Late Quaternary uplift and earthquake potential of the San Joaquin Hills, southern Los Angeles basin, California

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ABSTRACT

Analysis of emergent marine terraces in the San Joaquin Hills, California, and ^{230}Th dating of solitary corals from the lowest terraces reveal that the San Joaquin Hills have risen at a rate of 0.21–0.27 m/k.y. during the past 122 k.y. Movement on a blind thrust fault in the southern Los Angeles basin has uplifted the San Joaquin Hills and has the potential to generate an M_w 7.3 earthquake within this densely populated area. Our structural modeling suggests that the fault dips to the southwest and slips at ~0.42–0.79 m/k.y., yielding an estimated minimum average recurrence interval of ~1650–3100 yr for moderate-sized earthquakes. Recognition of this blind thrust extends the known area of active blind thrusts and fault-related folding southward from Los Angeles into coastal Orange County.

INTRODUCTION AND GEOLOGIC SETTING

The Whittier Narrows and Northridge blind thrust faults in the Los Angeles, California, area were recognized only after they generated damaging, moderate-sized earthquakes (M_w 6.0 and 6.7) in 1987 and 1994 (Bullard and Lettis, 1993; Scientists of USGS and the Southern California Earthquake Center, 1994). Blind thrust faults are often associated with active folds (Stein and Yeats, 1989; Ward and Valensise, 1994; Lettis et al., 1997). Indications of late Quaternary folding are present in the San Joaquin Hills at the southern margin of the Los Angeles basin (Fig. 1). We present stratigraphic and geomorphic analyses in combination with ^{230}Th coral dating to calculate rates of uplift and evaluate the potential for blind thrust earthquakes beneath the San Joaquin Hills.

The Los Angeles basin is a northwest-trending structural trough bounded by active reverse and left-lateral faults of the Transverse Ranges to the north and by active right-lateral faults of the Peninsular Ranges to the northeast and southwest (Wright, 1991; see inset map in Fig. 1). The San Joaquin Hills are the topographic expression of a northwest-trending anticline between San Juan Capistrano and Huntington Mesa (Vedder, 1975; Lajoie et al., 1991) (Fig. 1). The Newport-Inglewood fault zone and its offshore extension (Wright, 1991; Fig. 1) bound the San Joaquin Hills on the southwest. The Newport-Inglewood fault zone generated the 1933 M_w 6.4 Long Beach earthquake near the mouth of the Santa Ana River (Hauksson and Gross, 1991).

Uplift of the San Joaquin Hills began in the early Pleistocene (Barrie et al., 1992). A suite of emergent marine terraces is present along the coastal San Joaquin Hills (Vedder et al., 1957). We extended previous mapping of terrace deposits (Barrie et al., 1992) and measured the elevations of shorelines and terrace platforms using geotechnical excavations, borings, natural exposures, and topography (Fig. 2). We correlated coastal terraces with inland terraces by comparing elevation, stratigraphic relationships, degree of dissection, soil profiles, and faunal assemblages (Kanakoff and Emerson, 1959; Peska, 1984).