TECTONIC GEOMORPHOLOGY, ACTIVE FOLDING, AND EARTHQUAKE HAZARD OF THE MISSION RIDGE FAULT SYSTEM, SANTA BARBARA, CALIFORNIA

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Investigation of the Mission Ridge fault on the Santa Barbara, California coastal piedmont identified potential seismic sources, several of which are expressed as anticlinal folds with tectonic geomorphic expression. The folds deform late Pleistocene alluvial fan and marine terraces age-dated by radiocarbon, uranium-series, optical stimulated luminescence, oxygen-isotope stratigraphy, and/or cosmogenic 21Ne analyses. Trench excavations across the forelimbs of folds of the Mission Ridge fault reveal active deformation including bending moment faulting and hanging-wall warping.

The westernmost segment of the Mission Ridge fault, the More Ranch fault, is exposed in a sea cliff exposure at Ellwood Beach. Vertical separation of the 44 ka marine abrasion platform due to faulting is approximately 7 m, whereas a monoclinal drape fold is formed in the terrace sediments. Analyses of continuous-drill core samples, seismic refraction data, and trench excavations on the More Ranch fault collected approximately 2 km east of the sea cliff exposure suggest: that the 44 ka marine terrace is anticlinally folded; fold relief across the 44 ka marine platform is approximately 14 m; and the estimated vertical rate of deformation is 0.32 m/ky.

Trench excavations across the Mission Ridge segment of the Mission Ridge fault system exposed 100 ka to 139 ka alluvial fan deposits, probably related to the 125 ka sea level highstand, folded with 90 m of vertical relief. From this evidence, the vertical rate of deformation is 0.75 +/- 0.15 m/ky. A trench pit excavation across part of the northern limb of the Mission Ridge anticline exposed fluvial and alluvial sediments that are increasingly tilted with depth. The fluvial units dip approximately 10o to the north and form part of the forelimb of the fold. Radiocarbon analyses of an organic peat horizon determine an age-date of 1690 A.D. or 1730 A.D for the fluvial deposits. Based on the arrival of Spanish settlers in 1782, we interpret that an earthquake occurred on the Mission Ridge segment between 1690 A.D. and 1730 A.D. Considering that the entire Mission Ridge fault consists of three segments, our seismic hazard analysis suggests that if one of the segments ruptured an earthquake of Mw6.5 would likely result. If all three segments ruptured, an earthquake of Mw6.8 to Mw7.0 would likely occur.