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3-D geometry of active deformation east of the San Andreas fault near Parkfield, northern California

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The thrust-and-fold belt east of the San Andreas fault extending from the Diablo Range to the Temblor Range has been studied in detail mostly at its toe, where a large amount of data is available from oil exploration. We focus more on the part of the belt closer to the San Andreas fault (SAF). We use earthquake data for the period 1980-2006 coupled with surface geology to examine the 3-D geometry of faults in the southernmost Diablo Range, in particular the SAF from just north of Parkfield to the end of the creeping section, and the faults immediately to the east of the SAF. We then combine the results of our study with existing detailed studies and recent earthquake data of the eastern part of the fold belt to produce a consistent structural model all the way to the San Joaquin basin.

From earthquake data we identify an active reverse fault just east of the SAF that abuts the SAF near the bottom of the seismogenic crust ($\sim$15 km depth). This fault strikes parallel to the mountain ridge above it, diverges from the SAF from north to south just like the ridge does, and it steepens close to the surface in its southern half. It matches a major mapped fault trace at the surface. The presence of such a fault would explain why this particular ridge has significantly higher structural relief than the surrounding areas, with the Franciscan brought to the surface. The fault also corresponds to a high electrical conductivity corridor in the upper crust.

Earthquakes also illuminate the 3-D shape of several other structures at the western margin of the San Joaquin basin, and indicate the presence of faulting to at least 18 km depth, deeper than can be inferred from oil data alone. Earthquake data are especially

useful for imaging the fault segmentation in this area. For example, the aftershocks associated with the 1985 Kettleman Hills earthquake delineate a ramp-flat structure that is clearly different and separate from the structure associated with the 1983 Coalinga event. In general, structures east of the SAF near Parkfield are west-rooting, steeply-dipping thrust faults oriented perpendicular to the regional compression.

Double-difference relocated earthquakes illuminate joint-like structures forming a "sliced-bread" pattern in the SAF near Parkfield. These structures are at the resolution limit, but their orientation matches the one predicted from the orientation of the stress field in this region. The orientation also agrees with the early SAFOD results that show a progressive increase in the angle between the SAF and the direction of maximum horizontal compression with increasing depth.