

**U. S. DEPARTMENT OF THE INTERIOR
U. S. GEOLOGICAL SURVEY**

**PHOTOGRAPHS
of
THE OCTOBER 17TH 1989
LOMA PRIETA, CALIFORNIA
EARTHQUAKE**

**J. K. NAKATA¹, C. E. MEYER¹, H. G. WILSHIRE¹, J. C. TINSLEY¹
and W. S. UPDEGROVE²**

Additional contributions by:

**D. M. PETERSON¹
S. D. ELLEN¹
R. A. HAUGERUD³
R. J. McLAUGHLIN¹
G. R. FISHER¹**

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1. U. S. Geological Survey, 345 Middlefield Road, Menlo Park, CA 94025
2. U. S. Geological Survey, University of Arizona, Tucson, AZ 85721
3. U. S. Geological Survey, University of Washington, Seattle, WA 98195

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On October 17, 1989, at 5:04:15 PM (PDT) a 7.1 magnitude earthquake severely shook the greater San Francisco and Monterey Bay areas. The epicenter was located approximately 14.5 km (9 mi) northeast of Santa Cruz and 96.6 km (60 mi) south-southeast of San Francisco near Loma Prieta Peak in the Santa Cruz Mountains. The hypocenter was at a depth of 13.5 km (8.4 mi) along the boundary of the Pacific and the North American plates. This boundary is expressed at the surface as the San Andreas Fault Zone.

This report is intended to supplement the photographs in Open-File Report 89-687 (Ramsayer, 1989) and an effort was made not to duplicate those images. The 102 transparencies in this collection are accompanied by a brief description and their general locations are plotted on the index map. Our photographic coverage reflects the time and resources available immediately after the event and is not intended to portray the limits of earthquake damage.

Original transparencies are available to publishers by contacting each photographer directly. If any duplicates are used from this document, please cite the photographer and the U. S. Geological Survey. There is no use fee, but "tear sheets" are requested.

Acknowledgements: We thank E. J. Helley for his insightful review comments and D. V. Prose for his assistance immediately after the earthquake.

Sources for additional information:

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Prose, D., 1990, When the Bay Area quakes. Made for TV documentary: U.S. Geological Survey, 20 minutes. Distributed by Global Vision, 3790 El Camino Real, Suite 221, Palo Alto, CA 94306.

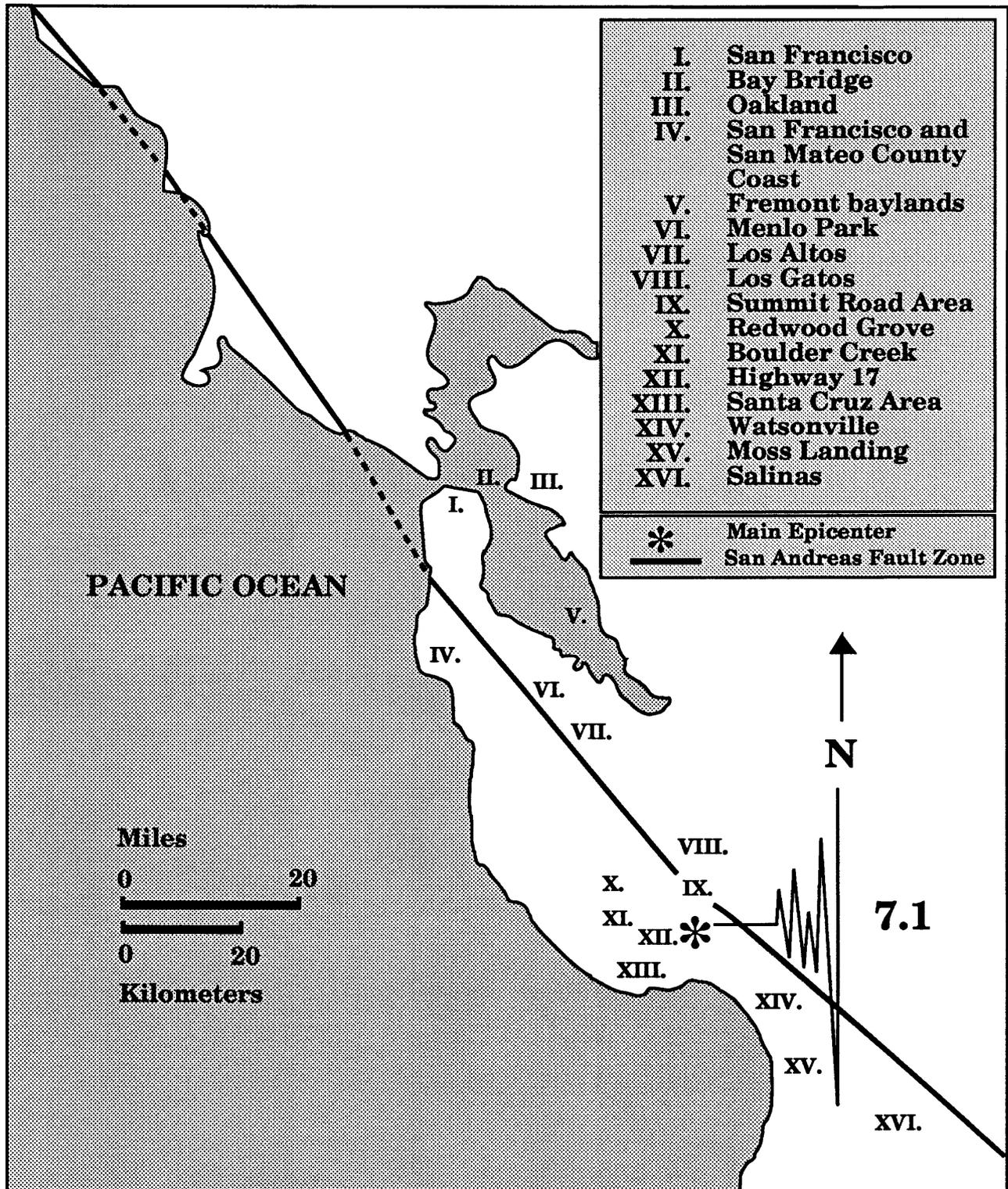
Ramseyer, C., 1989, Color photographs showing examples of structural damage and surficial effects of the M 7.1, October 17, 1989 Loma Prieta, California earthquake: U.S. Geological Survey Open-file report 89-687.

U. S. Geological Survey, 1989, The Loma Prieta Earthquake of October 17, 1989: Earthquakes and Volcanoes, vol. 21 #5.

U. S. Geological Survey, 1990, The Loma Prieta Earthquake of October 17, 1989: Earthquakes and Volcanoes, vol. 21 #6.

PHOTOGRAPH LOCATION MAP

LOMA PRIETA EARTHQUAKE 1989



INDEX MAP

A generalized index map showing the location of the 16 photographed sites.

I. SAN FRANCISCO

- Slide #1 I-1. Cars crushed by collapsing brick facade near 5th and Townsend. Five people were killed at this locality while leaving from work. [Meyer]
- 2 I-2. Crushed car near the intersection of 5th and Townsend, *South of Market*. [Meyer]
- 3 I-3. **Aerial view** of collapsed buildings and burned-out section at Beach and Divisadero, *Marina District*. [Meyer]
- 4 I-4. Demolition of collapsed building and watering down of burned section, October 18, 1989, Beach and Divisadero, *Marina District*. [Meyer]
- 5 I-5. Ground view of collapsed building and burned section shown in I-3, Beach and Divisadero, *Marina District*. [Meyer]
- 6 I-6. Lack of adequate shear walls on the garage level exacerbated damage to this structure at the corner of Beach and Divisadero in the *Marina District*. [Nakata]
- 7 I-7 Entrance and garage level of a Beach street apartment complex in jeopardy of collapsing, *Marina District*. [Meyer]
- 8 I-8. An automobile lies crushed under the third story of this apartment building in the *Marina District*. The ground levels are no longer visible because of structural failure and sinking due to liquefaction. [Nakata]
- 9 I-9. Collapsed brickwork from a corner apartment building in the *Marina District*. [Meyer]
- 10 I-10. Smoldering remains of the apartment complex at the corner of Beach and Divisadero, the *Marina District*. [Nakata]
- 11 I-11. A search and rescue team in the *Marina District* wait for a building to be buttressed before entering structure. [Nakata]
- 12 I-12. Tom Brokaw of NBC News prepares script for a live broadcast from the *Marina District*. [Nakata]
- 13 I-13. Electric wires being removed from unstable towers by city utility workers. Arresting sparks from broken wires were a priority in those areas with broken gas mains. [Nakata]

II. BAY BRIDGE

- Slide 14 II-1. **An aerial view of roadbed collapse near the interface of the cantilever and truss sections of the San Francisco-Oakland Bay bridge, view northwest.** [Meyer]
- 15 II-2. **Aerial view of the collapsed section of the San Francisco-Oakland Bay bridge, view west.** [Meyer]
- 16 II-3. **Sand volcano or “sand boil” measuring 2 meters (6.6 feet) in length erupted in median of Interstate 80 west of the Bay Bridge toll plaza when ground shaking transformed loose water-saturated deposit of subsurface sand into a sand-water slurry (liquefaction). Vented sand contains marine shell fragments.** [Tinsley]

III. OAKLAND

- 17 III-1. **Aerial view of collapsed sections of the Cypress viaduct of Interstate 880.** [Wilshire]
- 18 III-2. **Aerial view of collapsed sections of the Cypress viaduct of Interstate 880.** [Wilshire]
- 19 III-3. **Reinforcement bars lie at the base of the Cypress viaduct near 14th street.** [Nakata]
- 20 III-4. **Remnant portion of the north and south bound viaduct exposing box girders near 14th street.** [Nakata]
- 21 III-5. **Side view of support column failure and collapsed upper deck, Cypress viaduct.** [Wilshire]
- 22 III-6. **Support column failure and collapsed upper deck, Cypress viaduct.** [Wilshire]
- 23 III-7. **Bent reinforcement bars in failed support column, Cypress viaduct.** [Wilshire]
- 24 III-8. **Pancaked upper deck, Cypress viaduct. Guard rail at right is on lower deck.** [Wilshire]
- 25 III-9. **Close-up of damaged reinforcement bars from a viaduct support column.** [Wilshire]
- 26 III-10. **Sheared reinforcement bar, Cypress viaduct.** [Wilshire]

Slide 27 III-11. Temporary support structures emplaced to prevent further collapse, Cypress viaduct. [Wilshire]

28 III-12. Demolition of Cypress structure near 14th street. [Nakata]

29 III-13. A downtown building at the corner of Alice and 13th streets lost part of its unreinforced brick masonry. [Nakata]

IV. SAN FRANCISCO AND SAN MATEO COUNTY COAST

- Slide#30 IV-1. Cliff Failure just south of San Gregorio Beach. The slide is 18.3 meters (60 feet) high and displaces approximately 6881 cubic meters (9,000 cubic yards) of material. The large boulders are 1 meter (3 feet) in size. [Peterson]
- 31 IV-2. Cliff failure north of Tunitas Creek. This face continued to slide for a few days following the the October earthquake. The event in progress exposed dark cliff material. [Peterson]
- 32 IV-3. Landslide north of Fort Funston. This slide mass is approximately 2,830 cubic meters (3700 cubic yards) and is 30 meters (100 feet) high. Photo IV-5 provides an aerial view of this slide. [Peterson]
- 33 IV-4. Headscarp of small slide at Redondo Beach. A scale is provided by the Red-handled rock hammer which is 30.5 cm (12 inches) long. [Peterson]
- 34 IV-5. **Aerial view** of large slides north of Fort Funston. A ground perspective of this slide is shown in IV-3. [Ellen]
- 35 IV-6. **Aerial view** of large slide at Daly City. This is the largest slide encountered in San Mateo County. The base is about 152 meters (500 feet) across at its widest point and displaced approximately 36,700 cubic meters (48,000 cubic yards) of material. [Ellen]

V. FREMONT BAYLANDS

- 36 V-1. KGO radio transmission towers, built on Bay mud in a salt evaporation pond used by Leslie Salt Company. Note progressively less damage to towers away from viewer. [Wilshire]
- 37 V-2. KGO radio transmission towers. [Wilshire]

VI. MENLO PARK

- Slide #38 VI-1. Unfastened bookcases in an office building fell during the primary shock. [Nakata]
- 39 VI-2. Books and air-conditioning duct were dislodged during earthquake. [Nakata]
- 40 VI-3. Seismographs at the U.S. Geological Survey record the (1) north-south horizontal, (2) east-west horizontal and (3) vertical components of the October 17th earthquake. [Nakata]

VII. LOS ALTOS

- 41 VII-1. **Aerial view** of collapsed 5-story tower, St. Joseph's Seminary. One person working in tower was killed. [Wilshire]
- 42 VII-2. **Aerial view** of collapsed 5-story tower, St. Joseph's Seminary. [Wilshire]
- 43 VII-3. Non-tectonic surface rupture crosses Highway 280 at the interface of a roadcut and fill area 2.5 kilometers (1.5 miles) north of Foothill Expressway. Note the partial collapse of sound wall which was under construction at the time of the earthquake. [Nakata]
- 44 VII-4. The cement retaining walls along Highway 280 formed an accordion-like pattern as a result of compression. [Nakata]

VIII. LOS GATOS

- Slide #45 VIII-1. Failure of unreinforced brick masonry caused collapse of the upper floor in downtown Los Gatos. [Nakata]
- 46 VIII-2. This photograph was taken in a ceramic shop during an aftershock. [Nakata]
- 47 VIII-3. Books lay scattered in downtown bookstore. [Nakata]
- 48 VIII-4. Many residents camped in their yards following the earthquake. [Nakata]
- 49 VIII-5. Personal messages posted on van at Emergency Center. [Meyer]
- 50 VIII-6. Vehicle crushed by collapsing unreinforced brick masonry. [Meyer]
- 51 VIII-7. Failure of porch on frame house. [Wilshire]
- 52 VIII-8. Drain grating shows the effects of compression. [Haugerud]
- 53 VIII-9. Downtown sidewalk buckled due to compression. [Nakata]

IX. SUMMIT ROAD AREA SANTA CRUZ MOUNTAINS

- Slide #54 IX-1. Crack system with 1.2 meters (4 feet) of vertical displacement across a clay tennis court; fracture passes across retaining wall and up slope beyond view. West of Summit Road, southeast of Highway 17. [Wilshire]
- 55 IX-2. A crack system destroys driveway adjacent to summit road 1/2 mile southeast of Highway 17. [Nakata]
- 56 IX-3. A geologist traces surface cracks in a corral adjacent to summit road approximately 1.6 kilometers (1 mile) southeast of Highway 17. [Nakata]
- 57 IX-4. Northwest-trending extensional crack where dam fill settled about .6 meters (2 feet) and pulled away from concrete spillway and north abutment of Austrian dam. [McLaughlin]
- 58 IX-5. Prominent N 15°W-trending extensional cracks up to 12 cm (4.7 inches) in concrete spillway to Austrian dam, north abutment. [Fisher]

X. REDWOOD GROVE SANTA CRUZ MOUNTAINS

- 59 X-1. Geologist exchanging information with rescue personal. [Nakata]
- 60 X-2. Bedroom showing the effects of the earthquake. [Nakata]
- 61 X-3. Failure of downslope support piers destroyed house. [Nakata]
- 62 X-4. Failure of downslope support piers destroyed house. [Nakata]

XI. BOULDER CREEK SANTA CRUZ MOUNTAINS

- Slide #63 XI-1. Collapse of garage built on fill. [Nakata]
- 64 XI-2. The lack of adequate shear walls and construction on fill contributed to the failure of this structure. [Nakata]
- 65 XI-3. House torn off the foundation by main shock. [Nakata]

XII. HIGHWAY 17 SANTA CRUZ MOUNTAINS

- 66 XII-1. Landslide debris filling both eastbound lanes of Highway 17 near Summit road. [Meyer]
- 67 XII-2. Landslide debris filling both eastbound lanes of Highway 17 near Summit road, foreground material is damaged lane separators. [Meyer]
- 68 XII-3. This roadcut near Summit road failed during the initial earthquake and subsequent aftershocks. To mitigate further sliding, Caltrans decreased the slope angle. [Nakata]
- 69 XII-4. Damaged lane separators, Highway 17. [Meyer]
- 70 XII-5. Broken concrete divider near the intersection of Summit Road and Highway 17. [Haugerud]

XIII. SANTA CRUZ AREA

- Slide #71 XIII-1. Clock tower near the north end of Pacific Garden Mall. Not known if clock was fast or if it ran for about 6 minutes following the earthquake. [Tinsley]
- 72 XIII-2. Bicycles crushed by falling unreinforced brick facade, Pacific Garden Mall. [Meyer]
- 73 XIII-3. Collapsed unreinforced brick facade, Pacific Garden Mall. [Meyer]
- 74 XIII-4. Rescue efforts, Pacific Garden Mall. [Meyer]
- 75 XIII-5. Removal of debris while searching for victims, Pacific Garden Mall. [Meyer]
- 76 XIII-6. Searching for victims at collapsed department store, Pacific Garden Mall. [Meyer]
- 77 XIII-7. Storefront damage, Pacific Garden Mall. [Meyer]
- 78 XIII-8. "*Unsafe to occupy signs*" were posted by the Governors Office of Emergency Services. [Nakata]
- 79 XIII-9. Collapsed outer wall of the *Medico Dental Building*, Pacific Garden Mall. [Nakata]
- 80 XIII-10. Close-up of collapsed wall of unreinforced masonry *Medico Dental Building* in the Pacific Garden Mall. [Wilshire]
- 81 XIII-11. Liquefaction in recent deposits of San Lorenzo river caused cracking and differential settling of river levee southeast of Riverside Avenue Bridge. Bridge piers and the north abutment area were also damaged by liquefaction. [Tinsley]
- 82 XIII-12. Landslide-displaced trees reflect earthquake-triggered slope failure along coastal bluff, New Brighton Beach area, Santa Cruz County. [Tinsley]

XIV. WATSONVILLE AREA

- Slide #83 XIV-1. Liquefaction in recent deposits of the Pajaro River formed these sand volcanoes along extensional fissures in a field prepared for autumn planting located near Pajaro, across the Pajaro River from Watsonville. Furrows are spaced about 1.2 meters (4 feet) apart. [Tinsley]
- 84 XIV-2. Vent of sand volcano produced by liquefaction is about 4 feet across in strawberry field near Watsonville. Strip spanning vent is conduit for drip irrigation system. Furrow spacing is about 4 feet on center. [Tinsley]
- 85 XIV-3. Liquefaction in recent deposits of the Pajaro River formed sand volcanoes along a fissure 6-7 meters (19.7-23 feet) in length. The variation in grain size and the partial erosion of the conical deposits of sand shows that venting of the slurry of sand and water was a complex series of depositional and erosional events triggered by the main shock and renewed by principal aftershocks in some instances. [Tinsley]
- 86 XIV-4. Ground shaking triggered liquefaction in a subsurface layer of sand, producing differential lateral and vertical movement in a overlying carapace of unliquified sand and silt, which moved from right to left towards the Pajaro River. This mode of ground failure is termed "lateral spreading" and is a principal architect of liquefaction-related earthquake damage. [Ellen]
- 87 XIV-5. Crack down front of Ford's Department Store, downtown Watsonville. Although this appears minor, the building suffered significant damage. [Wilshire]
- 88 XIV-6. Houses not bolted down securely were easily dislodged from the foundation in downtown Watsonville. [Nakata]
- 89 XIV-7. Many homeowners buttressed their foundations to prevent further damage from aftershocks in downtown Watsonville. [Nakata]
- 90 XIV-8. Broken utility lines in house that shifted off its foundation, downtown Watsonville. [Wilshire]
- 91 XIV-9. Collapse of porch in downtown Watsonville. [Nakata]

- Slide #92 XIV-10. This house was dislodged and moved .75 meter (2.5 feet) from the cement stairway in downtown Watsonville. [Nakata]

- 93 XIV-11. Structural failure of twin bridges carrying Highway 1 across Struve Slough, near Watsonville. [Tinsley]

- 94 XIV-12. Close-up of the collapsed bridge section on Highway 1 at Struve Slough. [Nakata]

- 95 XIV-13. Failure at the joist/columns interface contributed to the collapse of the roadbed bed on Highway 1. [Nakata]

- 96 XIV-14. Support column of bridge across Struve Slough, Highway 1. Enlargement of hole where support enters the ground is an effect of lateral shaking. This caused the concrete to breakup where the column joined the bridge and was instrumental in the roadbed collapse. [Wilshire]

- 97 XIV-15. Support columns of Highway 1 bridge across Struve Slough protrude through road bed. This resulted from collapse of the road bed after the effects of lateral shaking shown in photo XIV-14. [Wilshire]

- 98 XIV-16. A fracture cuts the roadbed, curbs and railings on the collapsed portion of Highway 1 at Struve Slough. [Nakata]

XV. MOSS LANDING

- Slide #99 XV-1. Liquefaction and subsequent strong tidal action destroyed the causeway carrying the Moss Beach access road across tidewater basin near Moss Landing. [Tinsley]
- 100 XV-2. Ground cracking and differential settlement owing to liquefaction of beach and Salinas River deposits damaged approach and abutment of bridge linking Moss Landing spit to the mainland, near Moss Landing Marine Laboratory. [Tinsley]
- 101 XV-3. Differential settlement due to liquefaction causes cracking of paved road on Paul's Island. [Ellen]

XVI. SALINAS

- 102 XVI-1. Partially razed earthquake-damaged unreinforced masonry buildings in Old Town historical district, City of Salinas. [Tinsley]