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INITIATION AND DEVELOPMENT OF THE SOUTHERN CALIFORNIA UPLIFT ALONG ITS NORTHERN MARGIN

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ABSTRACT

Analysis of three first-order leveling lines that traverse the White Wolf fault (site of the 1952 $M = 7.7$ earthquake), each resurveyed nine times between 1926 and 1974, reveals probable preseismic tilting, major coseismic movements, and a spatial association between these movements and the subsequently recognized southern California uplift. In examining the vertical control record, we have both searched for evidence of systematic errors and excluded from consideration portions of the lines contaminated by subsurface fluid and gas extraction. Movements have been referred to an invariant datum based on the 1926 position of tidal BM 8 in San Pedro, corrected for subsequent eustatic sea-level change.

An 8 μrad up-to-the-north preseismic tilt (6 cm/7.5 km) was apparently recorded on two adjacent line segments within 10 km of the 1952 epicenter between 1942 and 1947. It is possible, however, that this tilt was in part caused by extraction-induced subsidence at one of the six releveled benchmarks. Data also show evidence of episodic tilts that are not earthquake related. At the junction of the Garlock and San Andreas faults, for example, an $\geqslant 5$ μrad up-to-the-north tilt (7.2 cm/$\leqslant$16 km) took place between Lebec and Grapevine within three months during 1964.

Comparison of the 1947 and 1953 surveys, which includes the coseismic interval, shows that the SW-fault end (nearest the epicenter) and the central fault reach sustained four times the uplift recorded at the NE end of the fault (+72 cm SW, +53 cm Central, +16 cm NE). A regional postseismic uplift of 4 cm extended $\geqslant$25 km to either side of the fault after the main event, from 1953 to 1956. An interval of relative quiescence followed at least through 1959, in which the elevation change did not exceed $\pm$3 cm.

The detailed pattern of aseismic uplift demonstrates that movement proceeded in space—time pulses: one half of the uplift at the SW-fault end and extending southward occurred between 1959 and 1961, one half of the

uplift at the NE-fault end and extending eastward occurred between 1961 and 1965, while the central fault reach sustained successive pulses of subsidence, uplift, and collapse (−4 cm, 1953–60; +7 cm, 1960–65; −2 cm, 1965–70). In addition, the number of aftershocks concentrated near the fault ends increased in the NE relative to the SW from 1952 to 1974. These observations suggest that the aseismic uplift may have migrated northeastward from 1959 to 1965 at an approximate rate of 7–16 km/yr.

Evidence for a mechanical coupling between the earthquake and the subsequent aseismic uplift is equivocal. At both fault ends, the major NW-bounding flexure or tilted front of the southern California uplift is spatially coincident with the coseismic flexure that preceded it. In addition, the postulated migration of vertical deformation is similar to the 1952 seismic event in which the rupture initiated at the SW end of the fault and then propagated to the NE-fault end. However, the spatial distribution of aseismic uplift, nearly identical at both fault ends and to the south and east, and near zero in the central fault reach, is distinctly different from the nonuniform and localized coseismic deformation.