

9 February, 06:00:41.6. Mag. 6.4. Main shock of the San Fernando earthquake. Epicenter  $34^{\circ}24.7'N.$ ,  $118^{\circ}24.0'W.$ , southern California, at a depth of about 8 km., P. This location is about 14 km. north of San Fernando in a sparsely populated area of the San Gabriel Mountains. No foreshocks were recorded. Numerous strong aftershocks were recorded. One hundred seventy-four aftershocks of magnitude 3.0 or greater were recorded up to 23:36:06.5 on February 9, with two of magnitude 5.8 occurring at 06:01:08.0 and 06:02:44.0. Thirty-one clear aftershocks were recorded on the Pacoima Dam strong-motion accelerograph, located about 8 km. south of the epicenter, from 06:01:08.0 to 06:05:58.0. The main shock record from the Pacoima Dam accelerograph showed the highest accelerations ever measured, 1.25 g. horizontally and 0.72 g. vertically. A very large number of aftershocks were felt, keeping people in a state of apprehension for weeks. An observer at Burbank reported over 120 aftershocks were felt up to June 21.

The earthquake was "generally" felt over approximately 208,000 sq. km. (80,000 sq. mi.) of California, Nevada, and Arizona (fig. 1). There were a few instances of the shock being felt beyond this area--at Bridgeport, Stockton, and Yosemite National Park, Calif., Tonopah, Nev., and Beryl, Utah.

Intensities ranging from VIII to XI (fig. 2) were indicated in an area of about 490 sq. km. (190 sq. mi.), with the one int. XI assigned to the Olive View Hospital complex. This facility, completed only a few months prior to the earthquake at a cost of approximately \$23.5 million, was declared a total loss. Intensities ranging from IX to X were generally indicated in the San Fernando-Sylmar area and adjacent areas, and were based on ground ruptures, damage to buildings, dwellings, highway structures, dams, underground pipelines, and other utility facilities. Considerable damage, mainly to older buildings and dwellings, occurred in the int. VII zone. Some were posted as "unsafe" and others, notably in the Alhambra, Beverly Hills, Burbank, and Glendale areas, were to be demolished. A few large buildings sustained some structural damage, but damage to large or high-rise buildings was chiefly in the form of cracked partitions, fallen plaster, and broken windows. Thousands of chimneys were damaged. There were numerous reports of inoperative elevators, principally owing to counterweights being out of guiderails.

It was reported that 58 persons died as a direct consequence of the earthquake: Three at the Olive View Hospital, 49 at the Veterans Administration Hospital, 2 by collapse of freeway overpass, and 4 at other locations, including one person killed by the collapse of an old building in downtown Los Angeles. Over 2,000 injuries were reported, many requiring hospital treatment.

Damage to public and private property was estimated at over \$500 million. It was reported that approximately 850 homes, 65 apartment buildings, and 574 commercial-industrial buildings were so damaged that they were vacated; some 4,800 homes, 265 apartment buildings, and 1,125 commercial buildings had appreciable

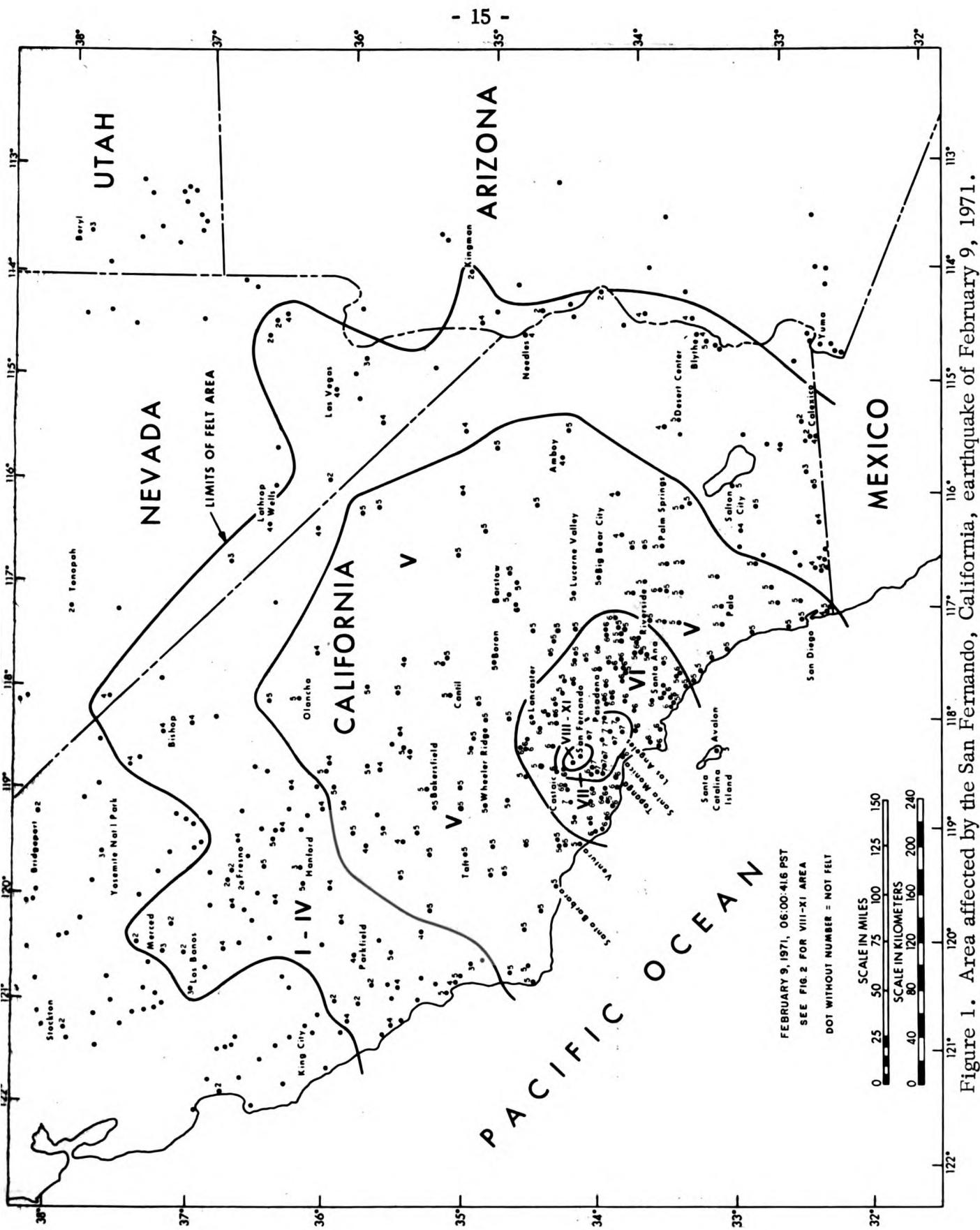


Figure 1. Area affected by the San Fernando, California, earthquake of February 9, 1971.

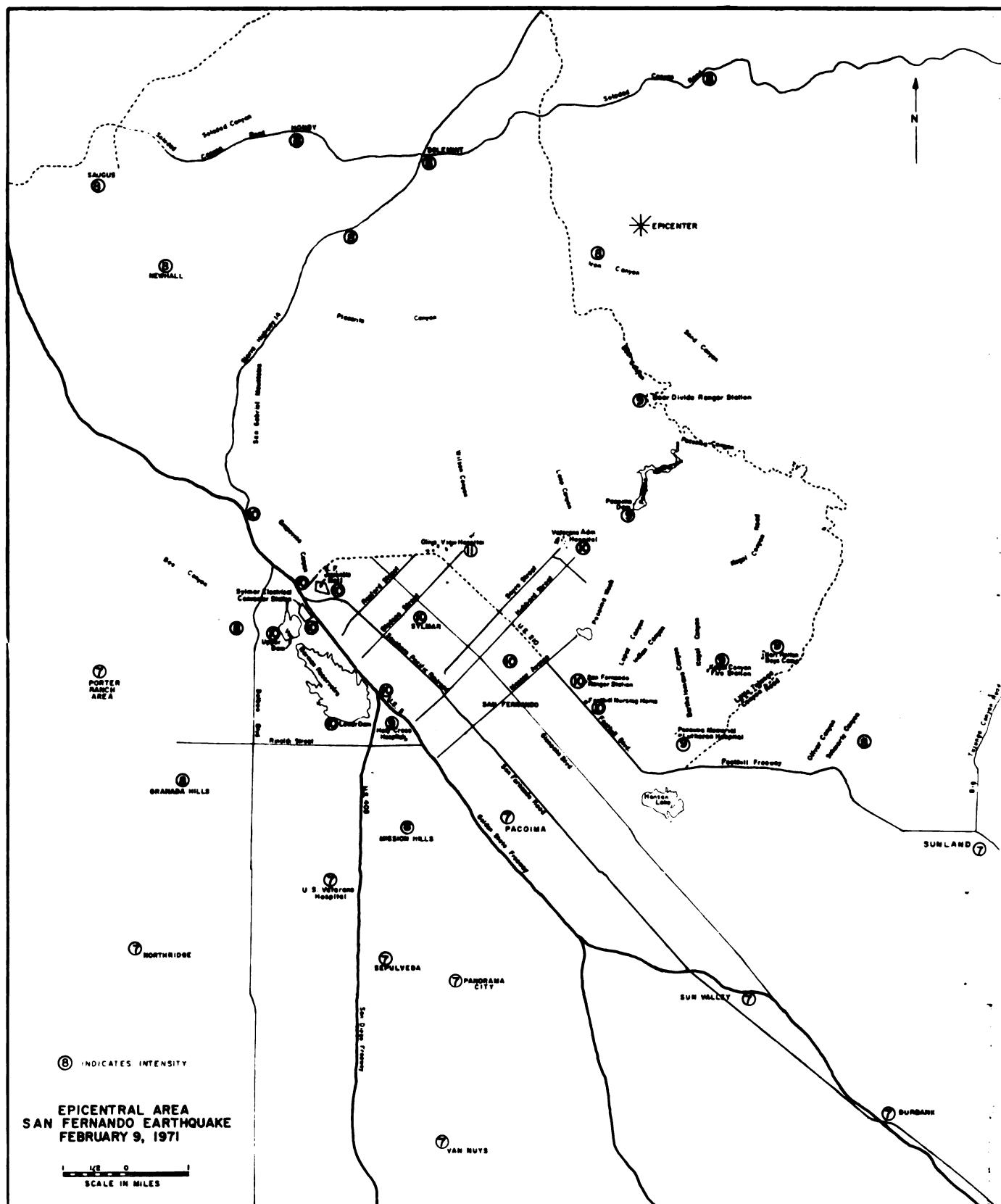


Figure 2. Epicentral area of the San Fernando, California, earthquake of February 9, 1971.

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damage; and about 30,000 structures had lesser damage. About 1,700 mobile homes were substantially damaged. The most spectacular damage was the collapse of major structures at the Olive View Hospital and the Veterans Administration Hospital, and the collapse of freeway overpasses. Public utilities and facilities of all kinds were greatly damaged--water, gas, sewer, and electric--both above and below ground. The near failure of the Lower Van Norman Dam caused authorities to evacuate thousands of people from areas below the dam until the water in the reservoir could be lowered and the extent of damage and danger determined.

The following estimates of damage are from a report by the Los Angeles County Earthquake Commission<sup>4</sup>:

<u>Jurisdiction or agency</u>	<u>Public property</u>	<u>Private property</u>
City of Los Angeles	\$ 92,000,000	\$210,000,000
County of Los Angeles	100,000,000	6,800,000
Other local jurisdictions	5,200,000	30,000,000
State of California	15,000,000	
Federal Government	10,000,000	
Metropolitan Water District	6,000,000	
General Telephone		4,700,000
Los Angeles School District	22,500,000	
Southern California Gas Company		2,000,000
Southern California Edison Company	_____	<u>750,000</u>
Total	\$250,700,000	\$254,250,000
Total (public and private)	<u>\$504,950,000</u>	

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<sup>4</sup> See references, p. 141

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The earthquake created a zone of discontinuous surface faulting, named the San Fernando Fault Zone, which extended from the Bee Canyon area (west of Upper Van Norman Lake) roughly eastward across the Sylmar-San Fernando area to the Big Tujunga Canyon area north of Sunland, a distance of about 20 km. The main rupture segment, designated the Sylmar segment, extended eastward from the intersection of Hubbard Street and Glenoaks Boulevard (in southern Sylmar-northern San Fernando area) across Foothill Boulevard to the Foothill Nursing Home. Although it was in this segment of the fault zone that the greatest concentration of ground distortion occurred, prominent ground displacements, fractures, and scarp were observed in other segments of the fault zone, notably in the Tujunga Segment, extending from the vicinity of the Foothill Nursing Home eastward into Big Tujunga Canyon, and in areas north and northwest of Upper Van Norman Lake. Surface faulting also occurred in areas away from the main segments of faulting, including an area just east of the Veterans Administration Hospital, Lopez and Kagel Canyon areas, on Kagel Mountain (just east of Pacoima Reservoir), and in areas east of Lower Van Norman Lake along the Golden State Freeway.

Severe ground fracturing and landsliding were responsible for extensive damage in areas not associated with faulting. There was severe ground cracking in the Olive View Hospital area, in the southwestern Sylmar and San Fernando areas, in the upper Granada Hills area west of Van Norman Lakes, and in many areas north and east of the Sylmar-San Fernando area. There was extensive landsliding and slumping, along with numerous fissures and sand boils, in the Van Norman Lakes area. It was reported that the appearance of the sand boils indicated liquefaction of soil in this area. The most damaging slide, called the "Juvenile Hall Slide," occurred in the Upper Lake area, where practically all structures and facilities located in or crossing this slide were severely damaged: highway overpasses and bridges, railroad, pipelines and canals, Sylmar Converter Station, San Fernando Valley Juvenile Hall, Joseph Jensen Filtration Plant, and other structures and facilities. Landslides and rockfalls were widespread and very numerous (over 1,000 were mapped from an aerial reconnaissance), with high concentrations in the foothills and mountainous areas of the San Gabriel Mountains. One of the larger slides occurred on the east side of Schwartz Canyon and was approximately 183 m. wide. Many roads were blocked by landslides and rockfalls in the area of severe shaking. Another type of ground rupture, which displayed the violence of this earthquake, was the numerous shattered ridge tops, with the soil of previously smooth surfaces upthrown, overturned, and pulverized. This type of ground disturbance was especially exemplified west of Grapevine Canyon, in the hills north of the Olive View Hospital, near Wallaby and Rajah Streets in the northeasternmost corner of Sylmar, west of Balboa Boulevard, east of Bartholomaeus Canyon, and on the ridges above Oliver and Schwartz Canyons.

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Intensity IX-XI:

San Fernando, Sylmar, and Adjacent Areas:

The one instance of int. XI was assigned to Olive View Hospital in the northern Sylmar area, north of Foothill Boulevard, where collapses of newly built, reinforced concrete, earthquake-resistive buildings reduced this \$23.5 million complex facility to a total loss. Four five-story wings pulled away from the main building, three toppled. The second story of a two-story building dropped to the ground level. All other buildings were seriously damaged. This damage was reported to have been the result of severe ground shaking, not of ground faulting.

The following is from a report by the Los Angeles County Earthquake Commission<sup>4</sup>: "Of particular interest is the new main Medical Center, which was dedicated just 30 days before the earthquake. Within this group are the six-story medical center building, a two-story psychiatric unit, a central heating plant, a one-story assembly building, and an ambulance-shelter canopy. All of these buildings suffered major structural damage. Three lives were lost in the medical center building: one from falling debris and two allegedly as a result of electric-power failure. The six-story building had four stair towers, which were isolated structurally from the upper five stories of the building. The supporting columns of three of these towers failed, permitting the towers to collapse onto the first-floor construction. The upper four stories of the main buildings, though damaged, retained their configurations. The lower two stories had column failures and some local floor areas collapsed. However, even though offset more than 2 feet, the structure as a whole remained standing, permitting the evacuation of the building through the two remaining interior stairs. Utilities in the building, including emergency facilities, were inoperative after the earthquake. The first story of the psychiatric building collapsed completely with the second floor settling down to ground level. No lives were lost in this building because no persons were present on the lower floor at the time of the earthquake. The 12 columns of the ambulance-shelter canopy all were shattered, permitting the roof to collapse on the ambulances beneath. The failure of cross-bracing members in one end wall was the main structural damage to the central heating building. Equipment within the building that was not anchored to the floor became displaced and one of the boilers shifted 52 inches relative to the building. The assembly building did not collapse, but the columns were severely distorted."

The following is from a report by U.S. Geological Survey Staff<sup>10</sup>: "Tectonic movements associated with the February 9, 1971, San Fernando earthquake produced a zone of surface breakage which partly follows the boundary between the San Gabriel Mountains and the San Fernando-Tujunga Valleys, and partly transects the northern salient of the San Fernando Valley. This latter zone of tectonic ruptures was specifically associated with some of the most extreme damage caused by the earthquake anywhere in the epicentral region. The zone of surface

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breakage trends roughly east-west, is about 15 km long, and is slightly concave towards the south. A notable discontinuity occurs near the middle of the arc where the western half is offset about 1 km north of the eastern half. The sense of movement along the breaks is complex. Almost all scarps are south facing, with the mountain block up relative to the valley block. Most of the larger scarps consistently show a left-lateral sense of motion, but a broadly defined zone of smaller scarps and cracks, which parallels in part the main zone of breakage, shows right-lateral offsets. Within the entire 15 km length of the surface breakage, the maximum vertical offset measured on a single scarp is about 1 m, the maximum lateral offset about 1 m, and the maximum shortening (thrust component) about 0.9 m.

"Surface ruptures that are known or suspected to be tectonic breaks created during the earthquake extend discontinuously from the San Diego Freeway just south of Lower Van Norman Lake to Big Tujunga Canyon. No such ruptures were found between the San Diego Freeway and the Osceola Street School or in the area from just east of San Fernando Road to just west of the intersection of Glenoaks Boulevard and Hubbard Street. The zone of breakage bends to the south about 0.4 km south of Lopez Dam, but some breaks may be continuous through the low hills into Lopez Canyon to the east. From the Foothill Nursing Home, eastward along the front of the mountains, the surface faulting is generally well defined, but locally discontinuous, to a point just east of Little Tujunga Canyon. East of this point, for a distance of about 2 km, no surface faulting is found along the front of the range. About 0.3 km east of the Lakeview Terrace Sanitarium, surface breakage again is in evidence, with only a few interruptions, to a point about 0.3 km into Big Tujunga Canyon. About 0.4 km farther up the canyon, a 0.3 km scarp marks the eastern limit of surface ruptures. From approximately Lopez Canyon east to Little Tujunga Canyon, discontinuous, usually smaller, breaks occur north of the relatively through-going line of breaks along the front of the range. Two of these breaks are found in Lopez Canyon, two in Bartholomaeus Canyon, four small breaks cross Kagel Canyon, and single breaks intersect Little Tujunga, Oliver, and Schwartz Canyons. A relatively short, presumably tectonic rupture characterized by a small south-facing scarp was recognized just east of the U.S. Veterans Hospital; it has no apparent continuity with the main zone of breakage to the south.

"The concentration of ruptures in some areas and their absence in others, and the apparent discontinuity near the middle of the breaks, allow a natural division into three segments. For convenience these segments are named as follows: (1) The surface faulting from the San Diego Freeway to just east of San Fernando Road is referred to as the Mission Wells segment of the San Fernando fault zone. (2) The ruptures from the intersection of Hubbard Street and Glenoaks Boulevard to the Foothill Nursing Home are referred to as the

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Sylmar segment of the San Fernando fault zone. (3) Some of the breakage that roughly follows the mountain front east of the nursing home is referred to as the Tujunga segment of the San Fernando fault zone.

"Mission Wells Segment of the San Fernando Fault Zone: Near the Mission Wells historical monument, 1.5 km east of Lower Van Norman Lake, a small south-facing scarp 0.05-0.25 m in height trends about N. 60° E. Surface cracks showing left-lateral offsets extend from just southwest of the northwest corner of Osceola Street School to about one block east of San Fernando Road. Cracks were also found in the concrete pavement of the Golden State Freeway along the strike of this zone, but these may have been caused by landslides. This segment has no surficial expression between the San Diego Freeway and the Osceola Street School, nor from a point about one block east of San Fernando Road to the intersection of Hubbard Street and Glenoaks Boulevard.

"Sylmar Segment of the San Fernando Fault Zone: The Sylmar segment is a well-defined zone of tectonic fractures that extends eastward from the heavily damaged shopping center at the south corner of the intersection of Hubbard Street and Glenoaks Boulevard to the range front immediately south of Lopez Dam. Cumulative displacement across the central part of this zone consists of left-lateral, vertical, and horizontal-shortening components as great as 1.9 m, 1.39 m, and 0.6 m, respectively. The maximum components of displacement across any individual break in the zone, however, are about half of these values, and they are far less across most breaks. This zone generally ranges from about 75 to more than 200 m in width, but virtually all the lateral movement and shortening caused by thrusting, together with about one-half of the vertical displacement, are concentrated in a narrow band along the southern border of the zone. The remainder of the vertical displacement is distributed across many small normal (extension) faults and a few small thrust faults that occupy the remainder of the zone and show minor left- or right-lateral displacement. Thus, the zone of fractures is divided into a narrow southern zone of shearing and thrusting and a wider northern zone of extension; vertical displacement occurs in both. This distribution of displacement is well shown by ruptured utility pipes beneath streets and by sidewalks, curbs, and streets.

"The extension or compression of sidewalks and curbs with respect to the underlying ground provides a basis for estimating surface distortion. For example, all the northwest-southeast trending streets (Foothill, Eighth, Glen-oaks) showed net extension across the fault zone, whereas the northeast-trending streets were shortened. Unfortunately, the large number of measurements required (commonly more than 100 in a block 400 m long) together with various uncertainties limits the accuracy of the determinations of net change across the fault zone to about  $\pm 0.1$  m. Our estimates were further hampered by street-

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repair crews, who swiftly removed sections of splintered or buckled sidewalks and curbs.

"Few fractures of the ground surface can be traced across streets, houses, and yards. Owing to their rigidity, streets (including curbs and sidewalks) tend to bridge the shear zone; this rigidity commonly allows compression to be transmitted to buckles and overthrusts in streets, curbs, and sidewalks as much as 100 m from the zone of ground breakage. On the other hand, extension is usually expressed in the overlying sidewalks and curbs at the closest construction joint (generally within a few meters) and in asphalt pavement by tensile failures normal to the length of the street and apparently within a few tens of meters of the underlying ground extension. Houses commonly hide faults that pass beneath them unless displacement is large enough (about 50-100 mm) to visibly affect the house. Many fractures that are obvious on bare ground are completely hidden by cultivation or planting. However, the small number of fractures that have displacements greater than 0.1 or 0.2 m, such as those that cross Bromont Street and the street just west of it, generally maintain continuity across these features. The net result of these effects is that the shear zone is revealed, if not sharply bounded, by obvious left-lateral offset of each street that it crosses, whereas the zone of extension is marked by normal faults and extension fractures across each street within the zone.

"The southern boundary of the zone of fractures is sharp, whereas the northern boundary is not. Obvious ground fractures cease a few tens of meters beyond the southern boundary of shearing and thrusting, whereas the zone of extension fractures has a diffuse boundary, marked by a gradual reduction in the number of fractures and displacement across them. The northern boundary of the zone of extension roughly limits the area in which extension fractures are evident across bare ground.

"The sharply defined main strand of the Sylmar fault segment changes northward into a broad area broken by numerous, relatively closely spaced faults which almost uniformly display small right-lateral offsets. The dimensions of the area showing fractures of this kind are about 1.8 km in the east-west direction, somewhat less than the length of the main part of the Sylmar fault segment, and about 1.3 km from north to south. The faults share the east-west trend of the left-lateral zone and generally show slight extensional gaping as well as right-lateral displacement. Where present, the sense of vertical components of movement is usually down on the north, or opposite to the direction of vertical offset in the belt of apparent right slip within the zone of the Sylmar fault segment. The right-lateral faults are usually simple, nearly linear fractures in the ground but have somewhat more complex traces where they break pavements, sidewalks, and concrete slabs of houses. Spacing of

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the faults ranges from a minimum of about 20 m to a maximum of about 100 m. Residents in the area state that many of the fractures showed only slight off-sets immediately after the earthquake and that they continued to move for several days thereafter.

"One of the most complex sectors of surface rupturing occurs northeast of San Fernando Airport in the area of apparent discontinuity between the Sylmar and Tujunga segments of the San Fernando fault zone. The complexity involves not only geometric irregularity of the fault strands but also loss of demonstrable continuity of the fault traces and possible variation in the sense of the lateral component of displacement.

"Between Maclay Avenue and Pacoima Wash, the sense of horizontal separation on the Sylmar segment reverses from left- to right-lateral. The northern or northeastern side, however, is consistently the relatively upthrown block. On the first street southeast of Maclay Avenue, the break shows about 0.12 m of left-lateral separation of curbs; but one block farther southeast, no lateral separation is visible on curb lines, suggesting (from the angular relationship of the fault trace and street) a small left-lateral component of slip. One block farther east, curbs are separated right-laterally about 0.3 m, reflecting either a yet smaller left-lateral component combined with the vertical component of offset, or possibly a small right-lateral component of movement. Immediately east of Pacoima Wash, the Sylmar segment of the fault displaces an originally linear north-south fence about 1.0 m in a left-lateral direction. Because the trace of the ground rupture is almost exactly perpendicular to the fence line, there is no ambiguity as to the sense of the lateral component of offset at that point.

"Eastward from the northern point of the spreading basin next to Pacoima Wash, the trace of the Sylmar segment of the fault curves abruptly to a southward trend and becomes approximately coincident with the base of the steep mountain front. The trace is visible only for a short distance at that location; however, despite the near absence of surficial breakage along the base of the slope southward to the reentrant canyons at the Burns ranchhouse, damaged water pipes excavated after the earthquake indicate at least 0.43 m of east-west shortening of the ground surface about 0.4 km northwest of the ranchhouse. The mountain block, furthermore, rose at least a few centimeters relative to the alluvial flat at that point. No obvious disturbance or cracking of the ground surface was evident at the shortened pipelines, raising the possibility that a similarly imperceptible compression zone may continue southward to the vicinity of the San Fernando Ranger Station.

"Near the San Fernando Ranger Station, the sidewalks and pavements at the

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southeast ends of two cul-de-sacs that run northwest-southeast were broken and shifted to the northwest; asphalt parking lots were disrupted; and two buildings were jammed together, causing severe structural damage to at least one of them. Their orientation indicates a strong component of northwest-southeast shortening. One of the cul-de-sacs, Montero Avenue, was shortened in a northwest-southeast direction by 1.07 m (the difference between the length measured by steel tape on February 14 and the length given in official records). A monument originally set on the projection of the centerline, and about 20 m southeast of the end of the street, was shifted about 0.2 m southwest of the centerline. The shortening buckled the sidewalk and flattened the circle at the end of the street and produced crescent-shaped openings between the curb and the sidewalk. The form of the ruptures both in the streets and in vacant lots indicates strong compression in the northwest-southeast direction and uplift of the southeast side, possibly combined with a minor right-slip component. Numerous landslide scarps up to 1 m high cut the flanks and ridges of the hill immediately to the east. Their presence suggests the possibility that settling and spreading of the bedded and jointed rock that constitutes the hill may have forced out a wedge of the alluvium at the base of the hill, produced most of the compressional effects, and masked whatever tectonic displacements may have occurred.

"The west end of the Tujunga fault segment may connect with the Sylmar segment along a hidden zone of compression near the base of the mountain slope in the vicinity of the San Fernando Ranger Station. It is furthermore possible that the Sylmar segment branches, and the eastern strand extends into the mountains along the line of the northernmost mapped faulting in Lopez Canyon. Demonstration of such a connection is not possible, however, because of the extensive landslides on the hill east of Burns Ranch.

"Tujunga Segment of the San Fernando Fault Zone: The Tujunga segment extends along the front of the hills on the north side of Tujunga Valley in a discontinuous fashion from the vicinity of the Foothill Nursing Home, which lies on the northeast side of Foothill Boulevard, eastward into Big Tujunga Canyon.

"In front of the nursing home the curb is raised about 1 m above the street level. A transverse component of movement, shown by about 0.9 m of shortening, was measured along a fence trending N. 50° E. on the east side of the nursing home. East of the nursing home, a low, but well-defined fault trace continues with only a few interruptions to the mouth of Lopez Canyon. Where the surface ruptures transect the lower slopes of the hills just east of the nursing home, the scarps are low, but well defined. A conspicuous zone of tension cracks about 2-3 m wide formed about 10 m upslope from the base of the scarps. On the west side of Lopez Canyon, the scarp, which is about 0.85 m in height, is a hummocky, multistranded bulge at the leading edge of the overriding northern block. In a trailer park immediately west of Lopez Canyon,

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the fault appears to follow a shallow-dipping plane in Tertiary marine deposits. About 0.4 km west of Lopez Canyon and for approximately 200 m along strike, the fault plane has a rather uniform dip to about 55° N. Just east of the canyon, the fault zone is defined by many subparallel imbricate breaks.

"Eastward from Lopez Canyon the fault zone is made up of many en echelon segments. About 0.8 km east of the mouth of the canyon, the dip of the fault appears to lessen to about 15° N., but tectonic scarps are difficult to distinguish from the toes of landslides in this area. At the mouth of Bartholomaeus Canyon, the scarp is about 0.25 m high, up on the north side, and shows about 0.1 m left-lateral offset of the streambank. The frontal scarp is about 0.60 m high and well exposed in Little Tujunga Canyon. East of this canyon for about 1.5 km, the zone is marked by compressional buckles and lacks developed scarps.

"A gap of 2.2 km, within which no tectonic breaks have been found along the range front, separates the breaks near Little Tujunga Canyon from a well-defined south-facing scarp on the north side of Big Tujunga Creek, about 0.4 km east of the Lakeview Terrace Sanitarium. The scarp is 150 m long and 0.35 m high, but it cannot be traced continuously across the creek. The south-east end of this ground breakage is connected by a few discontinuous scarps to a well-developed line of surface rupture that is continuously traceable for about 0.9 km to the east. This line of ruptures is developed mostly in unconsolidated stream sediments which have been extensively churned by earth moving equipment, and the appearance and height of the fault scarp here vary considerably along strike. About 1.5 km east of the Lakeview Terrace Sanitarium, this break cuts interlayered thin-bedded siltstone and conglomerate exposed on the north edge of Big Tujunga Wash. The fault plane here strikes about N. 70° W. and dips 55-60° N. Slickensides, which may or may not be related to the most recent movement, are developed in a thin zone of fault gouge and dip straight down the fault plane. The gouge indicates that the February 9 movement at this point occurred along a preexisting fault.

"A few meters east of the faulted bedrock, the scarp, which is again in the stream sediments, becomes indistinct and cannot be distinguished from ridges formed by earth-moving equipment. Two disconnected scarps, each about 150-200 m long, continue en echelon to the east. The more easterly of these offsets the extension of Oro Vista Avenue about 0.3 m in a left-lateral sense. The height of this scarp is about 0.5 m, in the stream bottom below this street. About 0.4 km east of this break lies the scarp which marks the eastern end of the tectonic breakage. This scarp is 0.3 km long and strikes N. 75° E. Part of it is developed in thin-bedded siltstone and with the siltstone dips 62° N. Movement was up on the north, about 0.4 m. Four cracks that cross Mount

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Gleason Avenue about 0.7 km farther east show both left- and right-lateral displacements up to 0.02 m, and are probably not tectonic breaks.

**"Surface Faulting in the Mountains North of the Tujunga Segment:** In addition to the fault trace at the mouth of Lopez Canyon, other February 9 traces cross the canyon 0.6 km and 0.9 km north of its mouth. The northernmost of these occurred on an existing fault that was marked by gouge and shearing in the adjacent rock, but the earlier faulting apparently was not expressed in the modern topography. Where this trace extends westward from Lopez Canyon Road, it crosses a flat artificially graded surface underlain partly by bedrock and partly by alluvium. A distinct fault scarp about 1 m high formed in the bedrock, whereas a gentle monocline developed in the alluvium. The bedrock here consists of bedded friable sandstone, conglomerate, and thin shale, and it has about the same attitude (strike N.  $80^{\circ}$  W., dip  $70^{\circ}$  N.) on both sides of the fault. The fault strikes N.  $80^{\circ}$  W. and dips  $65^{\circ}$  N. at the surface, and this attitude continues to a depth of at least 10 m, where the fault was penetrated by a 36-inch borehole drilled to install a wire extensometer. The gentle monocline that marks the fault in the alluvium is some 30-35 m wide. Although the difference in height across the monocline is about the same as across the scarp, it would be difficult to identify this as a structural warp from the profile alone.

"Near the east end of the scarp, slickensides in the gouge are inclined  $58^{\circ}$  from the horizontal which indicates a somewhat lower ratio (0.635) of strike slip to dip slip than was obtained from the displaced bulldozer features (0.76). It is uncertain, however, whether these slickensides formed on February 9 or during an earlier movement on the same fault plane.

"About 0.6 km north of the mouth of Lopez Canyon, a small scarp bulges up the pavement of the Lopez Canyon Road, with the north side elevated about 0.2 m. A roadcut alongside the break exposes disturbed and somewhat slumped sandstone and siltstone, but no positive evidence or prior movement such as a gouge zone or structural truncation of bedding is visible. About 110 m due west of this scarp, however, a northward-dipping fault surface is visible on a steep face cut in similar sedimentary rocks. Although preearthquake reference lines are not present across this break, a thrust movement of a few centimeters, possibly with a minor left-lateral component of slip is evident. In contrast to the cut at the road, the offset here appears to have occurred along a preexisting fault, as shown by gouge and the slight structural discordance of the underlying beds at the fault. The offset apparently dies out westward within the upper part of the cut, and no tectonic rupturing was found on a projected line at any point higher on the hill. Whether this fault joins the scarp to the east of Lopez Canyon Road is uncertain. Pavement and soil in the intervening sector are located on fill and are strongly fractured. This breakage, however, is probably nontectonic, and the continuity of the two offsets is in doubt.

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"Thirteen fractures exhibiting right-lateral offset break Lopez Canyon Road between 0.27 km and 0.53 km north of the Tujunga segment of the San Fernando fault zone. The net right-lateral offset across these breaks is about 0.5 m, of which about half is concentrated in a narrow zone at its southern edge. Although the breaks cannot be traced either west or east, it is likely that they are of tectonic origin. They appear to be similar to breaks within the broad zone of right-lateral rupturing immediately north of the Sylmar segment.

"Another well-developed south-facing scarp lies about 0.4 km up Little Tujunga Canyon from the frontal scarp. This upper scarp is a hummocky bulge similar to those at the range front. It dies out about 0.3 km east of Little Tujunga Road, but it continues westward almost to Kagel Canyon. Just west of Little Tujunga Canyon, the scarp is 0.45 m high. Several small scarps cross Kagel Canyon, but cannot be traced for any distance outside the canyon. A small south-facing scarp extends westward from the bottom of Bartholomaeus Canyon but cannot be traced east of it. Although the scarp is little more than a buckle in the bottom of the canyon, on the ridge 0.3 km to the west, it is about 0.30 m high and displays about 0.58 m of left-lateral offset.

"Prominent scarps of probable tectonic origin cross the bottoms of Oliver and Schwartz Canyons about 0.4 km north of their mouths. The scarp in Oliver Canyon is about 0.9 m high and that in Schwartz Canyon about 0.3 m. Although both are probably parts of longer structural features, they cannot be traced with confidence outside of the canyons through the extensive landslides which mantle the surrounding hillsides.

"Scarp East of the Veterans Hospital: Although extensive damage to man-made structures occurred along a zone extending from Upper Van Norman Lake to the head of Pacoima Wash, there is only one scarp in this zone interpreted to be of possible tectonic origin. This scarp is about 300 m long and is expressed as a small nearly east-west surface rupture. It is between the U.S. Veterans Hospital and Pacoima Wash and is well exposed in cuts and fills of a partly developed housing tract near Rajah Street. In the banks of cuts, the slip surface dips generally northward between  $36^{\circ}$  and  $48^{\circ}$ , parallel to bedding of sandstone and conglomeratic sandstone of the Pacoima Formation. Displacement is apparently directly updip, and the maximum relative uplift of the northern slide is about 0.18 m. Westward the strike of the break gradually swings toward the southwest. A line joining the western end of the continuous fracture to a short scarp with vertical offset observed on Hubbard Street would have a southwesterly trend. Although the rupture has the appearance of a tectonic fracture, it conceivably could represent the bulged toe of an unexpectedly large landslide whose upslope limits have not been recognized.

"The projection of the fault, as it continues along its last observed trend,

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passes well south of the Veterans Hospital. Although no further tectonic breaks were recognized west of the scarp, this does not preclude the possibility that the zone from west of Juvenile Hall to the Veterans Hospital was tectonically active during the earthquake. For example, left-lateral deformation may have occurred across the zone near the Juvenile Hall, as a postearthquake resurvey of San Fernando Road showed a small left-lateral and southward shift of a point due west of the Juvenile Hall with respect to a point at the corner of Roxford Street and San Fernando Road.

**"Tectonic and Engineering Implications:** To recapitulate, mapping of the tectonic fracture zones shows that faulting associated with the San Fernando earthquake was characterized by left-reverse oblique slip of up to 2.4 m along an approximately east-striking fault system that dips north about  $55^{\circ}$  at the surface. The sense of movement determined from surface measurements accords closely with that deduced from fault-plane solutions for the main shock. Detailed mapping has also shown that the zone of tectonic fractures is defined on the south by a conspicuous major break or narrow shear zone; we identify virtually no tectonic fractures south of this boundary. The northern boundary of the breakage zone, however, is diffuse.

"The gross relationship between earthquake damage and surface faulting is demonstrated by the remarkable concentration of major damage within the zone of surface breaks along the Sylmar segment. The gross relationship between damage and deformation in the thrust plate above the faults with surface breakage is shown, but more equivocally, by the great predominance of major damage in the upper plate. The occurrence of major damage along the mountain front between and beyond the Olive View and U.S. Veterans Hospitals suggests the possibility of faulting in that area. Tectonic fractures here could easily be masked by the abundant landslides; nevertheless, we have direct evidence of only one relatively short break along this zone that could be interpreted as tectonic."

The following is from a report by R. B. Saul<sup>7</sup>:

"Effects of the San Fernando Earthquake in the Oat Mountain Quadrangle: Within the quadrangle, disruption of the ground surface in response to the earthquake of February 9, 1971 was confined mainly to a zone roughly 2 miles wide along the eastern boundary of the quadrangle (a line roughly coincident with Balboa Boulevard) from Rinaldi Street on the south, north to about San Fernando Pass. Across most of the southeast quarter of the Oat Mountain quadrangle, the complexly imbricate surface zone of the Santa Susana thrust trends due east. In general, the sense of movement is from north to south. Furthermore, subsurface data indicate that this thrust is folded along

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an east-west axis. West of Bee Canyon no element of this thrust appears to have moved during the recent earthquake. East of Bee Canyon tectonic and/or lurching motion appears locally to have been coincident with or closely parallel to the sole of the Santa Susana thrust zone as previously mapped and may represent a local deflection of energy along existing planes of weakness. Where the base of the Santa Susana thrust crosses the road to St. Vincent de Paul Camp left-lateral movement offset a line on the pavement about 1 foot, with no visible vertical component of movement. To the west of this road the trace of ground movement turns northwest into Bee Canyon, athwart the zone of the Santa Susana thrust, and appears to be absorbed along the strike of the bedding in the sedimentary rocks of the north wall of Bee Canyon. Northeast of St. Vincent de Paul Camp road, ground breakage follows the trace of the sole of the Santa Susana thrust along a discontinuous and locally ambiguous series of breaks as far as the large road cut on Balboa Boulevard north of Van Norman Lake. In the low-lying areas, surface cracks appear to be largely the result of lurching or settling of alluvium. In hilly areas, effects range from minor lurching of fills and soils to intensely shattered soil, landslides and rockfalls. The most severe effects are principally confined to the square mile surrounding the mouth of Bee Canyon. Here, soil and weathered rock debris on ridge crests lies in cracked and jumbled disorder as though it had been heaved, and the flanks of most ridges are scarred by shallow landslides. In the Bee Canyon and Cascade Oil Field area, rocky ridges, road cuts, and the steep cliff along the north side of the canyon yielded rockfalls."

The following is from a report by T. L. Youd<sup>11</sup>:

"A large number of landslides formed in the vicinity of the Van Norman Lakes in response to the February 9 earthquake. Only the slides in recent alluvium are discussed here. Extensive slumping occurred in the alluvium around the margins of both the Lower and the Upper Van Norman Lakes. In some places a nearly continuous line of scarps formed. The scarp on the west shore of the lower lake is more than 1 km long. Sand boils commonly formed below these scarps.

"A recently filled and graded area west of the upper lake was broken up by numerous fissures, which generally tended to parallel the shoreline and the contour of the previous surface . . . Extensional and vertical displacements in the fill indicate movement toward the reservoir either in the form of block glides or in slightly rotated slumps. Sand boils erupted in the southern part of this fracture zone some 180 m from the lake and several meters above the water level at the time of the shock.

"Many fissures formed in the area west of that described in the previous paragraph. Of those observed, the most notable were in a schoolyard in the mouth

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of Bee Canyon, nearly 1 km from the upper lake. These fissures were characterized by vertical displacements of as much as 50 mm (millimeters) and continuous lengths of perhaps 100 m. They seemingly formed the head of a landslide which had moved down the very mild slope (about  $1.5^{\circ}$  or 2.5 percent) eastward toward the upper lake.

"The most damaging slide in the vicinity of the lakes formed a tonguelike feature (in plan) extending northeastward from the upper lake for a distance of 1.2 km. Located on or crossing this slide, hereafter called the Juvenile Hall slide, are a major part of the San Fernando Valley Juvenile Hall, trunk lines of the Southern Pacific Railroad, San Fernando Boulevard, Interstate Highway 5, the Sylmar electrical converter station, and several pipelines and canals. Earthquake damage to these facilities will likely exceed \$30 million.

"The available evidence indicates that the displacements associated with this feature are of landslide rather than tectonic origin.

"Resurvey of San Fernando Boulevard revealed that the distance across the slide from the survey point at the Interstate 5 overpass to a point near Olden Street had shortened 43 mm. Relative to the Roxford Street intersection with the San Fernando Boulevard (southeast of the slide), the survey points near the Interstate 5 overpass (northwest of the slide) had moved south 300 mm and west 210 mm. These relative movements are considerably less than the total down-slope movements of the slide, which ranged from 0.5 to 1.0 m (based on visual observation and cumulative measurements of displacements across fissures). Thus, it appears unlikely that the feature mapped as the Juvenile Hall slide had a tectonic origin, even though the southwest movement of the Interstate 5 overpass with respect to the Roxford Street intersection could have been produced by left-lateral tectonic displacement on a northeast trending fault or fault zone through the area of the slide.

"The surface on which movement occurred has a very gentle slope; it averages about  $1.5^{\circ}$  (2.5 percent) over its entire length assuming that the toe of the slide is at the shoreline of Upper Van Norman Lake. The maximum slope was about  $3^{\circ}$  (5 percent) near the head. Surprisingly, the average slope between the Juvenile Hall and the converter station, which appeared to be the minimum, was only  $0.9^{\circ}$  (1.5 percent).

"Numerous sand boils erupted on the lake floor, presumably near the toe of the slide. These were exposed after the water level was lowered. Sand boils were also found at the following locations: Behind the converter station near the base of the graded fill, in a field south of Juvenile Hall, and along the north edge of the railroad grade in front of the Juvenile Hall Administration Building.

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"During the earthquake, the crest of the Upper Van Norman Dam subsided a maximum of 0.9 m and shifted downstream a maximum of 1.5 m with respect to its abutments. In the light of this it would appear that a low-gradient slide, similar to the one described above, may have cut through the valley floor behind the dam and caused these movements.

"The most reasonable explanation for slippage of the Juvenile Hall slide on a slope of such low gradient is that the underlying soils were partially or completely liquefied during the earthquake. The many sand boils observed on or near the slide are evidence that this occurred.

"It is also probable that movements on many, if not all, of the other slides in the alluvium surrounding the Van Norman Lakes were directly attributable to increased pore water pressures generated by the earthquake."

Highways, Railways, and Roads:

Most of the major and spectacular damage to highway structures and bridges occurred in an area along U.S. Highway 5 at the interchanges of 5/210 and 5/14, located about 1-1/2 km. apart. At the Route 5/210 interchange (Foothill Boulevard and Golden State Freeway), three highway overpasses totally collapsed and two required rebuilding. Two men were killed at this location when one of the overpasses collapsed onto their truck. Bridge columns failed. Pavement cracked and buckled. At the Route 5/14 interchange (Golden State and Antelope Valley Freeways), two spans of a nine-span bridge collapsed. A bridge also collapsed at the interchange between the Golden State Freeway and San Diego Freeway. It was reported that almost all remaining structures in the general vicinity of the interchanges (possibly as many as 70) were damaged to some extent, many requiring extensive repair. Bridges on the Antelope Valley, Foothill, and San Diego Freeways also were seriously damaged, especially along Foothill Freeway in the Sylmar-San Fernando area. Press reported the Newhall and Old Sierra Highways and Bouquet Canyon Road were closed by slides and bridge damage. There was some bridge damage along the Soledad Canyon Road areas east of Saugus. Many other roads were blocked by slides in the San Gabriel Mountains. Numerous roads and city streets in northern San Fernando Valley were made dangerous or impassable by landslides, cracks, and buckling. Railroad traffic also was disrupted owing to displacement and distortion of rails and to a collapsed overpass which fell onto the track. In front of the San Fernando Valley Juvenile Hall facilities, railroad tracks were twisted and broken and displaced as much as 1.2 m.

Dams:

The old Upper and Lower Van Norman earthfill dams were damaged to the extent

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that rebuilding is required. The reservoir keeper of Lower Van Norman Dam reported: "We live on the reservoir grounds at the bottom of the dam on the west end (11729 Strandwood Ave.). No ground cracks around the house. Chimney damaged badly. One crack in foundation. Stove, refrigerator, and dresser shifted. No broken plaster; no broken windows. Damage was slight. My wife and child were up, getting ready for school. She heard the shock coming. I was asleep. I tried to get out of bed but couldn't, until the worst of it was over. I made a quick check of the family and a quick check of the house, then dressed and went to check the dam. When I got to the main road going to the top of the dam, I could see, through the dust, an irregularity of the crest of the structure below, looking to the top. I drove to the top of the dam and around the west abutment and saw the damage to the face. It was hard to believe what I saw."

Pacoima Dam, located about 2 km. northeast of the San Fernando Veterans Administration Hospital, reportedly sustained \$1.5 million damage to its abutments. Massive rockslides blocked the access road to the dam, preventing immediate inspection of the accelerograph located there. Waterlines were damaged. In view of the apparent high intensity in this area, the following, as reported by the caretaker of the dam, is of interest: "Caretaker's house is a one-story wood frame building (built in 1953), situated on loose fill (fill done in 1938). It is approximately 12 by 12 m. and rests 0.6 m. off the ground on a concrete perimeter foundation with wood plate around the foundation. There was no damage to the concrete foundation and only minor damage to the wood support. The brick chimney was undamaged. There were hairline cracks in ceiling plaster and above doors; no doors were out of plumb. Doors on a 1.8-m.-high hutch opened and the first row of glasses was thrown out; then the doors closed and rest of glasses did not break. Some objects fell in the house. Huge rock rolled down and broke outside stucco but the rock did not come through into the house. An old nearby house (built in 1937) had outside brick chimney separate from frame but the chimney did not fall. At the dam, an empty tank (under construction) shifted about 15 cm. off foundation." It was reported that Lopez and Hansen Dams sustained only minor damage.

Other Water Supply and Distribution Systems, Flood Control, and Power Facilities:

There was extensive and severe damage to underground waterlines, gaslines, sewers, tunnels, flood control facilities, and electrical facilities and structures. It was reported that it will be necessary to completely rebuild the sewer system in the area bounded by Hubbard Street, Glenoaks Boulevard, Harding Street, and Eighth Street. In the Upper Van Norman Lake area, sections of several canals were damaged badly; several flood control dikes suffered slumping. Approximately \$2-1/2 million damage was reported to the Los Angeles Flood Control facilities, and about half of this loss was caused by breakage of reinforced concrete open channel and underground box channels. In one case,

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breakage extended for the length of a city block. Substantial damage occurred to Wilson Canyon Channel, Mansfield Avenue Storm Drain, Pacoima Wash, Lopez Canyon Channel, and Glenoaks Boulevard Drain, all in the San Fernando-Sylmar area. Lopez Debris Basin, north of Hansen Dam, was seriously damaged. Damage was estimated at \$6 million to Metropolitan Water District of Southern California. At Joseph Jensen Filtration Plant (about 0.4 km. northwest of Upper Van Norman Lake), there was extensive ground cracking in the plant area, with lateral movement of 0.3 m. or more, and extensive damage to above and below ground structures. A huge steel water storage tank buckled and anchor bolts pulled out. The Balboa Inlet Tunnel (4.3 m. in diameter) had about 90 m. of lining damaged badly at a point about 457 m. from its downstream portal. It was reported the San Fernando Tunnel (5.4 m. in diameter and about 9 km. long, which extends from Magazine Canyon to Pacoima Wash, experienced about a 1.9-m. vertical displacement between its portal and a point 7.2 km. into the tunnel. The First and Second Owens River Aqueducts were damaged. The Second Aqueduct was damaged in its Saugus pipeline portion (pipes buckled and supports moved) between Terminal Hill and Magazine Canyon. Water service to the Granada Hills, Porter Ranch, Sylmar, and other high-elevation areas in the San Fernando Valley was disrupted by the many trunkline breaks on the Susana, Granada, and Maclay trunklines. On the Granada line, most of the 10 or 12 breaks were in the Joseph Jensen Filtration Plant area. The wood roof collapsed at the small Maclay Reservoir on the Maclay High Line, and cracking occurred at the sides and corners of the basin. Damage at the Sylmar Converter Station (Pacific Intertie), west of Upper Van Norman Lake, was estimated at approximately \$22 million. It was reported the most severe damage to this plant involved electrical equipment and underground conduit. There was extensive damage to converters, transformers, and circuit breakers. Heavy outdoor electrical equipment, some weighing many tons, was overturned. Building damage included many cracks and separations of concrete walls. It was estimated that this facility would be out of operation for about a year. A power-generating plant north of the station also was damaged seriously. There was severe damage to electrical equipment at the Olive Switching Station, about 0.8 km. west of the Sylmar Converter Station, where insulator-supported equipment collapsed and several large transformers overturned. Severe damage was sustained at the Olive View Powerplant, where large boilers were shifted as much as 1.2 m. and where tanks and motors were torn loose from anchorages. Many elevated water tanks were damaged; some were shifted, overturned, and destroyed. A large steel tank just north of Olive View Hospital was ruptured. An elevated water tank east of San Fernando Ranger Station (in Lopez Canyon) was shifted from its pad and destroyed. A Fiberglas tank near the northwest shore of Lower Van Norman Lake was overturned. A large tank at Granada Hills was damaged. Many water wells were damaged. In general, all utility facilities--gas, electric, and water--in the severe damage areas of San Fernando and Sylmar were out of service. The water distribution system for the city of San Fernando was almost completely destroyed by ground cracking and by violent shaking.

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All reservoirs leaked; two could not be repaired. Many underground gas and waterlines were separated, buckled, or fractured. Nearly every pipeline in the major ground rupture zone was damaged. All telephone equipment in the Sylmar Central Office of the General Telephone Company (Polk St. and Borden Ave.) was totally destroyed. Damage to the building and equipment was estimated at \$4.5 million. In the Sylmar area, many pole transformers were thrown down; insulators and crossarms were broken; wires and poles were knocked down; and cable was sheared off in underground ducts. Four gas transmission lines, ranging in diameter from 30.4 to 66.0 cm., were damaged between Newhall and San Fernando, resulting in loss of gas supply to the San Fernando-Sylmar area. A main feeder gasline (40.6 cm. in diameter) broke and erupted in flames on Glenoaks Boulevard between Hubbard and Bledsoe Streets, shutting off service to 20,000 homes. Oil field facilities and related structures sustained minor damage to tanks, roads, pipelines, and a few wells in Aliso Canyon, Cascade, Newhall, Newhall-Potrero, Oak Canyon, Placerita, and Ramona Oil Fields.

Damage to Other Structures:

San Fernando Veterans Administration Hospital: Major collapses of older unreinforced masonry buildings occurred at this complex facility. Forty-nine were killed; many were injured.

San Fernando Valley Juvenile Hall Facilities: Severe and extensive damage occurred to practically all buildings; one collapsed. Buildings were evacuated. Fissures about 45 to 60 cm. wide and about 1.2 to 1.5 m. deep were observed at this site.

San Fernando Industrial Tract (east of intersection of Foothill Blvd. and Arroyo St.): Most structures were posted as unsafe. Severe ground cracking, lurching, and compression-ridging occurred at this site. Sidewalks were torn up and buckled.

Sylmar Industrial Tract (east of San Fernando Road in Bledsoe and Bradley areas): Most buildings were posted as unsafe. Many roofs and walls collapsed. Considerable ground cracking and compression-ridging occurred.

Foothill Nursing Home (just east of Foothill Blvd. and about 0.5 km. south of San Fernando Ranger Station): The building, a one-story concrete block structure, was damaged severely. The curb and sidewalk in front of the building was raised about 0.9 m. by surface faulting that also passed under the building.

Holy Cross Hospital (southeast of Lower Van Norman Lake): Major structural damage occurred to this seven-story reinforced concrete building. Extensive and severe cracking was observed. Also, the nearby Indian Hills Medical Building was damaged badly.

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Pacoima Memorial Lutheran Hospital (about 2.8 km. southeast of Foothill Nursing Home): Major structural damage was sustained to four-story reinforced concrete building.

Schools:

The following is from a report by California Institute of Technology<sup>2</sup>: "Most schools in the San Fernando Valley were post-1933, and these experienced little damage from shaking. Some wood frame buildings were shifted on their foundations, and some cracking was experienced. The foundations of several school buildings, such as Van Gogh School and Sylmar High School, were disrupted by permanent ground displacements, but structural damage was not such as to constitute any undue hazard to occupants. However, in some cases, light fixtures and ceilings, supposedly designed to withstand earthquake shaking, fell and these would have been hazardous. The generally good behavior of the school buildings in the San Fernando Valley is due mainly to the fact that they were well constructed one- and two-story structures, mostly wood frame and plaster, that were significantly stronger than the minimum requirements of the building code. Of the pre-1933 schools, Morningside School at Maclay Avenue and Fifth Street in San Fernando was closest to the center of the earthquake. One of the two structures at this site was a good quality, two-story brick bearing wall building (1928) which was very badly cracked by the ground shaking. Although it would not have injured occupants during the earthquake, it did appear afterwards to be in a most dangerous condition, and it has been demolished. Since the earthquake, most of the old buildings have been closed. A few were judged to be in a good condition and not unduly hazardous to the occupants, and these will be used for a limited period of time."

Private Dwellings:

Severe and extensive residential damage occurred in the area of permanent ground displacement, beginning in the area of Glenoaks Boulevard and Hubbard Street and extending east across northern San Fernando (north of Maclay Ave.) and on into the foothills to the east. Many houses, including mobile homes, were cracked very badly and shifted from foundations. Many one- and two-story apartment buildings also were damaged extensively. Another area of severe and extensive damage to residential houses was between the Olive View Hospital and the Veterans Administration Hospital where some residences were damaged beyond repair and some were in a state of collapse; many shifted off foundations. Practically all concrete block walls and chimneys fell. Also, many dwellings in various states of construction in the area east of the Veterans Administration Hospital were damaged heavily; some collapsed.

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The majority of the following reports were obtained through the questionnaire card canvass:

San Fernando:

2043 Phillipi Street (northwest corner of San Fernando, about 2.7 km. southeast of Olive View Hospital). Felt by, awakened, and frightened all in community (observer sleeping in 25-year-old, well-built, one-story wood frame building). "I was awakened by roar just before shock and was on feet when it hit. No one sound could be distinguished. The building and everything in it shook so violently that the combined sounds were deafening. In my block, streets split and were displaced in about 10 places; one place in street was buckled. Other streets in the area were split, cracked, twisted, and buckled far worse than my street. My chimney top shot straight up, then fell on the roof. It was pulled straight up, with its reinforcement rods left in main body of chimney. Swimming pools in the area lost 5,000 gallons or more of water. One pool, two blocks away, was pushed under decking nearly to the house foundation. All bedroom furniture in three bedrooms, except beds, was overturned. Every bottle lid was screwed off or loosened, even new bottles. Eighty-five percent of glass and pottery broken, even 'melmac.' Moderate-to-severe plaster cracks in walls and ceilings of every room. Ninety-nine percent of block walls down, including reinforced walls. I have only slight damage to my house, but half a block away, every other house is condemned; one block away, 90 percent of the houses are condemned. All water-pipes and many gaspipes had to be replaced in a 36-block area of San Fernando where I live." Ground: Compact soil over bedrock, no fill.

1942 Chivers Street (northeast of Glenoaks Blvd., about 3 km. south of Olive View Hospital). Felt by and awakened all in community; frightened all in 20-year-old, well-built, one-story wood frame building. "Couldn't distinguish earth noises from building noises." Trees and bushes shook; vehicles rocked. Ground cracked; landslides; water disturbed. Chimneys, tombstones, elevated water tanks, etc., cracked, twisted, and overturned. Hanging objects swung violently. Small objects shifted, overturned, and fell. Furniture shifted, overturned, and broke. Plaster cracked. "Ground fractures. Waterlines and gaslines broken in street. According to the U.S. Geological Survey, the lot was shortened by about 0.3 m. Most concrete block fences knocked down." Damage moderate to house. Ground: Gravelly, sloping.

Foothill Boulevard and Vaughn Street (about 0.8 km. east of San Fernando Airport).

"Building about 6 months old. Floor is up and down 0.3 m. near rear of the building. Side walls torn loose from glu-lam beams. Rear lintel broke. Front wall (S-W) looks good. Waterpipe in street (0.6 m. in diameter) broke."

12300, 12314, 12424 Gladstone Avenue (northeast of Foothill Blvd., about 0.8 km. northeast of San Fernando Airport). "Building (concrete tilt-up) at 12300

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Gladstone moved 0.3 m. into building at 12314 Gladstone, ground and all, at west corner. This was possible because it sat back about 0.3 m. behind adjoining building. The 12314 Gladstone building (concrete block) was only moved 10 cm. off footings at west corner. Floor distorted badly. Compression lines in rear yard running north-south. Building about 3 years old. Street buckled. At 12424 Gladstone (building about 1 year old), northeast rear wall failed because nails pulled through 1.27-cm. plywood roof diaphragm. Nails also pulled through plywood on southwest wall. Southwest block wall, supported by frame and stucco office in front, did not fail, but front block corners were completely broken. Building leaning about 7.6 cm. to west. Diagonal east-west cracks, about 2.5 cm. wide, in floor."

12401 Filmore Street (Filmore St. and Foothill Blvd., northeast of Glenoaks Blvd., about 1.6 km. southeast of San Fernando Airport). Felt by, awakened, and frightened all in community (observer sleeping in new, well-built mobile home). Loud earth noises. Trees and bushes shook; vehicles rocked. Small objects fell. Furniture overturned and broke. Plaster broke and fell. Windows cracked. Ground cracked; landslides; water disturbed. Chimneys overturned. "Mobile home, 18.3 by 6.1 m., weight 11 tons (with wheels off), moved 1.2 m. and was broken apart. Waterpipes and gaspipes in ground were twisted and broken. All dishes and glassware broken; food thrown from refrigerator; all closets emptied of contents; locked doors came open. Noise was overwhelming. Personal feeling was one of resignation to the inevitable--surprised to be alive after shock was over. Also, complete panic after the shock was over due to no communication. Learned later that a fault was located about 61 m. from our home." Damage great. Ground: Compact.

Glenoaks Boulevard, southeast of Hubbard Street (Brown's contracting yard). The following is from California Institute of Technology report<sup>2</sup>: Heavy lathe moved 2.7 m. in northerly direction, leaving straight skid mark. Locomotive (1880 vintage), standing on rails and ties in yard, overturned.

Sylmar:

13151 Chesterwood (near Gladstone Ave., east of Foothill Blvd.). Felt by, awakened, and frightened all in community (observer lying down in well-built, one-story wood frame building). Motion rapid, rippling, thrusting; direction up and down and north-south, with small east-west movement; 30 seconds of strong motion, 15 minutes of moderate motion. Loud, cracking and roaring earth noises, sounded like noise made by a jackhammer. "I was 30 seconds inside and 5 to 15 minutes outside." Hanging objects swung north-south. Trees and bushes shook moderately. Small objects and furniture overturned. Dishes and furniture broke. Plaster, walls, and chimneys cracked. Chimneys, columns, and monuments fell. Damage slight to wood; considerable to brick. Cracks in roads; about 0.9 to 1.2 m. of thrusting. "Many cracks in roads and pavement. Some houses condemned but most wood frame and stucco houses

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survived with little damage. Most brick walls were down. Freeway bridges collapsed." Ground: Rock, clay, and sand, level.

12939 Gladstone Avenue (near Gridley St., east side of Foothill Blvd.). (VIII)

Felt by, awakened, and frightened all in community (observer walking in old, well-built, wood frame and stucco building). Felt as if a bomb had exploded. Loud and instant earth noises. Vehicles rocked; car shifted. Ground cracked; landslides; water disturbed. "Landslides in the hills." Chimneys and water tanks cracked, twisted, and overturned. Hanging objects swung violently. Small objects shifted, overturned, and fell. Furniture shifted, overturned, and broke. Plaster and windows cracked. Lights out. Damage moderate to great. Ground: Some rocky; mostly alluvial clay soil.

13321 Gridley Street (near Gladstone Ave., Maclay Rancho Section). (VIII) Felt by

all in community; frightened all in well-built, one-story wood frame and stucco building (observer lying down). Moderate rumbling earth noises. Ground cracked. Reinforced concrete block chimney had to be demolished. Hanging objects swung violently in circular direction. Small objects overturned and fell. Furniture overturned and broke. Stucco cracked; plaster cracked and fell. One window cracked. House off footing; door sills, window frames out of line. "House first lifted and settled, then rolled from side to side. All cupboard doors opened, spilling contents on floor. Furniture against wall toppled; furniture standing free did not fall. Attached garage is on slab; slab cracked and separated from house about 2-1/2 to 4 cm. One exterior wall out of line; one chimney wall demolished." Damage great. Ground: Compact, sloping.

13972 Sayre Street (between Borden Ave. and Foothill Blvd., near Phillipi Ave., southwest of Foothill Blvd.). (VIII) Felt by, awakened, and frightened all in

community (observer walking). Very loud earth noises. Trees and bushes shook; vehicles rocked. Ground cracked; landslides; water disturbed. Chimneys, tombstones, elevated water tanks, cracked, twisted, and overturned. Houses off foundations; cement slabs cracked in half and spread. Hanging objects swung violently north-south. Small objects fell and broke. Furniture shifted, overturned, and broke. Windows cracked. Damage moderate. Ground: Gravel and clay, compact, level.

14141 Foothill Boulevard (about 1 km. southwest of Olive View Hospital, near Polk St.). (VIII) Felt by, awakened, and frightened all (observer sleeping in old, one-story wood frame and stucco building). Roaring earth noises. Vehicles rocked. Ground cracked; landslides; water disturbed. Tombstones, elevated water tanks, cracked, twisted, and overturned. Pipes broke. Hanging objects swung violently northeast-southwest; objects fell in various directions. Small objects thrown. Furniture shifted and overturned. Plaster cracked, broke, and fell. Wall moved. Hot water heater torn from wall. "All animals panicked; horses broke corrals. The earthquake shook, rolled, and heaved. Fires broke out everywhere. All birds left at dawn before the shock hit." Ground:

Sandy loam, level.

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13477 Bradley Street (northwest Sylmar area, between Roxford St. and Foothill Blvd.). (VIII) Felt by and awakened all in community; frightened many; all in 12-year-old, well-built, wood frame and stucco building. Hanging objects swung violently. Small objects overturned. Furniture shifted. "There were so many sounds it is impossible to describe them. All I can say is that they were very violent. Limbs on my trees were shaken off. My block wall fell. Vehicle moved about 0.6 m. In the community, there were many chimneys down and some houses were off foundations. Little plaster cracking in my home; no windows cracked. Damage to my home was slight." Ground: Compact soil, level.

15445 Cobalt Street (west Sylmar area, south of Roxford St., near San Fernando Rd.). (VIII) Felt by, awakened, and frightened all in community (observer lying down in new, well-built, metal mobile home). Loud earth noises, like those made by a train. Trees and bushes shook; vehicles rocked. Ground cracked; water disturbed. Chimneys and tombstones overturned. Hanging objects swung violently east-west. Small objects overturned. Furniture shifted. "I was never so frightened in all my life. I have never been a nervous person, but during these last 2 months I get scared at the least little movement. I know I'd rather be in a mobile home than a house during an earthquake. I was at work during one of the aftershocks and it was worse than the first shock--the building rocked and swayed, and I was very frightened." Damage slight at mobile home. Ground: Gravelly, sloping.

14343 Berg Street (near Glenoaks Blvd., north of Sayre). (VIII) Felt by, awakened, and frightened all in community (observer sleeping in 14-year-old, well-built, one-story wood frame and stucco building). "All noises blended into one loud, rumbling roar." Trees and bushes shook; vehicles rocked. Ground cracked; water disturbed. Walls fell. Gaslines broke. Hanging objects swung violently in all directions. Small objects shifted, overturned, and fell; all dishes fell to floor. Furniture shifted, overturned, and broke, such as chest-on-chest dresser. Plaster cracked, broke, and fell. Window broke. "Building sound as far as known." Ground: Compact, level.

13597 Simshaw Avenue (about six blocks south of the southeast boundary of the Veterans Administration Hospital grounds). (Excerpted from a letter to Robert D. Nason, Earthquake Mechanism Laboratory, ERL, NOAA) (VIII) "The first shock was sudden; no warning rumble. I thought it was an explosion. We went up and down, with the noise and jolts accelerating. I can recall four very hard up-and-down motions, the last one being the hardest. The sound seemed ear-splitting--I thought my eardrums would burst. It was impossible to hear anyone, so we just didn't bother. My daughter said she was screaming but not one of us heard her. My husband, a large, strong man, tried to force himself up from the bed but was slapped down each time. Five times he tried, straining with every muscle, until he was exhausted. I had trouble hanging onto the bed. We could hear nothing but the noise of the earthquake. The slapping motion of the earth seemed to be in an east-west direction, with the last slap ending

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in a hard motion to the west, toward Olive View Hospital. We were shaking between the up-and-down motions. Now we started to roll. I was holding onto the bed for 'dear life' to keep from being thrown into the furniture. I could see the clock glide across the room. I looked out the window from the bed. The window starts at about 1.5 m. from the floor and goes to about 0.45 m. from the ceiling. I could clearly see the outline of the trees against the sky (it is a 360-acre area, rather open), the tops of the trees, the sky, the dark area of growth, and the very dense area--I expected to see the ground any minute. This was repeated with every roll. At one point I thought the house would go over with the next roll as each roll was worse than the last. That, I believe, was the end of the major motion, as my husband and I jumped out of bed almost simultaneously. It was when we were in the rolls, north-south direction, that I could hear everything falling and breaking. The 'slaps' felt as if one were being blown around and up in the air, then coming down hard, like being in the center of a big explosion. The concussion was unbearable. During the rolls the sound was much more bearable. When we got to the bedroom door we found it was jammed with furniture, including the heavy dresser and the sewing machine, which was upside down. The minute I could get a few centimeters gap in the door, I yelled to my children to get outside, and not to wait for us. My husband had the door cleared in seconds. My four children were huddled in the hall. We were now in the aftershocks. The hall was leaning in first one way, then another. We pushed the children down the hall. We were thrown against each side of the wall all the way to the front door. Then came another hard aftershock, and my husband could not get the door open. As the shock eased, he was able to jerk the door open, bending the middle hinge badly. We were the first ones out on our street. We stood on the lawn and watched Pacoima Dam light up with a hazy glow and then fade. The light came from behind the front of the dam and was a steady light, not a flash. There were lots of slides and dust. We could hear lots of large rocks rolling down off the dam area, and thought the dam was breaking. We left the children in the car, which was bouncing up and down with every shake. By now, people were starting to come out of their houses. I just sat in the middle of the yard, I was so dizzy and dazed. The ground was bumping up gently, and I noticed that I was sitting on one of the cracks in the yard but I just didn't care. I saw people who looked simply frightened 'out of their lives' and some who looked absolutely blank. We felt as though we had been through an explosion. It wasn't until we were in the aftershocks (in the hall) that I suspected it was an earthquake. We returned to the house a minute or two at a time to gather shoes and robes. It took us 2-1/2 hours to find my husband's glasses even though he knew where he had left them. At daylight, we were amazed to find the house structurally intact, as we had been thinking it would be totally ruined. Inside, however, it was a mess, taking over 3 weeks to straighten it up. The house has a slab floor and drywalls, and stood up well. We had about \$181 in structural glass

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damage, even the shower doors were broken. Our neighbors on both sides of us were not so lucky. In general, things were scattered in a very even pattern throughout the house. I took a straight pin, which was embedded about half way in, out of my bedroom wall. I have written down most of the details as I remember them and given a lot of thought to them, trying to be as exact as possible, if anyone could be exact through it. I asked my doctor how Pacoima Lutheran Hospital was and he said, 'Bombed!' Somehow that just explains things perfectly."

22117 Sierra Highway (about 5 km. northwest of Sylmar). "All other earthquakes that I have experienced were of a rolling motion, but this one felt as if the bottom fell out of everything. I felt a falling sensation, and jumped up to try to get out, but I was knocked down to my knees. I was sitting at the kitchen table when it struck. Everything began to fall; all dishes and glassware crashed to the floor; then in about 5 seconds the light went out. I finally got to my feet, after about 30 seconds, and yelled to my wife to hurry down so we could get outside. If we had been sitting on a big vibrator, it couldn't have shaken us any harder. There was no rolling or horizontal motion. It was a straight-up-and-down motion. A big bookcase and a large commode upstairs fell toward the east. There was no noise as in other earthquakes I have experienced. This one hit without warning. This old house was built in 1915 and is on pretty solid ground. My service station across the street from me was not damaged. About 0.8 km. south of me, near that new freeway that was being built and where so many bridges were lost, there is a mountain that is torn all to pieces--looks as if it went through a grinder. The north side of my house didn't seem to get hit as hard as the south side."

Kagel Canyon Area:

12587 N. Dexter Park Road (Los Angeles Fire Station No. 74, about 5 km. southeast of Veterans Administration Hospital, in sec. 32, T. 3 N., R. 14 W.). Felt by, awakened, and frightened all in community (observer sitting in old, well-built, one-story wood frame building). Building made loud snapping sound. Loud earth noises, similar to noise of jet plane. Trees and bushes shook; vehicles rocked. Ground cracked; landslides; water disturbed. Chimneys, tombstones, elevated water tanks, etc., cracked, twisted, and overturned. Gas main broke; power off. Hanging objects swung violently in various directions--east-west, north-south, all directions; also strong vertical motion experienced at this location. Small objects shifted, overturned, and fell; furniture shifted, overturned, and broke. Plaster cracked, broke, and fell. Windows cracked. "This building was moved off foundation approximately 0.3 m. and had to rise over sill at least 11 cm. to settle down without damage to shingles." The following is an excerpt from a report by B. J. Morrill<sup>5</sup>:

"Firemen were resting in the wood frame quarters building . . . Mr. J. White, duty fireman, stated that he was tossed out of bed onto the floor

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and the bed landed on top of him. Every object in the building was upset. Even the handset of a standard wall phone came off its hook. Loud, cracking and thunderlike noises added to the general confusion. The building was shifted off its foundation. Outside, rocks were thrown off the ground, and large cracks appeared in both soil and rock . . . many ground cracks appeared throughout the area. The surface of a hill adjacent to the building exhibited the 'shattered earth' effect reported . . . a few miles to the west. A nearby rock roadcut appeared to have exploded, and the adjacent road was offset in many places . . . A 20-ton fire truck in the garage . . . moved 6 to 8 feet fore and aft, 2 to 3 feet sideways without leaving visible skid marks on the garage floor. The truck was in gear, and the brakes were set. Damage to the truck was a bent rear step, broken windshield, shattered red light, and siren broken off. Also, a ladder and a hook were broken. Marks which appear to have been made by the right rear tire were found on the door frame . . . 3 feet above the floor, while the metal fender was not damaged. The fender extends several inches out beyond the upper portion of the tire. Four feet above the floor the hose rack was broken by the rear step of the truck. The step was bent up while the hose rack was broken downward. The rear of the garage was pushed outward 6 to 8 inches, and the final position of the truck was about 4 feet out the front of the garage, with the garage door resting on the cab." Morrill also suggests that the building accelerated upward, with respect to the ground, at a rate of at least 1 g. for about 0.1 second.

12557 Kagel Canyon Road. Felt by, awakened, and frightened all; general panic (observer sleeping on second floor of 10-year-old, well-built, two-story wood frame and brick building). Felt like an explosion. Loud earth noises. Ground cracks; landslides; water disturbed. Chimneys, tombstones, and elevated water tanks cracked and twisted. Masonry shattered; wood twisted. Hanging objects swung violently in all directions. Small objects fell; furniture shifted, overturned, and broke. Plaster cracked and broke; windows cracked. Damage moderate to great. "Many aftershocks." Ground: Sandstone, fill, hilly, sloping, and level.

11825 West Trail (south Kagel Canyon). Felt by, awakened, and frightened all in community (observers sitting and standing in old, well-built, one-story wood frame building). House moved northeast-southwest in bucking motion and made nail-pulling sounds. Loud earth noises, like noise of low-flying jet plane. Trees and bushes shook; vehicles rocked. Four ground cracks around house, three about 2.5 cm. wide and one about 10 cm. wide; ground raised in several places. Ten-cm.-wide cracks in 0.3-m.-thick walls. Retaining walls fell. House full of plaster cracks. Stucco walls cracked. Foundation broken in two places. Hanging objects swung violently northeast-southwest and up and down. All items fell from cabinets. Most small objects fell and broke or were ruined by fluid. Furniture shifted, overturned, and broke; refrigerator on rollers moved; one old refrigerator overturned. Damage moderate. "Husband heard the shock coming. Hard rattle at first, then in 1-2 seconds I was thrown from chair and my husband was dumped into the tub; then back-and-forth motion. I was able to reach

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the hall and get the children under a doorway until things slowed down, then we went outside. Lights went out in the first movement. Water out but gas and telephone OK. Ground seemed to keep moving. We have 3 acres (San Gabriel Range, first mountain by valley) with three houses. Lower house had little damage; no landslides or broken pipes. The second house, about 38 m. or so higher up, had cracked foundation; 0.3-m.-thick walls cracked 2.5 to 10 cm.; four deep ground cracks, two under the house. Third house, about another 30 m. higher up than the second house, had cement floors buckled and cracked; deep ground cracks; pipes separated; new garage (side room) separated from house and slightly askew; 1.9-cm. floor crack in cement; door wedged closed; everything dumped from cabinets, and lots of stored glass windows broken. Water main in front of this third house was broken in five places."

13706 N. Kagel Canyon Road. Felt by and awakened all (observer sleeping in new, well-built, one-story concrete block building). Building made snapping sound. Loud earth noises. Trees and bushes shook; vehicles rocked. Ground cracked. Chimneys cracked. Water tank off foundation. Fifteen m. of natural stone wall, running west-east, fell. Hanging objects swung violently east-west. Small objects fell and broke. Furniture shifted and overturned in all directions and broke. Plaster cracked. Damage moderate. Ground: Rocky, compact, sloping. "My husband was awake and was thrown from north to south. Furniture was overturned from north-south, east-west, and west-east. Refrigerator was out of position from south to north about 46 cm. Kitchen cabinets, from both north and south shelves, were almost emptied. In living room, articles on north end of room slid off tables toward north, and on south end of room all books were dumped onto the floor from west to east. Most violent action seemed to be from east to west, from final position of furniture."

Kagel Canyon. The following was excerpted from a letter by Doreen Russell, Secretary, Kagel Canyon Civic Association: "Many of our homes have been totally destroyed, while others just next door had no real structural damage. For example, our home had very slight damage, but two of our immediate neighbors, one (who owns) a very new house and the other a much older structure, lost their homes. Severe ground scarp at Glen Haven Cemetery."

Karl Holton Boys Camp (about 5.6 km. southeast of the Veterans Administration Hospital, in Marek Canyon, branch of Little Tujunga Canyon). Extensive damage to buildings. Forty-six m. of 4.3-m.-high concrete block wall collapsed. Extensive landsliding and ground fracturing. Severe structural damage where ground cracks passed through or adjacent to the buildings. The camp was evacuated.

Little Tujunga Ranger Station (12371 N. Little Tujunga Road, about 0.8 km. south of Karl Holton Boys Camp). (Report from Hugh E. Masterson, District Fire Control Officer.) Felt by, awakened, and frightened all in community; general panic (observer lying down in well-built, one-story concrete block building). Loud earth noises. Ground heavily fractured. Water tank twisted. Concrete cesspool, waterlines, and pavement damaged. Hanging objects swung violently north-south. All crockery, china, bric-a-brac, pictures, etc., broken;

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everything upside down. Plaster cracked in several rooms. "My station building is No. A-3, one of six buildings plus two occupied mobile homes. Very heavy damage to all the buildings at the station. Many inspectors have been at the station but no final estimate made of the damage; however, it will probably exceed \$1 million." Ground: Compact, level.

Little Tujunga Road-Bear Canyon Area (Bear Divide Ranger Station, NW. 1/4, sec. 7, T. 3 N., R. 14 W., about 2.7 km. north-northeast of Pacoima Dam). Felt by and awakened all in community; frightened many (observer in new, large trailer home). Trailer bounced up and down. Very loud earth noises. Trees and bushes shook; vehicles rocked. Landslides. Rockslides on road up to 382,500 cu. m. Many cracks in fill ground and in solid ground. Block wall broken. Small objects shifted and broke; furniture shifted. Water sloshed from toilet bowls. "A giant up-and-down motion, changing to north-south side motion. Mobile home dead-manned from concrete to 1.27-cm. cable to 0.96-cm. eyebolts--eyebolts straightened out." Ground: Fill over rock, compact soil, level to 40 percent grade.

Intensity VIII:

Granada Hills:

The following is from a report by Lew and others<sup>3</sup>: Van Gogh Street School: "Constructed in 1968. The school is in an area of ground rupture directly west of the Upper Van Norman Reservoir. The construction is a single-story wood frame and stucco. Although there was no collapse, there was major structural damage which consisted of buckling of slabs on grade, fracturing of concrete foundation walls, and displacement of bearing walls in the zone of cracked foundations. The lunch shelter columns were permanently bent approximately 15° at the base at the point of weakness created by openings for electrical outlet boxes. A cantilever concrete block garden wall leaned approximately 10° but remained standing. The underground utilities were severely damaged. The school has been repaired and is fully occupied." Patrick Henry Junior High School: "Constructed in 1959. The buildings are primarily one- and two-story reinforced grouted brick and concrete bearing wall structures. The major structural damage consisted of fracturing of four second-story columns of a two-story covered arcade. The concrete roof of the arcade was shored to prevent collapse. The longitudinal concrete wall in the classroom buildings, extending the full length of the buildings, sustained some hairline diagonal cracks near both ends of the building. The cracking can be attributed to shrinkage stresses that existed prior to the earthquake. A concrete curb at the corner of the mechanical penthouse fractured under the steel column at the brace connection. Structural damage was minimal; however, a major loss of lighting fixtures constituted a real hazard. There was nominal damage to acoustical ceiling tile. Electrical conduits were damaged. The damaged arcade has been removed. The entire school is in use." Structural damage at the Van Gogh Street School was reportedly caused by ground surface movement, and damage at the Patrick Henry Junior High School resulted from vibrational movement.

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17201 Courbet Street (about 1 km. west of Upper Van Norman Reservoir). Felt by, awakened, and frightened all in community (observer lying down in strongly built, one-story wood frame building). Motion slow, lasted about 2 minutes; direction east-west and up and down. Loud earth noises heard by many about 3 seconds before shock was felt. Hanging objects swung east-west. Pendulum clocks, facing south and east, stopped. Trees and bushes shaken strongly. Small objects and furnishings shifted; vases, etc., small objects, and furniture overturned. Plaster, windows, walls, chimneys, and ground cracked. Knick-knacks, books, pictures, and plaster fell. Dishes, windows, and furniture broke. Twisting and fall of chimneys, columns, and monuments. Damage great to masonry and concrete. Ground: Soil, compact, level.

16834 Bircher Street (southwest of Lower Van Norman Reservoir). Felt by and awakened all in community; frightened many (observer standing on second floor of 12-year-old, well-built, two-story wood frame building). Moderate earth noises heard by person outdoors. Trees and bushes shook; vehicles rocked. Block fences fell. Hanging objects swung violently northeast-southwest. Mantel pieces thrown and broken. China cabinet overturned. Minor plaster cracking. "Our tract (wood floors, lath, plaster, and stucco; one- and two-story homes) suffered minimal damage. However, newer dwellings to north and northwest (slab, wallboard construction) sustained major damage, many condemned. Holy Cross Hospital is about 4 km. east and the Van Gogh Street School is about 2 km. north of our home. Many commercial markets had major to minor damage; many business buildings marked 'unsafe.' Minor ground cracks north of our tract. Damage slight at my home." Ground: Compact, adobe fill; lot is level, tract is sloping.

10518 Encino Avenue. Felt by, awakened, and frightened all (observer walking in old, well-built, one-story stucco building). Loud earth noises. Ground cracks; landslides; water disturbed. Chimneys, tombstones, and elevated water tanks cracked, twisted, and overturned. Hanging objects swung violently. Small objects swung violently. Small objects shifted, overturned, and fell. Furniture shifted, overturned, and broke. Plaster cracked, broke, and fell. Damage slight. Ground: Compact, level.

17608 Blackhawk Street. (VII) Felt by, awakened, and frightened all in community (observer standing in new, well-built, one-story wood frame building). Faint, roaring earth noises preceded shock. Trees and bushes shook; vehicles rocked. Hanging objects swung violently east-west. Small objects overturned and fell; all cupboards on east-west walls emptied. "No observed fissures, faults, or landslides. Most 10.2-cm.-thick concrete block walls in neighborhood (running north-south) are down. East-west walls seem pretty good. Water tank, 113 1., shifted about 7.5 cm. S. 70° W. Several 0.32-cm.-thick cracks at attachment of garage to house and around bottom plate. No damage to our 10.2-cm.-thick block wall running north-south with #3 bars @ 81.3 cm. on center." Damage moderate. Ground: Compact, silty clay, slightly sloping to south.

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- 12038 Bambi Place. (VII) Felt by, awakened, and frightened all in community (observer sleeping in well-built, one-story wood frame building). Building rattled and vibrated. Ground cracked. Water and power off. Chimneys damaged in neighborhood. Small objects overturned and fell; glass and dishes broke. Bookcases moved about 15 to 20 cm. Damage slight.
- 12817 Neon Way. (VII) Felt by, awakened, and frightened all in community (observer sleeping in new, well-built, one-story wood frame building). Everything rattled. Building rocked back and forth. Loud earth noises. Trees and bushes shook; vehicles rocked. Ground cracked. Hanging objects swung violently north-south. Small objects overturned and fell. Furniture shifted, overturned, and broke. Cement and plaster cracked. "Everything affected." Damage slight to moderate. Ground: Compact, sloping; filled in.
- 16939 Colven Road. (VII) Felt by, awakened, and frightened all in community (observer sleeping in new, well-built, one-story wood frame building). "Tremendous displacement of building." Loud earth noises, like sonic boom. Chimney and concrete block wall cracked and knocked over. Hanging objects swung violently east-west. Small objects fell. Furniture overturned and broke. Plaster cracked and broke. Shower door cracked. Toilet bowl broke. Damage slight. Ground: Rocky, level.
- 16329 San Jose Street. (VII) Felt by, awakened, and frightened all in community (observer sleeping in 6-year-old, one-story wood frame building). Building creaked and banged loudly. Loud, rumbling or roaring earth noises. Chimneys overturned. About 0.6 m. of water slopped from swimming pool. Hanging objects swung violently east-west. Small objects fell. Floor lamps overturned. Plaster cracked. Damage slight. "There was quite a lot of vertical movement during the first part of the shock. It was almost impossible to walk for the first few seconds. I tried to walk and felt as if I were walking uphill." Damage slight. Ground: Compact, silty sand, level.
- 15832 Chatsworth Street. (VII) Felt by and awakened all in community (observer lying down on first floor of 50-year-old, well-built, two-story wood frame building). Earth noises sounded like a stampeding herd of horses. Trees and bushes shook; vehicles rocked. Foundation, driveway, and waterpipes cracked. Chimney broke at roofline. Two ceilings of tile fell. One light fixture and all pictures and mirrors down. Shelves and cupboards emptied. Bookcase and water cooler broke. "Outside damage was limited to west side. Our biggest bother was sorting and returning several thousand books to shelves. The shelves (fastened to the walls) were not damaged, just emptied. Later additions to the house were finished with wallboard--all seams cracked and must be redone. All plumbing in one bathroom broke." Damage slight. Ground: Compact, adobe.
- 10342 Odessa Avenue. (VII) Felt by, awakened, and frightened all in community (observer sleeping in 11-year-old, one-story wood frame building). Building made snapping sounds. Loud earth noises. Small objects fell; furniture shifted. Minor amount of plaster fell. Block wall collapsed. Minor driveway crack.

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Rock-facing in decorative chimney cracked. "Our home and community is located about 5 to 8 km. from the hardest hit areas of Sylmar and San Fernando. The house faces in a northwesterly direction, and during the shock it seemed to move north-south. Our driveway break (minor) also runs north-south. The block wall which collapsed in yard runs east-west. Our neighbor also commented about the north-south movement, although their home faces south and runs east-west. Based on the condition of the interior of house (fallen lamps, books, and dishes, etc.) it seemed that the front side (west) of house moved more than the back side. There was little displacement of objects on eastern side, but much on west side. Aftershocks also have seemed to move the house north-south, with only occasional east-west shocks. Although the aftershocks have decreased considerably in the three weeks since the main shock, I find the most disconcerting problem now is the continual popping sounds in walls and cabinets, sometimes very loud, and the creaking and springy feeling of the floors. I do believe so many homes in our area came through the earthquake so well because of the interior wallboard walls. Many of our friends who have lath and plaster did not come through the shock nearly so well." Ground: Claylike, compact, level.

9949 Ruffner Avenue. (VI) Felt by and awakened all in community; frightened few (observer sleeping in new, well-built, one-story wood frame building). Windows, doors, dishes, etc., rattled; building swayed. Generally moderate earth noises. "At first a mild shaking, then a severe jolt, lasting about 1 minute. Considerable amount of water splashed from swimming pool ( $15^{\circ}$  angle) onto the patio. Minor cracks in patio. House suffered no severe damage. Ceiling beams were slightly twisted. Fish tank, 76 l., on stand did not fall, but about half of the water sloshed out. Considerable noise from ground rumble; wavelike formations in ground. Very fortunate." Ground: Compact, level.

11959 Salem Drive. (VI) Felt by, awakened, and frightened all in home (observer sitting in 11-year-old, well-built, one-story wood frame building). Windows, doors, and dishes rattled; building creaked. Hanging objects swung north-south. Small objects shifted and fell; furniture shifted; lamps fell. Cupboard doors opened. Plaster cracked. Electricity off. Damage slight. Ground: Compact, adobe; terraced hill.

10208 Monogram Avenue. (VI) Felt by and awakened all in community; frightened many (observer sleeping in old, well-built, one-story wood frame building). Windows, doors, and dishes rattled; building creaked. Trees and bushes shook; vehicles rocked. Hanging objects swung violently north-south and east-west. Small objects shifted, overturned, and fell; all dishes fell from cupboard. Furniture shifted. Plaster cracked slightly. "No structural damage." Ground: Clayey, compact, level.

17525 Los Alimos Street. (VI) Felt by all and frightened many in community; awakened and frightened all in 15-year-old, well-built, one-story wood frame building. Up-and-down pounding and twisting motion of building. Loud earth noises. Electricity and water off. Hanging objects swung violently from side to side. Small objects shifted, overturned, and fell; items thrown from cupboards.

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Heater overturned. Small plaster cracks. Ground: Clay, compact, level.  
17163 Rinaldi Street. (VI) Felt by, awakened, and frightened all in community (observer standing in new, well-built, one-story wood frame building). Windows, doors, and dishes rattled; building creaked. Camper appeared to be shoved closer to truck cab. Small objects shifted, overturned, and fell. Damage slight. Ground: Compact, level.  
No address given. (VI) Felt by all and frightened many in community; awakened all in old, well-built, one-story building. Windows, doors, dishes, etc., rattled. Loud earth noises. Furniture shifted, overturned, and broke. Windows cracked. Damage slight. (Report from Superintendent of Post Office.)

Mission Hills:

No address given. Felt by and awakened all in community; frightened many (observer walking in well-built, one-story stone building). Building twisted and shook. Trees and bushes shook; vehicles rocked. Ground cracks; landslides; disturbed water. Chimneys, tombstones, and elevated water tanks cracked and overturned. Hanging objects swung violently in various directions. Small objects shifted, overturned, and fell; furniture shifted, overturned, and broke. Plaster cracked, broke, and fell. Windows cracked. Damage great. Ground: Compact, level.

Mission San Fernando Rey (about 0.8 km. south of the Holy Cross Hospital). Adobe walls were severely cracked.

10222 Norwich Avenue. (VII) Felt by, awakened, and frightened practically all in community (observer sleeping in 10-year-old, well-built, one-story wood frame building; did not awaken 1-year-old child). Building very noisy. Loud earth noises. Trees and bushes shook; vehicles rocked. Hanging objects swung violently. Small objects shifted and overturned and broke. Heavy objects (15-kg. tape recorder, ashtrays, large outside planter) were thrown 0.9 to 1 m. and overturned. Six-year-old boy thrown out of bed. Light objects were not moved. "Noticed high-frequency, low-amplitude vertical motion at beginning of shock; low-frequency, high-amplitude lateral motion at end." No structural damage to building. Ground: Alluvium, compact, level.

15214 Tuba Street. (VI) Felt by and awakened all in community; frightened many (observer sleeping in well-built, one-story wood frame building). Windows, doors, dishes, etc., rattled; building creaked severely. Loud earth noises. Disturbed water. Hanging objects swung violently. Small objects fell. Damage slight. Ground: Compact, level.

Newhall-Valencia area:

Newhall:

The National Earthquake Information Center<sup>6</sup> reported: "Four old buildings in downtown Newhall were condemned by the City Engineer, who also estimated 90 percent of the fireplaces and chimneys on two-story houses were damaged in the area. One concrete wall was knocked down; most homes sustained only superficial damage." Gasline broke on Lyons Avenue. Newhall phone plant was flooded by a broken water main. The California Institute of Technology<sup>2</sup>

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reported that a glass manufacturing company (between Newhall and Saugus) sustained \$10 million damage to buildings, storage bins, and furnaces. There was damage to oil refinery storage tanks and pipelines at the Newhall refinery located about 3.2 km. southeast of Newhall<sup>1</sup>. The bottom of one jet-fuel storage tank buckled, and there were scattered leaks elsewhere in the plant. The chief problem for the refinery was lack of water. Both sides of a booster pump on the waterline leading to the refinery were ruptured. Minor damage was done to testing equipment in the laboratory.

18909 Sierra Estates Drive (about 8 km. northeast of Newhall post office). Felt by, awakened, and frightened all in community (observer sitting on second level of new, tri-level wood frame building). Vehicles rocked. Water supply cut off. Some chimneys loosened from homes; walls, concrete slabs, etc., cracked. Many store windows broke. China closet overturned. Damage great. Ground: Compact, sloping. (This observer gives "place" as Newhall, Soledad, and entire area.)

26861 B Avenue of the Oaks (about 8 km. northeast of Newhall post office). Felt by, awakened, and frightened all in community; general panic (observer sleeping in new, one-story wood frame building). Vehicles shifted. Ground cracks; disturbed water. Side walls lifted and shifted; retaining walls tilted. Drywalls had few cracks. Hanging objects swung violently southeast-northwest. Small objects shifted, overturned, and fell. Furniture shifted and overturned. "Shock was like a dropping motion, then a shift from northeast-southwest. Large TV thrown off stand. Bookshelves and books on floor; lamps thrown to floor; kitchen cupboards emptied of all contents, canned goods, dishes, etc. Refrigerator doors thrown open and contents slid out onto floor. Large dresser (on short legs) full of material, shifted about 23 cm. on carpeted floor. Had to leave premises due to my wife being disturbed." Damage moderate. Ground: Compact fill, level.

24522 Walnut Street. Frightened all in home and community (observer lying down in old, poorly built, wood frame building). House creaked very strongly. Loud earth noises. Trees and bushes shook; vehicles rocked. Hanging objects swung violently in every direction. Furniture shifted, overturned, and broke. Ground cracks; landslides; disturbed water nearby. Chimneys, tombstones, and elevated water tanks cracked, twisted, and overturned. Plaster cracked. Moderate damage to house. Ground: Compact, level.

24736 Walnut Street. (VII) "We were not at home during the earthquake, but when we returned home we found beds, heavy bookcases, the stoves, dressers, etc., had all shifted. The house is an old, wood frame building. One bookcase was overturned. Top of chimney, to about 1.2 m. below the roofline, broke off and fell, and made a dent in the lawn about 0.3 m. deep. All rooms except the kitchen have cracks in walls. Outside concrete slab is cracked. No broken windows."

Newhall Ranger Station (about 1-1/2 km. south of Newhall). (VII) Felt by, awakened, and frightened all in community (observer lying down in old, well-built, one-

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story wood frame building). House rocked and heaved, and made crashing, splintering, and breaking sounds. Loud, explosivelike earth noises a split second before shock. Trees and bushes shook. Ground cracked. Pipelines broke. Chimneys cracked and bricks "rearranged." Hanging objects swung violently south. Small objects shifted, overturned, and fell. Furniture shifted. Plaster cracked. Windows separated from casement but glass did not break.

"This site is a 1-acre housing compound of the U.S. Forest Service administrative buildings. The structures, two offices, one 6-bay garage, one barracks, several small outbuildings, and one residence, were constructed in 1934, and are of wood; very well built. All doors and cabinets in the residence and offices were thrown open and contents spilled to the floor. Direction of thrust appeared to be to the south. No furniture of any appreciable size was knocked over, but very heavy pieces were shifted several cm. Electricity, phone, and water services were knocked out at impact. Cracks in plaster and paneling of not much significance. Hairline cracks are apparent in and on all of the buildings, but appear to be the result of aftershocks." Damage slight. Ground: Compact, level.

23405 La Glorita Circle. (VII) Felt by all and awakened many in community; frightened many in new, two-story wood frame building (observer sleeping). Loud, rumbling earth noises. Patio block walls loosened. Lamps and books fell. Piano and refrigerator moved. Plaster cracked slightly over windows and doors.

"Market 2 blocks away lost windows." Damage slight. Ground: Level.

22739 W. 8th Street. (VII) Felt by, awakened, and frightened all (observer standing in 8-year-old, well-built, two-story wood frame building). Building moved violently. Loud earth noises. Hanging objects swung north-south. Small objects overturned and fell. Furniture shifted and overturned. Plaster and windows cracked. Damage slight. "The apartment swayed violently, throwing me from side to side. Everything came out of cupboards and refrigerator. Lights went out. Terrifying experience. Had head wound from some unknown object."

Ground: Level.

23157 Market Street. (VI) Felt by all in community; awakened all in new, well-built, one-story wood frame building; frightened few children. Windows, doors, dishes, etc., rattled; building rumbled. Faint earth noises at first, then grew louder. Driveway cracked. Small objects shifted. Ground: Compact, sloping.

24200 Lyons Avenue, Valencia; building in Valencia Shopping Center. (VII) The USGS-NOAA report<sup>9</sup> stated: "The building is a one-story brick masonry and wood roof construction. Masonry walls appear to be continuous on three sides of the building, but are reduced to relatively short walls on each side of the large glassed opening at the front. A large sign projects above the roof at one end of one of the short walls. Large sections of the suspended ceiling collapsed; almost all the glass in the front wall broke. The brick walls at the front spalled at ceiling level, and additional spalling occurred near ceiling level at the sign support."

25310 Via Calinda, Valencia. (VII) Felt by, awakened, and frightened all in

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community (observer sleeping in new, well-built, one-story wood frame building). Roaring earth noises. Water disturbed. Chimneys cracked, twisted, and overturned. Hanging objects swung violently; chandelier fell. Small objects shifted, overturned, and fell; mirrors fell from walls; dishes fell out of cupboards. TV overturned. Small amount of plaster cracked, broke, and fell. Windows cracked in nearby houses. "In the city of Newhall block walls were knocked over." Damage moderate. Ground: Compacted fill over level ground.

25349 N. Avenue Ronanda, Valencia. (VII) Felt by and frightened all in community; awakened all in new, well-built, one-story wood frame building. Building creaked considerably. Loud earth noises. Chimneys cracked, twisted, and overturned. Garden walls down. Hanging objects swung violently northeast-southwest. Small objects overturned and fell; many dishes broke. Furniture shifted and overturned. "Sensation of violent rotary motion." Ground: Compact.

25657 Avenida Jolita, Valencia. (VII) Felt by, awakened, and frightened all in community (observer standing on second floor of new, well-built, two-story wood frame building). Windows, doors, and dishes rattled. "Could not hear earth noises because of falling objects." Chimney separated from house. Hanging objects swung moderately east-west. Small objects shifted, overturned, and fell; many items fell. Furniture shifted, overturned, and broke. Some plaster cracking. Damage slight. Ground: Compact, level; former farmland.

23919 Via Onda, Valencia. (VII) Felt by, awakened, and frightened all (observer sleeping on second floor of new, two-story wood frame building). Building creaked loudly. Loud earth noises. Chimneys cracked. Block wall fell. Slabs cracked. Hanging objects swung violently. Small objects fell. Furniture shifted and overturned. Plaster cracked. Damage slight. Ground: Gravelly, sloping.

Saugus, Honby, and Soledad Canyon areas east of Saugus:

Saugus. Felt by all in community; awakened and frightened many. Trees and bushes shook; vehicles rocked. Ground cracked. Trailer foundations cracked. Hanging objects swung violently. Most light fixtures fell. Small objects shifted, overturned, and fell. Furniture shifted, overturned, and broke. Plaster cracked, broke, and fell. Windows broke. "There were eight people working in the post office at the time. Everyone got out just in time to avoid falling light fixtures. Equipment was tossed around more in our trailer complex (seven aluminum trailers placed together) than it was in our main office (wood and brick building). The crew maintained their composure, as far as I could see, but it was the general consensus that if the shock had lasted much longer, panic would have resulted." Ground: Sloping and level.

Honby area (about 6 km. east by north of Saugus):

North Oaks Shopping Center and Honby School. The USGS-NOAA report<sup>9</sup> noted the following: "Department store, 19419 Soledad Canyon Road: The building is one story with brick exterior walls, glued-laminated beams, and panelized wood roof. The rear wall of the building separated from the roof by about 9 inches in one area, and the adjacent roof section collapsed. Other sections of roof along the side walls also collapsed, and purlins were pulled out of their supports.

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Building material store (19407 Soledad Canyon Road): The building is one story with brick exterior walls, interior columns, and wood roof construction. Brick piers spalled at connection to wood beams along front wall. Interior partitions cracked. Several main beams were pulled out from the masonry at their support along the front wall. Ledgers along masonry walls were pulled out, and parts of the roof structure collapsed. Cracks occurred in the paving of a nearby parking lot . . ." The report also stated that at the Honby School, ground surface cracking occurred throughout the site. One crack passed through one of the school buildings.

27327 Camp Plenty Road, Honby (just north of Soledad Canyon Road). Felt by, awakened, and frightened all in community (observer sleeping in old, well-built, one-story wood frame building). Loud earth noises, like multiple sonic booms. Six-hundred-pound transmitter overturned to south. Bookcase overturned and others moved. Plaster cracked. "All plasterboard joints show cracks. Some vertical cracks in foundation. No ground cracks here, but shopping centers close by (about 274 m.) have cracks in blacktop parking lots. Roof collapsed on north side of W. T. Grant Building. Fifty to 70 percent of store windows broke. Highway bridges need repairs to approaches. Aftershocks for first 2 days were sharp, like sonic booms; later aftershocks were quiet shakes preceded by rumble." Damage slight. Ground: Adjacent to Santa Clara River bed, level.

27430 Airport Avenue, Honby. Felt by, awakened, and frightened all in community; general panic (observer sleeping on second floor of new, well-built, two-story wood frame building). Loud, rumbling earth noises. Ground cracked; disturbed water. Chimney cracked; top pulled about 10 cm. away from house. Block walls fell; others were loosened (walls running east-west). Hanging objects swung violently. Electricity off. Small objects overturned and fell; dishes and vases crashed. Furniture shifted. Plaster cracked, broke, and fell. One window broke. Sliding closet doors (tops only) came out of grooves. Shelves were emptied. "All persons I have spoken with said it felt as if their building would topple. We have about a 4.8-m. trailer parked in driveway and it twisted or jumped over 0.3 m. In the community, streets cracked, curbs broken, and many buildings were condemned. I teach at the Honby School (one-story building; six classrooms). Over 2.5-cm.-wide floor crack across center of slab; section dropped about 4 cm.; some doors will not open and some will not close; new blacktop cracked and broken. Many people have asked for transfers for their children and are leaving the community. At my home (front faces west), a front door latch (locked) broke off; the door was opened but held by safety catch. Same thing happened at neighbor's house. Damage moderate to house." Ground: Sandy, level, gently sloping to street.

27416 Dewdrop, Honby. Felt by, awakened, and frightened all in community (observer sitting in well-built, one-story wood frame building). Loud earth noises. Ground cracked. Chimneys, tombstones, and elevated water tanks cracked, twisted, and overturned. Hanging objects swung violently. Small

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objects fell. Furniture shifted, overturned, and broke. Plaster cracks in swimming pool. Damage moderate. Ground: Level.

28189 Hot Springs Avenue (north Honby area south of Plum Canyon). (VII) Felt by, awakened, and frightened all in community (observer sitting in 7-year-old, fairly well-built, one-story wood frame building). Building bounced in all directions. Locked doors swung open, then closed. Could not hear earth noises because of house noise and the noise of breaking objects. Vehicles rocked. About 0.6-cm.-wide ground cracks. Block walls flattened. Chimneys cracked and twisted. Hanging objects swung violently in all directions. Small objects overturned and fell. Stucco cracked. Damage slight to building. Ground: Rocky, gravelly, mixed with clay, level (mesa).

10511 Soledad Canyon Road, near Soledad (about 11 km. east by north of Honby).

Felt by, awakened, and frightened all in community (observers walking and sleeping in old, well-built, one-story wood frame building). Building swayed. Loud earth noises. Trees and bushes shook; vehicles rocked. Ground cracked; landslides; disturbed water. Chimneys cracked, twisted, and overturned. Roof split. Dishes and miscellaneous articles scattered and broke. Water heater tore loose. Hanging objects swung violently east-west. Furniture shifted, overturned, and broke. Damage slight to house. Ground: Sandy, decomposed granite, loose, compact, level.

Solemint and southeast of, in Iron Canyon. The USGS-NOAA report<sup>9</sup> noted that at Solemint (east of Honby), the Soledad Canyon School was damaged by ground surface movement. Diagonal cracking was observed throughout the school site. The press reported that southeast of Solemint, in Iron Canyon, a house and land "slipped" more than 9 m. and that Head Road in Iron Canyon "dropped" 4.5 m.

#### Intensity VII:

##### Alhambra:

The following, from Steinbrugge and others<sup>8</sup>, does not include publicly owned structures: "Fifty-five buildings damaged; 15 posted unsafe; 5 commercial buildings demolished or to be demolished; 400 chimneys damaged; estimated total dollar loss, \$2 million." Other observers stated: "Damage was light, except to old buildings in business district where some (very few) plate glass windows were broken; one old brick building lost parapet walls and front." "Damage was slight in the Alhambra area. In wood frame buildings, damage was limited to cracked plaster and windows, broken dishes and knickknacks. Store buildings suffered broken plate glass windows. Chimneys pulled away from some buildings. Several unreinforced brick parapets fell." Press reported powerlines were down. "My office (2 N. El Molino) is in a one-story brick building with large plate glass windows; no damage to windows or building. Two blocks west, one plate glass window was lost in a full block of large plate glass windows."

823 S. Almansor Street. (VI) Felt by and awakened all in community; frightened many (observer walking in new, one-story wood frame building). "Started

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- with a high-frequency vibration that set dishes rattling; then the ground motion, not too sharp or of high acceleration but appeared to have a sizable amplitude." Pendulum clock, pendulum swinging east-west, did not stop. Small objects shifted. Water in toilet tank sloshed out north-south. Ground: Compact.
- 718 N. Monterey Street. (VI) Felt by all and frightened many in community; awakened all in new, three-story wood frame building (observer in shower). Doors and drawers opened; some dishes fell out. Trees and bushes shook; vehicles rocked. Hanging objects swung moderately north-south. "Damage slight in neighborhood. Earthquake appeared to have long duration, about 10 to 15 minutes, due to the aftershocks. Noticeable up-and-down motion." Ground: Compact, level.
- 112 E. Alhambra Road. (VI) Felt by and awakened all in community; frightened many (observer lying down on third floor of new, three-story wood frame building). Building made loud racking sound. Moderate earth noises. Trees and bushes shook; vehicles rocked. Swimming pool lost 31 to 46 cm. of water. Hanging objects swung moderately east-west. Small objects shifted, overturned, and fell; furniture shifted. Plaster cracked; windows broke. Damage slight. Ground: Gravelly, compact, level.
- 801 Geranio Drive. (VI) Felt by all in community; awakened and frightened all in old, well-built, one-story wood frame building (observer standing). Loud earth noises. Small objects shifted. Slight plaster and stucco cracks. "First noticed fairly loud noise, similar to a very noisy truck; then the house started to shiver, then shake. Direction of motion not noted. Shaking seemed to last an eternity." Ground: Compact, sloping.
- 1605 S. Garfield Avenue. (VI) Felt by, awakened, and frightened all in community (observer lying down in old, well-built, one-story wood frame building). Building creaked moderately. Loud earth noises. Chimneys cracked. Hanging objects swung violently east-west. Small objects shifted, overturned, and fell. Few hairline cracks. Ground: Compact, level.
- 777 E. Valley Boulevard. (VI) Felt by and awakened all in community; frightened many (observer sleeping in new, well-built, one-story wood and concrete block building). Extensive rattling of windows, doors, dishes, etc.; building creaked throughout tremor. Moderate earth noises, similar to heavy wind, preceded shock. Trees and bushes shook. Electrical transformer explosions; power out for almost 1 hour. Small objects shifted west-east; furniture shifted. Only minor plaster cracks. Ground: Clay loam, compact, level.
- 2412 Capetown Avenue. (VI) Felt by, awakened, and frightened all (observer standing in well-built, one-story wood frame building). Building creaked rather violently. Electrical flashes noted outside; light went out momentarily. Hanging objects swung violently. Loose objects fell to floor. Few minor plaster cracks. "This area in which I live consists of several hundred well-constructed wood frame homes built in the mid-50's. This was by far the strongest shock felt during my 17 years at this location. From my observations since the earthquake, there appears to be no damage to homes or streets in this immediate

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area. I understand that the buildings in the business district of Alhambra did sustain varying degrees of damage." Ground: Compact clay, sloping; small hills.

820 N. Hidalgo Avenue. (VI) Felt by all in community; awakened all and frightened few in old, well-built, one-story wood frame building. "Too much dish rattling to hear any creaking of house or earth noises." Hanging objects swung strongly east-west. Small objects shifted. Plaster cracked near some door frames. "No noticeable outside effects." Ground: Clayey, level.

Altadena:

1701 Coolidge Avenue. Felt by and awakened all; frightened few (observer lying down in well-built, one-story wood frame building). Motion rapid; direction east-west. Loud earth noises. Chimneys fell. Small objects and furnishings shifted; small objects and furniture overturned. Plaster, windows, walls, chimneys, and ground cracked. Knickknacks, books, pictures, and plaster fell. Damage slight (?). Ground: Soil, level. Press reported powerlines down.

2624-G N. Lake Avenue. Felt by and awakened all in well-built, one-story wood frame and concrete slab apartment building over concrete garages (observer sitting; couldn't get up). "Almost solid aftershocks for half an hour. Couldn't distinguish other noises due to general falling and crashing of objects. Power failure in a few minutes was worse than the aftershocks. Everything tall fell. Left for work at 6:58 a.m. No evidence of shock as I drove south on Lake Avenue. However, in the Board of Education Building (in Pasadena), library shelves had fallen west from against east wall. Books from shelves were also tossed every which way. Things in hall cupboards fell. General problem. Big window at Bullocks, Pasadena, shattered. Aftershocks came with regularity every few minutes after the initial bump which definitely preceded the sway in Altadena. I would say we had between 10 and 20 small aftershocks--sometimes no more than a queasy vertigo--after the initial shock. At least four were of fair violence."

510 E. Calaveras Street. (VI) Felt by and awakened all in community; frightened many; all in well-built, one story concrete block building with concrete slab floors. "All motion seemed rapid, jerky, horizontal; no vertical acceleration felt." Block creaked; roof groaned. Trees shook. Chimneys cracked and twisted. Hanging objects swung violently east-west. Small objects fell. About one-tenth of water in fish tank splashed out. Plaster cracked. Damage slight. Ground: Gravelly loam, alluvial fan; 6-percent grade.

988 Mount Curve Avenue. (VI) Felt by and awakened all in community; frightened many (observer lying down on second floor of two-story wood frame building). Loud earth noises from west heard by few 3 seconds before shock. Hanging objects swung east-west. Pendulum clock facing north stopped. Trees and bushes shook moderately. Small objects and furniture shifted; vases and small objects overturned. Plaster, walls, and chimneys cracked. Knickknacks, books, pictures, dishes, and plaster fell. Damage slight. Rapid motion from west, lasting 1 minute. Ground: Rocky soil, loose, sloping.

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3104 Mount Curve Avenue. (VI) Old, poorly built, two-story wood frame building.

"Wife and I were awakened but children were not; wife was frightened; I was alarmed." Windows, doors, and dishes rattled severely; building creaked severely. Books and dishes thrown from shelves. Two bad plaster cracks; brick wall cracked. Damage slight. Ground: Gravelly, loam, sloping.

Post Office. (VI) Felt by and frightened all in well-built, one-story stucco building. Entire building swayed and shook. Loud earth noises. Trees and bushes shook; vehicles rocked. Flashes in sky due to shorting transformers. Hanging lights swung violently. Mail fell from cases. Plaster cracked, broke, and fell. Ground: Compact, sloping.

1601 Crest Drive. (VI) Felt by and awakened all in community; frightened all in 14-year-old, one-story wood frame building (observer lying down). Building creaked severely. Faint earth noises. Water splashed from swimming pool. Chimney cracked slightly; powder and chips around fireplace. Hanging objects swung moderately. Doors opened on north-south cupboards. Loose headboard on bed overturned north-south. Ground: Decomposed granite.

154 E. Wapello Street. (VI) Felt by and awakened all in old, well-built, one-story wood frame building; frightened few. Moderate earth noises. Hanging objects along all walls swung moderately. Small objects shifted, overturned, and fell. Furniture in garage overturned and broke. Top of fireplace cracked. Ground: Compact, sloping.

12104 N. Craig Avenue. (VI) Felt by and awakened all in community; frightened many (observer walking on second floor of old, well-built, two-story wood frame building). Some racking sounds of building. Loud, rumbling earth noises. Hanging objects swung violently in mostly north-south direction. Small objects overturned and fell. TV fell off shelf. Plaster cracked and broke. Top of chimney collapsed. Damage slight. Ground: Gravelly, compact, level.

925 Concha Street. (VI) Felt by and frightened all in community; frightened all in old, well-built, one-story wood frame building. Building creaked very loudly. Loud earth noises. Small objects shifted, overturned, and fell. Water in swimming pool splashed violently north-south. Books dumped from shelves; dishes knocked from cupboards. "All aftershocks were plainly felt; slight water action observed on surface of pool. House is about 3 m. above street, with steep driveway to garage under house." Ground: Sloping, filled in.

1065 Concha Street. (VI) Felt by, awakened, and frightened all in community (observer sleeping in old, one-story wood frame building). Windows, doors, dishes, etc., rattled very severely. Loud earth noises. Trees and bushes shook; vehicles rocked. Water disturbed. Hanging objects swung moderately northwest-southeast. Small objects overturned. Plaster cracked, broke, and fell (minor). "One piano in neighborhood escaped caster cups. Substantial amount of broken china and kitchenware. Aftershocks easily felt, but of much less intensity." Ground: Compact, sloping.

3078 Raymond Avenue. (VI) Felt by, awakened, and frightened all in well-built, one-story wood frame building (built in 1940). Noisy and twisting west-east motion.

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Pods fell from carob tree. Hanging objects swung moderately northwest-south-east. Small objects shifted. Ironing board overturned. Plaster cracked very slightly. Ground: Decomposed granite, compact, sloping.

254 W. Harriet Street. (VI) Felt by, awakened, and frightened all in community (observer lying down in strongly built, one-story wood frame building). Rapid up-and-down motion. Loud earth noises, 4 to 5 seconds before shock, seemed to come from all directions. Hanging objects swung northeast. Trees and bushes shook moderately. Small objects and furnishings shifted; furniture shifted slightly. Two plates on wall broke. "Knickknacks and books fell from shelves on north-northeast walls, some traveled across room; nothing fell from east-west walls." Ground: Rocky, sandy sediment on alluvial fan.

3083 N. Olive Avenue. (VI) Felt by all in community; awakened and frightened all in strongly built wood frame building (observer lying down). Rapid northwest motion. Moderate earth noises, 1 second before shock, seemed from all directions. Hanging objects swung. Trees and bushes shook moderately. Small objects and furnishings shifted; vases, etc., overturned; knickknacks fell. Ground cracked. Chimney twisted. Ground: Level.

1234 Sonoma Drive. (VI) Felt by and awakened all in community; frightened many (observer sleeping in well-built, 22-year-old, one-story wood frame building). Building creaked rather strongly. Trees and bushes shook; vehicles rocked. Small objects shifted, overturned, and fell. "No damage to our chimney, but others were not so lucky." Ground: Principally clay and decomposed granite; very little top soil.

2087 N. Grand Oaks Avenue. (VI) Felt by, awakened, and frightened all in community (observer sleeping in well-built, 31-year-old, one-story wood frame building). Windows rattled. Moderate earth noises. Trees and bushes shook. Hanging objects swung moderately north-south. Small objects shifted. Ground: Rocky, level.

1920 Midwick Drive. (VI) Felt by all in community; awakened and frightened all in new, well-built, one-story wood frame building (observer sleeping). Dishes rattled violently; walls made straining sound. Hanging objects swung east-west. Lamps overturned; glasses thrown from desk. Plaster chips fell on mantel. Small cracks in brick. "It was a violent motion. Lights with mercury switches flashed on and off. Books shifted to front edges of bookshelves." Ground: Gravelly, level, slightly sloping.

No address given. (VI) Felt by and awakened all in well-built, one-story wood frame building (observer sleeping). Building creaked. Loud earth noises. Dogs howled. Water in swimming pool, about 15 cm. below deck, splashed out. Small objects shifted, overturned, and fell.

Beverly Hills:

The following, from Steinbrugge and others<sup>8</sup>, does not include publicly owned structures: "135 buildings damaged; 2 commercial buildings demolished or to be demolished; 1,000 chimneys damaged; estimated total dollar loss, \$800,000."

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8500 Wilshire Boulevard. (VI) "The greatest damage at my father's office (10-story building plus two-floor garage) was that all shelves mounted on one west-facing wall were thrown to the floor (shelf standards ripped off)."

709 N. Alta Drive. (VI) Felt by, awakened, and frightened all in community (observer sleeping on first floor of old, well-built, two-story wood frame building). Trees and bushes shook; vehicles rocked. Hanging objects swung moderately north-south. Small objects shifted, overturned, and fell. Windows cracked in some commercial buildings. "Motion seemed predominantly north-south. When inspecting buildings near the epicenter, owners said that aftershocks were very closely spaced for a long time after the main shock." Ground: Compact, sloping.

9545 Tullis Drive. (VI) Felt by all in community; awakened and frightened many (observer sleeping in well-built, one-story wood frame building). Couldn't hear house noises due to earth rumble. Water sloshed from many swimming pools in the area. Books fell from both north-south and east-west walls. Bookshelf fell. One bowl broke; one lamp broke. One loosened and cracked hearth brick. "Continuing aftershocks." Ground: Sloping.

8725 Clifton Way. (VI) Felt by and awakened all in community; frightened few (observer sleeping on first floor of new, three-story wood frame building). Loud earth noises. Hanging objects swung moderately north-south. Small objects and some glassware fell. Furniture shifted very slightly. Some plaster cracks. Damage very slight. "Saw one chimney failure; some store windows cracked." Ground: Adobe, level.

2267 Betty Lane. (VI) Felt by, awakened, and frightened all in community (observer in fairly new, well-built, one-story wood frame building). Building creaked. Hanging objects swung violently. Small objects shifted and fell; bottles fell off shelf; some dishes shifted enough to cause breakage. Power off. Ground: Bedrock; Santa Monica Mountains.

Burbank:

The following, from Steinbrugge and others<sup>8</sup>, does not include publicly owned structures: "445 buildings damaged; 25 posted unsafe; demolished or to be demolished--residential, 3; commercial, 3; churches and schools, 1; 500 chimneys damaged; estimated total dollar loss, \$4 million."

209 N. Naomi Street. Felt by and awakened all in community; frightened many; general excitement. A number of persons left their houses during the shock; people walked unsteadily. Observer's house (built in 1947) is a well-built, one-story wood frame building with later additions. Other houses in the neighborhood are mostly one-story wood frame dwellings with exterior stucco (built about 1947). "This neighborhood is located in southwestern Burbank. Motion in this area was an increasingly rapid, complex shaking for roughly 10 to 15 seconds after being awakened. After the motion had reached a peak, it began slowly to decrease in intensity; however, ground motion did not stop completely until after a considerable length of time; there was a short interval before the next shock. Two roars (very prominently heard in this neighborhood) were emitted from a

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powerplant about 3 km. from here as the quake caused valves to close as steam shot out. Power was knocked out in this neighborhood and remained out for slightly more than 2 hours. Many plate glass windows at nearby business establishments were broken. A substantial number (about 10 percent) of chimneys in this neighborhood were cracked, several so severely that their upper portions had to be removed. A few chimneys were slightly separated from houses, and the upper portions of a few were very slightly twisted. One straight crack, clearly visible from the street, extended from the base to the roof of a single-story library about 0.4 km. to the north, and several long, conspicuous cracks formed in plaster interior walls of a church about 0.8 km. north of here. Damage in other parts of Burbank: Instances of cracked walls, badly cracked chimneys, shattered windows, and other damage were common in much of Burbank. Some old buildings had extensively damaged walls and ceilings and were considered unsafe. Some of the severe damage included the fall of portions of the exterior walls just below the roofs of a church and a rest home, both relatively old buildings near downtown Burbank, and walls of both predominantly of brick. Although the worst damage was typically to older buildings, minor damage was common in newer ones. In spite of much costly damage in places, at many other places damage was virtually nil. Brilliant, quick flashes of light were seen in various directions (apparently related to effect on powerlines or transformers). In my house a number of things fell from shelves or tables, or were tipped over, or changed positions (as happened, undoubtedly, at all houses near here). A few knickknacks in precarious positions seemed surprisingly virtually unaffected; however, a water softener tank, just outside the house, jiggled off one of its three supports and tilted. The tank is too heavy for one person to move without great difficulty. Nothing in my house was broken. Glassware broke at next-door neighbor's house. Probably some things were broken at nearly every house around here. (Incidentally, relatives living in eastern foothills of Burbank reported figurines in glass dome were turned around even though the dome itself was unaffected. No windows were damaged at our house and none were damaged at most of the neighbors' houses. Our house had no obvious damage. The walls of our next-door neighbor's house developed some narrow cracks in various places. Narrow cracks developed in walls, especially at corners of windows and doors, in many buildings in this neighborhood. Small chips of plaster fell in several buildings. Some garden walls were cracked, several were significantly weakened.) This observer reported that more than 120 aftershocks had been felt up to June 21. Ground: Compact alluvial soil, level.

702 N. Bel Aire Drive. Felt by all and frightened many in community; awakened all in old, well-built, one-story wood frame building. Loud earth noises. Chimneys cracked, twisted, and overturned. Hanging objects swung violently. Small objects overturned and fell. Plaster cracked, broke, and fell. Windows cracked. "Damage great to unreinforced brick." Ground: Gravelly, rocky, sloping.

Post Office. (VI) Felt by and frightened many in community (observer active in new, one-story precast concrete building). Ceiling fell--strings of lights. Loud earth

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Noises. Vehicles rocked. Electricity disturbed. Hanging objects swung violently. Small objects shifted, overturned, and fell. Furniture shifted. One plate glass window, 3.6 by 3.6 m., broke. Damage moderate. Ground: Compact, level.

919 University Avenue. (VI) Felt by and awakened all in community; frightened all in 20-year-old, well-built, two-story wood frame building (observer lying down). All cupboard doors opened. Loud, rumbling earth noises. Water splashed from swimming pools. Chimneys on neighbors' houses cracked and twisted. Flashes from powerlines. Hanging objects swung violently in generally east-west direction. Doors banged. Books, vases, groceries, etc., fell. Lamps overturned. Furniture shifted. Plaster cracked at some doors and windows. No structural damage. Ground: Terraced pads at foot of Verdugo Mountains, compact.

611 Santa Anita Avenue. (VI) Felt by and awakened all in community; frightened many (observer sleeping on second floor of 12-year-old, well-built, two-story wood frame building). Moderate earth noises with high-pitched sound. Electricity and phones out. Hanging objects swung moderately. Small objects shifted, overturned, and fell. Furniture shifted and overturned. Plaster cracked. "The earthquake once it was over didn't seem so bad. We were alive and had suffered very little damage in comparison to others. The most frightening part was the aftershocks--not knowing when they would come or how strong they would be. We lived in continual fear for the next few days." Ground: Compact, sloping.

1014 N. Florence Avenue. (VI) Felt by, awakened, and frightened all in community; general panic (observer sleeping in old, one-story wood frame building). Heavy items moved from walls. Earth noises. Water disturbed. Hanging objects swung violently. Small objects shifted, overturned, and fell. Plaster cracked. Damage slight. Ground: Alluvium, level.

733 S. Mariposa Street. (VI) Felt by, awakened, and frightened all in old, well-built, two-story building. Loud earth noises. Hanging objects swung. Small objects shifted, overturned, and fell. Plaster cracked and fell.

1411 Chandler Boulevard. (VI) Felt by, awakened, and frightened all in community (observer sleeping in old, well-built, wood frame building). Building rocked. Water emptied from birdbath. Small objects shifted, overturned, and fell. Slight plaster crack. Ground: Compact, level.

524 E. Santa Anita Avenue. (VI) Felt by, awakened, and frightened all in community (observer sleeping on first floor of new, well-built, two-story wood frame building). Loud, rumbling earth noises. Vehicles rocked. Water disturbed. Small objects shifted, overturned, and fell. Plaster fell. Ground: Sloping.

807 E. Andover Drive. (VI) Felt by and awakened all in well-built wood frame building; frightened few. Wood joints moved. Hanging objects swung moderately east-west. Moderate earth noises. Glasses knocked out of cupboards; vases and books fell. Furniture shifted. "I have checked approximately 12 houses in my area and found no structural damage. Only items of interest were the movement of furniture, items falling out of cabinets, off tables, dressers, etc., and broken windows. Damage slight." Ground: Gravelly, compact, sloping.

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Canoga Park:

Topanga Plaza Shopping Center (May Company store; from Headlines, a May Company publication, undated). "Twenty-five plate glass windows in the escalator well shattered. Approximately 50 percent of merchandise and display fixtures damaged or destroyed in the China Department. The bedding and linen stock-rooms were a tangle of toppled shelving and merchandise. Ceiling tiles and complete light casings fell. On the roof, four 4-ton fans were sheared from their bolts, and the fans moved 2 to 9 inches out of position. The Lamp, Mirror, Picture, and Television Department also received extensive damage to merchandise. The Lower Level and Middle Level also received damage. The major problem was water. Three inches of water had seeped into these levels by mid-morning as the result of damaged waterpipes in an adjacent department store in the shopping mall. The building was carefully inspected by engineers and building inspectors before storemembers were permitted to enter. Damage to the structure was only surface damage, and the building was found to be in good condition."

21301 Saticoy Street (Alcon Liquor and Delicatessen Store). Felt by, awakened, and frightened all (observer sleeping in well-built, one-story brick building). Trees and bushes shook; vehicles rocked. Exterior walls cracked and separated about 1.9 cm. in some places. Hanging objects swung violently in all directions. Small objects fell. Plaster cracked. Two windows broke. Damage slight. "The events took place in Canoga Park. The building is a small shopping complex. One of the stores sells liquor and groceries. Damage to bottles was extensive--40 percent of the stock fell off shelves, even though the shelves were wired to prevent falling. Movement seemed to be north-south and west-east." Ground: Compact, level.

20749 Arminta Street. (VI) Felt by, awakened, and frightened all in 10-year-old, well-built, one-story wood frame building. Loud, roaring and rumbling earth noises. Water splashed from swimming pool. Garage floor cracked; numerous superficial plaster cracks; one wall crack, about 45 cm. long, extended through wall. Hanging objects swung violently east-west. Small objects, too numerous to mention, fell. Furniture shifted. "Our home was shifting so violently that it was difficult to walk. We did not see any cracks immediately after the initial shock. All the cracks seemed to develop after that and during the aftershocks. All cracks and damage occurred at west end of the house. We are located on a corner and the section of the house on the corner suffered all the damage. We have found that several other 'corner' houses in our tract suffered much more damage than the houses situated between two other houses." Damage slight. Ground: Compact, level.

7733 Delco Avenue. (VI) Felt by all and frightened many in community; awakened all in fairly new, well-built, one-story wood frame building. Water escaped from street hydrants. Electricity off 1 hour. "Awakened by mild rolling motion of several seconds' duration, pause of a few seconds, then a sharp jolt followed by violent shaking in all directions, both lateral and vertical. The

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intensity built up during a period of 30 to 60 seconds, then abruptly stopped; then after a short pause was followed by more, milder, rolling shocks. Electric power went out at the end of the violent shock period. Flashes of light were observed during shocks. I lost all sense of direction during violent shaking. It was difficult to locate exit door in dark bedroom. Immediately after the shock a check was made for gas leaks, water leaks, broken electric cords or wires both inside and outside--none was found. No neighbors were observed outside. Power failure apparently general in the neighborhood. No structural damage noted. Many books fell from tops of bookcases and from a shelf in one closet. Bookcases did not overturn. One table lamp, 0.9 m. tall, in corner of living room, was found in middle of room about 3 m. from its original position; other table lamp just toppled over. All fallen objects were from locations on inside walls. Nothing along outside walls of house fell or moved. Water in aquarium sloshed out and water in neighbor's swimming pool sloshed out." Ground: Compact, level; mostly adobe.

7233 Kelvin Avenue. (VI) Felt by, awakened, and frightened all in home and community (observer lying down on first floor of well-built, two-story stone building). Building rocked. Closet and cupboard doors opened; articles on floor. Loud earth noises, like an approaching train. Trees and bushes shook; vehicles rocked. Portable TV (on stand) shifted. Brick garden wall fell on neighbor's car. About 0.8 m. of pool water sloshed out. Damage slight. Store windows broke. Ground: Compact, level.

7701 Canoga Avenue (Post Office). (VI) Felt by, awakened, and frightened many in community (observer walking in old, one-story concrete block building). Building shook violently. Moderate, rumbling earth noises. Weaving motion made standing difficult. Hanging objects swung violently in all directions. Small objects and furniture shifted. Protective shields on fluorescent fixtures fell along with some tubes. Poles and wires shook. "Flashing between dock shed and building needs repairs, but no obvious structural damage." Ground: Compact, level.

22435 Marlin Place. (VI) Felt by all in home and community; awakened all in well-built, one-story wood frame (slab on grade) building. Main motion seemed east-west. Building shook rapidly. "Block wall, running north-south, fell in next lot to west of us." Ground: About 0.6 m. of compacted fill over former farmland, level.

23012 Gilmore Street. (VI) Felt by and awakened all in community; frightened all in old, well-built, one-story wood frame building (observer sleeping). Trees and bushes shook. Water sloshed from neighbor's swimming pool. Small objects shifted and fell; furniture shifted. Few minor plaster cracks. "Minor foundation cracks, but possibly due to other causes." Damage slight. Ground: Compact, level.

8742 Farralone Avenue. (VI) Felt by, awakened, and frightened all in community (observer lying down in two-story wood frame building). Doors swung. Small objects and lamps overturned; knickknacks, books, and pictures fell. Dishes broke. Damage slight. Motion rapid; lasted 1 minute. Ground: Rocky; hilltop.

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Valley Park Highlands. (VI) Felt by, awakened, and frightened all in community (observer sleeping in well-built, one-story wood frame building). Entire house rattled; sound of nails being pulled. Moderate earth noises. Pool water sloshed out. Minor plaster cracks. Ground: Compact, sloping.

20002 Blythe Street (Winnetka district of Canoga Park). (VI) Felt by, awakened, and frightened all in community (observer sleeping in new, well-built, one-story wood frame building). Small objects overturned to west. Furniture shifted, overturned, and broke. Minor damage. Ground: Alluvium.

Other observers at Canoga Park reported: 23952 Archwood Street (west area): "I heard a rumbling noise just prior to feeling the shock. Predominantly east-west vibration with some north-south motion. Felt more like several quick vibrations, then a little slower, then several quick motions, with a total response effort similar to a boat action in water." 23825 Vanowen Street (west area): "No dishes, glasses in cupboards broken or noticeably moved. No books fell from bookcase. Lost about 3.8 cm. of water from 28-1. fish tank; light hood on tank bounced out of place but did not fall off. Many pictures on walls did not move or shift. The large, heavy, hanging lamp over dining table swung more than moderately but not violently in an east-west direction. During the first aftershock, about a half hour later, the lamp swung in a north-south direction but not as hard this time." 6911 McLaren Avenue (northwest area): "Shock was felt for a considerable length of time. Rattling, creaking, etc., noises were continuous. Telephone and power out. Water was running, but during the day it became contaminated and remained so for about 1 day."

Encino:

4710 Noelne Avenue. Felt by, awakened, and frightened all in old, well-built, one-story wood frame building. Building sounded as if it were coming apart. Two palm trees knocked over. Flagstone and concrete driveway cracked; concrete and flagstone pool deck raised 1.3 cm. above pool tile; steel support column of porch roof shifted 3.8 cm. out of concrete base; garage roof support timber, 10 by 30 cm. and 6.1 m. long, shifted about 2.5 cm. on north end. Hanging objects swung violently north-south. Small objects shifted, overturned, and fell. Furniture shifted. Plaster cracked. About 0.3 m. of water sloshed from pool. Damage about \$4,000. Ground: Compact.

4581 White Oak Place. (VI) Felt by, awakened, and frightened all in community (observer sleeping in well-built, one-story wood frame building). Twisting and rubbing of lumber in building. Faint earth noises. Waterlines broke. Hanging objects swung violently northeast-southwest. Small objects shifted, overturned, and fell. Furniture shifted. Plaster cracked. Ground: Level (hillside cut).

16657 Oldham Street. (VI) Felt by and awakened all in community; frightened many (observer sitting in 10-year-old, well-built, one-story wood frame building). Loud earth noises. Trees and bushes shook; vehicles rocked. Electricity out. Block walls broke. Hanging objects swung violently. Pool water sloshed out on east side of pool. Ground: Silty, clayey gravel, level pads in hills.

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No address given. (VI) Felt by and awakened all in well-built, one-story wood frame building (observer sitting); frightened few. Windows, doors, dishes, etc., rattled severely; building creaked severely. Trees shook violently. Pool water sloshed out, swamping yard with water. Hanging objects swung violently; swag light fell. Small objects shifted. Plaster cracked; some chimney cracks. Damage moderate. Ground: Compact, level.

Fillmore. Felt by, awakened, and frightened all in community (observers sitting and sleeping in old, well-built, one-story wood frame buildings). Loud earth noises. Vehicles rocked. Water sloshed from swimming pools. Chimneys, plaster, and windows cracked. Hanging objects swung violently east-west. Small objects overturned and fell. Furniture shifted. "We lost one building in town--a dress shop--when the roof caved in. Two other business buildings were damaged: One furniture store lost part of the roof in the rear of the building and a hardware store lost part of the brick firewall on the north side of the building. All of the grocery and liquor stores in town suffered losses when canned and bottled goods fell off the shelves and display counters. Electrical service was out in the surrounding rural areas for a short time, about 5 to 15 minutes." "I was awakened by a terrific shaking of the bed and a terrible noise. Seemed as if the house would fall to pieces, but the only damage to the structure was to an outside brick chimney which was separated from the house by about 1.9 cm. About 2-1/2 city blocks away, the side of a two-story brick building fell on a one-story frame roof and demolished the smaller building. There was some damage to an orange-packing house. The lights were out for a few minutes." Ground: Compact, level.

Flintridge (southwest of La Canada; 34°11' N., 118°10' W.). Felt by all in community; awakened all in old, well-built, two-story wood frame building (observer standing). Building creaked loudly. Loud earth noises. Trees and bushes shook; vehicles rocked. Water sloshed from swimming pool. Heavy chimney sheared off at roofline. Plaster cracked throughout interior. Minimum cracking of exterior stucco. Roof tiles shifted and broke. Torsion of building visually observed. Interior wood and lath and plaster failed (both horizontally and diagonally) in shear, and vertically in tension. Also some compression parallel to wave travel. Wall damage was extensive; ceiling damage was moderate. "Very little displacement, horizontal or vertical, at right angles to direction of wave travel (bookshelves at right angles to maximum displacement line were emptied, those parallel were not; same for shelves and cabinets)." Ground: Gravelly, compact, level.

Glendale:

The following, from Steinbrugge and others<sup>8</sup>, does not include publicly owned structures: "31 buildings posted unsafe; buildings demolished or to be demolished-- residential, 13; commercial, 23; churches and schools, 5; 3,250 chimneys damaged; estimated total dollar loss, \$2 million." Press reported the Glendale Presbyterian Church (built in 1923) was severely damaged. The First Methodist Church was not damaged, but in the 54-year-old former sanctuary

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behind it, towers fell through the roof. A Glendale press report (dated Apr. 7, 1971) stated earthquake damage to Glendale schools had reached an estimated \$272,561. Repairs and damage ranged from a low of \$18 at Daily High School to a high of \$57,400 at Crescenta Valley High School. Damage at Clark Junior High School was set at \$56,250. Students probably will not be allowed to use the Hoover High School auditorium this year as the structure apparently has to be beefed up, brick facing removed, etc. Another press report (dated Apr. 22, 1971) stated demolition occurred at 40 separate general locations and included 400 chimney projects. Major demolitions were the Glendale Presbyterian Church sanctuary at 219 E. Harvard Street (\$70,283) and the First United Methodist Church at Jackson Street and Wilson Avenue (\$47,317). Repair of public buildings, utilities, and related costs amounted to \$342,589. The Public Service Building, costing \$257,000 in restoration from quake damage, was hit the worst.

1414 Virginia Avenue. Felt by and awakened all in community; frightened few in old, well-built, one-story wood frame building (observers walking and sleeping). Too much noise from breaking glass to hear building noise. Three chimneys broken off at roofline across street; two cracked next door. Hanging objects swung moderately. Small objects shifted and fell (25 percent of dishes broke). Furniture shifted. Minor plaster cracking. Ground: Compact, slightly sloping.

126 Burchett Street. Felt by all in community (observer sitting in old, one-story wood frame building). Rapid rocking and trembling of building. Windows opened. Trees shook. Water brownish color. Chimneys collapsed. Street lights flashed. Electricity off. Small objects shifted and fell along west side of building. Furniture shifted. Plaster cracked at northwest corner of building. Damage slight at observer's home. Ground: Gravelly, level.

241 N. Jackson Street. Felt by and awakened all in community; frightened few (observer sleeping on third floor of new, well-built, three-story wood frame building). Loud building noise, mainly from roof area. Trees and bushes shook. Few chimneys overturned in area. Hanging objects swung moderately east-west. Only glasses fell. Furniture shifted slightly. Plaster cracked in area. Many windows cracked in community. Moderate damage to several nearby buildings. Ground: Compact, level.

Post Office. Felt by, awakened, and frightened all in community (observer on main floor of old, well-built, three-story granite block building). Building sounded as if it would collapse. Loud earth noises. Ground cracked. Chimneys overturned. Hanging objects swung violently north-south. Small objects fell. Furniture overturned and broke. Plaster and windows cracked. Damage moderate (no structural damage). Ground: Level.

322-1/2 N. Kenwood Street. Felt by all and awakened many in community (observer lying down on second floor of older-type, two-story wood frame building). Felt as if building would collapse. Faint, rumbling earth noises. Chimney across street collapsed. Two lamps broke. Plaster cracked. Bookcase fell (west wall); refrigerator moved out about 8 cm. from south wall. One brick (quite heavy) from brick bookcase was thrown about 2 m. Ground: Level.

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1155 N. Brand Boulevard. Felt by, awakened, and frightened many (observer sleeping on ninth floor of well-built, 11-story reinforced concrete building). Building moved in circular motion. Too much noise within building to hear earth noises. Hanging objects swung north-south and east-west. Small objects shifted, overturned, and fell; many items broke. Furniture overturned and broke. Plaster cracked, broke, and fell at lath and plaster partitions at ends of walls. The two elevators in building were put out of commission due to counter balances being knocked out of their guiderails. No structural damage. Ground: Sand and gravel, alluvial fill.

3039 San Gabriel Avenue. Felt by, awakened, and frightened all (observer lying down in strongly built building). Loud earth noises. Trees and bushes shook strongly. All lights swung. All small objects and furnishings shifted; vases, etc., small objects and furniture overturned. Plaster, windows, walls, chimneys, and ground cracked. Knickknacks, books, pictures, and plaster fell. Dishes, windows, and furniture broke. Damage considerable. Ground: Compact.

1340 Barrington Way. (VI) Chimney broke. Substantial plaster cracking.

641 W. Lexington Drive. (VI) Felt by and awakened all lying down in old, well-built, one- and one-half-story wood frame building. Building shook and creaked very strongly. About 1.8-m.-high block wall fence down. Glasses and dishes broke. Lamps, etc., fell. Plaster cracked on bedroom ceiling. Ground: Level.

705 E. Cypress Street. (VI) Felt by and awakened all; frightened many (observer in old, well-built, two-story wood frame building). Hanging objects swung violently. Small objects shifted, overturned, and fell. Plaster cracked. Damage slight. Water sloshed from swimming pool. All clocks stopped; some were damaged in fall from shelves and mantel. Ground: Rocky, sloping.

1824 Wabasso Way. (VI) Felt by, awakened, and frightened all in community (observer standing in strongly built, one-story wood frame building). Faint earth noises. Hanging objects swung east-west. Trees and bushes shook slightly. Small objects and furnishings shifted. Vases, etc., small objects overturned; knickknacks, books, and pictures fell. Dishes broke. Damage considerable. Ground: Compact, level.

1416 Highland Avenue. (VI) Felt by, awakened, and frightened all in community (observer in well-built, one-story wood frame building). Chimneys damaged. Hanging objects swung violently. Small objects shifted, overturned, and fell. Furniture shifted. Damage slight. Ground: Gravelly, sloping.

3472 Roselawn Avenue. (VI) Felt by, awakened, and frightened all in community (observer in new, well-built, one-story wood frame building). Hanging objects swung moderately. Small objects shifted, overturned, and fell. Furniture shifted. Plaster cracked slightly around openings. Fireplace displaced about 0.2 cm. from wall. Damage slight. Ground: Gravelly, sloping.

1615 Don Carlos Avenue. (VI) Felt by and frightened all (observer standing in old, fairly well-built, two-story wood frame building). Loud, roaring earth noises. About 0.3 m. of water splashed from pool. Hanging objects swung violently

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east-west. Dishes thrown out of cupboards; books fell. Mirror broke. Ground: Gravelly, sloping.

723 E. Chestnut Street. (VI) Felt by, awakened, and frightened many in community; all in old, two-story wood frame building. Moderate earth noises. Trees and bushes shook; vehicles rocked. Several swimming pools lost 0.3 to 0.6 m. of water. Hanging objects swung moderately. Small objects overturned and fell; most lamps and items on tables fell to the floor. Furniture shifted; 20-l. water cooler overturned. Plaster cracked. Damage slight. "Motion very jerky rather than rolling; lasted about 1 minute. Noise, mostly building noise, was very loud. Felt strong shock about 2 to 3 minutes later. Aftershocks have been numerous. Several felt every night until February 20. Many were strong enough to overturn a lamp or two. Very difficult to sleep. Most were felt at night between 10 p.m. and 3 a.m." Ground: Compact, level..

La Canada:

Press reported powerlines down.

1001 Ridgecliff Lane. Felt by all in community (observer standing on second floor of strongly built, wood frame building). Noise seemed to come from all directions. Trees and bushes shook strongly. Small objects shifted and overturned. Knickknacks fell. Chimneys fell. Damage considerable.

200 Michigan Avenue (St. Francis High School). Felt by all and frightened many in strongly built, brick and concrete building (observer lying down). Small objects and furnishings shifted; 160-l. fish tank moved about 15 cm. Vases and small objects overturned; knickknacks, pictures, books (from east-facing bookshelf), and plaster fell; low, false ceiling bent and fell. Chimneys fell. Damage slight at observer's home. Ground: Soil, compact.

4914 Alta Canyada. (VI) Felt by, awakened, and frightened all (observer lying down in weakly built, one-story wood frame building). Loud earth noises from north. Hanging objects swung north, northeast, and east-west. Trees and bushes shook strongly. Small objects and furnishings shifted; vases and small objects overturned. Plaster, windows, and walls cracked. Knickknacks, books, and plaster fell. Ground: Rocky, loose, sloping.

936 Craig Avenue. (VI) Felt by, awakened, and frightened all in community (observer standing in old, one-story wood frame building). Very loud earth noises. Chimney cracked. Hanging objects swung east-west. Small objects overturned and fell. Furniture overturned. Plaster cracked. Windows broke. Damage moderate. Ground: Compact, sloping.

4234 Shepherds Lane. (VI) Felt by and awakened all in community; frightened many (observer in well-built, one-story wood frame building). Rumbling earth noises. Hanging objects swung violently. Small objects overturned. Plaster fell. Damage slight. Ground: Gravelly, loose, level and sloping.

4607 Hillard Avenue. (VI) Felt by, awakened, and frightened all in old, well-built, one-story wood frame building. Hanging objects swung violently north-south. Small objects fell. Furniture shifted. Plaster cracked, broke, and fell. One small window broke. Damage moderate. Ground: Compact, sloping.

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- 2216 Fairhurst Drive. (VI) Felt by, awakened, and frightened all in community (observer in one-story wood frame building). Loud rumble. Hanging objects swung east-west. Trees and bushes shaken strongly. Stove moved. Vases and ashtrays overturned. Chimney cracked. Knickknacks, books, and pictures fell east-west. Dishes and jars broke. Damage slight. Ground: Rocky.
- 5429 Burning Tree Drive. (VI) Felt by, awakened, and frightened all in community (observer in strongly built, two-story wood frame building). Rumbling earth noises at first, then a deafening roar. Doors slammed; hinges pulled loose. Trees and bushes shook strongly. Furnishings shifted. Small objects fell. Damage slight. Ground: Rocky, granitic.
- 5008 Crown Avenue. (VI) Felt by, awakened, and frightened all in old, well-built, one-story wood frame building. Building popped and crackled. About 5 cm. of water sloshed from swimming pool. Hanging objects swung moderately north-south. Small objects shifted and overturned. Plaster cracked (two small vertical cracks at corners). Damage slight. "At 6:10 a.m. surface of pool showed violent action. At 7:00 a.m., pool surface was smooth but water was still swaying about 3 cm. from end to end." Ground: Compact, sloping.
- 4143 Forest Hill Drive. (VI) Felt by and awakened all in community; frightened many (observer in well-built, one-story wood frame building). Building creaked loudly and continuously during shock. Faint earth noises. Trees and bushes shook. Pool water sloshed violently. Hanging objects swung moderately north-south. Small objects shifted. "There was a distinct feeling of significant vertical acceleration during the early moments of the shock." Ground: Weathered granite, sloping.
- No address given. (VI) Felt by, awakened, and frightened all in well-built, one-story wood frame building. Loud earth noises. Trees and bushes shook; vehicles rocked. Chimney cracked. Slab in patio raised and cracked. Hanging objects swung violently north-south. Small objects fell. Pictures tilted. Plaster cracked. Ground: Compact, level.

La Crescenta:

- 4946 Pennsylvania Avenue. Felt by, awakened, and frightened many in community (observer in well-built, one-story wood frame building). Vehicles rocked. "I was driving on steep road about 1-1/2 km. from home; returned home." Chimneys cracked and overturned. Many false fronts of buildings were damaged badly. Hanging objects swung in seemingly north-south direction. Small objects fell. Furniture overturned and broke. Plaster cracked by fireplace; fireplace damaged from floor to ceiling. Water and furnace pipes broke. Damage moderate. Ground: Rocky, sloping.
- 4904 Pennsylvania Avenue. Felt by, awakened, and frightened all in community (observers sleeping and standing in old, well-built, one-story wood frame building). Violent up-and-down motion accompanied by loud earth noises. Vehicles rocked. Lath house down. Chimneys cracked; had to be removed immediately. Hot water tank lines broke. Hanging objects swung violently. Small objects overturned and fell; furniture shifted. Plaster cracked and broke. Interior and

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exterior stucco cracked at corners. Damage moderate. Damage to building and contents estimated at \$3,000. Ground: Rocky, level.

5542 Pine Glen Road. Felt by and awakened all in community; frightened many (observer in shower on second floor of new, well-built, two-story wood frame building). Moderate, rumbling earth noises. Chimneys cracked, twisted, and overturned. Hanging objects swung moderately north-south. Small objects shifted and overturned, mostly in east-west direction, some north-south. Old plaster cracks opened. Unreinforced (pre-1933) brick parapet failures. "We had very little breakage from dishes and knickknacks, probably due to the bedrock foundation, but friends living out in the center of the canyon or on deeper alluvial deposits had considerable glass and dish breakage. One friend on third floor of wood frame apartment building had a wall-mounted a.c. unit fly east half-way across the room. I tried to analyze the direction of motion at my house from swinging of lamps and displacement of objects and finally decided it had to be east-west, even though swag lights in bedroom were swinging north-south." Ground: Decomposed granite; level pad with steep cut in rear.

2938 Henrietta Avenue. Felt by and awakened all in community; frightened many (observer sleeping on second floor of old, well-built, two-story wood frame building). Deep, pronounced earth rumble. Trees and bushes shook. Tops on few chimneys broken off. Some old stone walls cracked. Small objects shifted, overturned, and fell; stores suffered greatly from fallen merchandise. Furniture on hard surfaces shifted. Plaster cracked, broke, and fell, principally in older buildings. Many windows cracked in old and new buildings. "Damage slight in my immediate location." Ground: Rocky, large boulders with rock and gravel, compact, sloping (about 10 percent grade).

3939 Santa Carlotta Street. Felt by, awakened, and frightened all in community (observer lying down on second floor of well-built, two-story wood frame building). Everything rattled. Loud earth noises. About 15 cm. of water splashed from swimming pool. Concrete and stone supporting wall dislocated; concrete pool deck cracked. Hanging objects swung, seemingly in northwestern direction. Small objects shifted, overturned, and fell. Furniture on casters shifted. Hairline plaster cracks in ceiling. Putty fell from windows. Concrete and wood connection shifted about 0.9 cm. Ground: Rocky, gravelly, sloping.

#### Los Angeles:

Moderate damage occurred in downtown Los Angeles, especially to older-type buildings with brick and masonry facings. Portions of an old building, the Mission Inn, collapsed, killing one person. Extensive damage occurred to some of the old historic buildings on Olvera Street. Press reported "unsafe" and "potentially unsafe" signs were posted at some buildings in "Little Tokyo" and along Main and Los Angeles Streets. Considerable nonstructural damage occurred to some of the larger buildings and to some high-rise buildings--plaster partitions cracked; fall of plaster and tile; broken windows. Many elevators were knocked out of service. Press reported the City Hall (27 stories; built in 1927) was a shambles from fallen plaster and cracked walls from the 15th floor up; extensive

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damage was reported in the Hall of Justice (15 stories; built in 1925) where windows were broken and plaster and tile fell to the floor; an 8-cm. crack was reported in the jail section. At the Hall of Administration (eight stories), roof cracked; seismic joints cracked throughout. At the Occidental Tower (built in 1965), ceiling tile fell, and there were a number of broken windows. There was some damage, largely cracked plaster, at the 42-story Union Bank Square Building where elevators were knocked out of commission. At the Roosevelt Building, marble was shaken loose in the lobbies and walls cracked. It was reported the 32-story Bunker Hill Tower, with its two 19-story buildings, sustained only minor damage to ceilings and walls. The old Los Angeles High School (a four-story, 92-classroom building; built in 1917 and rebuilt after the 1933 earthquake) was ordered razed because of damage. It was reported the May Company store was closed to customers because of extensive interior damage. Chimneys fell, plaster cracked and fell, and windows broke in many other areas and districts of Los Angeles City. The California Institute of Technology<sup>2</sup> reported that there were reports of ruptured gaslines in Highland Park, and in Eagle Rock, it was reported a ruptured gasline blew a crater in a freeway overpass bridge.

The following reports were received from private observers:

Abbey Hotel (825 W. Eighth Street). Frightened all in the building. "Old, poorly built, four-story building. Section about 1.5 by 2.4 m. fell away from lobby wall; waterpipe damage at this break. Primary shock was moderate shaking for first 5 to 10 seconds, then grew rapidly in intensity; stayed at maximum for about 40 seconds, with immediate aftershocks of strong rolling motion, floating feeling; building noise almost ceased during this period. It seemed that during these aftershocks ground noises could be heard, sounding like large masses of rock, at great depth, being shifted against one another. Some damage: Cracks, about 0.6 to 0.9 cm. in width, opening on wall corners adjacent to stairway entrances on each floor; on ground floor (lobby), plaster fell from ceiling above last flight of stairs and adjacent ceiling area where wall fill and plaster fell out. Lights in room flickered on and off during the main shake, with floor lamp in great agitation. Damage slight to building. Much masonry-facing damage one block away; much window breakage and masonry-facing damage on taller buildings."

May Company store (from Headlines, a May Company publication, undated). "The downtown store was closed to storemembers early Tuesday morning while building inspectors, store security and engineers checked every area of the store. The building was considered structurally sound and safe for entry; but because of the damages to the interior the store remained closed to customers. The 'back' stairwell, escalators and elevator wells seemed to have suffered the most damage. Walls surrounding the back stairs and the walls in the adjacent halls sustained much surface damage in cracked and fallen plaster, and in some cases, holes in walls and at corners were visible. Main wall supports were in good condition and were not damaged. The escalators were extensively damaged. Exterior damage to the store was confined to display windows and decorative

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treatment on the building. Well over 60 percent of the plate glass windows were shattered. Some slight damage was noticeable on cornices and ornamental trim."

Olympic Boulevard and Alameda Street (about 3 km. south by east of Civic Center).

"The building in which I work (Olympic and Alameda) sustained approximately 400 broken windowpanes, about 35 by 51 cm., all steel sash. Almost 100 percent of these were on the north and south sides of the building. One or two freight-type elevators were inoperative owing to guide tracks warping and permitting counter-balance weights to swing free."

127 S. Serrano Avenue (in area about 2 km. southwest of Los Angeles City College).

Felt by and awakened all in community; frightened many (observer sleeping on second floor of old, well-built, two-story wood frame building). Two loud cracking sounds of building, then many creaking sounds. Pool water splashed about 6 m. horizontally. Almost all nearby chimneys fractured. Small objects shifted, overturned, and fell; dishes and glasses broke. Bookcase fell; dresser moved. Many new plaster cracks appeared in all eight rooms. Damage slight. Ground: Compact, level.

3812 Terry Street (in area about 1.2 km. northwest of Silver Lake). Felt by, awakened, and frightened all in community (observer standing on second floor of fairly new, two-story wood frame building). Building creaked severely. Loud, crackling earth noises. Vehicles rocked (cracked water hose to radiator).

Water shaken from house gutters. Hanging objects swung violently north-south. Small objects overturned and fell; some "flew" through the air. Furniture shifted; heavy chest moved 30 to 38 cm. away from wall. Plaster cracked, broke, and fell; ceramic tile fell. "Everything in front apartment that was movable shifted. I attempted to walk across the room but was unable to do so." Damage moderate. Ground: Compact, adobe.

932 Maltman Avenue (Silver Lake area, about 0.8 km. from southwest shore). Felt by and awakened all in community; frightened many (observer sleeping on second floor of new, two-story wood frame building). Moderate earth noises. Trees and bushes shook; vehicles rocked. Chimneys cracked and overturned. Water splashed from swimming pools in the area. Hanging objects swung moderately. Small objects shifted. Some plaster cracked, broke, and fell; one window cracked. Damage slight. Ground: Compact, sloping.

4411 Los Feliz Boulevard (south of Griffith Park). Felt by, awakened, and frightened all in community (observer standing on second floor of new, well-built, 13-story reinforced concrete building). Building creaked. Moderate earth noises. Chimneys cracked, twisted, and overturned. "Older masonry buildings generally damaged." Hanging objects swung violently east-west. Small objects and furniture shifted. Plaster cracked. Damage moderate. Ground: Alluvial deposits and decomposed granite, sloping.

2835 Sunset Place (about 4 km. west by north of Civic Center, near Lafayette Park).

Felt by observers lying down on first floor of old, two-story wood frame building. Everything shook and rattled; building creaked. Powerlines flashed at rear of building. "Chimneys in same block fell; some cracked and will be removed.

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There were reports of broken dishes in the area. We had nothing broken; one small mirror fell." Ground: Very compact, slightly sloping.

Hollywood area. Sidewalks buckled. Windows broke. Chimneys cracked and fell.

Buildings were damaged, especially brick buildings. "After the earthquake, people were outside on sidewalks and would not go back inside because of the aftershocks. I thought the building would disintegrate. Part of a brick wall on roof fell. Arch over building entrance cracked, creating danger. Brick buildings seemed to be more damaged than single-structure cement buildings."

"Lights out almost immediately and things overturned. Saw flashes of light from shorted telephone pole transformers--thought the whole city was ablaze. Got dressed and went outside; sat in car, as I thought there would be aftershocks, and there were. Noted some traffic lights were inoperative. People went outside after the shock, then attempted to go back inside, but aftershocks kept them outside for about 25 minutes." Observer at 1627 N. Normandie Avenue reported: "Older brick buildings received the most damage. Chimneys cracked. Heavy objects moved. Water sloshed from toilet bowls. This area where I live was apparently jolted heavier than other sections of Hollywood. Perhaps adobe soil is responsible."

5238 College View Avenue (south of Ventura Freeway and just southeast of southeast corner of Glendale city limits). Felt by all, awakened most, and frightened many in community (observer sitting in 60-year-old, well-built, one-story wood frame building). Trees and bushes shook; vehicles rocked. Hanging objects swung moderately. Small objects shifted, overturned, and fell. Furniture shifted slightly. Observer reported there was no damage to his home, but most neighbors' chimneys were cracked, twisted, and overturned. Ground: Decomposed granite and alluvium, slightly sloping.

5415 Wameda Avenue (Eagle Rock area). Felt by, awakened, and frightened all in community (observer lying down in strongly built, one-story wood frame building). Very loud earth noises. Whole house shook violently--had to "hold on." Hanging objects swung back and forth. Trees and bushes shook moderately. Drawers opened. Furniture moved. Plaster cracked and fell; window broke. Books and pictures fell; everything askew. Dishes "flew" out of cupboards and shattered. Air raid siren short-circuited. Car fell off jack stands in garage. Ground: Level.

5151 State College Drive (California State College, just northeast of Monterey Park city limits). "On the California State College Campus the new eight-story Administration Building is built on about 7 pairs of reinforced concrete columns (no first floor). Column pairs 1 and 7 exhibit tension cracks. No other columns show any damage. Plaster cracks, 45° diagonal, only in east-west walls. Corners of rooms and steel door frames show separation cracks. Bookcases fell if facing east-west; generally did not fall if facing north-south."

3566 Lowry Road (in area about 0.8 km. southeast of Griffith Park, west of Golden State Freeway). Felt by all in community; awakened and frightened all in new, well-built, two-story wood frame building. Building swayed and vibrated.

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Chimneys cracked, twisted, and overturned in older homes. Hanging objects swung, seemingly east-west. Small objects shifted, overturned, and fell. Considerable ceiling and glass damage in vicinity. "Many pre-1933 masonry buildings severely damaged, some beyond repair, within about a 3-km. radius of my house." Ground: Rocky, sloping.

Fifth and Spring Streets (Alexandria Hotel). (VI) "I saw substantial to heavy plaster cracking on sixth and eighth floors. Minor cracking elsewhere in the building."

545 S. Figueroa Street. (VI) Felt by observer in basement of old, well-built, 13-story concrete and steel building. Building made grinding noise. Vehicles rocked; light poles swayed. Hanging objects swung north-south. Portions of plaster fell in elevator shafts. Rapid ground motion. "I walked outside and looked up at the Atlantic Richfield Towers; could hear cracking sounds throughout the 52-story structure, but did not observe anything falling."

234 S. Figueroa Street. (VI) Felt by and awakened all in community; frightened many (observer on sixth floor of new, well-built, 19-story concrete and steel apartment building). Too much building noise to have heard earth noises. Water disturbed. Hanging objects swung violently. Small objects shifted, overturned, and fell; furniture shifted. Hairline plaster cracks. Damage slight. Ground: Level.

222 S. Figueroa Street. (VI) Felt by, awakened, and frightened all in community (observer sleeping on 19th floor of new, well-built, 19-story reinforced concrete building). Building creaked with very solid sound. Loud noise; may have been building noise. Hanging objects swung violently north-south. Small objects overturned and fell; furniture shifted, overturned, and broke. Ground: Level.

900 N. Alameda Street (Terminal Annex Post Office Building). (VI) Felt by and awakened all in community; frightened many (observer walking in basement of old, well-built, five-story building). Stairwells creaked. Moderate earth noises. Trees and bushes shook; vehicles rocked. Hanging objects swung violently east-west. Small objects shifted, overturned, and fell; furniture shifted, overturned, and broke. Plaster cracked, broke, and fell. Damage slight. "Damage to the building was mainly due to falling light fixtures and plaster. Stairwells seemed to receive the greatest plaster damage. Expansion joint between the old and new wings was damaged." Ground: Compact, level.

34° N., 118°15' W. (no specific address given but coordinates place the area about 1-1/2 miles west of Vernon). (VI) Felt by, awakened, and frightened all in community (observer sleeping in old, well-built, one-story wood frame building). Rolling, pitching and swaying motion. Loud earth noises. Trees and bushes shook; vehicles rocked. Chimney cracked. House and foundation moved up. Hanging objects swung violently in all directions. Small objects shifted, overturned, and fell; furniture shifted, overturned, and broke. Plaster cracked, broke, and fell. Damage slight. "Aftershocks at 21:00 on same day were almost as violent as the main shock, but not as long." Ground: Rocky, sloping.

1426 Carroll Avenue (about 1.6 km. north by west of Civic Center). (VI) Felt by and awakened all in community; general panic (observer sleeping on second floor of old, two-story wood frame building). Moderate earth noises. Hanging objects

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swung. Small objects shifted, overturned, and fell. Some plaster cracks in wall. Ground: Compact; top of a small hill.

111 N. Hope Street (in area about 2.4 km. southwest of Civic Center). (VI) Felt by, awakened, and frightened many in community (observer sitting on 11th floor of new, 15-story reinforced concrete and steel building). Doors closed; file drawers opened; blinds moved. Hanging objects swung east-west. Small objects fell out of cabinets. Plaster cracked and fell. Only one window broke in the building. "Radio Station KMPC went off the air same time as shock hit." Ground: Level.

2140 W. Olympic Boulevard (about 3.2 km. west by south of Civic Center). (VI) New, L-shaped, concrete block building. Observer's office on fifth floor at corner end of building. A bookcase, about 1.8 m. high, full of books, was overturned. Objects fell off desks and shelves. Cracks in brick at second floor.

961 S. Elden Avenue (about 4 km. southeast of Civic Center, near Olympic Blvd.). (VI) Felt by, awakened, and frightened all in community (observer lying down on second floor of poorly built, three-story building). Loud, rumbling earth noises. Hanging objects swung violently. Small objects shifted, overturned, and fell. Furniture shifted, overturned, and broke. Plaster cracked, broke, and fell. Damage moderate. Ground: Compact, level.

2827 W. Seventh Street (about 3.6 km. west by north of Civic Center). (VI) Felt by and frightened all (observer walking on first floor of old, two-story wood frame building). All building joints creaked and rattled. Chimneys cracked next door. Hanging objects swung violently east-west. Small objects shifted, overturned, and fell; furniture shifted. Windows cracked. Damage slight.

538 S. Oxford Avenue (about 4.4 km. west by north of Civic Center). (VI) Felt by and awakened all in new, well-built, three-story reinforced concrete and steel building (observer on second floor); frightened many. Violent north-south jerking motion. Bed shook violently. Faint earth noises. Considerable creaking and snapping of building. Telephone wires arced. Hanging objects swung moderately north-south. Small objects fell; wine rack fell off refrigerator and bottles broke. Furniture shifted. Small areas of plaster fell; noticeable crack on wall in stairwell between floors 1 and 2. A number of people ran into the street. "Considerable and frequent aftershocks." Ground: Alluvium, compact, level.

960 S. Oxford Avenue (about 6.4 km. west of Civic Center). (VI) Felt by, awakened, and frightened all in community (observer sleeping on third floor of old, well-built, three-story wood frame building). The rattling and noise of overturning objects masked any other sounds. Most objects under 4.5 kg. shifted, overturned, and fell; some heavy furniture shifted slightly. Plaster cracked, broke, and fell, and windows cracked in nearby houses. Damage slight. "Although there was no damage to my building, brick and block buildings nearby did have damage, though not great, excepting the Los Angeles High School. I noted that cupboards, shelves, etc., facing north-south had little thrown out, while those facing east-west were emptied. Most spectacular effect was the shorting of transformers--it was like a bomb attack." Ground: Compact, filled in, sloping (landscaped).

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- 210 S. Citrus Avenue (about 9.2 km. northwest of Civic Center). (VI) Felt by and awakened all on second floor of old, well-built, two-story wood frame building; frightened few. Fences rattled. Moderate earth noises. Upper portion of brick chimney shattered. Hanging objects swung moderately east-west. Small objects fell. Plaster cracked. Damage slight. Ground: Compact, level.
- 1037 Ridgeley Drive (near Olympic and San Vicente Blvd.). (VI) Felt by all and awakened many in community (observer sleeping in well-built, one-story building); frightened few. Building moved back and forth. Moderate earth noises. Trees and bushes shook; vehicles rocked. Hanging objects swung east-west. Small objects shifted, overturned, and fell. Plaster cracked, broke, and fell. Damage slight. Ground: Compact, level.
- 435 S. Curson Avenue (east of Beverly Hills). (VI) Felt by all; awakened and frightened many in community (observer sleeping on 13th floor of fairly new, 13-story reinforced concrete building). Walls and windows made cracking sounds. Trees and bushes shook; vehicles rocked. Water disturbed. Hanging objects swung violently in roughly north-south direction. Small objects fell from bookcases, etc. Tropical fish aquarium moved. Plaster cracks on several walls but none serious. Ground: Compact, level.
- Century Plaza Hotel (Century City district, southwest of Beverly Hills). (VI) Felt by, awakened, and frightened all in new, reinforced concrete and steel building (observer on 11th floor; 18 stories). Building made grinding noise. Loud, roaring and rumbling earth noises. Hanging objects swung violently. Plaster cracked and fell. "We were told that the Century Plaza Hotel was built to vibrate and sway during an earthquake, and indeed it did. Only a few small pieces of plaster fell in our room on the 11th floor, but a friend's room on the seventh floor was covered with small bits of plaster. We also noticed, walking down the fire stairs, that the further down we got, the more the plaster was cracked, and the larger the pieces that had fallen out. Everyone we saw in the lobby was frightened; one woman was hysterical."
- Crenshaw May Company Store (from Headlines, a May Company publication, undated). (VI) "Crenshaw experienced damage in the Liquor Department, and display windows around the store splintered during the sharp jolt. Surface damage to the interior was also apparent."
- 2053 Meadow Valley Terrace (Elysian Park area). (VI) Felt by and frightened all in community; awakened many (observer sleeping on first floor of old, two-story wood frame building). Seemed as though walls might fall. Water disturbed. Chimneys twisted. Lights flickered off and on (not turned on). Knickknacks thrown off shelves and tables. Plaster cracked. "I was scared 'to death.'" Ground: Silty sand, sloping; on hillside.
- 4622 Verdugo Road (1 block southeast of Glendale city limits). (VI) Awakened and frightened all in community (observer active in one-story wood frame building; duplex). Felt as if one were on choppy water in a boat. Thudding sounds underneath the house, along with strong vibrations. One dish thrown to floor. Small settling cracks in house. Two doors away, a chimney was cracked at top. Every

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aftershock was preceded by a rumbling-type noise. Several of the shocks rattled a china cabinet much more than the main shock."

122 N. Citrus (south Hollywood area, near Beverly Blvd. and Highland Ave.). (VI) Felt by, awakened, and frightened all in old, one-story wood and stucco building. Building creaked moderately. Moderate to loud earth noises. About 5 cm. of water sloshed from swimming pool. Hanging objects swung violently north-south. Small objects shifted and fell. Minor plaster cracks. "No chimneys damaged in this block; however, at least five or six chimneys were damaged 2 blocks south of us." Ground: Compact, level, underlain by adobe.

2400 N. Gower Street (Hollywood Hills). (VI) Felt by and awakened all in community; frightened all (observer in old, well-built, one and one-half story wood frame building). Building creaked strongly. Trees and bushes shook; vehicles rocked. Chimneys cracked. Some earth moved north-south. Hanging objects swung moderately north-south. Small objects shifted, overturned, and fell. Furniture shifted. Plaster cracked, broke, and fell. "We noticed that plaster cracks seemed far more numerous later than just after the main shock."

Ground: Gravelly, sloping.

6311 Yucca Street (east Hollywood area). (VI) Felt by and awakened all; general panic (observer standing on second floor of old, four-story wood frame building). Hanging objects swung violently southwest and north. Small objects shifted, overturned, and fell. Small items of furniture overturned. Plaster cracked, broke, and fell. Damage great. Ground: Compact, level.

806 N. Genesee Avenue (west Hollywood area). (VI) Felt by, awakened, and frightened many in community (observer lying down in old, well-built, one-story wood frame building). Chimneys cracked slightly. Plaster cracked in all corners of house; old cracks enlarged. "It seemed a miracle that the house was still standing and functioning normally after all that shaking. No major damage other than plaster cracks of which there were many." Ground: Loose soil, level.

433 S. Mansfield Avenue (southwest Hollywood area). (VI) Felt by and awakened all in community; frightened many (observer in old, well-built, one-story wood frame building). Loud earth noises. Trees and bushes shook; vehicles rocked. Chimneys cracked. Hanging objects swung moderately. Small objects shifted. Ground: Adobe clay, compact, level.

1711 N. Gramercy Place (Hollywood area). (VI) Felt by and awakened all in new, one-story wood frame building; frightened few. Building creaked. Loud, rumbling earth noises. Trees and bushes shook; vehicles rocked. "Water in the street (water main probably opened at joint). The only aftershocks felt in this building were those with a magnitude of 4 or greater." No damage. Ground: Decomposed granite, compact fill, slightly sloping.

219 N. Manhattan Place (south Hollywood area). (VI) Felt by and awakened many in old, well-built, two-story building; three small children on second floor were not awakened; frightened many. Building rocked east-west. Small objects shifted, overturned, and fell. Plaster cracked, broke, and fell. Chimney displaced about 0.6 cm. at about 15 cm. above roof. Ground: Level.

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- 1202 N. Fuller Avenue (west Hollywood area). (VI) Felt by, awakened, and frightened all in community (observer in new, well-built, two-story wood frame building). Faint earth noises. Hanging objects swung north-south. Small objects shifted, overturned, and fell. Plaster cracked and broke. "General plaster cracking; outside stairs cracked." Damage slight. Ground: Alluvial fill, compact, very gently sloping.
- 753 N. Las Palmas Avenue (south of Hollywood, near Beverly Blvd. and Highland Ave.). (VI) Felt by many; awakened all (observer in well-built, one-story wood frame building). Moderate earth noises. Trees and bushes shook; vehicles rocked. Ground cracked. Swimming pool lost about 0.9 m. of water. Hanging objects swung violently east-west. Small objects overturned. Refrigerator, washer, dryer, etc., shifted slightly. Wide cracks in block wall and warping cracks in backyard cement floor. Ground: Filled in, level.
- 6827 S. Cimarron Street (just west of Inglewood city limits). (VI) Felt by and awakened all in one-story wood frame building; frightened many. Moderate earth noises. Small objects fell. Furniture shifted. Plaster fell. Chimney cracked. "At my place some sidewalks buckled and a few trees were leaning. Most neighbors complained of a few minor cracks, mostly on outside of structure." Damage slight. Ground: Sloping.
- Lincoln Park area (Holiday Inn, Marengo St. at Mission Rd., about 1 km. southwest of Lincoln Park). (VI) Awakened all and frightened many in new, seven-story reinforced concrete building. Partitions and ceilings shifted. Hanging objects swung violently. Small objects overturned. Furniture shifted. Plaster cracked in stairwell. "Power failed in hotel. All stoplights in vicinity out. Much glass broken in area stores and restaurants." Ground: Sloping.
- 519-1/2 N. Heliotrope Drive (south of Los Feliz district, near Los Angeles City College). (VI) Felt by, awakened, and frightened all in community (observer walking on second floor of old, well-built, two-story building; four flats). Some people ran from houses. Building shook severely. Some earth rumble heard. Vehicles rocked. Hanging objects swung violently east-west. Small objects shifted, overturned, and fell. Furniture shifted. Plaster cracked. Cabinet doors and drawers all opened. Lights and phone out. "Others in the apartment building had a few things broken too. So many aftershocks, so close together, too many to count. Plaster also cracked during the aftershocks. Aftershocks were mostly sharp jerks on the house; direction east-west; some north-south shakes." Damage slight. Ground: Level.
- 3549 Ashwood Avenue (Mar Vista area). (VI) Felt by, awakened, and frightened all in rather old, one-story wood frame building. Loud earth noises. Ground cracked; sidewalks and streets cracked. Hanging objects swung violently in circular motion. Small objects overturned and fell. Furniture shook. Ground: Level.
- 3611 Stewart Avenue (Mar Vista area). (VI) Felt by and awakened all in community; frightened many; all in old, well-built, one-story wood frame building. Loud, rumbling and rolling earth noises. Minor cracks in patio cement. Many cracks in cement seams of cinder block fence. Numerous cracks in stucco foundation.

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- Hanging objects swung moderately. Some small objects fell from shelves. Some lightweight furniture shifted slightly. Small hairline plaster cracks in some rooms. "Damage considered nil by construction and building safety inspectors; that is, nothing needs repairing. Motion was like that which one would feel while riding on a train, but of much greater magnitude. We also felt most of the aftershocks during the first 2 to 3 weeks; jolting motions, as if one's car were bumped in the rear by another vehicle." Ground: Compact, level.
- 3605 Globe Avenue (Mar Vista area). (VI) Felt by and awakened all; frightened few (observer on fifth floor of well-built, 10-story brick building). Loud earth noises. Fence broke. Small objects shifted, overturned, and fell. Furniture shifted. Plaster cracked, broke, and fell. Windows cracked. Damage slight. Ground: Gravelly, steep.
- 4043 McLaughlin Avenue (Mar Vista area). (VI) Felt by and awakened all in community; frightened many (observer in old, one-story wood frame building). Loud earth noises. Landslides. Hanging objects swung violently. Small objects fell. Furniture broke. Windows cracked. Damage moderate.
- 3647 Barry Avenue (Mar Vista area). (VI) Felt by, awakened, and frightened many in community; all in well-built, one-story wood frame building. Loud earth noises. Trees and bushes shook; vehicles rocked. Books and other objects fell. Hanging objects swung violently east-west. Plaster cracked. Ground cracked. Damage slight. Ground: Gravelly, level.
- 3612 Grandview Boulevard (Mar Vista area). (VI) Felt by all in well-built, one-story building; awakened and frightened many in community. Moderate earth noises. Ground cracked. Water disturbed. Hanging objects swung moderately in circular direction. Damage slight. Ground: Gravelly, sloping.
- 3658 Centinela Avenue (Mar Vista area). (VI) Felt by and frightened all on second floor of rather old, two-story wood frame building. Building shook very strongly. Trees and bushes shook; vehicles rocked. Lights flashed. Hanging objects swung moderately. Small objects fell. Damage slight. "Horses disturbed. Store windows broke. Burglar alarms rang. Fire in restaurant at Westwood." Ground: Steep.
- 12546 Pacific Avenue (Mar Vista area). (VI) Felt by and awakened all; frightened few (observer sitting in poorly built, two-story wood frame building). Moderate earth noises. Trees and bushes shook; vehicles rocked. Water disturbed. Chimneys cracked. Hanging objects swung violently back and forth. Small objects fell. Furniture shifted. Plaster cracked, broke, and fell. Damage slight. Ground: Compact, level.
- 3333 Cabrillo Boulevard (Mar Vista area). (VI) Frightened all in well-built, one-story wood frame building. Loud earth noises. Trees and bushes shook. Chimneys cracked. Ground cracked. Hanging objects swung moderately in circular direction. Small objects shifted. Furniture overturned. Plaster cracked. Damage slight. Ground: Filled in, level.
- 4609 McConnell Avenue (south Mar Vista area). (VI) Felt by all in community; awakened and frightened many (observer in fairly well-built, one-story wood frame

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building). Moderate earth noises. Crack in back wall of house. Hanging objects swung violently east-west. Some small objects shifted. Plaster cracked. Damage slight. Ground: Marshy, level.

13017 Psomas Way (Mar Vista area). (VI) Felt by and awakened all in stone building; frightened few. Moderate earth noises. Chimneys cracked. Hanging objects swung moderately. Small objects fell. Plaster cracked. Damage slight. Ground: Filled in, sloping.

10567 Cushdon Avenue (Rancho Park area). (VI) Felt by, awakened, and frightened all in community (observer in old, well-built, one-story wood frame building). Building creaked loudly. Trees and bushes shook; vehicles rocked. Hanging objects swung violently north-south. Small objects shifted, overturned, and fell. Furniture shifted. Plaster cracked. Damage slight. Ground: Level.

2864 McConnell Drive (Rancho Park area). (VI) Felt by, awakened, and frightened all on second floor of partly old and new, well-built, two-story wood frame building. Building swayed strongly. Loud earth noises. Furniture rocked. Trees and bushes shook. Swimming pool lost about 0.3 m. of water. Hanging objects swung moderately. Flowerpots fell off table. A little paint popped off walls. "Could hardly stand up and move. Everything seemed covered with dust. Lights flashed in sky; thought house was on fire. Seemed strongest in east-west direction, at least that is the direction in which most objects were moved or which caused objects to be broken." Ground: Rocky, clay, compact, slightly sloping.

1908 Walcott Way (Silver Lake area). (VI) Felt by and awakened all in community; frightened many (observer on upper level of well-built, two-level wood frame building). Chimneys cracked. Heavy cement statue, weight about 113 kg., thrown from pedestal. Hanging objects swung violently east-west. Small objects shifted, overturned, and fell. Plaster cracked. Few foundation cracks. Water in toilet and pets' dishes almost emptied. "Heavy objects such as planters and pottery thrown from shelves, while lighter objects just shifted around." Damage slight. Ground: Clay, compact, steep (on top of hill).

2431 Moreno Drive (Silver Lake area). (VI) Felt by and awakened all in community; frightened many (observer lying down in 20-year-old, well-built, one-story wood frame building). Loud roar heard. Small landslide 1 block to north. Hanging objects swung violently northwest-southeast. Small objects shifted, overturned, and fell. Ground: Shale and sandstone, sloping (on hillside).

1955 Monon Street (about 1 km. northwest of Silver Lake). (VI) Felt by, awakened, and frightened all in community (observer in well-built, two-story wood frame building). Loud earth noises. Fish pool overflowed. Top 0.9 m. of chimney (across street) demolished. Hanging objects swung moderately east-west. Small area of plaster fell to floor. Damage slight. "Very slight structural damage to residences. Some plate glass broke in stores. Not much swaying motion; best described as a snappy, sharp shock." Ground: Rocky, sloping.

13141 Valley Vista Boulevard (Studio City area). (VI) Felt by, awakened, and frightened all (observer lying down in old, well-built, one-story wood frame building). Building shook in up-and-down direction. Moderate earth noises. Hanging

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objects swung violently in all directions. Small objects fell from shelves.

Plaster cracked. Ground: Sloping.

3704 Broadlawn Drive (about 0.8 km. south of Universal City, just south of Cahuenga Blvd.). (VI) Felt by and awakened all in 20-year-old, well-built, one-story wood frame building; awakened and frightened many in community. Rumbling earth noises, like approaching train. Lost about 5 cm. of water from pool. Hanging objects swung moderately north-south. Books shifted about 10 cm. Furniture shifted. Minor plaster cracks. "Felt as a severe bumping motion while southbound on San Diego Freeway about 500 feet south of interchange with Ventura Freeway." Ground: Hillside.

3145 La Suvida Drive (just southeast of Universal City, between Universal City and Hollywood Reservoir). (VI) Felt by all in old, well-built, two-story building; awakened all; frightened many. Plaster walls and ceilings cracked. Furniture shifted. Ground: Silty sand, sloping.

4843 Ledge Avenue (just northwest of Universal City). (VI) Felt by and awakened all in well-built, one-story wood frame building; frightened few. Hanging objects swung moderately northwest-southeast. Small objects fell. Furniture shifted. Plaster cracked. Damage slight. Ground: Compact, level.

1631 E. 48th Place (about 1.6 km. west of Vernon, between Vernon Ave. and Slauson Ave.). (VI) Felt by, awakened, and frightened many in community (observer sleeping in old, well-built, one-story wood frame building). Building shook. Small objects shifted, overturned, and fell. "One house in my block had chimney overturned." Ground: Compact, slightly sloping.

9422 Wilmington Avenue (Watts area). (VI) Felt by all and frightened many in community (observer sleeping in old, well-built, one-story wood frame building). Hanging objects swung moderately east-west. Small objects overturned; furniture overturned. Plaster broke. Damage slight. Ground: Level.

325 W. 118th Street (southeast Watts area). (VI) Felt by, awakened, and frightened all in old, one-story wood frame building. Loud earth noises. Trees and bushes shook. Ground cracked. Large crack in front porch. Hanging objects swung violently. Small objects shifted and fell. Furniture overturned. Plaster cracked and fell. Windows cracked. Damage moderate. Ground: Level.

8939 S. Sepulveda Boulevard (Westchester area). (VI) 'In our office building, near International Airport, the third floor of building showed some damage from the main shock. The building is steel frame with shear walls at the stair and elevator wells. Extent of damage is very minor, but cracks in the shear walls appear to be deeper than the paint. We also felt aftershocks on evening of the 9th.'

West Los Angeles area (May Company store, from Headlines, a May Company publication, undated). (VI) "West Los Angeles store also sustained earthquake damage to merchandise and displays in the Upper Level. The China Department had considerable breakage. Ceiling tiles around the outer edges were loosened and/or fell. The large plate glass windows in the skylight shattered to the floor. The Liquor Department suffered and the 'good spirits' leaked into the engine room on the Lower Level. The parking garage also showed some damage."

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2555 S. Westgate Avenue (West Los Angeles area). (VI) Felt by, awakened, and frightened all in community (observer in old, well-built, one-story wood frame building); general panic. Very hard shaking in northwest-southeast direction; lasted about 40 to 45 seconds. Building creaked and windows shook very loudly. Loud, rumbling earth noises. Trees and bushes shook; vehicles rocked. Small objects shifted, overturned, and fell. Furniture shifted. Plaster cracked. Hanging objects swung violently north-south. One window swung open; doors on medicine cabinets opened; file drawers moved out about 20 to 25 cm. "Many aftershocks during the first hour and for rest of the day, quite high in intensity; shocks felt for few days with varying degrees of intensity. Believe my family and self were in slight shock condition after the main shock. It was quite an experience." Ground: Compact, level.

1514 Greenfield Avenue (West Los Angeles area). (VI) Felt by, awakened, and frightened all in community (observer in old, well-built, two-story wood frame building). Everything not firmly attached to building rattled; straining noises of nails at studs and plates and crunching noises at top and bottom of studs. Water disturbed and chimneys damaged (not directly observed). Hanging objects swung violently. Small objects shifted, overturned, and fell. Furniture shifted. Ground: Gravelly, level.

1447 Brockton Avenue (West Los Angeles area, about 0.8 km. southwest of Veterans Administration grounds). (VI) Felt by, awakened, and frightened all in community (observer in new, well-built, two-story wood frame building). Faint earth noises. Trees and bushes shook; vehicles rocked. Water disturbed. Chimneys cracked. Hanging objects swung moderately east-west. Plaster cracked in shear walls around openings. Damage slight. "Tremor lasted about 1 minute. Period of swinging lamps slightly less than 1 sec." Ground: Gravelly, compact, level.

11000 Wilshire Boulevard (Federal Building, Wilshire Blvd. and Veteran Ave.). (VI) Felt by all and frightened many in community (observer working on 11th floor of new, 17-story reinforced concrete building). Continuous rolling motion; all observable area was in motion. Moderate earth noises. Plaster cracked. Damage slight. Ground: Compact, level.

807 Westholme Avenue (Westwood area). (VI) Felt by, awakened, and frightened all in new, two-story wood frame building. So much object and building noise that no particular noise could be identified. Small objects shifted, overturned, and fell. Furniture shifted. Numerous cracks in plaster and stucco. Ground: Compact, sloping.

1936 Greenfield Avenue (Westwood area). (VI) Felt by, awakened, and frightened all (observer in old, one-story wood frame building). Felt as if a 747 jet plane were flying over. Small objects shifted, overturned, and fell. Plaster cracked, broke, and fell (cracks in ceiling and about chimney). Damage slight. Ground: Level.

Montrose:

Press reported powerlines were down.

The following was reported by postmaster. Felt by, awakened, and frightened many

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in community (observer walking in 15-year-old, well-built, one-story concrete block building). Twisting motion of building. Moderate earth noises. Trees and bushes shook; vehicles rocked. Ground cracked. Water disturbed. Chimneys and water tanks cracked, twisted, and overturned. Hanging objects swung violently. Small objects shifted, overturned, and fell. Furniture shifted and overturned. Plaster cracked and broke. Windows cracked. Damage moderate. Ground: Rocky, sloping.

- 2261 Luana Lane. Felt by, awakened, and frightened all in old, well-built, one-story wood frame building. Very violent shaking. Chimney across street overturned. Small objects fell. Furniture shifted. Plaster cracked. Damage slight.

North Hollywood:

11304 Chandler Boulevard (report from postmaster). Felt by, awakened, and frightened all in community (observer sleeping on first floor of old, well-built, two-story cement building). Everything shook. Loud earth noises. Water mains broke. Chimneys fell. Large plate glass windows broke. Hanging objects swung violently in all directions. Furniture moved about 5 cm. in westerly direction. Plaster cracked, broke, and fell in some buildings. Exterior bricks cracked. Windows cracked at three post office stations. "Had to evacuate one carrier building." Ground: Compact.

7071 Varna Avenue. Felt by all in community; awakened and frightened all in new, well-built, one-story wood frame building. Moderate earth noises. Block walls cracked and dislocated. Hanging objects swung violently north-south. Small objects shifted, overturned, and fell. File cabinet overturned. Ground: Gravelly, sandy, river deposit, compact, level.

7262 Farndale Avenue (about five blocks northwest of Burbank Airport). "I was awakened at 6:00 a.m. The house shook and rolled, and there were rumbling noises but not extremely loud. Climbing out of bed during the shaking, I was able to walk to my daughter's room. She was awake and was not terrified. Oven and refrigerator were shifted about 10 cm. Flat steel plates (11 kg. each) were moved on uncarpeted surface of floor. General disruption in all rooms. No readily observable cracks in ceilings or walls. Cement block wall in yard cracked at cemented joints; displacement about 2.5 cm. Immediately after the shock subsided (lasted about 20 to 30 seconds), I checked lights and phone--they still worked. Water OK. I felt about five or six aftershocks between about 6:09 and 6:19 a.m.; then I sat down to record more aftershocks." This observer reported he felt 34 shocks to 1:30 p.m., with the strongest at 6:35, 6:44, 8:00, 8:30, 10:57, and 10:59 a.m., and at 12:57 p.m. Stopped keeping record after 1:45 p.m.

5513 Morella Avenue. (VI) Felt by, awakened, and frightened all in community (observer sitting in basement of old, well-built, five-story reinforced concrete building). Moderate earth noises. Trees and bushes shook; vehicles rocked. Hanging objects swung violently east-west. Small objects shifted, overturned, and fell. Furniture shifted, overturned, and broke. Plaster cracked, broke, and fell (cracks about 0.6 cm. wide). Windows cracked. Damage moderate. Ground: Compact, level.

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5555 Morella Avenue. (VI) Felt by, awakened, and frightened all in community (observer in 24-year-old, one-story reinforced concrete block (wood roof) building). Building creaked very strongly. Moderate earth noises. Trees and bushes shook; vehicles rocked. Elliptical holes in ground observed around pipe risers for lawn sprinklers. Small objects shifted, overturned, and fell. Furniture shifted. Plaster cracked, broke, and fell (small amount at ceiling edges).

Ground: Alluvium, level.

12423 Debby Street. (VI) Felt by, awakened, and frightened all in community (observer lying down in fairly new, one-story wood frame building). Building swayed strongly. Water in streets from swimming pools. Hanging objects swung violently in all directions. Small objects shifted, overturned, and fell. Extensive damage to dishes and glassware. Moderate plaster cracking. Ground: Compact, level.

7922 Lemp Avenue. (VI) Felt by, awakened, and frightened all in community (observer sitting in new, one-story wood frame building). Loud earth noises. Driveway cracked. Hanging objects swung violently. Small objects overturned and fell; dishes fell from cabinets. Furniture shifted. Plaster cracked (14 cracks in walls; four cracks in ceiling). Garden wall cracked (separated) at intersection. Ground: Clay, compact, level.

10432 Valley Spring Lane. (VI) Felt by, awakened, and frightened all in community (observer on first floor of old, well-built, two-story wood frame building). Building rumbled. Loud earth noises. Trees and bushes shook; vehicles rocked. Water splashed from swimming pool. Hanging objects swung violently east-west. Small objects shifted, overturned, and fell. Furniture shifted. Ground: Sandy silt, compact, level.

1113 Acama Street. (VI) Felt by, awakened, and frightened all in community (observer on second floor of well-built, three-story wood frame building). Building creaked very loudly. Loud earth noises. Hanging objects swung violently. Small objects fell. Plaster broke. Damage slight. Ground: Compact, level.

7716 Laurel Canyon Boulevard. (VI) Felt by, awakened, and frightened all in new, well-built, two-story wood frame building. Faint earth noises. Chimneys cracked. Hanging objects swung moderately east-west. Small objects shifted, overturned, and fell. Damage slight. Ground: Gravelly, level.

10848 W. Otsego Street. (VI) Felt by, awakened, and frightened all in old, well-built, one story wood frame building. Loud earth noises. Trees and bushes shook; vehicles rocked. Chimney separated from house about 0.6 cm. Small objects fell. Plaster cracked. Damage moderate. Ground: Filled in, level.

11827 Stagg Street. (VI) Felt by and awakened all (observer in new, well-built, one-story wood frame building). Loud earth noises. Hanging objects swung violently east-west and north-south. Small objects shifted, overturned, and fell. Bookcase overturned. Ground: Sandy, level.

7734 Goodland Avenue. (VI) Felt by, awakened, and frightened all in new, well-built, one-story wood frame building. Loud, roaring earth noises. Hanging objects swung violently north-south. Small objects fell; much glass breakage. Furniture

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shifted. Plaster cracked by fireplace. All objects fell to south. Wall bookshelves collapsed. Cabinets opened and bottles fell out. Ground: Firm sandy silt, level.

4932 Penny Avenue. (VI) Felt by all in community; awakened all and frightened few in old, well-built, one-story wood frame building. Straining of wall and roof framing. Moderate to loud earth noises. About 18 cm. of water sloshed from pool. Chimney separated from main portion of house. Hanging objects swung moderately to strongly, seemingly north-south. Vases and one sculpture overturned. Plaster cracked. "Strong, vertical motion felt. Lawn sprinkler system defective (possibly from earthquake)." Ground: Compact, level.

2 Toluca Estates Drive. (VI) Felt by, awakened, and frightened all in community; general panic (observer in old, well-built, one-story wood frame building). Building made loud noise. Loud earth noises. Lost 1,135 l. of water from pool. Hanging objects swung violently northeast-southwest. Many objects shifted. Furniture shifted slightly. Ground: Sandy loam, alluvial, level.

Northridge and Porter Ranch District:

Northridge Hospital (Roscoe Blvd. near Reseda Blvd.). Lew and others<sup>3</sup> stated:

"Five-story steel frame structure with reinforced brick masonry shear walls. The exterior cladding was of brick veneer. Damage to the veneer was extensive on the east and west elevations. The shear walls in the first story were badly cracked at many places. All mechanical and electrical equipment was functioning after the earthquake, including elevators."

San Fernando Valley State College (18111 Nordhoff St.). It was reported that \$245,000 damage was sustained at the college, and was caused principally by collapsing bookshelves, toppling furniture, and falling glass from broken light fixtures and broken windows. A California Institute of Technology<sup>2</sup> report noted that only very minor cracking of structural members was found in the various buildings on this campus, which included an eight-story dormitory and an eight-story office tower.

9723 Rathburn Avenue. Felt by, awakened, and frightened all in community (observer in 14-year-old, well-built, one-story wood frame building). Building creaked loudly. Loud earth noises. Hanging objects swung east-west. Small objects fell. Furniture overturned and broke. Small plaster cracks. Block yard walls, about 1.7 m. high, demolished. "The severe shaking seemed to last for about 2 to 3 minutes. Multistory wood frame stucco buildings in neighborhood suffered extreme damage in shear walls but little damage in horizontal elements, such as floors and ceilings. Modern reinforced masonry buildings all seem damaged around corners at roof level." Ground: Silty sand, compact, level.

10027 Wish Avenue. Felt by, awakened, and frightened all in community (observer in new, well-built, one-story wood frame building). Building creaked very violently. Hanging objects swung violently north-south. "Very violent ground motion, seemed rippling, causing the house to tilt about 5°. Little or no structural damage or plaster cracking in the residences in our immediate vicinity. Considerable damage to concrete block walls in the area, particularly those oriented

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in an east-west axis. Approximately 30 m. of wall totally destroyed on my property. Floor lamps and table lamps were all tipped over. Considerable breakage of dishes and bric-a-brac." Ground: Silty alluvium, very fine, compact, level.

10952 Etiwanda Avenue (near Chatsworth St. and Reseda Blvd.). Felt by and awakened all in community; frightened many (observer in 15-year-old, well-built, one-story wood frame building). Roaring earth noises combined with noise of huge bookshelves breaking loose; all cabinets opened; great crashing noise. Vehicles rocked. Lost about 0.6 m. of pool water. Chimneys cracked, twisted, and overturned. Hanging objects swung violently south-north. Small objects fell. Furniture shifted, overturned, and broke. Plaster cracked, broke, and fell. Five-drawer steel file cabinet overturned. Ground: Filled in.

8419 Yolanda Avenue (near Roscoe and Reseda Blvds.). Felt by, awakened, and frightened all in community (observer in well-built, one-story wood frame building). House made very loud cracking noise; walls moved; floors rose and fell; difficult to distinguish earth noises from building noises. Trees and bushes shook. Above-ground pool damaged. Block wall cracked. Hanging objects swung violently southeast. Small objects fell. Upright piano moved about 20 cm. east; refrigerator moved about 0.9 m. southeast. Paint cracked. Damage slight. Ground: Adobe, very slightly sloping; high water table.

10306 Sylvia Avenue. Felt by and awakened all in community; frightened all in well-built, one-story wood frame building. Building creaked loudly. Rumbling earth noises. Driveway cracked. Swimming pool lost about 12 cm. of water. Block walls toppled and weakened. Portable planters moved. Hanging objects swung violently east-west. Small objects shifted, overturned, and fell. TV overturned. Bed moved about 15 cm. Plaster cracked slightly. Damage slight. Ground: Adobe, compact, sloping.

17527 Burton Street. Felt by and awakened all in community; frightened many (observer in fairly old, well-built, one-story wood frame building). Loud earth noises. Vehicles rocked. Water disturbed and dirty. Trailer knocked off jacks. Electricity off 30 minutes; phone out for 2 hours. Hanging objects swung violently north-south. Small objects shifted, overturned, and fell. Furniture shifted and overturned. Chest of drawers fell south. Pots and pans dumped out of cupboard (doors open to west). Movement was difficult. Many aftershocks were felt during first 2 days; several thereafter. Ground: Compact, level.

18822 Chase Street. Felt by, awakened, and frightened all in community (observer in new, one-story wood frame building). Everything rumbled and rattled. Sounded as if the house were being shaken down. Loud earth noises. Patio cement cracked and old cracks widened. Chimney fell next door. Block walls weakened and ready to topple. Hanging objects swung east-west. One lamp toppled; one glass swag fixture broke. Water cooler broke. Shower glass cracked. Plaster cracked. Water sloshed out of toilet bowl. "We were awakened from a sound sleep by the violent motion and noise. With much difficulty we made our way into the children's bedroom. One bedroom door was jammed

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shut. All four of us were in the hall long before the tremor of the first shock had subsided. I was nauseated as soon as I got to our bedroom doorway, and for about a half-hour afterward I felt as if I were walking uphill. I cut my toe on some broken glass but I was so numb that I didn't notice it until about 7 a.m. I have adjusted fairly well to the numerous aftershocks. The only ones that bother me are the ones that jerk the house. The shock of February 20 renewed much of the terror I had felt but forgotten." Ground: Alluvium, level.

19530 Pine Valley Avenue (west Porter Ranch District). Felt by, awakened, and frightened all in community (observer in new, two-story wood frame building). Building rumbled, groaned, and swayed northeast-southwest. Earth noises so loud that noise from falling objects could not be heard. Trees and bushes shook. Lost 0.6 m. of water from swimming pool; metal pool cover thrown about 2 m. to west. Chimneys cracked, twisted, and overturned in the vicinity. Wrought-iron fence broke. Hanging objects swung violently in circular direction; hanging light with about 2.4 m. chain swung in large circle. Small objects fell; dishes broke. Door lock broke. Furniture shifted. Plaster fell. Small overhang roof (tile) sagged and must be replaced. "Aftershocks have caused cracks in plaster and small, partial roof and garage door to sag. For the first several hours we felt seasick." Ground: Compact, on hill.

18908 Kirkcolm Lane (about 5.5 km. due west of Lower Van Norman Lake, in Porter Ranch District). Felt by, awakened, and frightened all in community (observer in new, one-story wood frame building). Building made violent sounds. Loud earth noises. Power out. No water for 4 days. Exterior block walls fell, breaking windows and putting holes in stucco walls and doors. Hanging objects swung violently north-south. Small objects shifted, overturned, and fell. Furniture shifted. Plaster cracked. Damage slight. "A remarkable experience to live through." Ground: Compact, level, and sloping.

17735 Fullerfarm Street. (VI) Felt by and awakened all in community; frightened few (observer in new, well-built, one-story wood frame building; large windows on south side). Trees and bushes shook. Lost about 20 cm. of water from swimming pool. Large rocks moved. Hanging objects swung violently east-west. Lamps overturned. Calculator fell to floor. No damage. Ground: Sandy clay, compact, level.

17060 Parthenia Street. (VI) Felt by, awakened, and frightened all in community (observer in old, well-built, one-story wood frame building). Floors and walls creaked and swayed. Trees and bushes shook; vehicles rocked. Lost about 0.6 m. of water from swimming pool. Hanging objects swung violently; light bulbs broke. Water sloshed out of toilet bowls. Small objects fell; dishes broke. Damage slight. Ground: Level.

19100 Celtic Street. (VI) Felt by and awakened all in community; frightened many (observer in new, two-story wood frame building on slab). Extreme creaking of building. Loud earth noises preceded shock. Street lights swayed. Hanging objects swung violently in all directions. Small objects fell. Small tables overturned in easterly direction; water cooler and lamps overturned. "I was sitting in the

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kitchen. I heard a deep, distant rumbling sound and immediately thought it was an earthquake. I moved to the stairs to alert my wife, but as I reached the stairs, a series of short, sharp jolts struck the building and I was unable to walk up the stairs. I then found myself braced in the kitchen doorway, but how I got there I don't know. In the meanwhile it seemed that the jolts had built up rather steadily in intensity and frequency; motion seemed to be predominantly east-west. Souvenir spoons held in reverse tapered slots were dislodged and fell to the floor. Damage to furnishings was assessed at about \$6.20. Observable damage in the immediate neighborhood was relatively minor. A small, nondesigned block retaining wall collapsed. About 30 to 45 cm. of water sloshed out of swimming pool."

Ground: Filled in, sloping.

19101 Celtic Street. (VI) Felt by and awakened all in community; frightened all in new, well-built, two-story wood frame building. Building creaked very loudly. Loud earth noises. Water splashed from swimming pool and commodes. Hanging objects swung violently east-west. Small objects shifted, overturned, and fell. Furniture shifted, overturned, and broke. Next-door swimming pool cracked. Next-door neighbor's wall knocked over; five blocks in upper course of 1.8-m.-high block wall knocked over. Damage slight. Ground: Compact, about 0.6 m. of fill.

9200 Wilbur Avenue. (VI) Felt by, awakened, and frightened all in new, well-built, one-story wood frame building. Faint earth noises. Hanging objects swung moderately. Small objects shifted, overturned, and fell. Furniture shifted. Plaster fell. Damage slight. Ground: Compact, level.

8806 Zeizah Avenue. (VI) Felt by and awakened all; frightened many (observer in well-built, two-story wood frame building). Loud earth noises. Trees and bushes shook; vehicles rocked. Pool lost about 0.6 m. of water. Hanging objects swung violently. Small objects overturned and fell. Furniture shifted, overturned, and broke. Ground: Compact, level.

9809 Donna Avenue. (VI) Felt by all in community; awakened and frightened all in new, one-story wood frame building. Building rocked back and forth and floor seemed to go up and down in undulating movement. Moderate earth noises. Everything shook. Slight crack at top of chimney. Hanging objects swung moderately north-south. Small objects overturned and fell; many dishes broke. Furniture shifted. "The houses in our neighborhood held up well. Experienced considerable movement in basically north-south direction and what felt like undulating of the floor. Many block walls, 1.5 to 1.8 m. high, toppled, particularly in the north-south direction, as personally observed." Ground: Sandy silt; former orchard.

10917 Des Moines Avenue. (VI) Felt by, awakened, and frightened all (observer in two-story wood frame building). Moderate earth noises. Water disturbed. Cement walls cracked. Hanging objects swung moderately east-west. Small objects shifted, overturned, and fell. Plaster cracked, broke, and fell very slightly (drywalls). Ground: Compact, sloping.

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Pacoima (excluding the more strongly shaken areas of northern Pacoima) and Arleta District south of Pacoima:

Van Nuys Boulevard, near Telfair Avenue (Pacoima Post Office; report from postmaster). Felt by, awakened, and frightened all in community (observer in old, well-built, one-story block building). Vehicles rocked. Ground cracked. Gas-lines broke. Chimneys overturned; outside block walls knocked down. Hanging objects swung violently. Small objects fell. Furniture overturned. Building shook rapidly back and forth for 1 minute. Crack in floor the length of the building (post office). Damage moderate. Ground: Sandy, sloping.

13563 Montague Street (Arleta district, south of Pacoima, in area just east of Panorama City). Felt by, awakened, and frightened all in community (observer in old, well-built, one-story wood frame building). Loud, roaring earth noises. Water disturbed. Hanging objects swung violently east-west. Small objects shifted, overturned, and fell. Furniture shifted, overturned, and broke. Plaster and windows cracked. Damage slight. "In our house the refrigerator door opened and everything fell out, also most things from the cupboards. Our next-door neighbor's cupboards face the same direction as ours but she lost only one bottle of catsup. Our kitchen had to be cleaned out with a shovel. Most of the furniture in the family room moved at least 15 to 20 cm. from walls, including a large player piano. We couldn't tell in which direction it was shaking--seemed to be both bouncing and swaying. We tried to walk through the house to get the children and had to hold onto the walls to keep from falling. Our block fences are all cracked but still standing. We have many cracks outside, but few cracks inside." Ground: Level, filled in.

9217 Dorrington Place (Arleta district). (VI) Felt by, awakened, and frightened all in community (observer in well-built, one-story wood frame building; on slab). Faint earth noises. Water spilled from toilets and fishbowl. Small objects shifted, overturned, and fell. Furniture shifted. Damage slight. "No structural damage; new cracks limited to stucco at corners of door frames and windows. Less damage to interior objects than in neighbor's house on conventional foundation." Ground: Compact, level.

9844 Mercedes Avenue (Arleta district). (VI) Felt by, awakened, and frightened all in old, well-built, one-story wood frame building. Entire house shook. Car rocked. Pool overflowed. Hanging objects swung east-west. Small objects fell and broke. Furniture shifted. Ground: Gravelly, level.

Panorama City:

13652 Cantara Street (Kaiser Foundation Hospital). Lew and others<sup>3</sup> reported: "Ten-story reinforced lightweight concrete shear wall structure. There was severe cracking of the shear walls in the first, second, and third stories. The doors to the interior stairwell on the second and third floors were rendered inoperable due to the crushing of the spandrel beam in the shear wall. The fourth-floor slab, which is the transfer slab between the circular tower shear walls and the walls below, cracked and displaced vertically. There was no apparent sign of structural damage above the fourth-floor level. About 50 glass panels fell from the building. All the elevators were out of service after the earthquake. The entire hospital remained in operation."

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14545 Lanark Street and 8155 Van Nuys Avenue. Building at 14545 Lanark Street was reported as very badly damaged. Building at 8155 Van Nuys Avenue also was damaged. (From a letter by Superintendent of Buildings, Department of County Engineer, Los Angeles.)

14861 Lorne Street. (VI) Felt by, awakened, and frightened all, except 3-year-old, in old, well-built, one-story wood frame building. Loud earth noises. Lamp and few books fell; fell toward south. Waterline broke between meter and house. Stucco cracked. Damage slight. "Both vertical and lateral movement of house was very pronounced." Ground: Compact, level.

8734 Tyrone Avenue. (VI) Felt by, awakened, and frightened all in old, well-built, wood frame building. Building moved and vibrated. Electricity went off at once over entire area. Hanging objects swung violently east-west. Small objects shifted and fell. Furniture shifted. Plaster cracked.

Pasadena:

The following, from Steinbrugge and others<sup>8</sup>, does not include publicly owned structures: "10 buildings damaged; posted unsafe, 4; demolished or to be demolished--churches and schools, 1; 2,000 chimneys damaged; estimated total dollar loss, \$2-1/2 million." A press report of Feb. 19, 1971, stated Pasadena city officials roughly estimated damage at \$200,000 to public property, with the majority of the loss attributed to road damage. The largest single item occurred on Park View Avenue, which runs parallel and east of Linda Vista Avenue. There approximately 243 m. of retaining wall standing 3 m. high was affected, with approximately 91 m. of the wall reduced to rubble. Estimates for repair of the wall make up the major portion of the \$200,000 figure.

4800 N. Oakgrove Avenue (Jet Propulsion Laboratory). One engineer at the laboratory estimated minor damage to the laboratory at about \$200,000. Another engineer reported: "I arrived at work about 7:50 a.m., and made numerous surveys of buildings on the laboratory grounds to assess structural damage. Structural damage was superficial. Some spalling of concrete columns and concrete block walls. Some cracking of concrete walls. Considerable damage to architectural finishes (plaster, suspended ceilings, lighting fixtures). Expansion joints and seismic joints had worked and caused buckling of threshold strips and buckling and displacement of metal water stops at joints. Some waterlines broke." The structure is a 12-story steel and concrete building. Ground: Compact, sloping.

1201 E. California Boulevard (Millikan Library, California Institute of Technology). The California Institute of Technology<sup>2</sup> reported: "Nine-story reinforced concrete building. Many bookshelves collapsed on the upper floors, and threw many books to the floor. With the exception of hairline cracking in the plaster around some window panels, no damage to the building itself was observed."

721 St. John Avenue. Felt by and awakened all in old, two-story wood frame building; frightened many. Much splashing of pool water. One chimney toppled, one damaged severely. Hanging objects swung violently. Small objects overturned. Plaster on three walls badly shattered. "House has cobblestone veneer on first floor which moved about 2.5 cm. The shortest chimney, about 1 m. above

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the roof, was completely destroyed. A second chimney, about 2.5 m. above the roof, was badly shattered and needs to be rebuilt. The third chimney, about 3.5 m. above the roof, had been rebuilt with reinforced masonry and it survived very well." Ground: Gravelly, alluvial fan, compact, level.

2150 Canyon Close Road. Felt by all in community (observer in new, well-built, one-story wood frame building). "Probably awakened all." Faint earth noises. Trees and bushes shook; vehicles rocked. Chimneys cracked, twisted, and overturned. Small objects shifted, overturned, and fell. Furniture shifted, overturned, and broke. Plaster cracked, broke, and fell. Windows cracked. Damage slight in the area. Ground: Rocky, gravelly, gently sloping.

116 Club Road. Felt by, awakened, and frightened all in community (observer in strongly built wood frame building). Loud earth noises. Hanging objects swung north. Furnishings shifted; vases, etc., overturned. Plaster, windows, walls, and chimneys cracked. Chimneys fell. Knickknacks, books, pictures, and plaster fell. Dishes and windows broke. Damage slight to brick. Ground: Compact, sloping.

890 S. Rosemead Boulevard. (VI) Felt by, awakened, and frightened many in community (observer in well-built, two-story wood frame building; went outside during shock). Building racked severely. Ground rolled. About 25 percent of water sloshed out of swimming pool. Chandelier swung violently north-south. Small objects shifted, overturned, and fell. Plaster cracked. Damage slight. Ground: Compact, level.

About 1-1/2 blocks from California Institute of Technology. (VI) Felt by observer in wood frame building. Loud earth noises; then severe earthquake. Motion seemed to last more than 2 minutes. Personal effects were tossed about the rooms; items tossed off furniture; furniture, including heavy appliances, was far from original position. Bookcases almost emptied; dishes and utensils jarred from cabinets. Lights flickered.

325 S. Orange Grove Boulevard. (VI) Felt by and awakened all in community; frightened few (observer in 11-year-old wood frame building; part of an apartment complex of 18 apartments in four two-story buildings). Loud earth noises. Chimneys cracked in neighborhood. Hanging objects swung moderately to violently. Small objects fell off tables, etc. Furniture overturned. Plaster cracked, especially around fireplaces. Windows cracked. Water thrown out of swimming pool, and seemed to indicate maximum motion in east-west direction. "Checking of other apartment also indicated maximum motion in east-west direction. Pendulum on grandfather clock hit sides and stopped. The upper removable part of a china cabinet moved east and one of its four supports left a groove about 10 cm. long." Ground: Loam, level.

281 E. Colorado (Post Office). (VI) Felt by all in old, well-built, two-story concrete and steel building; general panic. Several rolling jerks. Loud earth noises. Hanging objects swung violently east-west. Furniture shifted. Plaster broke and fell. Damage slight. Ground: Compact, level.

515 S. Bonita Avenue. (VI) Felt by and awakened all in old, well-built, two-story

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wood frame building; frightened few. Small objects shifted, overturned, and fell. Brick chimney cracked. Small amount of plaster cracking. Ground: Gravelly, alluvial fan, level.

2223 Loma Vista Street. (VI) Felt by and awakened all in community; frightened few (observer in old, well-built, one-story wood frame building). Moderate earth noises. One small vase fell. Furniture shifted slightly. Superficial plaster cracks. "Some windows cracked and some chimneys cracked and twisted in community." Ground: Gravelly, gently sloping.

1140 Hastings Ranch Drive. (VI) Felt by all in community; awakened and frightened all in well-built, one-story wood frame building. General building noise. Some cracking of chimneys. Some small objects shifted, overturned, and fell. Some plaster cracked. "No real damage." Ground: Compact, sloping.

1405 S. Oakland Avenue. (VI) Felt by, awakened, and frightened all in community (observer in old, well-built, one-story wood frame building). Building creaked and thumped. Loud earth noises. Small objects shifted and overturned. Items shifted to north. Furniture shifted. "Chimneys cracked and overturned in the area but not at my residence." Ground: Clayey, sloping.

140 Glen Summer Road. (VI) Felt by and awakened all in community; frightened many (observer in old, well-built, one-story wood frame building). Chimneys cracked. Small objects shifted, overturned, and fell. Ground: Compact, level.

1989 E. Mountain Street. (VI) Felt by and awakened all in community; frightened many (observer in strongly built wood frame building). Moderate rumbling earth noises from all directions about 5 seconds before shock. Trees and bushes shook moderately. Small objects and furnishings shifted; small objects overturned. Plaster, walls, and chimneys cracked. Knickknacks, books, pictures, and plaster fell. Dishes broke. Damage slight. Ground: Conglomerate, level.

6 Westmoreland Place. (VI) Felt by, awakened, and frightened all in community (observer in strongly built, two-story wood frame building). Loud earth noises, seemed from all directions but especially from underneath, heard about 5 seconds before shock. Hanging objects swung mostly north-south. Trees and bushes shook moderately. Mirrors and pictures fell from walls, etc.; statues and clocks fell. Plaster, walls, and chimneys cracked; chimney moved 12 to 15 cm. west and a part of it fell. "Mostly just minor damage to building." Ground: Soil, compact, on slope.

916 Linda Vista Avenue. (VI) Awakened and frightened all in strongly built, two-story wood frame building. Loud earth noises from east. Hanging objects, doors, etc., swung. Trees and bushes shook slightly. Small objects shifted; mirrors and clocks broke. Plaster cracked. Damage slight. Ground: Compact, level.

1355 Daveric Drive (northeast Pasadena, north of Foothill Blvd.). (VI) Felt by and awakened all in community; frightened few (observer in new, well-built, one-story wood frame building). Loud earth noises. Bushes shook; vehicles rocked. Chimneys and ground cracked. Hanging objects swung violently. Small objects fell. Furniture shifted. Plaster cracked. Damage slight. Ground: Decomposed granite, steep.

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Reseda:

7032 Reseda Boulevard. Felt by and awakened all in community; frightened many (observer in new, fairly well-built, one-story wood frame building). Building made wrenching sound. Loud, rumbling earth noises. Water slopped from tubs. Block garden wall fell in southerly direction. Hanging objects swung violently west. Small objects shifted, overturned, and fell. Refrigerator shifted. Plaster cracked. "The 1.8-m.-high block garden wall that fell was not reinforced by steel. Some roofs in the area buckled. Asphalt driveways and some new sidewalk around power poles cracked. Doors on cupboards and furniture facing north or south flew open; on shelves running north-south, nothing fell, not even from those near the ceiling. Windows in house are all aluminum-framed and did not crack, though quite large. Damage moderate and slight. Stucco cracks were widened by aftershocks." Ground: Clay, partly filled in, level.

7320 Reseda Boulevard (Post Office). (VI) Felt by all in old, well-built, one-story brick building; frightened few. Waterline in air-conditioning system broke. Hanging objects swung east-west. Canceling machine moved about 10 cm. "During the initial shock I was standing near the center of the floor in the workroom. The floor seemed to move back and forth in an east-west direction. Because of the large expanse of the ceiling, with no support posts, there was considerable creaking of the roof trusses. The workroom floor is about 30 by 45 m. Some plaster fell from the Postal Inspector's galley, which runs through the center of the building, and mostly fell from the end and from the area around the steel side supports. Before the tremor ceased, all lights in the building went out. The 50 or more employees left the building. No apparent structural damage." Ground: Compact, level.

7211 Reseda Boulevard. (VI) Felt by, awakened, and frightened all in old, well-built, two-story wood frame and stucco building. Small objects overturned and fell. Furniture shifted. Plaster cracked. Damage slight. Ground: Compact, level.

19438 Calvert Street. (VI) Felt by, awakened, and frightened all (observer in 15-year-old, one-story wood frame building). Faint earth noises. Swimming pools overflowed. Hanging objects swung violently east-west. Small objects shifted, overturned, and fell. "Block garden walls fell." No damage to observer's house.

7913 White Oak Avenue. (VI) Felt by, awakened, and frightened all in community (observer in old, one-story wood frame building). House shook violently. Loud, roaring earth noises. Bookcase overturned. Dishes and cans fell out of cupboard; dishes broke. Hanging objects swung violently south. Post on porch shifted. Plaster cracked on ceiling. Damage slight. Ground: Sandy, level.

18707 Haynes Street. (VI) Felt by and awakened all in community; frightened many (observer in 15-year-old, well-built, wood frame building). Moderate earth noises. Trees and bushes shook; vehicles rocked. Hanging objects swung violently east-west and north-south. Small objects shifted, overturned, and broke. Plaster cracked. Ground: Level.

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Sepulveda:

Holiday Inn (corner of Roscoe Blvd. and Orion St.). The California Institute of Technology<sup>2</sup> reported: "Seven-story reinforced concrete building. Extensive damage to interior plaster walls, to the plumbing fixtures, etc., on the second, third, and fourth floors. The upper three floors were not damaged severely. The non-structural damage has been estimated at approximately \$250,000."

Veterans Administration Hospital (about 4 km. south of the Lower Van Norman Reservoir). Lew and others<sup>3</sup> reported: "Buildings range from one to six stories and are designed to resist earthquake forces. Overall, there was only minimal structural damage to the hospital. The operation of the hospital was not interrupted. However, extensive elevator and plaster repairs were required and a number of seismic joints required replacement."

9037 Burnet Avenue (2 blocks east of Sepulveda Blvd., 1/2 block south of Nordhoff). Felt by, awakened, and frightened all in community (observer in about 40-year-old, well-built, one-story wood frame building). Very loud, rumbling earth noises. "Telephone pole tilted east-west (across street). Chimney cracked vertically where it lies against the house. Huge crack on cement foundation of garage floor, running east-west across the floor. Small chicken shed tilted south. The house was a mess inside. Anything on top of furniture, mantels, tables, etc.) was thrown down and broken. Stove and icebox in kitchen moved. In the garage, a 1.8- by 1.8-m. bookcase, full of books, was overturned. Garage had to be 'dug through' to put things back in place. It suffered worse than the house. We inspected the house and did not see any new cracks, but since the aftershocks, we have found many new cracks, running south-north, about the thickness of a razor blade. There are many old cracks running in the same direction. All of our cement porches (three) have shifted about 2 cm. away from the house. We have found exterior cracks on garage and house since the aftershocks. In our house, all objects on north-south walls fell; in neighbor's house (across street), all objects on east-west walls fell, none on north-south walls." Ground: Creek bottom, sandy, level.

10108 Gloria Avenue. Felt by and awakened all in community; frightened many (observer in well-built, one-story wood frame building). Loud earth noises. Trees and bushes shook; vehicles rocked. About 18 m. of block wall fell and about 45 m. cracked. Hanging objects swung violently. Small objects fell from kitchen cabinets and in garage. Dishes and lamps broke. Interior and exterior plaster cracks. Damage moderate. Ground: Compact, level.

9752 Marklein Avenue. Felt by all in community; awakened and frightened all in new, well-built, one-story wood frame building. Water disturbed. Garden wall cracked. Stucco slightly cracked; minor kitchen counter tile cracking. Hanging objects swung violently north-south. Furniture shifted. Heavy books on north-south shelves fell sideways--not off shelves. Portable TV against north wall fell to floor. Kitchen and both bathroom floors were littered with broken glass. Hot water heater tank connections loosened; water leaked. China cabinet and refrigerator on east-west walls shifted about 15 cm. from walls. No structural damage." Ground: Compact, filled in, level.

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Post Office (report from postmaster). Felt by and awakened all in community; frightened few (observer in new, well-built, one-story concrete block building). Loud earth noises. Trees and bushes shook; vehicles rocked. Ground cracked; landslides; water disturbed. Chimneys cracked. Hanging objects swung violently in all directions. Small objects shifted, overturned, and fell. Furniture shifted. Plaster and windows cracked. Slight nonstructural damage to post office building. Ground: Compact, level.

8861 Langdon Avenue. (VI) Felt by, awakened, and frightened all in community (observer in new, two-story wood frame and stucco building). Building bounced up and down. Loud, banging earth noises. One-third of water splashed from swimming pool. Lights out. Small objects fell, some broke. Furniture shifted. Walls cracked; plaster cracked. Damage moderate. Ground: Compact, level.

15901 Gledhill Street (near Veterans Administration Hospital). (VI) Felt by all in community; awakened and frightened all in well-built, one-story wood frame building. Loud earth noises. Slight spalling of sidewalk at pool joints. Hanging objects swung violently. Small objects shifted, overturned, and fell; dishes broke. Planter, about 0.9 m. high, moved about 0.6 cm. from south wall. Ground: Adobe, underlain by sand, level.

Corner of Sepulveda Avenue and Nordhoff Street. (VI) Felt by, awakened, and frightened all in community (observer in old, well-built, 5.2-m. travel trailer). Rumbling earth noises. Trees and bushes shook; vehicles rocked. Water and gas service disturbed. Hanging objects swung moderately. Small objects in cupboard overturned; radio fell. "Plaster cracked and fell; many windows cracked in the area, including windows at furniture store. Damage very slight at our place." Ground: Level.

Sherman Oaks:

Union Bank Building (northeast corner of Sepulveda and Ventura Blvds.). The USGS-NOAA<sup>9</sup> reported the following: "The structure is 13 stories high over a two-level subterranean garage. Structural damage was limited principally to the four-corner columns." Nonstructural damage was reported as: "Elevators out of commission; several doors in the second, third, fourth, and fifth floors were slightly jammed, indicating some partition movement; considerable areas of ceiling tile over the second floor fell; one dry-wall partition at the east end of the building buckled and showed horizontal movement; some steel stairlandings pulled away from their supports but were still functional; five large panes of glass in the first floor cracked or broke; marble veneer in the first-floor lobby cracked and fell away from the walls and had to be replaced. The upper floors showed the least damage, and the penthouse showed no damage. The mechanical equipment in the penthouse was intact and securely mounted."

Bank of California Building (across street from the Union Bank Building). Lew and others<sup>3</sup> reported: "Twelve-story reinforced concrete building. There were cracks in the building frame over most of its height. These were especially pronounced in the connection of the lightweight concrete beams to the normal weight concrete columns. This damage was being repaired with epoxy."

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3817 Cody Road. Felt by, awakened, and frightened all in community (observer in 15-year-old, one-story wood frame building). Moderate earth noises. Trees and bushes shook; vehicles rocked. Ground cracked slightly. Unreinforced chimneys cracked, twisted, and overturned. Hanging objects swung violently. Small objects shifted and overturned. Plaster cracked. Damage slight. "The major ground motion seemed to be east-west; lasted for about 1 minute. Very little damage to houses in general vicinity (hillside houses on rock), but houses at lower elevations on softer substrata appeared to sustain larger accelerations and more damage." Ground: Rocky, hillside.

15204 Sutton Street. Felt by, awakened, and frightened all in community (observer in old, well-built, one-story wood frame building). Loud, roaring, thunderlike earth noises. Sidewalk slab cracked. Chimneys cracked. Small objects overturned and fell. Plaster, on both east-west and north-south walls, cracked in several rooms. Drawers and cabinets on north wall of kitchen were disturbed more than others in the house. Candelabra rolled or was thrown from piano top in an easterly direction for a distance of about 2 m. "All people remarked that vertical motion definitely occurred as well as horizontal motion." Ground: Silty clay, alluvial, 4 percent slope toward north.

4245 Longridge Avenue. (VI) Felt by and awakened all in community; general panic (observer in well-built, two-story wood frame building). Loud earth noises. Hanging objects swung violently north-south. Small objects fell; bottles broke. TV set fell off shelf. Ground: Compact, level.

4628 Allott Avenue. (VI) Felt by, awakened, and frightened all in community (observer in old, well-built, one-story wood frame building). Loud earth noises. Water press regulator broke; heater gas valve cracked. Small objects fell. Plaster cracked. Damage slight. Ground: Compact, level.

13141 Addison Street. (VI) Awakened and frightened all in community; general panic (observer in old, well-built, two-story wood frame and stone building). Trees and bushes shook; vehicles rocked. Hanging objects swung back and forth. Small objects shifted, overturned, and fell. Plaster cracked, broke, and fell. Damage slight. Ground: Loose, level.

13140 Otsego Street. (VI) Felt by and awakened all in community; frightened all in old, well-built, one-story wood frame building. House jerked violently north-south. Everything in house disturbed. Water in pool splashed out. Hanging objects swung violently north-south. Furniture shifted. "All power was out. Telephone out of order. Water was not fit for drinking." Ground: Alluvium, level.

2370 Roscomare Road. (VI) Felt by, awakened, and frightened all in community (observer in new, well-built, two-story wood frame building). Moderate earth noises. Trees and bushes shook; vehicles rocked. Hanging objects swung north-south. Small objects shifted. Plaster cracked in few places. Ground: Loose, very steep; house on level lot.

3720 Stone Canyon Avenue. (VI) Felt by, awakened, and frightened all in new, well-built, one-story wood frame building. Building creaked very loudly. Loud earth noises. Trees and bushes shook; vehicles rocked. Pool water disturbed.

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Hanging objects swung violently east-west. Small objects overturned. Plaster cracked. Damage slight. "Movement was primarily horizontal; very little vertical motion. The period seemed very long, about 1.5 sec. Duration also was very long and constant, about 30 sec." Ground: Gravelly, sloping.

South Pasadena:

The following, from Steinbrugge and others<sup>8</sup>, does not include publicly owned structures: "Buildings damaged, 20; posted unsafe, 1; 300 chimneys damaged; estimated total dollar loss, \$275,000." Observer reported community water tank leaked.

1645 Amberwood Drive, No. 15. Felt by, awakened, and frightened all (observer in old, moderately well-built, three-story wood frame building). Faint earth noises. Earth moved in southeast direction. Pool water disturbed. Some chimneys damaged on older houses in the area. Frictionless objects on floor displaced about 0.6 m. Hanging objects swung violently northwest. Small objects overturned and fell. Refrigerator moved about 0.3 m. in northwest direction. Small plaster cracks over doors and windows. Damage slight. Ground: On slope of Raymond Hill; on Raymond Fault.

2018 Berkshire Avenue. (VI) Felt by, awakened, and frightened all in community (observer in old, well-built, three-story wood frame building). Moderate earth noises. Two chimneys damaged (bricks fell and all others loosened). Water in swimming pool sloshed out about 2 m. on each side of pool. Hanging objects swung violently. Small objects overturned and fell. Furniture shifted. Plaster cracked. Damage slight. "One ground crack on Monterey Road. About 75 chimneys damaged in the community (75 reported to city, probably substantially more affected). Large plate glass windows in several stores broke." Ground: Compact, sloping.

1336 Elmpark Street. (VI) Felt by and frightened all in well-built, one-story wood frame building. Indoor house planter, 0.9 m. high, overturned to northwest. Water from aquarium sloshed to north. Hanging objects swung violently. Many knickknacks fell and broke; china and crockery fell and broke. "Greatest damage to chinaware was caused by items falling from window valances on west wall of house and from items falling out of open-front china closet against west wall and facing northeast." Ground: Adobe, level.

218 Los Laurees (Monterey Hills area). (VI) Felt by and awakened all in community; frightened many (observer in new, well-built, one-story wood frame building; slab in most of building). Walls shook strongly. Moderate earth noises. Hanging objects swung moderately east-west. Lamps, vases, etc., overturned. Water sloshed out of one toilet bowl. One old crack in garage slab appeared to be widened slightly. "One hundred chimneys were down in South Pasadena and at least that many were damaged." Ground: Compacted fill, sloping.

1326 Via Del Rey. (VI) Felt by and awakened all in community; frightened few (observer in new, well-built, one-story wood frame building). Loud earth noises. Chimneys cracked. Hanging objects swung moderately east-west. House shook as from an unbalanced ventilating fan. No damage to house or contents. "In the

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old section of town many unreinforced brick chimneys cracked or fell. Some old brick parapets fell in the commercial area. One or two buildings of unreinforced masonry construction showed severe cracking." Ground: Rocky, shale; level pad on hillside.

- 413 El Coronado. (VI) Felt by all in community; awakened and frightened all (observer on second floor of new, two-story wood frame building). Loud earth noises. Wood fence door fell. Hanging objects swung violently north-south. Small objects fell. Furniture shifted. Plaster cracked, some fell. Two large windows shattered. Damage moderate. Ground: Gravelly, level.
- 720 Orange Grove Avenue. (VI) Felt by and awakened all in old, well-built, two-story wood frame building. Building rocked. Moderate earth noises. Chimney separated from building by about 2.5 cm. at top of roof ridge. Candlesticks overturned; minor displacement of dishes. "Motion seemed to be in all directions, including vertical (house faces due west); heavy shaking; not wavelike or rhythmic." Ground: Compact, level.
- 1608 Amberwood Drive. (VI) Felt by, awakened, and frightened all in community (observer in 10-year-old, well-built, two-story wood frame building). Building rocked and creaked. Moderate earth noises. Hanging objects swung violently north-south. Some dishes broke. Furniture shifted. Minor plaster cracks. Damage slight. "Shock was quite severe." Ground: Gravelly, top of hill, level stress slope front to rear.

Sunland:

8632 Le Berthon Street (northwest Sunland area). Felt by, awakened, and frightened all in community (observer in well-built, one-story wood frame and stucco building). Loud earth noises. Trees and bushes shook. Block walls fell. Hanging objects swung east-west. Small objects shifted, overturned, and fell. Furniture shifted, overturned, and broke. "Our heavy plate glass mirror in bedroom was ripped off the wall, taking some plaster off the wall. Built-in oven was sprung from the cabinet. The hutch in dining room was thrown down, breaking all contents, and landed on the dining room table, badly damaged." Ground: Sandy loam, level, and terraced.

8442 Oswego Street. Felt by, awakened, and frightened all in community (observer in well-built, one-story wood frame building). Loud earth noises. Trees and bushes shaken strongly. Small objects and furnishings shifted; vases, etc., small objects, and furniture overturned. Plaster, windows, walls, chimneys, and ground cracked. Knickknacks, books, pictures, plaster, and walls fell. Dishes, windows, and furniture broke. Damage slight to brick. Ground: Level.

10734 Nassau Avenue. (VI) Felt by, awakened, and frightened all in community (observer in old, well-built, one-story wood frame building). Patio roof groaned and shuddered. Rocks in garden rolled. Hanging objects swung north-south. Small objects shifted, overturned, and fell. Furniture shifted, overturned, and broke. Plaster cracked, broke, and fell. Windows cracked. "Damage to furniture and dishes was in excess of \$900." Ground: Sloping.

10114 McBroom Street (west Sunland area). (VI) Felt by and frightened all in old, one-story wood frame building. Building creaked loudly. Loud earth noises.

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Hanging objects swung violently. Glasses, food, etc., fell from cupboards. Furniture shifted. "Shock was violent enough to knock one off his feet if not holding on to something solid." Ground: Rocky, slightly sloping.

Sun Valley:

No address given (report from postmaster). Felt by, awakened, and frightened all in community (observer in well-built, one-story brick building). Faint earth noises. Trees and bushes shook; vehicles rocked. Chimneys cracked, twisted, and overturned. Hanging objects swung violently. Small objects shifted, overturned, and fell. Damage moderate. "Motion of shock was in different directions--east-west, north-south; stronger in some areas. Many aftershocks." Ground: Compact, level.

13146 Schoenborn Street. (VI) Felt by all and frightened many in community; awakened all in 16-year-old, one-story wood frame building. Moderate rumble. Water in street due to sloshing of swimming pools. Hanging objects swung violently northwest-southeast. Small objects shifted, overturned, and fell; crystal broke. Furniture shifted and overturned. "I was standing at the time; motion was a violent northwest-southeast shaking. Dining room fixture, on 1.2-m. chain, swung to the ceiling. Glass and crystal fell from every china closet in the neighborhood. No apparent damage to houses in this neighborhood. Typical one-story stucco tract houses seem to react well with no apparent cracking or other damage." Ground: Sandy silt, level.

12444 Jerome Street. (VI) Felt by, awakened, and frightened all in community (observer in 16-year-old, moderately well-built, one-story wood frame building; drywalls). Building creaked loudly; sounded like cracking of wood rafters and studs. Loud, rumbling earth noises. Trees and bushes shook; vehicles rocked. Outside reinforced concrete block wall cracked. Many small objects shifted, overturned, and fell. Furniture shifted slightly. Damage slight. Ground: Sandy, level.

10448 La Tuna Canyon Road (about 2.5 km. northeast of Sunland in La Tuna Canyon). (VI) Felt by, awakened, and frightened all in community (observer in old, well-built, one-story wood frame building). Building sounded as if it were tearing apart. Loud, explosivelike earth noises. "Many people thought it was a bomb. A terrible clap of thunder and lightning combined, then the shaking." Trees and bushes shook; vehicles rocked. Water disturbed. Hanging objects swung violently. Objects moved east-west, piano, refrigerator, etc. Plaster cracked. Damage slight. Ground: Loose, sloping.

Tarzana:

18525 Linnet Street. Felt by, awakened, and frightened all in community (observer in 20-year-old, well-built, one-story wood frame building). Loud earth noises. Trees and bushes shook; vehicles rocked. Water disturbed. House foundation cracked. Waterpipe broke. Small objects shifted, overturned, and fell. Furniture shifted; bed moved up and down and across the floor. Plaster and windows cracked. Toilet and bathtub line damaged. Damage moderate. "There are still (Mar. 9) numerous strong aftershocks. Since we are only 1 block from the area which was evacuated, there was some fear of danger from the Van Norman Dam." Ground: Compact, level.

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18648 Clark Street (Post Office). (VI) Felt by, awakened, and frightened all in community (observer in well-built, one-story wood frame and brick building). Faint earth noises. Vehicles rocked. Hanging objects swung violently north-south. Small objects shifted. Furniture shifted. Plaster fell. Slight damage to brick. Ground: Adobe, level.

18210 Karen Drive. (VI) Felt by and awakened all in community; frightened many (observer in 18-year-old, one-story wood frame building). Trees and bushes shook; vehicles rocked. Cracks widened in pavement and asphalt driveways. Hanging objects swung moderately. Small objects shifted, overturned, and fell. Plaster cracked and fell. Damage slight. "The initial shock was like a sledge-hammer blow; then a creaking, chattering, shaking, and rocking motion, lasting about 20 to 30 seconds. Aftershocks were also hammerlike blows, with shaking." Ground: Shale outcrop, level and sloping; part pad, part fill.

Tujunga:

9427 Crystal View Drive. Felt by and awakened all in community; frightened many (observer in well-built, one-story wood frame building). Faint earth noises. Trees and bushes shook; vehicles rocked. Minor cracking of pavement. Chimneys cracked. Hanging objects swung violently. Small objects shifted, overturned, and fell. Windows cracked (limited mostly to commercial buildings). "Most of the dwellings in the area suffered only minor damage. Some older dwellings suffered moderate to major damage, but these were very few. Many commercial buildings had broken plate glass. Few commercial buildings suffered moderate damage." Damage slight (to observer's home). Ground: Rocky, compact, sloping and steep; many dwellings in area on compacted fill.

Report from postmaster. Felt by, awakened, and frightened all in community (observer walking in well-built, two-story concrete block building). Loud earth noises. Trees and bushes shook; vehicles rocked. Ground cracked. Chimneys cracked, twisted, and fell. Electrical wires down. Hanging objects swung violently east-west. Glass broke. Fixture fell. Small objects fell. Furniture shifted. Plaster and windows cracked. Brick and cement dust fell. Damage slight. Ground: Rocky, sloping.

10346 Fernglen Avenue. Felt by, awakened, and frightened all in community (observer in well-built, one-story wood frame building). Building bounced up and down at least 15 cm. Loud earth noises. Waterpipe, 1.9-cm. diameter, broke. Chimneys cracked and overturned on some houses (not observer's). Hanging objects swung violently. Small objects overturned and fell. Furniture shifted. Plaster and windows cracked. Damage moderate. "From February 9 through February 13 we experienced an average of 12 aftershocks; on February 14, four; on February 15, three. Some came with no warning and just caused a rolling sensation; others would give a warning that sounded like a freight train in the distance, becoming slightly louder, then the jolt. Some jolts shook the house back and forth; others hit with one explosivelike sound and shaking like a sonic boom." Ground: Rocky, overlain by 0.9 m. of top soil, sloping.

10549 Pinyon Avenue (near mountains). (VI) Felt by, awakened, and frightened all

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in community (observer in old, well-built, two-story wood frame building). Building rattled very loudly. Loud, growling earth noises. Trees and bushes shook; vehicles rocked. Chimneys cracked. Hanging objects swung violently north-south, east-west. Small objects shifted and fell. Furniture shifted. Plaster cracked. Two dozen windows cracked. Damage slight. Ground: Rocky, compact, sloping to west.

Van Nuys:

8183 Lesner Avenue (west of Van Nuys Airport, near Balboa Blvd.). Felt by, awakened, and frightened all in community (observer in old, well-built, one-story wood frame building). Everything rattled; building creaked loudly. Moderate earth noises; some loud noises. Ground cracked. Water disturbed. Chimneys cracked, twisted, and overturned. Hanging objects swung violently west-east. Many items broke. Furniture shifted and broke. Many cracks in interior plaster. "People were very frightened, but kept control. In our general area, loss was mostly to dishes and personal items. Parts of block walls came down; water heaters moved, some off elevated stands (most were inside of houses in service porch area). Some people were thrown out of bed. Some cars rolled out of driveways or garages. Traffic became a major problem on streets in the area."

Ground: Compact, level.

17464 Runnymede Street (west of San Diego Freeway). Felt by, awakened, and frightened all in community (observer in 17-year-old wood frame building (slab floor)). Building sounded as if it were cracking. Loud, roaring and rumbling earth noises. Block walls cracked. Pool water sloshed over top of house; pool water lowered by 1.2 m. Water muddy. Hanging objects swung violently east-west. Lamps, books, and stereo fell. TV and chairs shifted about 0.6 m. Plaster cracked in most rooms. One window cracked. Slab cracked. Damage moderate; more outside than inside. Ground: Compact, level.

7863 Greenbush Avenue. (VI) Felt by, awakened, and frightened all in new, well-built, one-story wood frame building. Pool water sloshed; water lowered by about 20 cm. Water splashed out of toilet bowl. Hanging objects swung violently. Books toppled from bookcases and figurines fell from shelves. Furniture overturned. Plaster cracked. Damage slight. Ground: Loose, silty sand.

5224 Allott Avenue. (VI) Felt by and awakened all in community; frightened many (observer in 20-year-old, well-built, one story wood frame building). Faint earth noises. Water sloshed from pool; water lowered by about 20 cm. Hanging objects swung moderately north-south. Small objects shifted. Ground: Compact, silty loam.

7454 Vista Del Monte. (VI) Felt by and awakened all in community; frightened many (observer in 15-year-old, well-built, one-story wood frame building). Moderate earth noises. Vehicles rocked. Pool water lowered by about 22 cm. Chimneys in vicinity cracked (not at observer's home). Hanging objects swung north-north-east-south-southwest. Small objects shifted, overturned, and fell. "Practically no damage to my house; only minor crack in pool deck. Cantilever deck kept more water from splashing out." Ground: Deep alluvium, level.

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14964 Leadwell Street. (VI) Felt by and awakened all in community; frightened many (observer in 15-year-old, one-story wood frame building). Heavy shaking for about 1 minute. Moderate earth noises. Slight ground cracks. Electricity off. Water became brownish. Hanging objects swung violently. Small objects fell. Furniture shifted. Plaster cracked. Water sloshed from pool; pool water lowered by about 0.3 m. Much debris in pool. Ground: Adobe and sand, level.

No address given. (VI) Felt by and awakened all in community; frightened all in old, well-built, two-story wood frame building. House shook and groaned. "Too frightened to notice earth noises." Hanging objects swung moderately. Pictures fell. Plaster cracked. Damage slight. "We have a street light outside our window, and it went out. I tried to get up but couldn't walk. Our backyard and patio was flooded by water from neighbor's swimming pool. The water splashed over the retaining wall with such force that it dug a hole 0.3-m. deep. Pipes were torn from water heater in basement. Electricity was out for 55 minutes. Water was like ink on the 9th and brown for a week afterward. We had no dishes broken, but glass in picture frames was broken. Our plaster is cracked in many places. Water splashed from upstairs toilet bowls, but not from the one downstairs."

Ground: Adobe, very slightly sloping.

6500 Fulton Avenue. (VI) Felt by and awakened all (observer in 18-year-old, fairly well-built, one-story wood frame building). Building shook violently. Electricity out (transformers on poles shorted). Small objects shifted and overturned. Hair-line cracks in exterior stucco. Ground: River alluvium, level.

5652-1/2 Hazeltine Avenue. (VI) Felt by, awakened, and frightened all in community (observer in well-built, two-story wood frame building). Everything rattled. Hanging objects swung. Small objects and furnishings shifted; small objects and furniture overturned. Knickknacks, books, and pictures fell. Dishes, windows, and furniture broke. Ground: Soil, level.

Verdugo City (just west of La Crescenta and Montrose). Felt by, awakened, and frightened all in community. "Many windows and dishes broke. Major damage to buildings in area. Without lights until 10:20 and limited telephone service for most of the day." At the post office (one-story concrete block building), small amount of plaster cracking in lobby. Some small objects fell from shelves. Furniture shifted. Water sloshed from toilet. Ground: Rocky, sloping.

Vernon. The following, from Steinbrugge and others<sup>8</sup>, does not include publicly owned structures: "Buildings damaged, 30; posted unsafe, 5; estimated total dollar loss, \$100,000." At the post office (VI), felt by all and frightened many working in new, fairly well-built, one-story concrete block building. Everything rattled. Floor had rolling motion. Too many other noises to hear earth noises. Light fixtures swung violently. Cases shifted. Ground: Level.

#### Woodland Hills:

22233 Buenaventura Street. Felt by and frightened all in community; general panic (observer in old, well-built, one-story cement block building). Ceiling made groaning sound. Trees shook; one tree leaned. Swimming pool half emptied. Cement work, especially pool decking, severely cracked. Hanging objects swung violently. Small objects fell. Furniture shifted and overturned. Plaster cracked. Damage moderate. Ground: On hillside.

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20513 Rhoda Street. Felt by, awakened, and frightened all in community. Loud earth noises from west about 10 seconds before shock. "I was just getting out of bed; felt a little shock; jumped in bed and stayed there; then in a few seconds I heard a very loud noise which sounded like train noise; then the shock!!! Things came crashing down. Books and trophys fell and nearly killed my father." Trees shook strongly; few branches broke off. Big TV and stereo moved few cm. Ceiling, floor, and walls cracked; more cracks in outside floor but not serious. Damage slight. Ground: Sloping and steep.

4674 Morro Drive. (VI) Felt by and awakened all in 18-year-old, well-built, two-level wood frame building; all were apprehensive. Moderate earth noises. Pool water sloshed out. Hanging objects swung moderately north-south. Small objects shifted, overturned, and fell. Patio furniture shifted. Plaster cracked. Cement block fences loosened; wooden fence weakened. Ground: Rocky, compact, on hillside.

22151 Tiara Street. (VI) Felt by, awakened, and frightened all in community (observer in well-built, one-story wood frame building with brick veneer). Faint rumbling earth noises. Trees and bushes shook; vehicles rocked. Hanging objects swung violently east. Closet contents fell to floor. Dishes broke. Chimney banged against plaster ceiling. Plaster cracked around chimney, over doors, and at some windows. Damage slight. "Ground motion appeared to be fairly uniform for about 1 minute. My house seemed to move mostly in an east-west direction. The frequency of vibration of my house was between 1/5 and 1/10 second. The aftershocks were very short and appeared small in magnitude. The ground noise was very difficult to distinguish from the general noise of falling objects and creaking wood." Ground: Compact, sloping.

22451 Hatteras Street. (VI) Felt by all in community; awakened and frightened all in new, one-story wood frame building (stucco and stone outside; plaster and brick inside). Vehicle in garage rocked. Water from next door pool in yard. Hanging objects swung violently. Small objects shifted, overturned, and fell. Furniture shifted. Damage slight. Ground: Clay, level.

6040 Nevada Avenue. (VI) Felt by, awakened, and frightened all in community (observer in new, well-built, two-story wood frame apartment building; parking area underneath). Violent shaking and tossing feeling. Water sloshed from swimming pool. Hanging objects swung moderately, mostly northward and eastward. Small objects shifted, overturned, and fell. Chest drawers opened. Plaster cracked around many windows and doors. Window in bathroom loosened from inside tile. Damage slight. "No electricity for 1 hour and 15 minutes. Electric power went out within seconds after start of shock. Gas and water supply remained OK. No telephone communication for 7 hours." Ground: Gravelly, some compact, some filled in, level.

19830 Gilmore Street. (VI) Felt by and awakened all in community; frightened all in one-story wood frame building. Light fixtures swung. Small objects shifted, overturned, and fell. Noticeable wallboard cracks. Many old hairline cracks enlarged. New hairline cracks developed. "Aftershocks seemed to be, in general, a rolling, wavy motion, causing a good shake. However, about one of four aftershocks seemed like a roll at first, then a big thud and dropping sensation."

9 February, 06:00:41.6--Continued.

Intensity VI:

Agoura. Felt by, awakened, and frightened all in community. Small objects shifted, overturned, and fell. Plaster cracked. Damage slight.

Agua Dulce (about 22 km. northeast of Saugus). Felt by and awakened all; frightened many or all. Ground cracked. Some jacks under trailer fell over and skirting buckled. Small objects overturned and fell. Furniture shifted; some overturned. Hanging objects swung violently. Damage slight to moderate. USGS-NOAA<sup>9</sup> reported that at the Agua Dulce Elementary School, several plastic light diffusers fell from fluorescent light tube fixtures and there was some light "cosmetic" damage.

Anaheim. Felt by, awakened, and frightened all in community. Cement and wall cracked; plaster cracked. Leak in hot water tank inlet. Damage slight. Water disturbed. Small objects shifted, overturned, and fell. Hanging objects swung violently north-south.

Arcadia. Felt by, awakened, and frightened all in community. Chimneys cracked. Plaster cracked; acoustic plaster fell; minor exterior plaster cracking. Power-lines down. Damage reported as slight by all observers. Furniture shifted and overturned. Small objects shifted, overturned, and fell. Trees and bushes shook; vehicles rocked. Hanging objects swung violently both east-west and north-south. Water splashed out of swimming pools. Lights flashed outside; lights went out. "Held on to door frame to stand up."

Baldwin Park. Felt by all and frightened many in community; awakened all in home. Plaster cracked. Small cracks in patio. Swimming pool water sloshed over. Trees and bushes shook; vehicles rocked. Hanging objects swung violently north-south. Small objects shifted and overturned. "Earthquake seemed to build up in intensity--from violent up-and-down motion to heavy roll. Felt strong aftershock at 8:00 a.m. on 9th while at work in City Of Industry. All felt it. Have felt several aftershocks with rolling motion."

Camarillo. Felt by, awakened, and frightened all. "St. Mary Magdalene Church suffered structural damage." Powerlines arced, causing blue flashes. Water disturbed. Hanging lamps swung about 0.9 m. northeast-southwest. Small objects shifted and fell. Pendulum fell off clock.

Carson. Felt by all in community; awakened and frightened all in home. "One chimney dislocated. Slight separation between exposed beam and plaster." Swimming pool lost about 15 cm. of water. Hanging objects swung violently east-west. Small objects fell.

Castaic and vicinity. Felt by and awakened all in community; frightened many. Waterline broke. Plaster cracked. Minor cement cracks in stairs. All observers reported damage as slight. Small objects fell; furniture shifted. Trees and bushes shook; vehicles rocked. Horse panicked and jumped fence. Field investigator from Seismological Field Survey reported observed damage at Castaic Junction (about 6 km. south of Castaic) was slight--plate glass window broke; some objects fell from shelves.

Cerritos. Felt by, awakened, and frightened all in home. "Other wood frame, one-

9 February, 06:00:41.6. Intensity VI--Continued.

story houses in community sustained some plaster and stucco cracking. There were also incidents of objects falling off shelves, etc."

Chatsworth. Felt by, awakened, and frightened all in community. Plaster cracked. Block wall, 0.9 m. high, overturned. Damage slight. Swimming pool lost about 8 cm. of water. Trees and bushes shook. Small objects shifted, overturned, and fell. Hanging objects swung violently--seemed east-west.

Compton. Felt by and awakened all in community; frightened many. Plaster cracked, broke, and fell. One window cracked. Powerline down. Steinbrugge and others<sup>8</sup> estimated total dollar loss at Compton, excluding publicly owned structures, at \$10,000. Hanging objects swung violently north-south.

Costa Mesa. Felt by most in community; awakened and frightened many. Plaster fell and some old plasterboard cracks reopened. Water sloshed from swimming pools. Hanging objects swung violently east-west. Vault door closed. Heavy shaking. "Aftershocks were not strong enough to slosh water from pool, but hanging objects swayed."

Covina. Felt by and frightened all in community; awakened many. Plaster cracked and old cracks widened. Hanging objects swung violently east-west and northwest-southeast. Small objects shifted, overturned, and fell. Trees and bushes shook; vehicles rocked. Cupboard doors popped open. "Appeared to be high-frequency vibration--not the slow rolling motion as felt with previous earthquakes in this area." "The aftershocks have been more frightening than the initial shock. Several times we have felt dizzy. On the evening of February 20 at about 10:00 and 11:00 there were two shocks that caused lamps to swing and windows to rattle." "Of the many aftershocks, we felt only a very few and they seemed light."

Crestline. Felt by and awakened all in community; frightened many. Chimneys cracked. Masonry cracked; some broke loose. Damage slight. "To date (Feb. 23), one delayed earthquake effect (happened on Feb. 16), first time fireplace was used after earthquake occurred: Due to cracked flue liner a residence was damaged to the extent of \$8,000 by fire in brick fireplace." Small objects shifted, overturned, and fell; bottles, etc., broke.

Cucamonga. Felt by, awakened, and frightened many in community. Some plaster cracking in community. Hanging objects swung moderately to violently north-south.

Culver City. Felt by and awakened all in community; frightened many. Plaster and windows cracked. Damage slight. Ground cracked (one report). Water disturbed. Small objects fell; furniture shifted. Hanging objects swung violently in all directions. Basketball pole swayed. Trees and bushes shook; vehicles rocked. Lights flashed. Phone out of order.

Downey. Felt by, awakened, and frightened all in community. Plaster cracked, broke, and fell. Slight cracks in chimney. Driveway crack widened. Damage slight. About 0.3 m. of water sloshed from swimming pool. Small objects shifted, overturned, and fell; furniture shifted. Hanging objects swung violently northeast-southwest. Street lights went off and on. Telephone pole crooked. Trees and bushes shook; vehicles rocked.

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Elizabeth Lake area (about 5 km. southeast of Lake Hughes; about 0.4 km. north of east shore). Felt by all in home and community. Plaster cracked. Lamps fell and broke. Small objects shifted southwest. Trees shook. Hanging objects swung violently northeast-southwest. Chickens were knocked from roosts. "Twelve heavy aftershocks felt within the next 2 hours."

El Monte. Felt by all in home; awakened all and frightened many. Power failure--wires broke. Small objects shifted, overturned, and fell; slight breakage of dishes. Furniture shifted some. "Continued tremors on successive days."

Fairmont Reservoir (about 3.2 km. north by east of Lake Hughes). Felt by and frightened all in community. Hanging objects swung violently in every direction. Small objects fell. Furniture shifted. "Our power went off at the first shock but came on again in about 10 minutes. Telephone communications were knocked out; restored 5 days later. Aftershocks were felt during the following 24 hours but they were very moderate."

Florence. Felt by all in community; awakened and frightened many. Plaster cracked; few windows cracked. Damage slight. Trees and bushes shook; vehicles rocked. Hanging objects swung violently. Small objects overturned; furniture shifted.

Fullerton. Felt by and awakened all in community; frightened many. Acoustical tile fell in bank building. Plaster cracked. New cracks in patio. Damage slight. Water sloshed from swimming pools. Small objects shifted, overturned, and fell. Hanging objects swung violently north-south. Trees and bushes shook; vehicles rocked.

Gardena. Felt by all in community; awakened and frightened many. Plaster cracked. Swimming pool water splashed "like ocean waves." Trees shook; vehicles rocked. Hanging objects swung violently east-west. Small objects shifted. "Initial strong jolt; then gentle rolling motion for about 1 minute."

Glendora. Felt by and awakened all in community; frightened many. Plaster cracked. Some small cracks enlarged (very few). Damage slight. Water sloshed from swimming pools. Small objects shifted and overturned. Hanging objects swung violently. Cabinet doors opened. "Many aftershocks."

Hacienda Heights. Felt by all in community; awakened and frightened many. Plaster cracked. Damage slight. Flashes from shorted powerlines. Water sloshed from swimming pool. Small objects shifted; all pictures shifted. Hanging objects swung violently. Trees and bushes shook; vehicles rocked. "Motion started as violent high-frequency shaking, then after about 15 seconds it changed to long period."

Hawthorne. Felt by all and awakened many in community; frightened few. Exterior cracks in plaster where apartment is cantilevered over driveway. Hanging objects swung violently east-west. "Lack of balance when standing. Short-period shaking for about 20 seconds, followed by long-period shaking."

Highland. Felt by, awakened, and frightened all in community. Plaster cracked. Damage slight. Small objects fell; furniture shifted. Trees and bushes shook; vehicles rocked. Hanging objects swung violently with a twisting motion.

Huntington Beach. Felt by and awakened all in community; frightened many. Plaster cracked. Drywall cracked and some ceiling panels fell. Some cracks in cement. Damage slight. "Very strong, sharp jolts, but very little damage." Small

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objects fell; furniture shifted slightly. Trees and bushes shook. Hanging objects swung moderately north-south.

Huntington Park. Felt by, awakened, and frightened all in home. Driveway cracked (transverse and diagonal cracks). Hanging objects swung violently east-west.

La Habra. Felt by, awakened, and frightened many in community. Plaster cracked. Plastic water connection cracked. Ground cracked. Damage slight. Pool water sloshed. Small objects shifted, overturned, and fell; furniture shifted. Hanging objects swung violently east-west. Trees and bushes shook; vehicles rocked.

Lake Hughes. Felt by, awakened, and frightened all in community. "Whipping action of pump shaft snapped pump pipe where it threads into submersible pump, causing a break in pipe which made pump burn up. Damage slight, except to pump." High wires swayed. Hanging objects swung violently east-west. Trees and bushes shook; vehicles rocked. Water disturbed. Small objects shifted, overturned, and fell; beds moved about 15 to 30 cm.

Lakewood. Felt by all in community; awakened and frightened many. Plaster cracked. Pool lost about 20 cm. of water. Electrical wires swayed. Hanging objects swung violently north-south. Small objects and furniture shifted. "Rolling motion; no extreme acceleration changes."

La Mirada. Felt by and awakened all in community; frightened many. Small cracks in plaster and foundation. Damage slight. Small objects shifted, overturned, and fell; furniture shifted. Pendulum clock stopped. Trees and bushes shook; vehicles rocked. "Initial shock lasted over 2 minutes. The vertical and horizontal motion was easily felt and seen. Two moderately severe aftershocks were felt at about 6:20 and 8:20 a.m., but the remainder (about four) were scarcely noticeable."

Lancaster. Felt by and awakened all in community; frightened many. Chimneys and plaster cracked. Damage slight. Many small objects shifted, overturned, and fell; furniture shifted. "Many aftershocks felt, but none that would cause heavy damage. The largest one was felt at about 9:00 p.m. on the 9th."

La Puente. Felt by and awakened all in community; frightened many. Plaster cracked in some homes. Damage slight. Hanging objects swung violently. Small objects shifted, overturned, and fell. Vehicle rocked. "Shock frightened all in our home. Noticed up-and-down and horizontal motion. House continued to sway back and forth considerably after shock had stopped."

Lenwood (small community about 11 km. southwest of Barstow). Felt by, awakened, and frightened all in community. Plaster cracked. Trees and bushes shook; vehicles rocked. Small objects and furniture shifted.

Littlerock. Felt by and awakened all in community; frightened many. Few reports of plaster cracking. One plate glass window broke. Bottles and cans fell off shelves at two stores. Damage very slight.

Lomita. Felt by and awakened all in community; frightened many. Plaster cracked in some buildings. Windows cracked in several stores in town. Damage slight. Small objects shifted. North-south swaying motion.

Long Beach. Felt by, awakened, and frightened all in community. Plaster cracked. "Minor damage at Long Beach." Elevator knocked off track. Water in swimming pool sloshed violently. Small objects shifted, overturned, and fell; furniture

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shifted. Hanging objects swung violently north-south, east-west, and northeast-southwest. Trees and bushes shook; vehicles rocked. "Shock lasted for 35 seconds. Started slowly, reaching a peak in about 10 seconds which lasted about 15 seconds; then tapered off."

Lytle Creek. Felt by and awakened all in community; frightened many. Cracks in walls and foundation. Small objects fell. Trees and bushes shook; vehicles rocked. Hanging objects swung moderately west-east. "We have not felt many of the aftershocks."

Malibu. Felt by, awakened, and frightened all. Plaster cracked. Landslides. Damage slight. Trees and bushes shook; vehicles rocked. Hanging objects swung violently, seemed east-west. Small objects shifted, overturned, and fell. Bubbles caused by gas seepage were observed emanating from the ocean floor off Malibu Point. The occurrence was investigated by scuba divers. USGS-NOAA<sup>9</sup> reported that the gas emanated from small holes and craters in the ocean floor. No ruptures or dislocations of the sea floor were observed during the dive.

Manhattan Beach. Felt by and awakened all in community; frightened many. Hairline cracks in plaster; old cracks slightly enlarged; old hairline cracks in patio slightly widened. Windows cracked. "Cement walls without adequate foundation were slightly tilted." Pool water sloshed. Elevated water tank made loud noises. Hanging objects swung violently. Two people ran outside and had to hang on to windowsill to keep balance. Tree, about 3.6 m. high, whipped violently. Press reported: "Facade and parapets on the old City Hall (built in 1916) have cracked to the point of collapse. Those cracks were brought out by the earthquake, but it is an old building and there will be more cracks." Aftershocks felt at 09:00 and 21:00.

Marina Del Rey. Felt by all in community; awakened many; frightened few. Grund cracked. Trees shook; vehicles rocked on roadways. Hanging objects swung violently. Small objects overturned and fell; furniture shifted. "Floor shook up and down fairly violently for over 1 minute, but no damage."

Maywood. Felt by, awakened, and frightened all in community. Transformers and high-tension lines arced and "sputtered." Damage slight. Small objects shifted, overturned, and fell. Trees and bushes shook; vehicles rocked. Hanging objects swung violently north-south. "Very difficult to walk--had to hold on to walls and doorways. Seemed as if one were riding on waves during the major aftershocks felt within the house. Felt many aftershocks as slight vibrations."

Mission Viejo (about 3 km. southeast of El Toro). Felt by and awakened all in community; frightened many. Plaster cracked and fell; exterior stucco cracked at corners of openings; concrete slab separated at cold joint. Swimming pool water washed about north-south, and did not calm down for 2 hours. Trees and bushes shaken strongly. "Rolling motion felt by husband in bed--almost enough to roll him out of bed. Aftershocks very slight--hardly noticeable--but continuous during evening of the 9th."

Monrovia. Felt by, awakened, and frightened all in community. Plaster cracked. Inside partitions cracked at joints. Damage slight. Pool water sloshed over pool. Hanging objects swung violently east-west; objects also swung north-south. Small

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objects shifted, overturned, and fell. "Felt as a rocking motion rather than sharp jolts, also some aftershocks; later aftershocks were jolts."

Monterey Park. Felt by, awakened, and frightened all in community. Chimneys and plaster cracked. About a 1.8-m.-long section of about 0.9-m.-high retaining wall pushed out and cracked but did not collapse. Old cracks reopened in cement block walls. Damage slight. Swimming pools lost about 15 to 20 cm. of water; very heavy wave action. Small objects shifted, overturned, and fell; some broke. Hanging objects swung violently north-south and northwest-southeast. Furniture shifted few centimeters. Trees and bushes shook; vehicles rocked. "Watched brilliant flare of electrical transformers (at about five locations) being shorted and burn out as quake shook." "Noticeable and disorienting ground motion, mostly lateral and fairly rapid, felt while jogging. Very noisy rattling of houses around me. No one came outside."

Moorpark. Felt by and awakened all in community; frightened many. Plaster cracked. Damage slight. Trees and bushes shook; vehicles rocked. Hanging objects swung violently. Small objects fell; furniture shifted, overturned, and broke.

Mt. Baldy area. The Mt. Baldy Ranger Station reported rocks fell on Mt. Baldy Road, but the road was not closed (press).

Newbury Park (about 6.4 km. southwest of Rancho Sierra Vista). Felt by and awakened all in home; frightened few. Chimneys and plaster cracked. Aluminum patio roof buckled. Damage slight. Trees and bushes shook; vehicles rocked. Small objects and furniture shifted.

Ontario. Felt by, awakened, and frightened many in community. Reports of cracked plaster. Press reported some ceiling tile was shaken loose at the Ontario International Airport, but that there was little other damage. Alarms were set off at two banks. Small objects shifted, overturned, and fell (in moderate amount). Trees and bushes shook; vehicles rocked.

Oxnard. Felt by and awakened all in community; frightened many. Plaster cracked. "Five or six chimneys in town were cracked." Some shaking of trees and bushes. Small objects shifted, overturned, and fell; furniture shifted. Hanging objects swung moderately north-south and east-west. "Lasted longer than any shock I've ever felt. Long, slow rolls, changing from north-south to east-west direction."

Palmdale. Felt by all in community; awakened and frightened all in home. Some cracks. Hanging objects swung violently east-west. Small objects shifted, overturned, and fell.

Palos Verdes Peninsula. Felt by all in community; awakened and frightened many. Plaster cracked. Two cracks in block retaining wall on east side of house; crack in porch now about 1.27 cm. difference between levels; two large windows cracked. Ground cracked; landslides; water disturbed. Trees and bushes shook; vehicles rocked. All pictures askew. Hanging objects swung north-south; moderately southeast-northwest.

Piru and vicinity. Felt by all and frightened many in community. Chimneys overturned. "Plaster cracked in several buildings in town." Damage slight. Trees and bushes shook; vehicles rocked. Hanging objects swung violently north-south. Small objects fell. California Institute of Technology<sup>2</sup> reported that the Santa

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Felicia Dam (about 4.8 km. northeast of Piru) was undamaged except for a narrow meandering crack across the crest at the east abutment, apparently shallow. Placentia. Felt by, awakened, and frightened all in community. Plaster cracked.

Damage slight. Hanging objects swung violently in every direction. Swimming pool water rose about 0.4 m. and sloshed for about 20 minutes after initial shock. Trees and bushes shook; vehicles rocked. Small objects fell. "The worst aftershock was about 8:05 a.m., when things swayed again."

Pt. Mugu. Felt by and awakened most in community; frightened many. Vehicles rocked; water disturbed. "Only minor damage was reported here. The Station Bowling Alley had all pins shaken from the automatic pinsetters and scattered about the lanes, while at the Commissary Store, cake mix and cereals fell and a few jars of baby food fell and broke. A few bottles and cans fell from shelves in the Navy Exchange Mini-Mart, but nothing was broken. Several residents reported losing water from fish tanks."

Port Hueneme. Felt by all in building; frightened few. Several new cracks in building.

Damage slight. Water tower swayed. Hanging objects swung violently east-west.

Quartz Hill. Felt by all in community; awakened and frightened many. Observer at Fire Station reported: "There are some new cracks, small and not long, in exterior stucco, mostly around doors and windows. There was no fall of chimneys in the area, and the only damage I have observed locally is one plate glass window broken in store. The original motion varied in intensity during the initial time, then there was a short pause of a few seconds and a second, shorter motion was felt. Motion was rapid, lasting about 40 to 50 seconds." Second shock (believed to be the first strong aftershock) also was felt. Other observers reported: Hairline stucco cracks. Knickknacks fell. House trailer swayed west-east. Damage negligible. Trees and bushes shook; vehicles rocked. Hanging objects swung moderately west-east.

Redondo Beach. Felt by, awakened, and frightened all in community. Plaster cracked, broke, and fell. Block fence cracked. Water heater damaged. Merchandise fell and broke in store. "Bathroom cabinets appear to have pulled slightly away from walls in both bathrooms. Many new fine cracks in exterior of building and around upper end of supporting parts; cracking of plaster exterior noticeable. Overall damage was surprisingly slight." "I work at the South Bay Center (May Company). We had a lot of breakage and items spilled in the aisles." Water disturbed in swimming pool. "Motion of building was an easy rolling, not sharp, lasting about 1 to 2 minutes." Mild aftershocks were reported felt at about 06:15, 07:37, 09:05, 21:00, and 21:19.

Riverside. Felt by and awakened all in community; frightened many. Plaster cracked. Slight damage to facing slumstone. Observer at Colton reported plaster was cracked at the University of California in the Geology Building. Small objects shifted, overturned, and fell. Trees and bushes shook; vehicles rocked. Hanging objects swung moderately northeast-southwest. Mild aftershocks were reported felt at about 06:20, 07:30, 08:00, 21:00, and 21:13.

Rosemead. Felt by, awakened, and frightened all in community. Plaster cracked.

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Damage slight. "Moderate breakage in area." Power failure for 1-1/2 hours. Small objects shifted, overturned, fell, and broke; furniture shifted. Hanging objects swung violently east-west and in all directions. Trees and bushes shook; vehicles rocked. "I noticed lots of light flashes after the worst was over, about 20 seconds."

Riboudoux (about 3 km. northwest of Riverside). Felt by all; frightened few. Plaster cracked. Hairline cracks inside and outside of building. Damage slight. Hanging objects swung violently east-west.

San Gabriel. Felt by, awakened, and frightened all in community. Chimneys and plaster cracked. Store windows cracked. Hairline cracks in exterior concrete walls. Block wall cracked. Damage reported as slight. The following, from Steinbrugge and others<sup>8</sup>, does not include publicly owned structures: "30 chimneys damaged; estimated total dollar loss, \$9,500." Small objects shifted, overturned, and fell. Hanging objects swung violently east-west, northwest-southeast. Electric wires twisted together. "Saw many transformers explode; thought it was lightning." At a restaurant, a heavy oven (on pedestal) moved west about 2.5 cm. Bed appeared to move in all directions but mainly north-south. "Rolling north-south sway, then, after a few seconds, the floor started to pitch up and down with an east-west movement; as the shock slowed down, it became a north-south sway again." "Motion of house was up and down with sudden drop." "Two distinct jolts; violent shaking, lasting about 40 seconds." "Aftershocks were mostly of a rolling motion."

San Jacinto. Felt by and awakened all in community; frightened many. Chimneys cracked. Plaster cracked in some buildings. Damage slight. Hanging objects swung violently north-south, then circular. Small objects shifted. Trees and bushes shook; vehicles rocked. Pendulum clock stopped.

San Marino. Felt by, awakened, and frightened all in community. Plaster cracked; small pieces fell. Chimney cracked. Plate glass broke. Damage slight. File cabinets moved north-south. Hanging objects swung violently east-west. Small objects shifted, overturned, and fell; furniture overturned. Water sloshed from swimming pools. "Chandelier, about 1.2 m. long, swung about 10 cm. from plumb in north-south direction. Shower doors bounced in floor tracks about three times per second. Vertical movement was a prominent component." "Duration of initial shock was about 45 seconds. Several rather strong aftershocks were felt within a few minutes of initial shock."

Santa Ana. Felt by and awakened all in community; frightened many. Plaster cracked. "Inspected two-story precast beams, block exterior walls, precast floor sections, interior nonbearing steel and plaster walls. Plaster on most interior nonbearing walls showed rather severe deflection of structure at first floor only. No structural damage of any consequence noticeable. The shock in our area seemed well damped, not sharp." Shook 6.7-m. trailer off jacks. Hanging objects swung moderately north-south and east-west.

Santa Fe Springs (Post Office). Felt by all; frightened many. Exterior building cracks slightly enlarged. Trees and bushes shook; vehicles rocked. Small objects and furniture shifted. Hanging objects swung moderately north-south.

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Santa Monica. Felt by and awakened all in community; frightened many. Chimneys and plaster cracked. The following, from Steinbrugge and others<sup>8</sup>, does not include publicly owned structures: "20 buildings damaged; posted unsafe, 1; 30 chimneys damaged; estimated total dollar loss, \$50,000." Nonstructural partitions cracked in 13-story building. Small objects shifted and fell; lamps overturned; furniture shifted. Hanging objects swung violently east-west. Trees and bushes shook; vehicles rocked. "It was a hard and comparatively long shake, lasting about 1 minute. Little, if any, structural damage to wood frame stucco houses." Vertical movement followed by horizontal shaking. Many tremors.

Santa Susana. Felt by, awakened, and frightened all in community. "Some damage in area, especially in retail stores where merchandise was strewn on floors and broken." Mortar line on block wall cracked. Crack appeared at interface of foundation and wood structure in the stucco covering external walls. Hanging objects swung violently; also moderately northeast-southwest.

Sierra Madre. Felt by, awakened, and frightened all in community. "Most of the damage was in grocery and liquor stores due to merchandise falling off shelves. One plate glass window in store broken. No structural damage in the city." Trees and bushes shook; vehicles rocked. Hanging objects swung moderately east-west, north-south, and northwest-southeast. Furniture shifted. Water sloshed over swimming pool. Electricity interrupted for a few minutes. "Continuous rolling motion; seemed maximum at beginning."

South Gate. Felt by all in community; awakened all; frightened many. One light fixture loosened but did not fall. Damage slight. Lights failed for about 1 minute. "Saw flash from transformers blowing about 0.4 km. away." Bookcase shifted about 2.5 cm. Small objects shifted, overturned, and fell. Water disturbed. Hanging objects swung violently east-west. Trees and bushes shook. "Tremors more than moderate, but only minor damage occurred in this locality. The duration seemed to be quite long. It was difficult to stand up. This was the strongest shock I have felt since 1933."

Studio City. Felt by, awakened, and frightened all in community. Ground cracked. Plaster cracked. Damage slight. Water in swimming pool sloshed out. Small objects and furniture shifted. Trees and bushes shook; vehicles rocked. Hanging objects swung violently.

Thousand Oaks. Felt by and awakened all in community; frightened many. Slight plaster cracking above several doors in one house. "Only damage to my house was that the house apparently wracked just enough so that one door would not latch." Cracks in sidewalk. Water disturbed. Trees and bushes shook; vehicles rocked. Small objects shifted; furniture shifted some. Hanging objects swung moderately east-west.

Topanga. Felt by and awakened all in community; frightened many. Rockslides. Plaster cracked. One chimney reported broken. Dryrock walls dislodged (minor). Damage slight. Some settlement of foundation, perhaps 1.2 cm. Planter box on casters (weight about 113 kg.) moved about 10 cm. north. Small objects overturned and fell; furniture shifted. Trees and bushes shook; vehicles

9 February, 06:00:41.6. Intensity VI--Continued.

rocked. Hanging objects swung violently; moderately north-south and east-west. Torrance. Felt by and awakened all in community; frightened many. Minor plaster cracking. Crack in patio slab. Window cracked. Damage slight. Water sloshed from swimming pools. Vehicles rocked. Hanging objects swung violently north-south. "Doors on east-west axis swung open and closed many times; north-south doors only vibrated. Shock at 8:00 a.m. was strong jolt, seemed almost as strong as the first one. Did not feel any of the earlier or later aftershocks." Tustin. Felt by many in community; awakened and frightened all in home. Plaster cracked. Swimming pool water sloshed out in large waves. Furniture shifted. Hanging objects swung moderately north-south. Twin Peaks. Felt by many and awakened all in community; frightened all. Some chimneys cracked. Upland. Felt by, awakened, and frightened all in community. Press reported a false ceiling, with a 2.4-m. neon light, fell to the floor; some cans fell from shelves at a market. Trees and bushes shook. Hanging objects swung violently in all directions. Furniture shifted. Pendulum clocks stopped. Pool water disturbed but did not slosh over sides of pool. Valinda. Felt by all in community; awakened and frightened all in home. Movement of exterior timber patio. Separation of mortar joints in block wall. Valyermo and vicinity. Felt by and awakened all in community; frightened many. At Ranger Station (about 2.4 km. northwest of Valyermo): One block building cracked. Damage slight. Trees and bushes shook; vehicles rocked. Hanging objects swung violently southwest-northeast. Small objects shifted, overturned, and fell. About 6.4 km. southeast of Valyermo (sec. 24 and 25, T. 4 N., R. 9 W.): Ground cracked. Trees and bushes shook. Hanging objects swung violently southeast and southwest. Small objects fell. Damage slight. In Juniper Hills area: Water disturbed. Hanging objects swung violently east-west. Small objects shifted, overturned, and fell. Trees and bushes shook; vehicles rocked. Venice. Felt by and awakened all in community; frightened many. Plaster and windows cracked. Damage slight. Pool emptied. "Transmission" moved about 0.46 m. Small objects fell. Furniture shifted. Hanging objects swung violently east-west. Bushes shook. Water dirty. Vincent (about 8 km. south of Palmdale). USGS-NOAA<sup>9</sup> reported that the Vincent Inter-tie Station had some electrical equipment similar to that at the Sylmar Converter Station, but only minor damage occurred. Walnut. Felt by and awakened all in community; frightened many. Plaster cracked (observer heard of this). Ground cracked; water disturbed (observer heard of this on radio). Vehicle moved about 15 cm. Small objects shifted, overturned, and fell. Trees shook. Hanging objects swung violently east-west; also moderately north-south. Aftershocks felt at about 06:32 and 07:59. West Covina. Felt by, awakened, and frightened all in community. Plaster cracked. "All plaster and paint cracked over door and window frames; cabinets slightly separated from ceiling. A heavy brass hanging lamp swung violently and continued swinging for 10 minutes." Driveway paving cracked. Damage slight. Small objects shifted, overturned, and fell, including canned goods. Furniture shifted.

9 February, 06:00:41.6. Intensity VI--Continued.

Water splashed from swimming pools. Hanging objects swung violently east-west, north-south, and northwest-southeast. Trees and bushes shook; vehicles rocked. Shock lasted about 1 minute. Aftershocks at 08:00 and 21:30.

Whittier. Felt by and awakened all in community; frightened many. Plaster cracked and old cracks reopened. "Slight cracking at 45 percent of door openings; metal vents projecting above roof slightly out of plumb; lost about 20 cm. of pool water--waves in east-west direction. Stucco house and garage has lots of hairline cracks 'all over,' and fireplace chimney has two large cracks near base. Concrete at roadways cracked." Damage slight. Telephone poles swayed. Small objects shifted, overturned, and fell; furniture shifted. Hanging objects swung violently east-west and north-south. Trees and bushes shook; vehicles rocked.

Intensity V: Acton and about 6.4 km. northwest of, Adelanto (plaster cracked), Alta Loma, Apple Valley (plaster cracked), Arroyo Grande, Artesia, Arvin, Avalon, Avila Beach, Azusa, Bakersfield and vicinity, Banning (small plaster cracks), Barstow, Beaumont (plaster cracked), Bell (some cracks), Bellflower (some old cracks reopened), Bell Gardens, Big Bear City (aftershocks at 06:08, 08:10; very slight aftershocks during rest of day), Big Bear Lake, Bloomington, Bonsall, Boron, Brea (plaster cracked in one room), Bryn Mawr, Buellton, Buena Park, Buttonwillow, Cachuma Village and Cachuma Dam, Cadiz (plaster cracked), Calabasas (windows cracked), Caliente, California City (plaster cracked), California Hot Springs, California Valley (formerly Simmler; cracks widened in cement floor), Calimesa, Camp Pendleton, Cantil, Capistrano Beach, Carlsbad, Carpinteria, Cartago, Casmalia, Cathedral City, Cedar Glen, Cedarpines Park, Charter Oak, Cherry Valley, China Lake, Chino, City Of Industry, City Terrace, Claremont (three aftershocks), Coachella, Colton (rapid succession of aftershocks and large cluster of minor aftershocks around 21:30 and 22:30), Corona, Corona Del Mar (plaster cracked; several brief aftershocks for 1 hour after main shock), Coronado, Crest Park, Cuyama, Daggett, Dana Point, Death Valley Junction, Delano, Delkern (plaster cracked), Del Mar, Desert Center, Desert Hot Springs, Diamond Bar (one small plaster crack), Di Giorgio (moderately strong aftershock within 15 minutes of the first shock), Duarte, Ducor, Dunn Siding (about 48 km. northeast of Yermo), East Los Angeles, Edison, Edwards Air Force Base (windows cracked), El Cajon, El Mirage area (west of Adelanto), El Segundo (old plaster cracks reopened), El Toro and Marine Corps Air Station (aftershock at 07:58), Encinitas, Escondido, Essex (plasterboard cracked), Etiwanda, Fallbrook and vicinity, Farmersville, Fawnskin, Fellows, Fontana and 8 km. north of, Forest Falls, Fort Irwin, Fort Tejon State Historical Park (near Lebec), Fountain Valley, Frazier Park and Chuchupate Ranger Station (near Frazier Park), Garden Grove, Gaviota, George Air Force Base, Gilman Hot Springs (windows cracked), Glennville, Goleta (small aftershock about 1 hour later), Gorman, Grover City, Halcyon, Harbor City (plaster cracked slightly), Havilah (about 8 km. south by west of Bodfish; hairline plaster cracks), Helendale, Hemet (some cracks) and 8 km. east of, Hermosa Beach, Hesperia, Highgrove (window cracked), Hinkley, Homeland, Homestead (about 6.4 km. northwest of Inyokern on Highway 6), Huron (some plaster cracked), Idyllwild, Imperial, Indio, Inglewood (windows cracked), Irvine, Irwindale (three cracks), Johannesburg, Johnsondale, Keene, Kelso, Kettleman City, Kern River Powerhouse No. 1 (Southern California Edison Co., about 16 km.

9 February, 06:00:41.6. Intensity V--Continued.

east-northeast of Bakersfield), Kern Canyon Powerplant (Pacific Gas and Electric Co., mouth of Kern Canyon), Kernville, Laguna Beach, Laguna Hills (plaster cracked), La Jolla (small plaster cracks), Lake Arrowhead, Lake Isabella, Lakeview, La Mesa, Lamont, La Quinta, Laton, La Verne, Lawndale, Lebec and vicinity, Lemoore, Leucadia, Lincoln Acres, Little Lake, Llano, Loma Linda, Lompoc, Lone Pine, Loraine (about 16 km. east of Caliente), Los Alamitos, Los Olivos, Los Prietos Ranger Station (about 16 km. northwest of Santa Barbara), Los Serranos (Chino area), Lost Hills (hairline plaster cracks), Lucerne Valley, Ludlow, Lynwood, McFarland, McKittrick, March Air Force Base, Maricopa, Mecca (plaster cracked and slight cracks in brick seams), Meiners Oaks, Midway City, Mira Loma, Mojave (very slight plaster cracks), Monolith, Montclair, Montebello (small plaster cracks), Moreno, Morongo Valley, Mt. Baldy, Mt. Wilson, Murrieta, National City, Newberry Springs, Newbury Park, New Cuyama, Newport Beach, Norco, North Palm Springs, Norton Air Force Base, Norwalk (plaster cracked; damage very slight), Nuevo, Oak Grove Ranger Station (about 16 km. southeast of Aguanga), Oak View, Oceano, Oceanside, Ocotillo, Ocotillo Wells (Desert Ironwoods Motel, about 4.8 km. west of Ocotillo Wells), Ojai, Olancha, Orange (one crack in chimney), Oro Grande, Ozena Guard Station (near junction of Highway 33 and Lockwood-Ozena Road), Pacific Palisades, Pala, Palm Desert, Palm Springs, Palos Verdes Estates, Paramount, Pattiway (Hudson Ranch), Pearblossom and about 8 km. south of; most aftershocks felt), Pedley, Perris, Phelan, Pico Rivera (aftershock at 08:00), Pinon Hills, Pioneertown (small plaster cracks), Pixley, Pomona, Porterville, Poway, Pumpkin Center (about 25.7 km. south of Bakersfield), Ramona, Rancho Mirage (minor plaster cracks), Rancho Santa Fe, Randsburg, Redlands, Red Mountain, Rialto, Ridgecrest, Rimforest, Ripley, Rolling Hills Estates, Rosamond, Running Springs, Sage Fire Control Station (about 19.3 km. southeast of Hemet), Salton City (west shore of Salton Sea), San Bernardino (heavy aftershock at about 08:00), San Clemente, Sandberg (Sandberg Ranch), San Diego, San Dimas, San Juan Capistrano, San Luis Rey, San Pedro, Santa Barbara (aftershock at about 06:30), Santa Maria, Santa Paula, Santa Ynez and about 6.4 km. southeast of, Santa Ysabel, Santee, San Ysidro (slight cracks in brick wall), Seal Beach (plaster cracked; negligible damage), Seeley, Shandon, Shafter, Shoshone, Signal Hill, Silverado, Simi, Solana Beach (two aftershocks felt), Solvang, South Laguna, South San Gabriel, Springville, Stanton, Sugarloaf, Sultana, Summerland, Sun City, Sunnymead, Sunnyside, Sunset Beach (plaster cracked), Surfside, Taft, Tecate, Tecopa, Tehachapi and Cummings Ranch (near Tehachapi), Temecula, Temple City, Terra Bella, Thermal, Thousand Palms, Tipton, Trabuco Canyon (about 9.7 km. northeast of El Toro), Traver, Trona, Ventucopa area (Reyes-Wegis Cattle Ranch, about 9.7 km. west of Ventucopa in Santa Barbara Canyon), Ventura (aftershock at about 06:30 barely felt), Victorville (slight tremor at about 06:00 on Feb. 10), Vista, Warm Springs (about 14.5 km. north by east of Castaic), West-end, Westlake Village (west of Malibu Junction), Westminster (plaster cracked), Wheeler Ridge, White Water, Wild (about 8 km. northeast of Helendale), Wildomar, Wilmington (plaster cracked), Winchester, Wrightwood, Yermo, Yorba Linda (dry-wall cracked some), and Yucaipa.

9 February, 06:00:41.6--Continued.

Intensity IV: Alpaugh, Amboy, Armona, Atascadero, Avenal and about 9.7 km. northeast of, Baker, Big Pine, Bishop, Blythe, Bodfish, Borel Powerhouse (21.6 km. south by southwest of Kernville Powerhouse No. 3 ( $35^{\circ}47' N.$ ,  $118^{\circ}26' W.$ ), Borrego Springs, Boulevard, Brawley (Wieman Ranch, about 11.3 km. west of Brawley), Burrel, Cabazon and about 16.1 km. east of (San Gorgonio Pass), Calexico, Cambria, Camp Nelson, Cardiff By The Sea, Cholame and Bitterwater Pumping Station about 29 km. southeast of Cholame, Chula Vista, Cima, Corcoran, Creston, Darwin, Death Valley (Furnace Creek Inn and Furnace Creek Ranch), Delano, Del Rey, Dinuba, Dulzura area (Barrett Dam), Eagle Mountain, Earlimart, East Highlands, Exeter, Firebaugh, Five Points, Fowler, Guadalupe, Guatay, Helm, Herndon, Imperial Beach, Independence, Inyokern (about 7 km. west of at Beckman Ranch), Ivanhoe, Jacumba, Jamul, Joshua Tree, Keeler, Kern River Powerhouse No. 3 (near Kernville,  $35^{\circ}47' N.$ ,  $118^{\circ}26' W.$ ), Kingsburg, Kings Canyon National Park, Lakeside, La Panza (about 40.2 km. east of Santa Margarita, on Highway 58), Lemongrove, Lindsay, Long Valley Dam (about 40.2 km. northwest of Bishop at Lake Crowley), Los Alamos, Miracle Hot Springs, Miramar Naval Air Station (Miramar), Miramonte, Mountain Center, Mount Laguna, Needles, Nestor, Nipomo, Nipton, Oildale, Orosi, Parkfield, Paso Robles, Pauma Valley, Piedra and about 11.3 km. south of, Pine Valley, Pismo Beach, Poplar, Posey, Potrero, San Marcos, San Onofre Nuclear Generating Plant (near San Clemente), Selma, Spring Valley, Stratford, Strathmore, Surf, Templeton, Three Rivers and Ash Mountain (near Three Rivers), Tulare, Twentynine Palms, Valley Center, Vandenberg Air Force Base (about 16.1 km. northwest of Lompoc), Warner Springs, Wasco, Weldon, Woodville, Woody, Yettem, and Yucca Valley.

Intensity IV in Arizona: Bullhead City, Ehrenberg, and Poston.

Intensity IV in Nevada: Dyer, East Las Vegas, Goodsprings, Las Vegas, Lathrop Wells, and Overton.

Intensity I-III: Biola, Bridgeport, Bryson area (Weferling Ranch), Caruthers, Clovis, Control Gorge Powerplant (about 20.9 km. northwest of Bishop), Earp, El Nido, Fresno, Hanford, Heber, Holtville, Hornitos (near), June Lake, Kaweah, Le Grand, Lockwood, London (Dinuba area), Los Banos, Los Osos, Merced, Milo (about 8 km. northeast of, near Springville), Moss Landing (Pacific Gas and Electric Company Steamplant; no motion actually felt, but considerable float movement in water tank), Palomar Mountain, Palo Verde, Parker Dam, Pinedale, Piute Mountain area (about 21 km. southeast of Bodfish), Plaster City, Point Arguello, Red Top, Riverdale, San Ardo, San Miguel, Snelling, Stockton, Strawberry, Wofford Heights, and Yosemite National Park.

Intensity I-III in Arizona: Kingman and Topock.

Intensity I-III in Nevada: Beatty, Boulder City, Logandale, Moapa, Pahrump, and Tonopah.

9 February, 06:00:41.6--Continued.

Intensity I-III in Utah: Beryl.

Reported not felt: Acampo, Adelaida (19 km. west of Paso Robles), Ahwahnee, Alpine, Altaville, Amador City, Angels Camp, Antelope, Arnold, Aromas, Arroyo Seco Guard Station (about 19 km. southwest of Greenfield), Atwater, Auberry, Avery, Badger, Balch Camp ( $36^{\circ}55' N.$ ,  $119^{\circ}05' W.$ , Pacific Gas and Electric Co.), Ballico, Banta, Bar B Ranch (about 13 km. southwest of Idria), Bard, Bass Lake, Bear Valley, Benton, Big Creek, Big Oak Flat, Bonita, Burson, Camp Connell, Campo, Campo Seco, Camp Roberts, Cantua Creek, Capitola, Castle Air Force Base (Merced), Cayucos, Ceres, Choice Valley area (south of Cholame, near Choice Valley School), Cholame (Alley Ranch, about 5 km. southeast of Cholame), Chowchilla, Clements, Coalinga, Coarsegold, Columbia, Contival Ranch (about 21 km. south of Hollister, on Cienega Road), Copperopolis, Corralitos, Coulterville, Cressey, Crows Landing, Cutler, Deep Springs, Delhi, Denair, Descanso, Desert Center area (Julian Hinds Pumping Plant, about 16 km. west of Desert Center), Dos Palos, Douglasflat, Drytown, Dulzura, Dunlap, Easton, El Cajon, El Centro, El Dorado, Elk Grove, El Portal, Empire, Escalon, Exeter area (Exeter Fauver Ranch), Farmington, Fiddletown, Fish Camp, Friant, Galt, Glencoe, Gold Rock Ranch ( $32^{\circ}53' N.$ ,  $114^{\circ}52' W.$ ), Gonzales, Goshen, Greenacres, Greenfield, Groveland, Gustine, Harmony, Harris Ranch (11 km. south of Hollister, on Cienega Road), Hathaway Pines, Havasu Lake, Herald, Hickman, Hilmar, Hollister, Holt, Hughson, Huntington Lake, Idria, Ione, Jackson, Jamesburg area (Search Ranch, south of Carmel Valley), Jamestown, Jolon, Julian, Kerckhoff Powerhouse (NW 1/4, sec. 2 and NE 1/4 sec. 3, T. 10 S., R. 22 E., vicinity of Auberry), Kerman, Keyes, King City, Knights Ferry, La Grange, Lakeshore, Lathrop, Lee Vining, Linden, Livingston, Lockeford, Lodi, Lone Pine (19 km. south of), Long Barn, Lonoak area (Mee Ranch, intersection of Highways 25 and 198), Los Banos (San Luis Dam), Lucia and Circle M Ranch (on coast, about 32 km. south of Big Sur), Madera, Mammoth Lakes, Manteca, Mariposa, Martell, Mendota, Midpines, Moccasin, Modesto and South Modesto, Mokelumne Hill, Monterey, Morro Bay, Mountain Ranch, Murphys, Newman, Niland, North Fork, Oakdale, Oakhurst, O'Neals, Orange Cove, Pacheco (Martinez area), Panoche ( $36^{\circ}36' N.$ ,  $120^{\circ}50' W.$ ), Paicines and vicinity (Bear Valley Fire Control Station at 25820 Airline Highway, and Mulberry), Parlier, Patterson, Pine Canyon (about 13 km. southwest of King City), Pinecrest, Pine Grove, Pinnacles National Monument (Pinnacles), Pioneer, Planada, Pozo (about 24 km. southeast of Santa Margarita), Plymouth, Prather, Priest Valley ( $36^{\circ}11' N.$ ,  $120^{\circ}42' W.$ ), Rail Road Flat, Raisin, Ranchita, Raymond, Reedley, Richgrove, Ripon, Riverbank, Sacramento area (Florin and Parkway), Salida, Salinas, San Andreas, San Francisco International Airport (San Bruno), Sanger, San Joaquin, San Jose, San Juan Bautista, San Lucas, San Luis Obispo, San Simeon and Hearst Ranch, Santa Margarita and about 3 km. southwest of, Santa Nella, Santa Rita Park, Saticoy, Sequoia National Park, Shaver Lake, Sheep ranch, Slack Canyon ( $36^{\circ}05' N.$ ,  $120^{\circ}40' W.$ ), Soledad, Sonora, Soulsbyville, South Dos Palos, Squaw Valley (near Orange Cove), Standard, Stevinson, Stovepipe Wells Village (Death Valley National Monument), Sutter, Three Rivers Powerplant No. 1 ( $36^{\circ}28' N.$ ,  $118^{\circ}52' W.$ ), Thornton, Tinemaha Reservoir (about

9 February, 06:00:41.6. Reported not felt--Continued.

29 km. north of Independence), Tollhouse, Toms Place (about 32 km. northwest of Bishop, just below Crowley Lake), Tracy, Tranquillity, Tres Pinos, Tuolumne, Turlock, Twain Harte, Vallecito (Calaveras County), Valley Home, Valley Springs, Victor, Vidal, Visalia, Volcano, Volta, Wallace, Walnut Grove, Waterford, Westley, Westmorland, Westpoint, White Pines, Wilseyville, Wilton, Winterhaven, Winters, Winton, Wishon, Woodbridge, and Woodlake.

Reported not felt in Arizona: Bagdad, Bouse, Dateland, Gadsden, Hackberry, Lake Havasu City, Oatman, Quartzsite, Roll, Salome, San Luis, Somerton, Tacna, Temple Bar Marina, Valentine, Wellton, Yucca, and Yuma.

Reported not felt in Nevada: Arden, Bunkerville, Caliente, Carp, Goldfield, Henderson, Hiko, Indian Springs, Luning, Mercury, Mesquite, Mina, Panaca, Pioche, and Searchlight.

Reported not felt in Utah: Cedar City, Central, Enterprise, Gunlock, Hurricane, Ivins, Kanarraville, La Verkin, Leeds, Milford, Modena, Newcastle, New Harmony, Pintura, Rockville, Saint George, Santa Clara, Springdale, Toquerville, Virgin, and Washington.

9 February, 06:10:28.0. Mag. 5.3.

Epicenter  $34^{\circ}24.7' N.$ ,  $118^{\circ}24.0' W.$ , southern California, at a depth of about 8 km., P. Aftershock of San Fernando earthquake.

Int. V at La Canada. Pool water splashed violently. At 07:00, pool water was still swaying about 4 cm. from end to end.

Also felt at Big Bear City (shocks felt for balance of the day), Burbank (strong shock; about 12 shocks during the next hour, and approximately 42 aftershocks reported felt throughout the day of Feb. 9), Di Giorgio (moderately strong aftershock within 15 minutes of the first shock), and in the Windsor Hills area north of Inglewood.

9 February, 06:16:12.9. Mag. 4.1.

Epicenter  $34^{\circ}20.3' N.$ ,  $118^{\circ}19.9' W.$ , southern California, at a depth of about 11 km., P. Aftershock of San Fernando earthquake.

Felt at Redondo Beach.

9 February, 06:19:50.2. Mag. 4.0.

Epicenter  $34^{\circ}21.4' N.$ ,  $118^{\circ}24.0' W.$ , southern California, at a depth of about 12 km., P. Aftershock of San Fernando earthquake.

Felt at La Canada (moderately severe) and Riverside (mild shock).

9 February, 06:43:46.7. Mag. 5.2.

Epicenter  $34^{\circ}18.5' N.$ ,  $118^{\circ}27.2' W.$ , southern California, at a depth of about 6 km., P. Aftershock of San Fernando earthquake.

Felt at Goleta (probably the shock reported felt about an hour after the main shock), North Hollywood, and in the Windsor Hills area north of Inglewood.