Ventura Special Fault Study Area (SFSA)

The SCEC Ventura Special Fault Study Area was established to promote interdisciplinary science that seeks to better understand the prospects for large, multi-segment thrust fault earthquakes in southern California, and to assess and address the hazards that these potentially devastating earthquakes may pose. The SFSA plans to support research in the fields of geology, paleoseismology, exploration geophysics, seismology, tectonic geodesy, rupture dynamics, strong ground motion forecasting, and tsunami studies. Within the timeframe of SCEC4, we hope to establish if a record of large, multi-segment thrust fault earthquakes exists in southern California, and to quantify the hazards associated with such events.

Ventura study area

The Ventura fault underlies the Ventura Avenue anticline, which is one of the fastest uplifting structures in southern California, rising at a rate of ~5 mm/yr [Rockwell et al., 1988]. Holocene terraces on the anticline suggest that it deforms in discrete events with 5-10 m of uplift, with the latest event occurring ~900 years ago (Rockwell, 2011). Moreover, recent excavations across the Ventura fault scarp, which runs through the city of Ventura, show evidence for large-displacement paleoearthquakes in the Holocene (McAuliffe et al., 2011; 2013). Based on conventional empirical scaling relationships, the amount of uplift recorded by the terraces and in the trenches would require large earthquakes (M7.5-8.0), suggesting that the Ventura fault ruptures in conjunction with other faults in the Transverse Ranges. Subsurface studies suggest that the Ventura fault is linked at seismogenic depths with the San Cayetano fault to the east (Hubbard et al., 2011; 2013) and the Pitas Point and Red Mountain fault to the west (Sarna-Wojcicki et al., 1976, 1982; Yerkes and Lee, 1987; Yerkes et al., 1987; Huftile and Yeats, 1995; Kamerling et al., 1999; 2003; Hubbard et al., 2011; 2013). Thus, the Ventura fault represents an important linkage between some of the largest, fastest-slipping reverse faults in the Western Transverse Ranges. Given the availability of geological, geophysical, seismological, and geodetic data in the region, the Ventura fault offers an excellent natural laboratory to investigate the potential for multi-segment thrust fault earthquakes and the hazards that they pose. These hazards include the prospect of severe ground shaking due to the extreme depth of the Ventura basin (> 12 km), as well as the potential for strong regional tsunamis when the ruptures extend offshore.

Goals

The Ventura SFSA seeks to:

1) Test and refine the record of large multi-segment ruptures on the Ventura fault system along strike, and extend the record back in time.
2) Determine how slip and deformation are distributed in these large, multi-segment ruptures, and how might this vary over multiple earthquake cycles.
3) Characterize the interseismic strain accumulation along the Ventura thrusts system.
4) Define a viable set of multi-segment rupture scenarios with dynamic rupture modeling, and evaluate these using the paleoearthquake record.
5) Define the intensity, duration, and distribution of strong ground shaking and tsunami run-up we should anticipate for these events.
6) Establish if there is a tsunami record associated with these events, and assess these hazards.

Specific task that are targeted for the coming year include:

A) Extending the paleoearthquake record in space and time – confirming if terrace, borehole excavation, and offshore seismic event records are consistent.
B) Developing and testing sets of alternative 3D fault representations for the possible linkages between the Ventura-Pitas Point and other thrust systems in the WTR. Make these available to the

SCEC Community for use in dynamic rupture modeling, fault system studies, and strong ground motion simulations. Please note that alternative fault models will be made available to the SCEC community by the end of 2013 and thus available for proposed 2014 research efforts.
C) Expanding the current geodetic data set to include more GPS stations, and InSAR scenes.
D) Using more advanced noise models to get realistic geodetic error bars.
E) Expanding upon kinematic rupture simulations using more detailed finite source representations and alternative slip models; explore the implications for strong ground motion forecasts.
F) Performing preliminary, simplified dynamic models of one or two scenario earthquakes for use as reference models for later, more precise work. Use these models to predict tsunami characteristics (e.g. inundation, impact on coastal infrastructure).
G) Characterizing (e.g. vertical and lateral trends in grain size, more chronology, XRF, diatoms, etc.) the hypothesized 1812 tsunami bed in Carpinteria Slough and use it as an analogue for identifying older tsunami beds in longer cores. Repeat the experiment in other locations (e.g. the Goleta Slough near Santa Barbara).

We encourage proposals through SCEC through the normal submission process that seek to address these goals and objectives. Please feel free to contact the SFSA leadership committee if you have any questions in preparing your proposals or about this research collaboration.

James Dolan (University of Southern California), dolan@usc.edu
Scott Marshall (Appalachian State University), marshallst@appstate.edu
Tom Rockwell (San Diego State University), trockwell@mail.sdsu.edu
John H. Shaw (Harvard University), shaw@eps.harvard.edu
Alexander Simms (UC Santa Barbara), asimms@geol.ucsb.edu

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