Realtime Information for the 1994 Northridge and 1995 Kobe Earthquakes

Comparison between Northridge and Kobe earthquakes

Northridge Earthquake
January 17, 1994

Mw 6.7
Deaths 57
Economic Loss ~$20 billion

兵庫県南部地震
Hyogo-ken Nambu Earthquake
January 17, 1995

Mw 6.9 (M_{jma} 7.3)
Deaths 5096
Economic Loss ~$100 billion

Southern Californians Cope With Earthquakes

For decades Southern Californians have worked to reduce their vulnerability to earthquakes. The 1994 Northridge shock, damaging as it was, proved the value of these efforts. Yet, much more needs to be done. Scientists are preparing new maps of the earthquake shaking hazard in Southern California. Such maps help make living in the region safer by focusing efforts to strengthen existing structures and by providing guidance in building new structures.

Millions of people reside in Los Angeles and its surrounding communities. This area is laced with numerous active faults that can produce strong earthquakes. Such faults underlie most of Southern California, a region that is home to more than 20 million people and vital elements of the Nation's economy. (Photo by I.K. Curtis Services.)

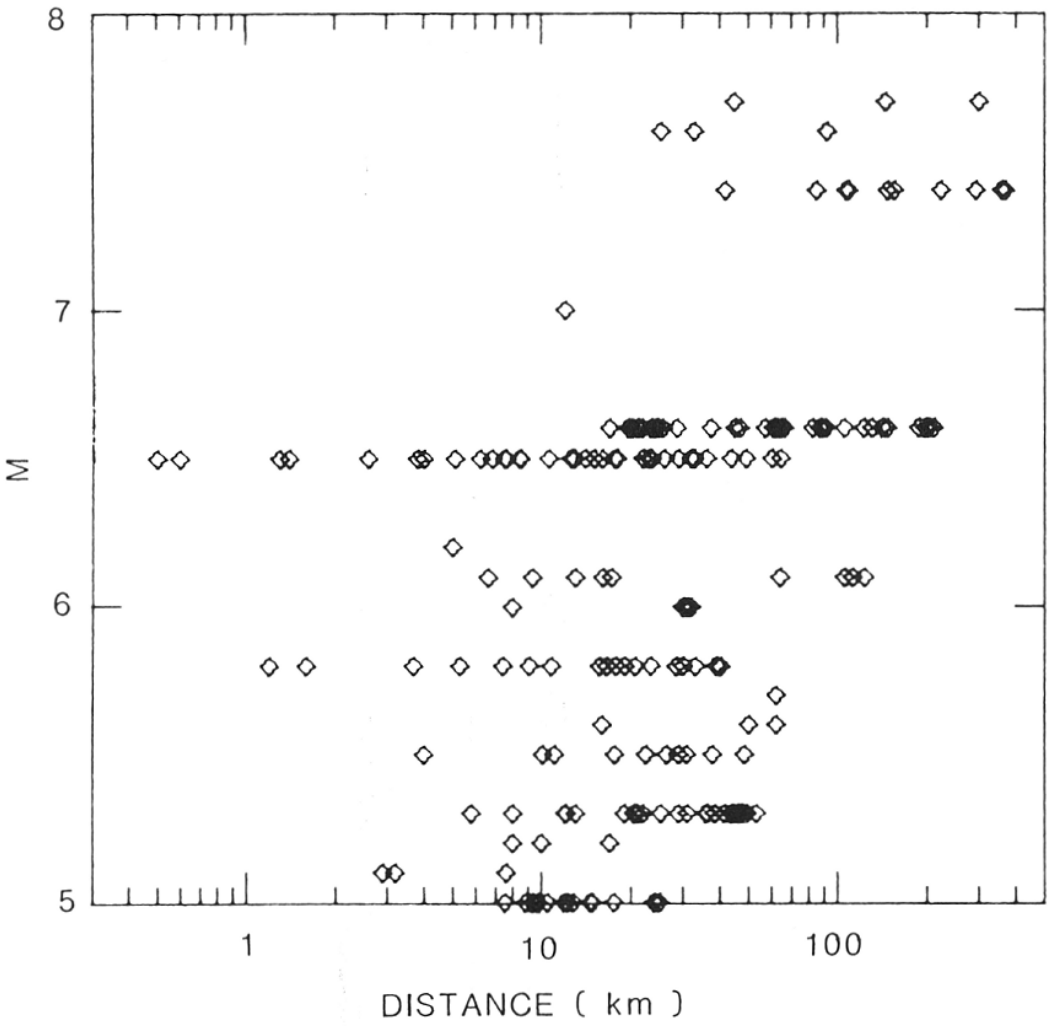
Collapsed Bridges

There were 5 collapses and over 170 damaged Bridges around Los Angeles

One year later in Japan…

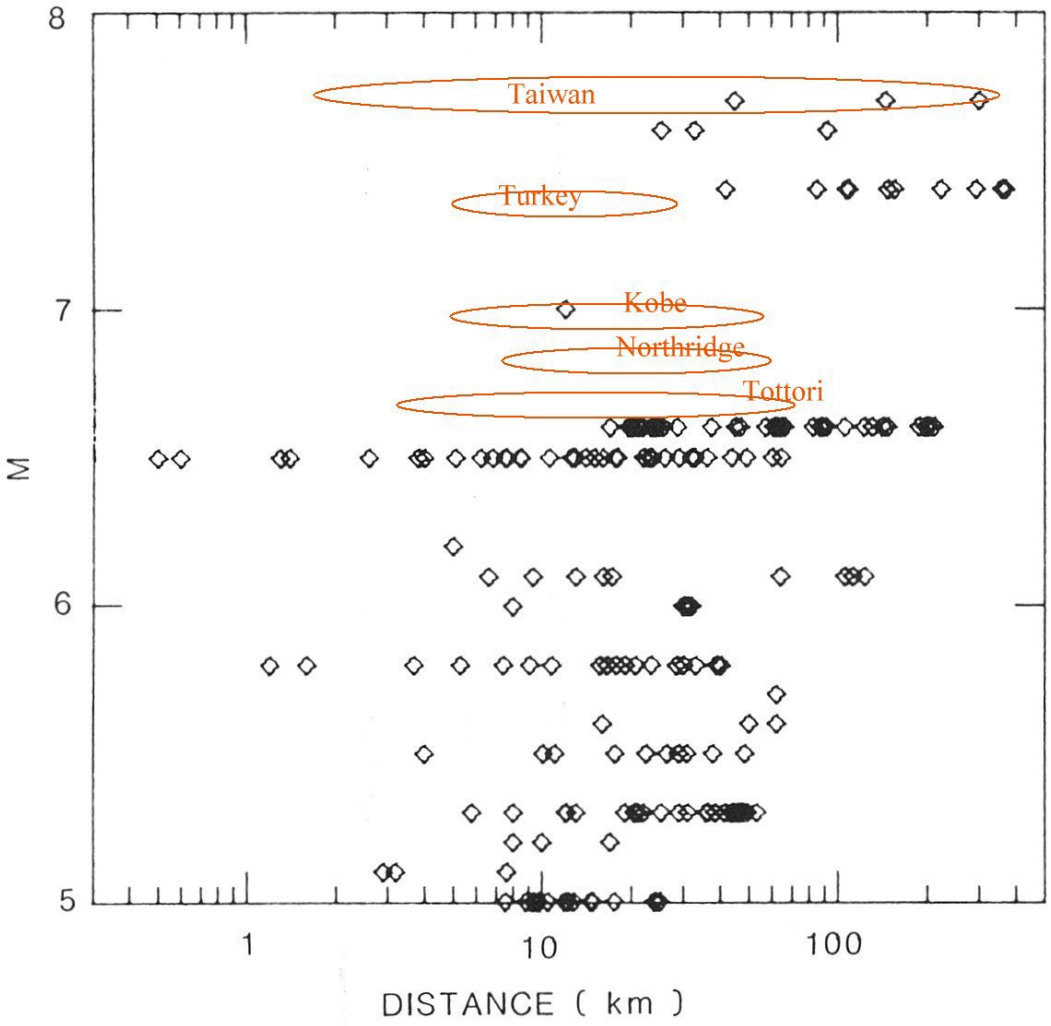
Collapsed Hanshin Highway in Kobe

Strong-Motion Data in 1982



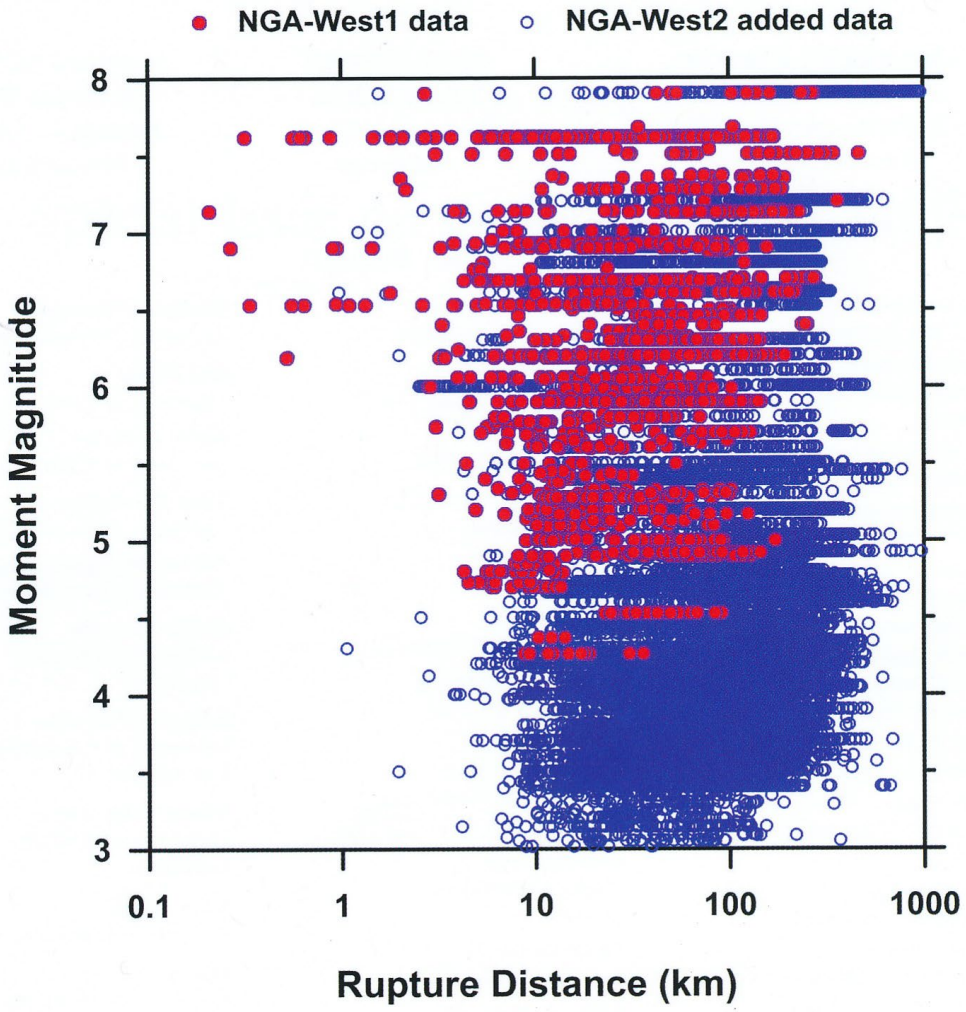
Boore and Joyner, 1982

Strong-Motion Data in 2004



Boore and Joyner, 1982

Strong-motion Data in 2014



Spectra Aug 2014

Caltech – USGS Broadcase of Earthquakes (CUBE)

24 hour duty carried the 'football'
(cellular telephone modem and laptap)

Dialed in to the online commuter and checked the automated phase picks and location

With verified information, a phone call was made to California Office of Emergency Services (0ES)

Goal was to report to OES in about 10 minutes (M>3.5)

(A Model for a Seismic Computerized Alert Network Science, Heaton, 1985)

January 17, 1994 Northridge Earthquake M6.7

1600 “red-tagged”
7300 “yellow-tagged”

Kaiser-Permanente building in Granada Hills

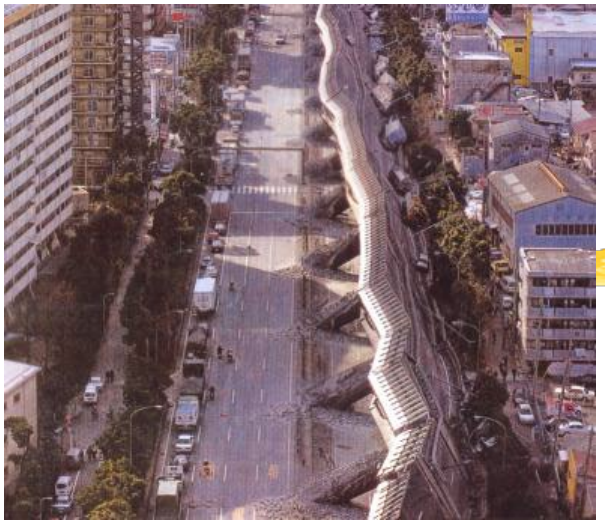
January 17, 1994 M6.7
Northridge, California Earthquake

04:31 Northridge Earthquake (automated location fails for mainshock)

04:45 Automated aftershock locations recorded

04:55 Announced to OES and media that earthquake was in northern San Fernando Valley with magnitude between 6 and 7

~8:00 Thrust mechanism on southward dipping fault was determined



January 17, 1995 M6.9
Hyogo-ken Nanbu (Kobe) Earthquake

05:46 Origin Time
(reports from Kobe and Sumoto not included because of failure of phone line)

6:00 Reported Intensity VI in Kobe

6:09 Corrected to Intensity V
i.e. maximum intensity was V in Kyoto, Hikone, and Toyooka

6:15 Corrected to Intensity VI in Kobe

3 days later Corrected to Intensity VII in Kobe and Sumoto

Lesson Learned for Realtime Systems

- Small earthquakes are different from big earthquakes
  - Data volume
  - Possible power failure in epicentral region
  - Unexpected things go wrong

- Estimating Magnitude can be difficult

- Need to carry out simulations of large earthquakes

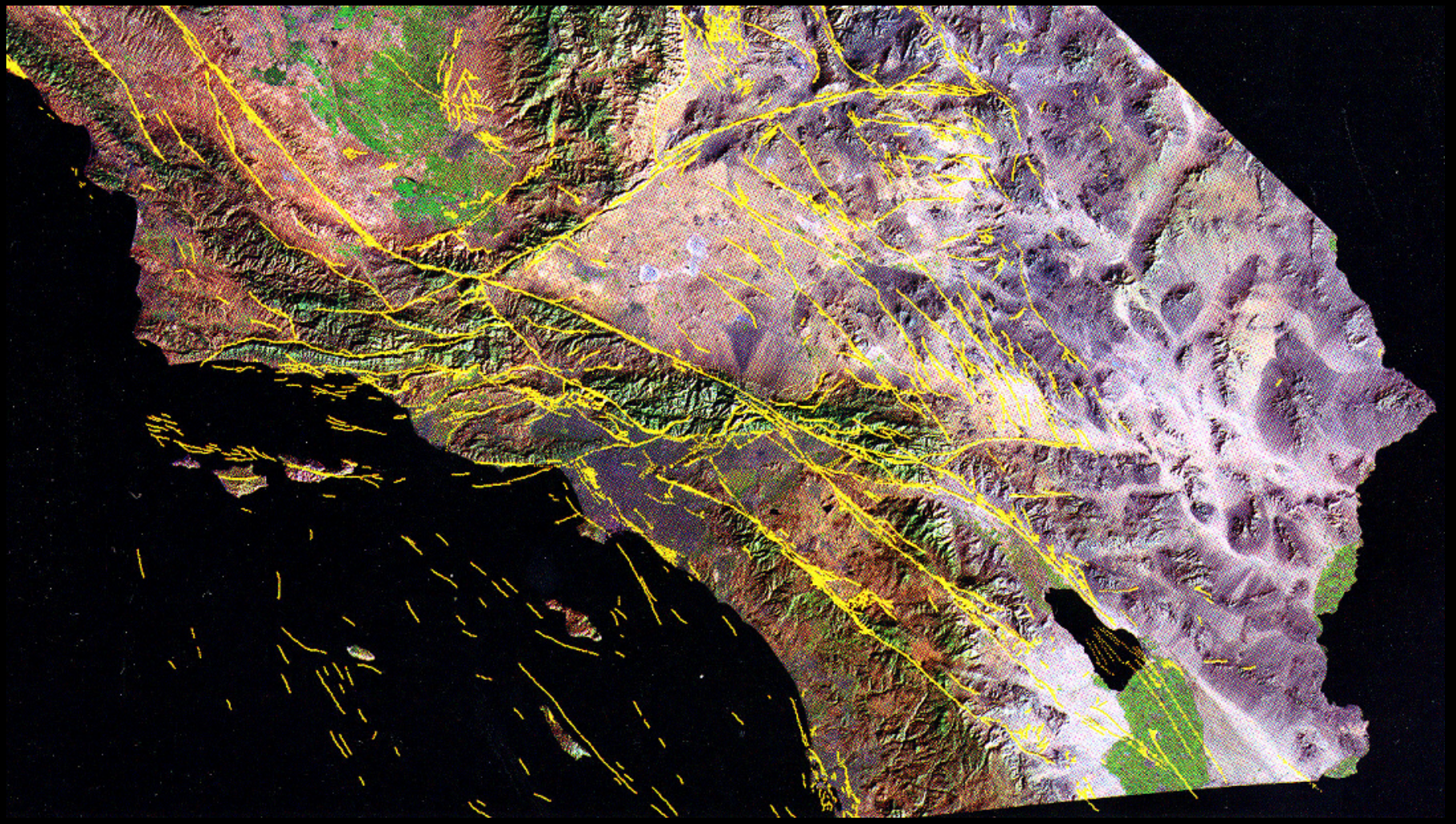
緊急地震速報とは？

地震をすばやくキャッチし、強いゆれが始まることを数秒～数十秒前にお知らせする新しい情報です。
テレビ・ラジオなどを通じて受けられる予定。 ※ただし、震源に近い場所では強い揺れに間に合わないことがあります。
詳しくは気象庁のホームページ(http://www.jma.go.jp/)までご参照ください。

画像元は「緊急地震速報企画小中学校標語コンクール」最優秀賞：高知県 高須小学校4年 北岡仁海さんの作品

国土交通省 気象庁

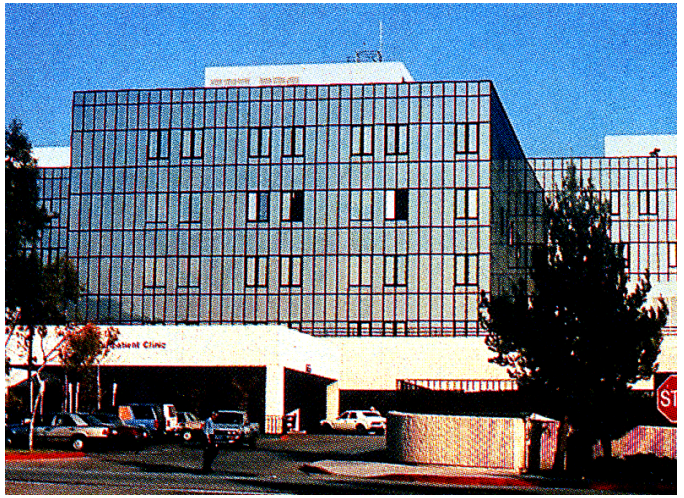
Media Coverage of Earthquakes in Los Angeles



1994 Northridge, California Earthquake

Lessons Learned …

Oliveview Hospital after the 1971 San Fernando earthquake



New Oliveview Hospital after the 1994 Northridge earthquake

Lessons Not Learned…

Antelope Valley Overpass after
the 1971 San Fernando Eq.

Antelope Valley Overpass after
The 1994 Northridge earthquake

Local Emergency Response

What did we learn from the Northridge earthquake ?

- Direct hit on modern cities
- Large economic impact for moderate event
- Importance of hidden thrust faults
- Large amplitude strong-ground motions
- Tested realtime information systems

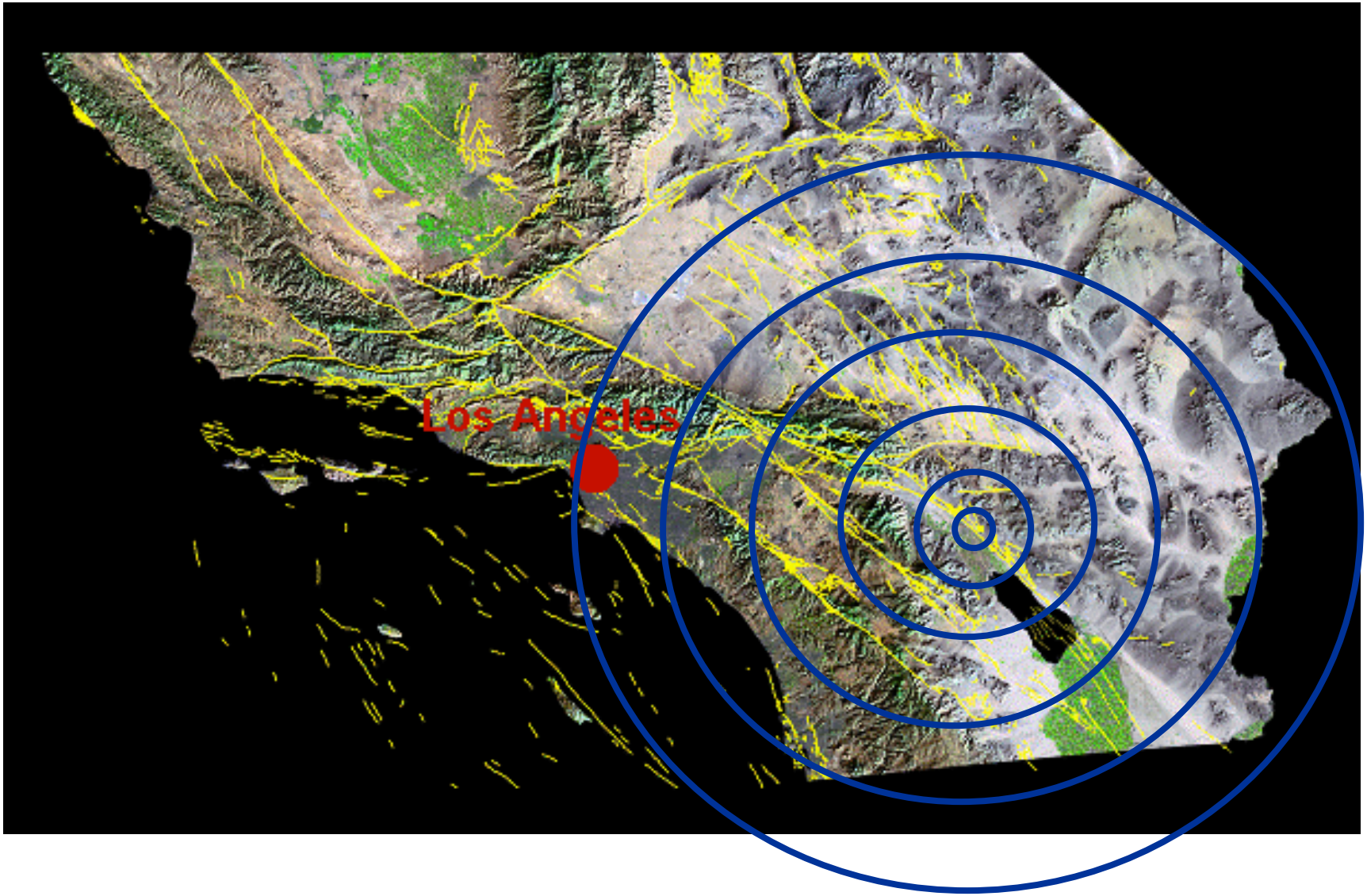
Steel's Performance in the Northridge Earthquake

Cracks were found in the welds of over 100
steel frame buildings following the Northridge earthquake

Northridge Building Damage

1600 “red-tagged”
7300 “yellow-tagged”

Kaiser-Permanente building
In Granada Hills



For an earthquake on the southern San Andreas it would take about 30 sec for the S wave to reach Los Angeles. (The S wave travels at about 18,000 km/h.) This is enough time to issue an Early Warning.

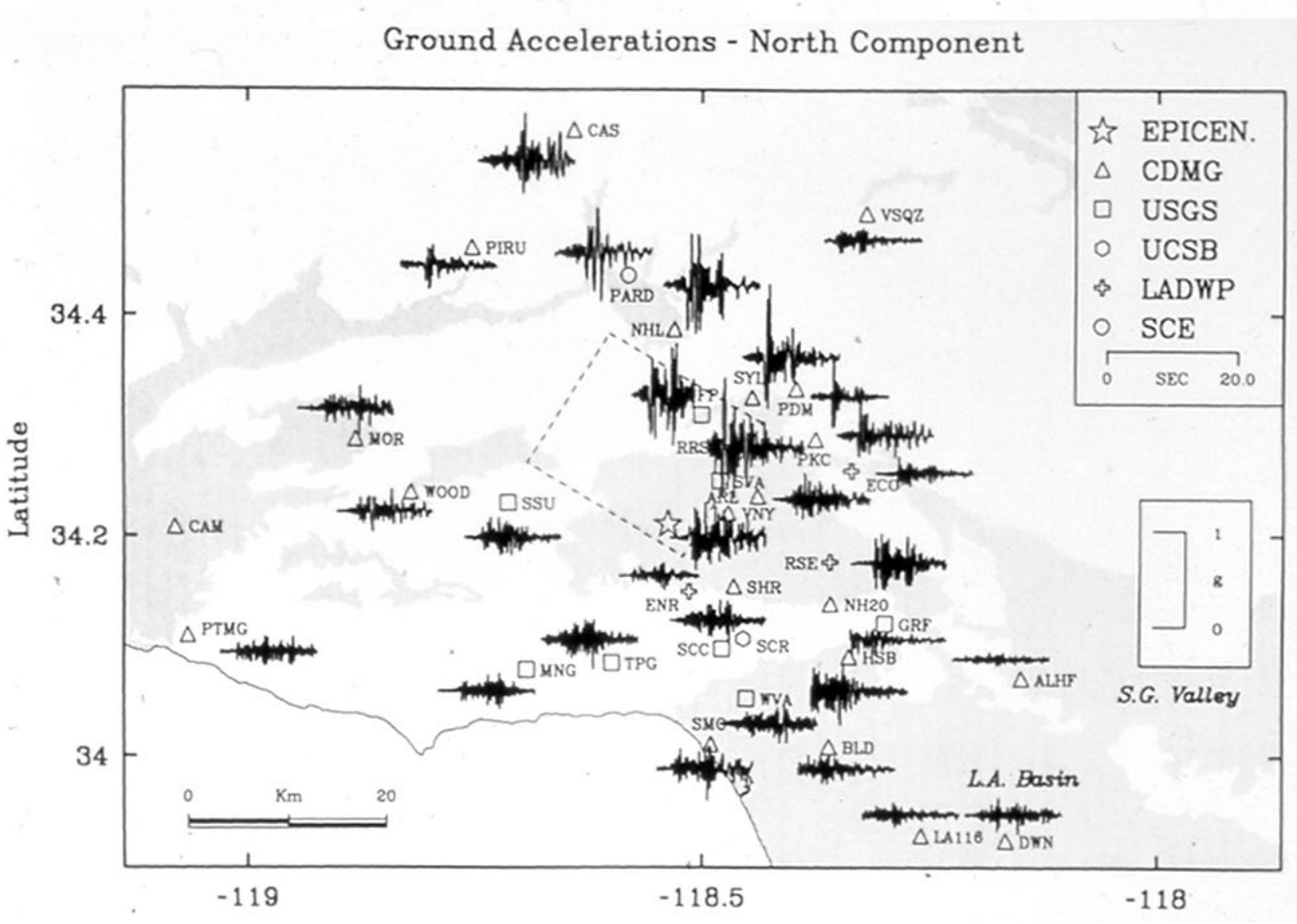
Balboa Blvd Fire

Success of Unreinforced Masonary Legislation in Los Angeles

What did we learn from the Northridge and Kobe Earthquakes ?

- Large economic impact and casualties for moderate sized event
- Importance of hidden thrust faults
  (Need better Geological Information about faults)
- Large amplitude strong-ground motions
  (Need better seismological and engineering information)

Distribution of accelerations in Los Angeles area



Comparison between Northridge and Kobe earthquakes

Northridge Earthquake January 17, 1994	Hyogo-ken Nanbu (Kobe) January 17, 1995
Mw 6.7	Mw 6.9 (M_{jma} 7.3)
Deaths 57	Deaths 5096
Injured 9,158	Injured 26,797
Damage ~US$20 billion ($2 \times 10^{12}$ yen)	Damage ~US$100 billion ($10^{13}$ yen)