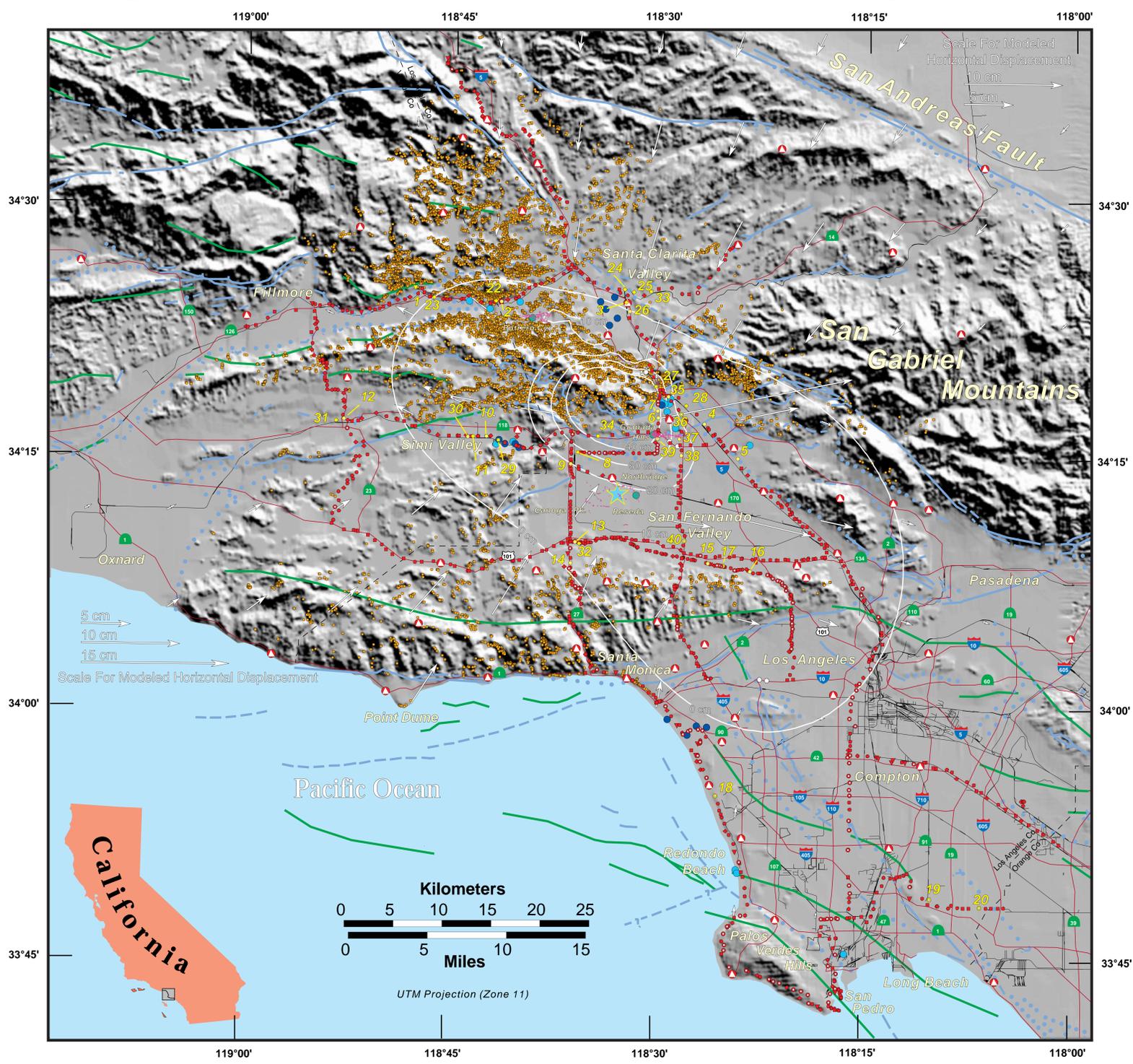


Damage and Restoration of Geodetic Infrastructure Affected by the 1994 Northridge, California, Earthquake



Explanation

The 17 January 1994, M=6.7 Northridge earthquake permanently distorted the ground surface, displacing geodetic monuments used by engineers and surveyors to construct and monitor the urban infrastructure. New coordinates and heights for 879 monuments displaced by the earthquake, as well as 100 new monuments, are given in the accompanying report, restoring the accuracy and integrity of the network.

The earthquake shaking also damaged engineered structures and caused surface cracking, liquefaction, and landslides. A geophysical model of the permanent earthquake deformation (shown by white contours and vectors) closely corresponds to the displacement of most monuments. The 40 monuments with displacements that differ from this model by more than 3 cm (1.2") are identified as anomalous; half of these are located in engineered structures; others are in engineered fill. The affected structures and fill may thus be in a weakened state as a result of the shaking, making them vulnerable to future earthquakes.

MOVEMENT OF LEVELING BENCH MARKS

Undisturbed (fits model)	Anomalous, with Identifier	Identifier, PIDs and anomaly in cm (- uplift; - subsidence)
●	●	1 EW9445 -3.6 21 EW4960 -8.1
●	●	2 EW4667 4.3 22 EW4870 -8.6
●	●	3 EW8985 8.0 23 EW8986 3.1
●	●	4 EW2315 3.3 24 EW5003 6.2
●	●	5 EW4773 -4.3 25 EW5006 6.2
●	●	6 EW4850 4.3 26 EW7051 7.5
●	●	7 EW4854 4.0 27 EW4885 -11.6
●	●	8 EW4795 -2.4 28 EW8089 -11.6
●	●	9 EW4427 -3.9 29 EW6942 -5.8
●	●	10 EW9478 4.0 30 EW4588 3.0
●	●	11 EW9473 -2.9 31 EW6937 5.0
●	●	12 EW4610 5.0 32 EW4321 -4.1
●	●	13 EW4326 -3.5 33 EW3012 -4.4
●	●	14 EW4366 3.2 34 EW8001 5.5
●	●	15 EW2212 4.6 35 AA3228 -9.2
●	●	16 EW2556 9.1 36 AA3231 -11.9
●	●	17 EW2201 -8.3 37 AA3234 -11.9
●	●	18 D12495 -1.8 38 AA3236 10.4
●	●	19 D12535 -11.6 39 EW4814 15.9
●	●	20 D12538 -1.6 40 AA3256 4.1

Global Positioning System monuments with coseismic observations of the ground displacement caused by the earthquake.

Modeled uplift (contours) and selected horizontal displacements (computed for points at the tail of the arrows) caused by the Northridge earthquake (see accompanying report and Wald, D., Heaton, T., and K. Hudnut, Bull. Seism. Soc. Am. 86, No. 1B, p. S49-S70, 1996).

EARTHQUAKE EFFECTS

- ★ 17 January 1994 M=6.7 Northridge Mainshock
- Location of bridges with major damage (I.G. Buckle, National Center for Earthquake Engineering Research, Technical Report NCEEER-94-0008, 1994)
- Landslides (E. L. Harp and R. W. Jibson, USGS Open File Report, 95-213, 1995)
- Site of Liquefaction inferred from subsurface studies (Holzer, T., Bennett, J., Tinsley, J., Ponti, D., and R. Sharp, Conference Proceedings, National Center for Earthquake Engineering Research, Tokyo, June 11-13, 1996).
- Site of Liquefaction (Staff of U.S. Geological Survey, USGS Open File Report, 96-263, 1996; I.C. Tinsley, USGS, in prep. 1996)
- Site of possible liquefaction (Staff of U.S. Geological Survey, USGS Open File Report, 96-263, 1996; I.C. Tinsley, USGS, in prep. 1996)
- Ground cracking associated with the Northridge Earthquake.
 - GRANADA HILLS: Hecker, S., Ponti, D., Garvin, T., Powers, J., Fumal, T., Hamilton, J., Sharp, R., Rymner, M., Prentice, C., and F. Cimini, USGS Open File Report 95-62, 1995.
 - POTRERO CANYON: Ponti, D. in prep. 1996.
 - NORTHRIDGE-RESEDA-CANOGA PARK: J. Slosson, J. Johnson, R. McCarthy, and T. Slosson, Calif. Seismic Safety Comm., in prep. 1996.

MAP BASE

- County boundary
- Railroad
- Active Geological Structures
 - Faults, well located (C. W. Jennings, Geologic Data, Map 6, Calif. Div. Mines & Geol., 1994)
 - Faults, inferred
 - Faults concealed by younger deposits
 - Fold formed above blind thrust faults (R. S. Sietz and R. S. Yeats, Scientific American, 1989)
- Highway Types
 - U.S. Interstate
 - U.S. Federal
 - State

This map and the accompanying report were funded by the Federal Emergency Management Agency as a Mission Assignment to the U. S. Geological Survey, with participation by the National Geodetic Survey, California Department of Transportation, and California Institute of Technology. This report is preliminary and has not been reviewed for conformity with U. S. Geological Survey editorial standards. Any use of trade, product or firm names is for descriptive use only and does not imply endorsement by the U. S. Government.

Map prepared by Anne Lilje (California Institute of Technology), Kathleen M. Hodgkinson (U. S. Geological Survey, Menlo Park), Kenneth W. Hudnut (U. S. Geological Survey, Pasadena), and Ross S. Stein (U. S. Geological Survey, Menlo Park).

B

U. S. Geological Survey Open File Report 96-517 (1996)