

California's Earthquakes

The 'Big One' is still to come

by Rogelio A. Maduro

The earthquake that shook California in the early hours of Jan. 17 may be the costliest disaster in U.S. history, with early estimates of losses exceeding \$30 billion. But top geologists warn that this earthquake was not the "Big One." While the magnitude of the Northridge earthquake was 6.8 on the Richter scale, the magnitude of the "Big One" is expected to be significantly greater, 8.3.

Geologists are now hotly debating the implications of the Northridge earthquake. One fundamental issue is whether this earthquake has increased the probability that the "Big One" will occur in the near future. Because the Northridge earthquake occurred in a thrust fault, many geologists argue that it will not increase regional stress. Other geologists argue

the contrary. According to Walter W. Hays, head of the earthquake monitoring division of the U.S. Geological Survey (USGS), the best estimate at present is that there is a 50% chance that a 8.3 magnitude earthquake is going to occur in the Los Angeles region in the next five years. This earthquake would take place along the San Andreas fault (see Figure 1, somewhere southwest of Los Angeles).

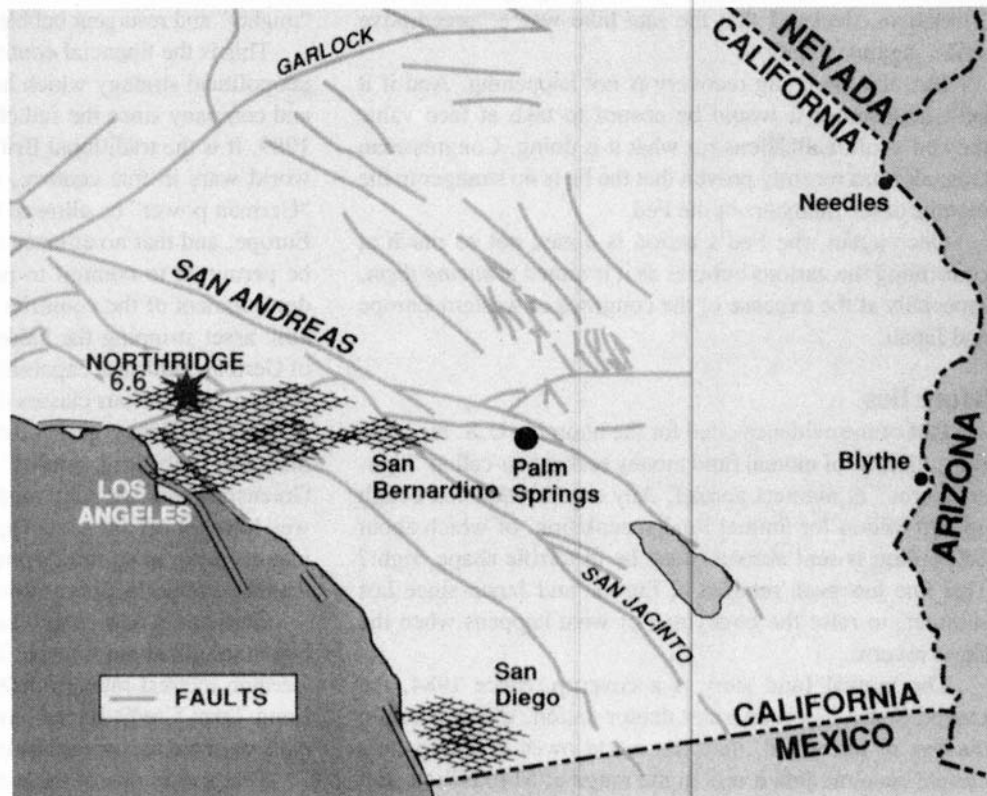
The Northridge earthquake wrought the following:

- It damaged eight major freeway systems.
- It triggered widespread ground failure (liquefaction and landslides), causing gas and water pipelines to rupture resulting in more than 100 fires and power outages for approximately 700,000 people and disruption of water service for 200,000 during the first few days.
- It damaged more than 25,000 homes and apartments. Approximately 11,000 of these were left uninhabitable.
- It damaged 150 schools, forcing them to close, and damaged several hospitals, forcing the relocation of patients.

Therefore, the fundamental issue that has to be addressed immediately is the need for improvements in existing infrastructure, including stronger houses, buildings, and highways, and a more stringent building code for future construction. This is necessary to prepare not only for a much larger earthquake, but also for the same type of earthquake.

According to the USGS, one reason why there was so much damage from the Northridge earthquake was an unex-

FIGURE 1
Location of
Northridge, California
earthquake, Jan. 17,
1994



Source: U.S. Geological Survey.

pectedly strong vertical motion. Usually in earthquakes, most of the ground motion is side-to-side, with little vertical motion. Therefore most structures are designed to withstand horizontal shaking. But in this case, the vertical shaking was as intense as, and in many cases more intense than, the horizontal shaking. One of the lessons learned is that building codes have to be rewritten once again to add further structural protection against this vertical shaking.

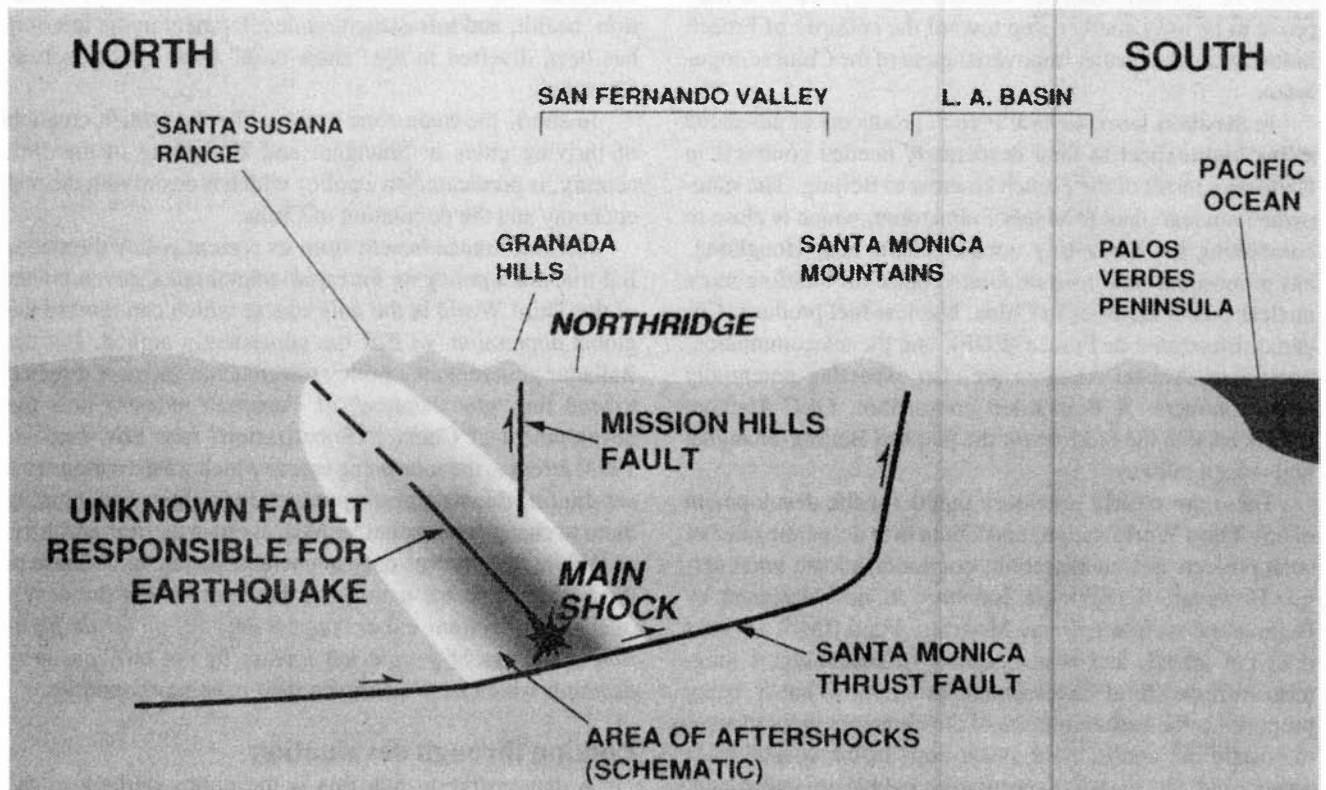
After some initial confusion, it was established that the Northridge earthquake occurred not along a series of faults connected to the San Andreas fault, but along a hidden fault beneath the San Fernando Valley. **Figure 2** shows a schematic cross-section of the fault. The main shock occurred approximately 10 kilometers below the surface. In a thrust fault such as this one, one block of ground moves or slips on top of another as a result of tremendous pressures and stresses built up over time. The San Andreas fault, in contrast, is a strike-slip fault, where the block moves sideways, causing a rupture.

Earthquakes caused by thrust faults are not as intense as those caused by strike-slip faults. For that reason, an earthquake along the San Andreas fault would be significantly more intense than the Northridge earthquake.

Earthquake prediction is a nascent discipline. The most that the USGS can provide at present is a general estimate of where and when an earthquake will occur within a span of several decades. In this case, however, the location and intensity of the Northridge earthquakes was accurately predicted by a NASA geophysicist in November of last year. The prediction was made by Dr. Andrea Donnellan, a geophysicist at NASA's Jet Propulsion Laboratory, in an article in *Nature* published Nov. 25, 1993.

Donnellan's study drew upon data from the Defense Department's Global Positioning System (GPS) of 24 Earth-orbiting satellites over 4.5 years that showed continuing deformation in the Ventura basin region, which she and her colleagues interpreted as rotation of blocks of crust. They wrote: "Our modelling suggests that the faults bounding the basin are locked at the surface, but are slipping at depths below about 2-5 km." They predicted a quake of up to 6.4 on the Richter logarithmic scale. Although Donnellan's methodology may not help predict the precise time of an earthquake, it can pinpoint its location more precisely. One fact is beyond dispute: Southern California is running out of time, and accelerated efforts are required to prepare for the next earthquake.

FIGURE 2
Schematic cross-section through the hypocenter of the Northridge earthquake



Source: U.S. Geological Survey.