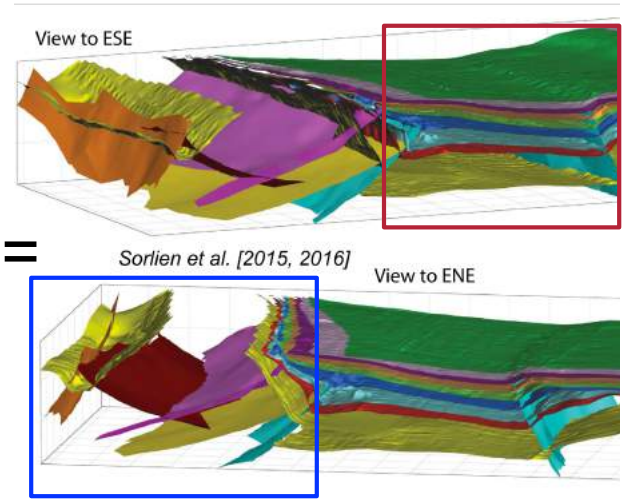
Initial upper crustal (top 5-6 km) 3D fault & fold geometry



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How is CFM 3D Fault Geometry Determined?

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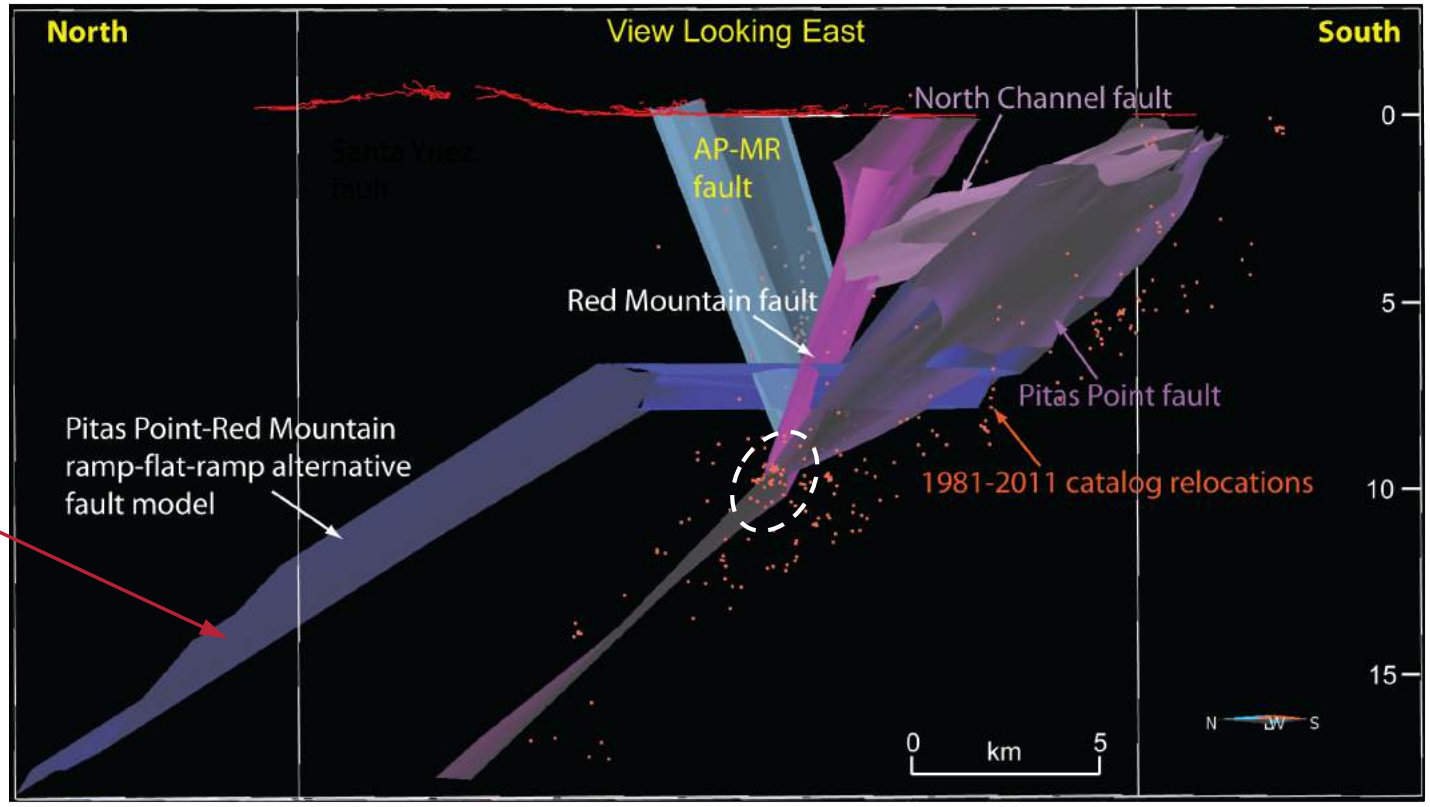
Step 2: Extending 3D fault geometry to seismogenic depths (earthquakes vs 2D fold models)

Example: North Channel-Pitas Point-Red Mountain fault system, Santa Barbara-Ventura Area

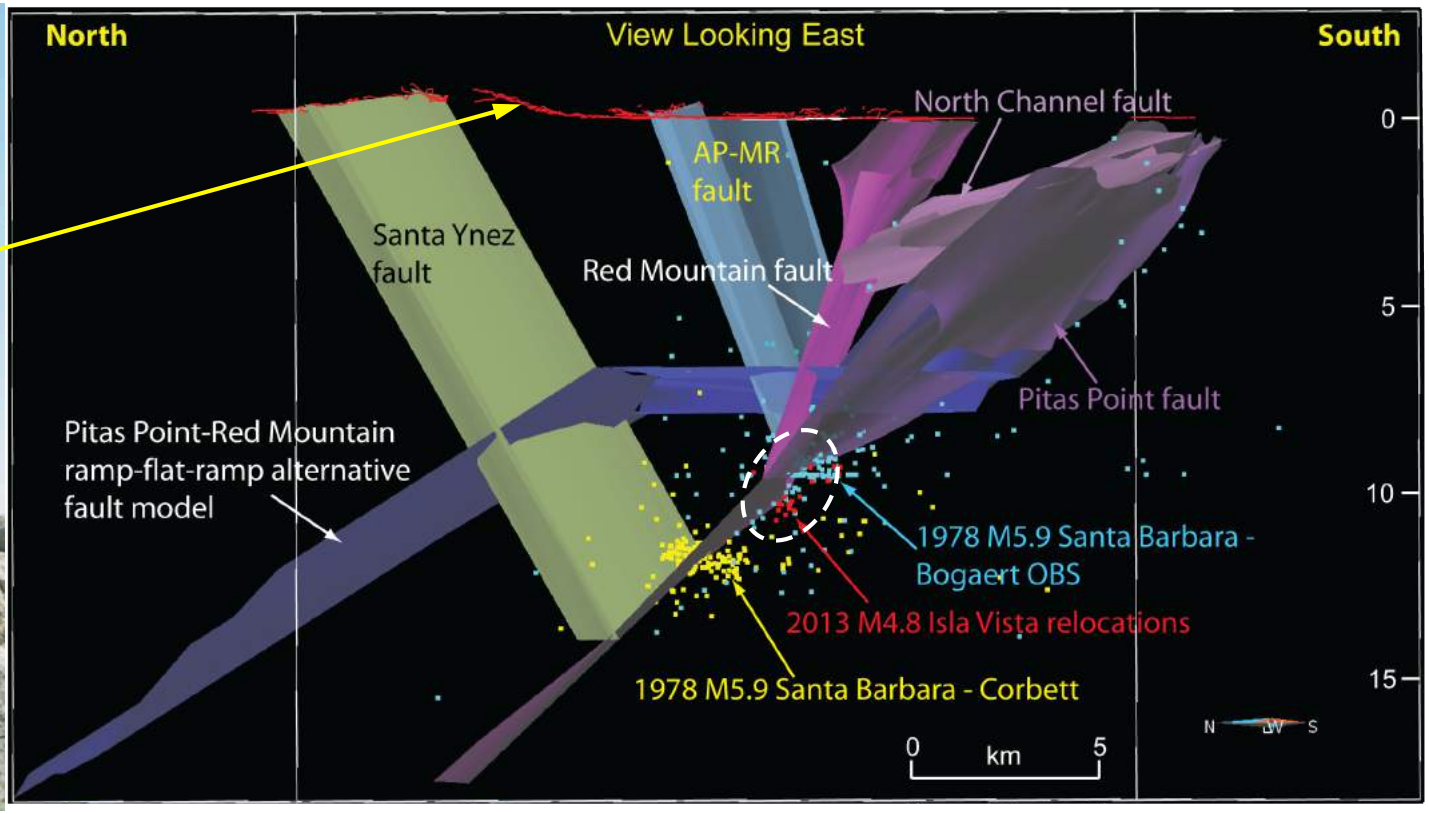
- 3D fault surfaces mapped in two-way travel-time converted to depth
- 1981-2011 Hauksson et.al. catalog hypocenter relocations
- Faults extended down-dip based on hypocentral and dominant focal mechanism nodal plane alignments
- Distinctive clustered concentration of hypocenters where major Pitas Point & Red Mountain faults intersect
- Alternate ramp-flat-ramp geometry [Hubbard et al., 2014] is based on 2D fault-related fold model projected along strike with dip, depth & location of lower ramp-flat strictly model dependent



How is CFM 3D Fault Geometry Validated?

Compare expected rupture model consistency with PBR preservation

Compare with independent relocated 1978 M5.9 Santa Barbara & 2013 M4.8 Isla Vista hypocenters not previously used in either model construction

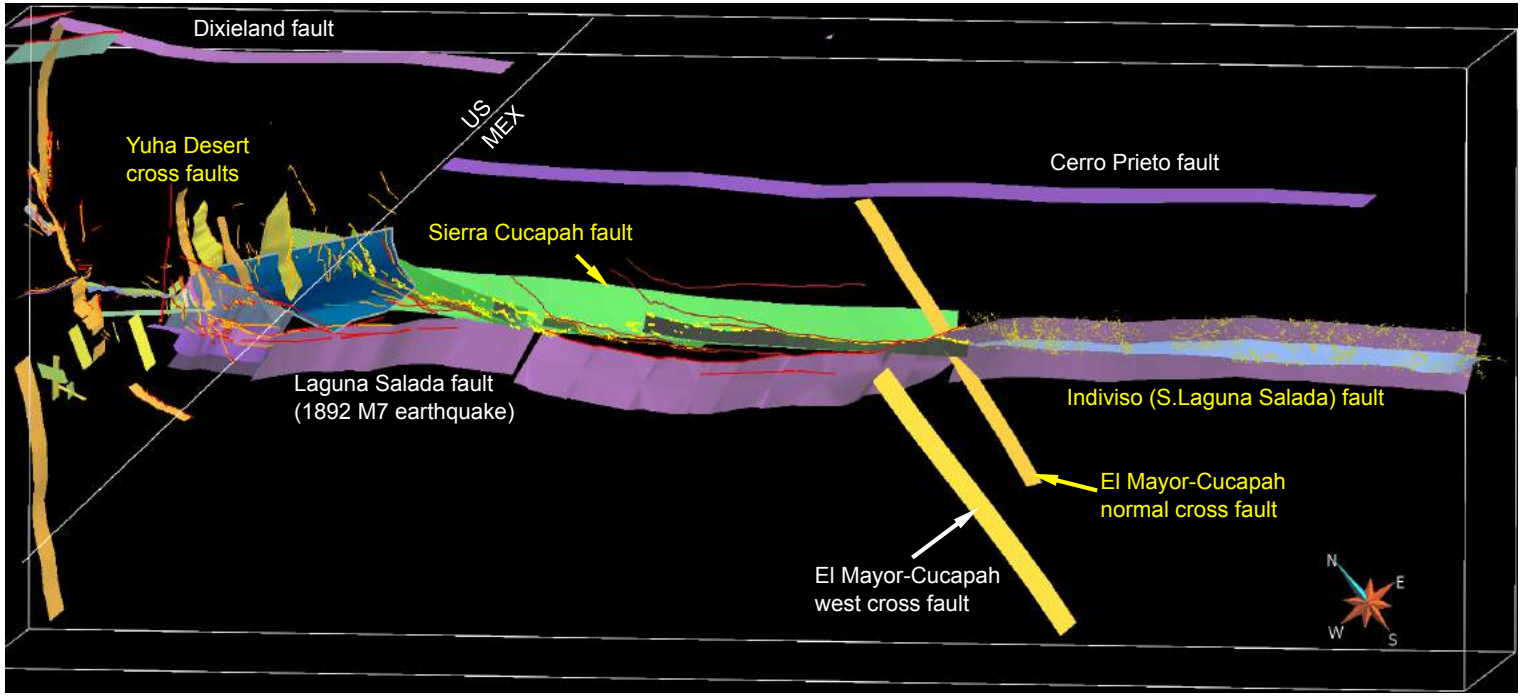


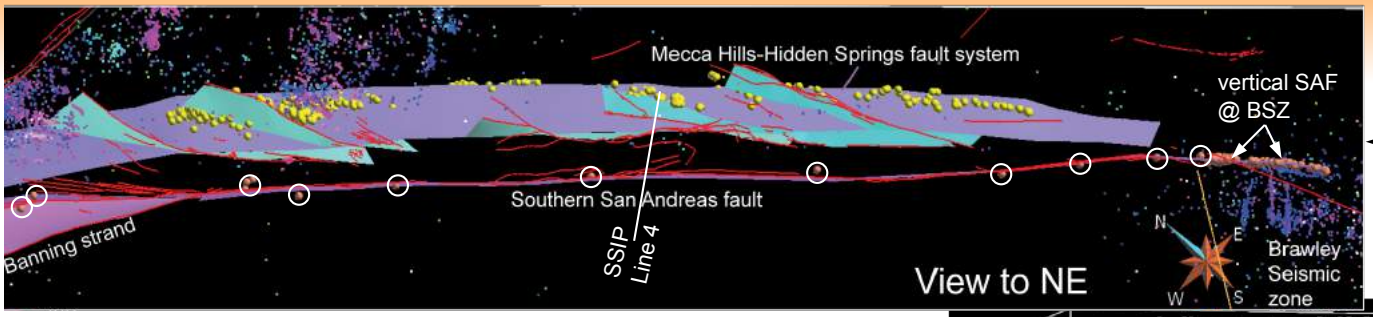
How Complex Does CFM 3D Fault Geometry Need to Be?

Example: 2010 M7 El Mayor-Cucapah sequence, Sierra Cucapah and Laguna Salada faults

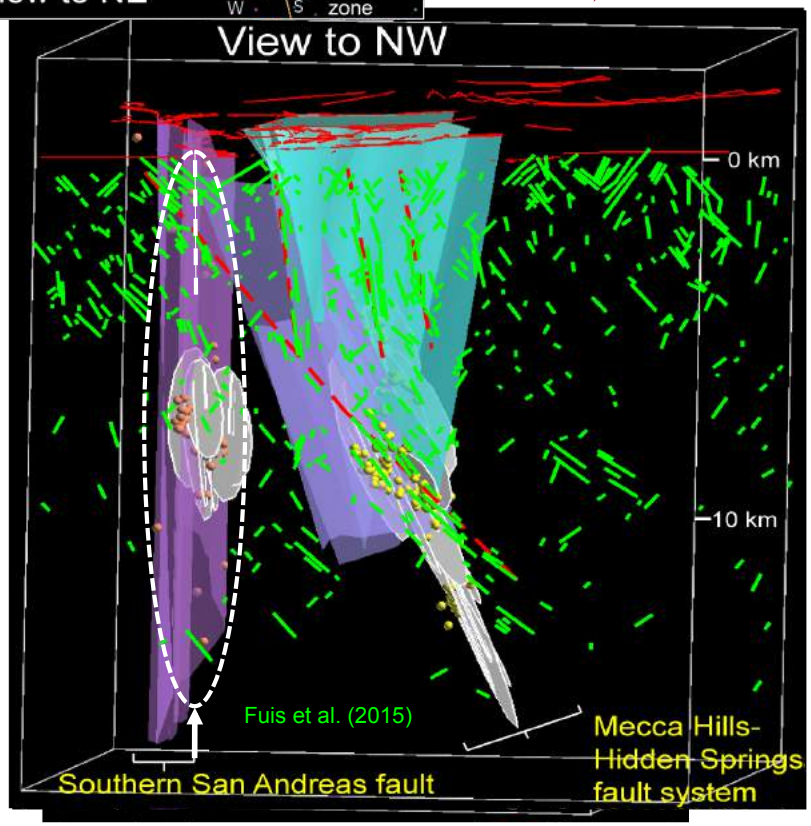
- El Mayor-Cucapah normal fault
- Sierra Cucapah & Indiviso faults
- Cerro Centinela & East Splay detachment faults
- Yuha Desert & other cross faults

Importance of active cross faults, detachments, and adjacent sub-parallel fault systems to understanding & modeling complex dynamic earthquake rupture





View direction shown below



Map view looking NE of the southern San Andreas fault and the adjacent, sub-parallel, NE-dipping Mecca Hills-Hidden Springs fault system.

Distinctly different sets of earthquakes define both a near-vertical southern San Andreas fault (orange events) and a sub-parallel, moderately dipping, adjacent Mecca Hills-Hidden Springs fault system (yellow events).

These distinct populations are reflected in the alignment of focal mechanism nodal planes.

In the Mecca Hills, reflected refractions along SSIP Line 4 image steep & dipping portions of the Mecca Hills-Hidden Springs fault system.

SSIP Line 4 reflections do not image the San Andreas fault where it is known to be near-vertical in the upper 4 km, or at deeper depth.

OBSERVATIONS

- Faults with similar 3D fault geometry, style of deformation & potential to be linked at depth can be organized into higher-level CFM fault systems. CFM-v5.2 3D fault set now contains nearly 400 individual faults organize into 105 fault systems.

- CFM uses available industry well data, structure maps & cross sections, 2D & 3D seismic reflection data, and correlated dated reference horizons to map 3D fault and fold structure in the upper crust.

- Alignments of relocated hypocenters & focal mechanism nodal planes can be used to extend 3D fault geometry deeper. Alternatively, ramp-flat fault surfaces can be developed based on 2D fault-related fold models projected along strike, but different 2D fold models will yield different fault geometry at depth.

- Recent NZ and CA earthquakes demonstrate that earthquake ruptures can be quite complex, and involve secondary cross faults, detachments, and adjacent, sub-parallel fault systems.

- There are still on-going debates about the 3D geometry of major faults like the Pitas Point-Red Mountain fault, or the San Andreas fault in the Coachella Valley, San Gorgonio Pass, and Cajon Pass.

- Strike-slip faults in southern CA are often multi-stranded -- with fault strands merging at depth, diverging with depth, or remaining closely spaced (2-3 km) & sub-parallel to depths over 12-16 km.