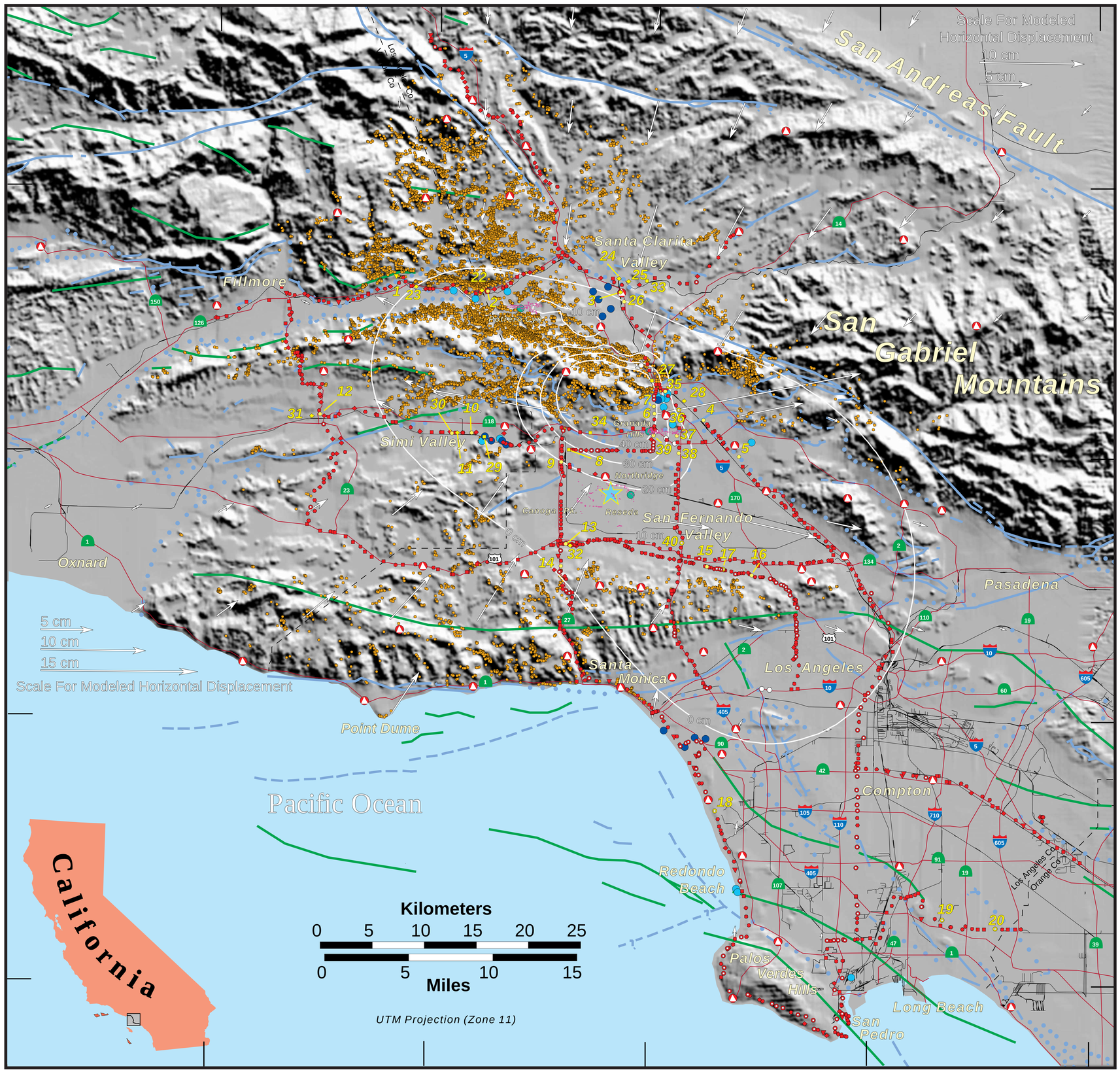
Damage and Restoration of Geodetic Infrastructure Affected by the 1994 Northridge, California, Earthquake



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 979 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	
●	1	Bedrock or Sediment Sites
■	1	Bridge Spans, Piers and Abutments
▼	1	Building Foundations
○	1	Catch Basins
◆	1	Culverts and Retaining Walls
▲	1	Tower Foundations

Identifier, PIDs and anomaly in cm (+ uplift; - subsidence)

1	EW9445	-3.6	21	EW4960	-8.1
2	EW4667	4.3	22	EW4670	-9.6
3	EW6895	8.0	23	EW6986	3.1
4	EW2515	3.3	24	EW5003	6.2
5	EW2473	-4.3	25	EW5006	6.2
6	EW4850	4.3	26	EW7051	7.5
7	EW4854	4.0	27	EW4865	-11.6
8	EW4792	-3.4	28	EW6899	-11.6
9	EW4427	-3.9	29	EW6942	-5.8
10	EW9478	4.0	30	EW4568	3.0
11	EW9475	-3.0	31	EW6937	5.0
12	EW4610	5.0	32	EW4321	-4.1
13	EW4326	-3.5	33	EW5012	-4.4
14	EW4366	3.2	34	EW9501	3.5
15	EW2212	4.6	35	AA3228	-9.2
16	EW2256	9.1	36	AA3231	-11.9
17	EW2201	-8.3	37	AA3234	-11.9
18	DY2495	-4.8	38	AA3236	10.4
19	DY2535	-11.6	39	EW4844	-13.9
20	DY2538	-4.6	40	AA3256	4.1

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

10 cm / 5 cm — 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 NCEER-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; J.C. Tinsley, USGS, in prep, 1996)

Site of possible liquefaction (Staff of U.S. Geological Survey, USGS Open File Report, 96-263, 1996; J.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., Rymer, M., Prentice, C., and F. Ciniti, 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
Faults, inferred
Faults concealed by younger deposits
(C. W. Jennings, Geologic Data, Map 6, Calif. Div. Mines & Geol., 1994)

Fold formed above blind thrust faults (R. S. Stein and R. S. Yeats, Scientific American, 1989)

Highway Types

605 — U. S. Interstate
101 — U. S. Federal
42 — State

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