

Analysis of Fault-Fold Structures along the Newport-Inglewood Rose Canyon Fault System at an unprecedented scale using 3D P-Cable seismic reflection data

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Abstract Body:

The Newport-Inglewood Rose Canyon (NIRC) Fault system is a complex dextral strike-slip system that is located primarily offshore for approximately 120 km from San Diego to the San Joaquin Hills near Newport Beach, California. Based on trenching and well data, the NIRC Fault Holocene slip rate is 1.5-2.0 mm/yr to the south and 0.5-1.0 mm/yr along its northern extent. An earthquake rupturing the entire length of the offshore system could produce an M7.3 earthquake and potentially impact around 20 million Southern California residents. In late 2013, we acquired the first high-resolution 3D Parallel Cable (P-Cable) seismic survey of the NIRC system as part of the Southern California Regional Fault Mapping project. These data were collected on the continental shelf and slope near the midpoint of the fault system offshore San Onofre and San Clemente, California. Analysis of these high-resolution data has allowed us to map subsurface deformation and construct a geochronology of strain partitioning due to fault segmentation and step-overs. For the first time, we have fully imaged a sequence of synform and antiform fault-fold structures in three dimensions and the complex geometry that created these structures. Given the 3.125 m resolution of the 3D data volume in all directions, the transition from a monocline to a fold to a fault is imaged in the crosslines, inlines, and time-slices. This transition is associated with secondary fault splays and step-overs that creates a “cusped-style” morphology in the time slice acoustic reflectivity, with the horns of the cusp being antiforms and intervening regions of the cusp being synforms. One of the main strands of the NIRC fault bounds these semi-circular patterns of acoustic reflectivity in the time slice. Such imagery allows us to define how fault segments interact laterally and at depth and the importance of small step-overs and secondary fault splays in how deformation is communicated to neighboring faults. We will present images of this fault-fold sequence by sequentially peeling back the crosslines for a given time slice, then peeling back the inlines, and finally shifting the time slices for a true 3D examination of this fault-fold structure. We will conclude by showing how this fault architecture shapes the continental margin in Southern California.

Plain Language Summary:

The Newport-Inglewood Rose Canyon fault system is a large collection of faults that run along coastal Southern California. These faults are mostly offshore but close enough to present a hazard to residents. Using state-of-the-art 3D geophysical tools, we have created high-resolution maps of structures under the seafloor that were created by this fault system in the vicinity of San Onofre and San Clemente, California. Using these maps we show examples of how fault segments tend to distribute strain and the crustal deformation that is created in the process. The analysis of such structures provides a certain amount of insight into the activity of the fault system itself.