

3-D Continuity of the San Andreas Fault between San Gorgonio Pass and Cajon Pass

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The San Andreas fault at San Gorgonio Pass does not have a clear surface trace and is considered aseismic. Our findings suggest in fact that the existence of a through-going vertical or near-vertical San Andreas fault between Yucaipa and North Palm Springs is highly unlikely. Only complex 3-D geometries are possible.

We mapped over 70 faults in the San Gorgonio Pass-San Bernardino Mountains region to depths of 20 km, using the catalog of 43,500 relocated 1975-1998 earthquakes of Richards-Dinger and Shearer (2000). A clustering algorithm was applied to the relocated earthquakes in order to obtain tighter earthquake clouds and thus better-defined fault surfaces. The earthquakes were then imported into Gocad, a 3-D modeling software that allowed us to separate earthquakes into coplanar clusters associated with different faults and fault strands and to fit optimized surfaces to them. We also used the catalog of 13,000 focal mechanisms of Hauksson (2000) to confirm the nature of the mapped faults.

We were able to constrain the 3-D geometry of the San Andreas fault near San Gorgonio Pass from the 3-D geometry of the fault network surrounding it. None of these faults are cut and offset by an hypothetical sub-vertical San Andreas. The San Andreas fault must therefore rotate to much shallower dips, or lose its continuity at depths between 3 and 15 km. The most likely configuration is the one where the San Andreas fault merges into the shallow-dipping San Gorgonio Pass thrust W of North Palm Springs. Strike-slip motion is taken up by both the thrust (the slip vector on the North Palm Springs segment of the thrust is reverse/right-lateral strike-slip) and by a series of NW striking faults in the footwall of the thrust. The W termination of the most active part of the San Gorgonio Pass thrust coincides with one of these footwall faults at depth, and with the south bend in the San Andreas fault strand N of Banning at the surface. This boundary also marks a change in the stress field, with a dominant strike-slip regime to the E (and localized thrusting between San Gorgonio Pass and Thousand Palms), and a normal-fault regime to the W all the way to Cajon Pass.

Considering the 3-D geometry of the San Andreas fault system in this region, the only kind of rupture possible for the San Andreas is a complex rupture. The present-day stress field allows for such a rupture, involving both strike-slip and reverse faulting, to occur between the Coachella Valley and Banning. However, both 3-D geometry and stress field are an obstacle to further rupture propagation towards the W, between Banning and Cajon Pass.