1994 Northridge Earthquake I

Lecture Objectives

-know main event characteristics

-recognize the main factors contributing to damages

Notes from:

http://greenwood.cr.usgs.gove/pub/open-file-reports/ofr-96-0263/

Next lecture:

-mitigation engineering

-future/lessons learned

Roles of the USGS?

-seismic hazard mapping

-instrumentation/seismic monitoring (seismometers, accelerometers, GPS)

-geologic studies of past displacement/deformation

-predictive models of seismic, surface motions

-dissemination of data, results, educational materials

-participation in mitigation policy planning

-mapping of all known faults in the region

Northridge 1994: Main facts

-Timing: January 17, 1994, 4:30 am
-Size: M = 6.7, 10-20 seconds of shaking
-Epicenter at Northridge, CA, on previously unknown fault
-energy focused on specific areas
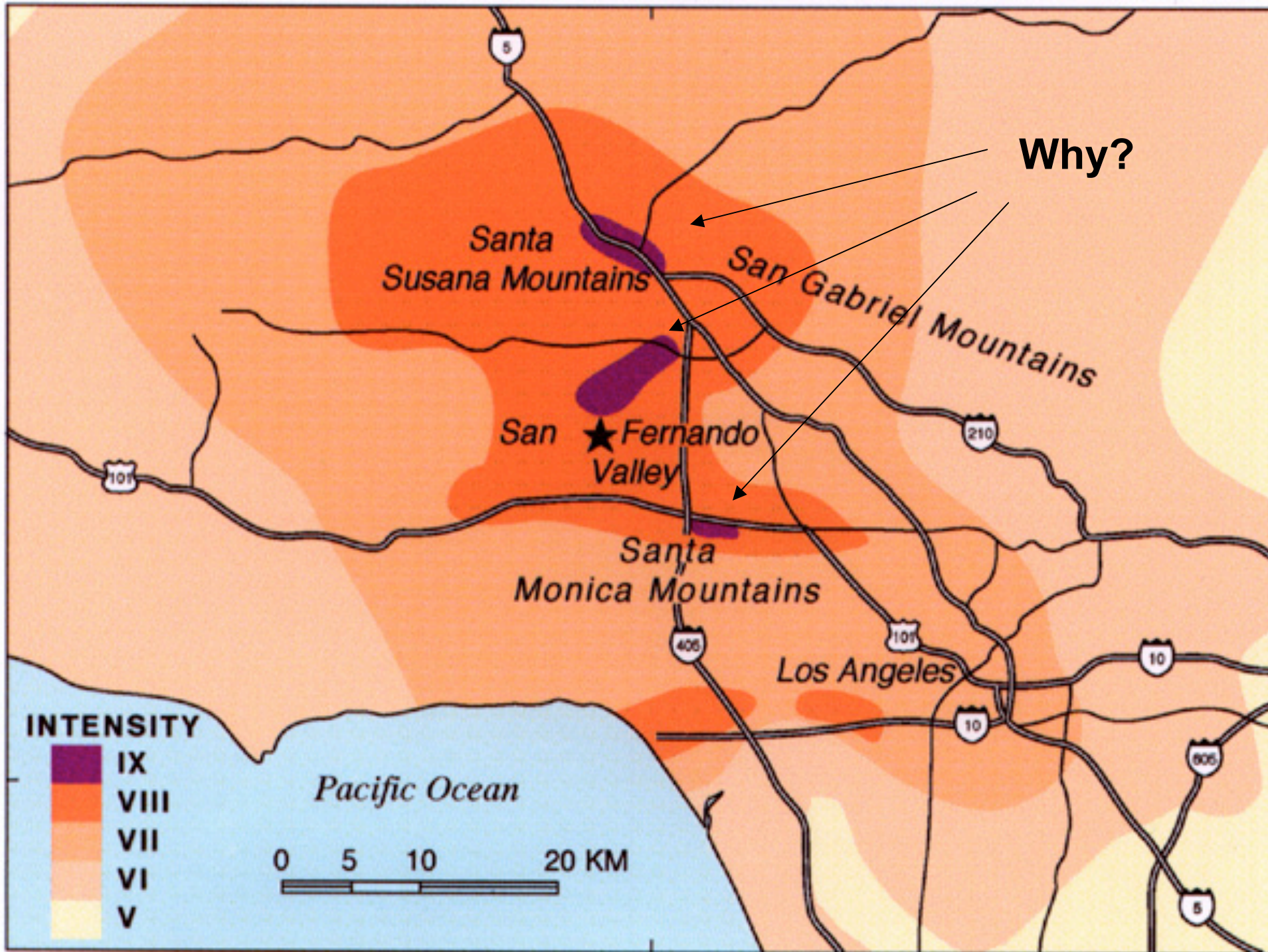-57 deaths; 9000+ injured; 20,000 displaced

Kobe, Japan (1 yr later)
        -M = 6.9
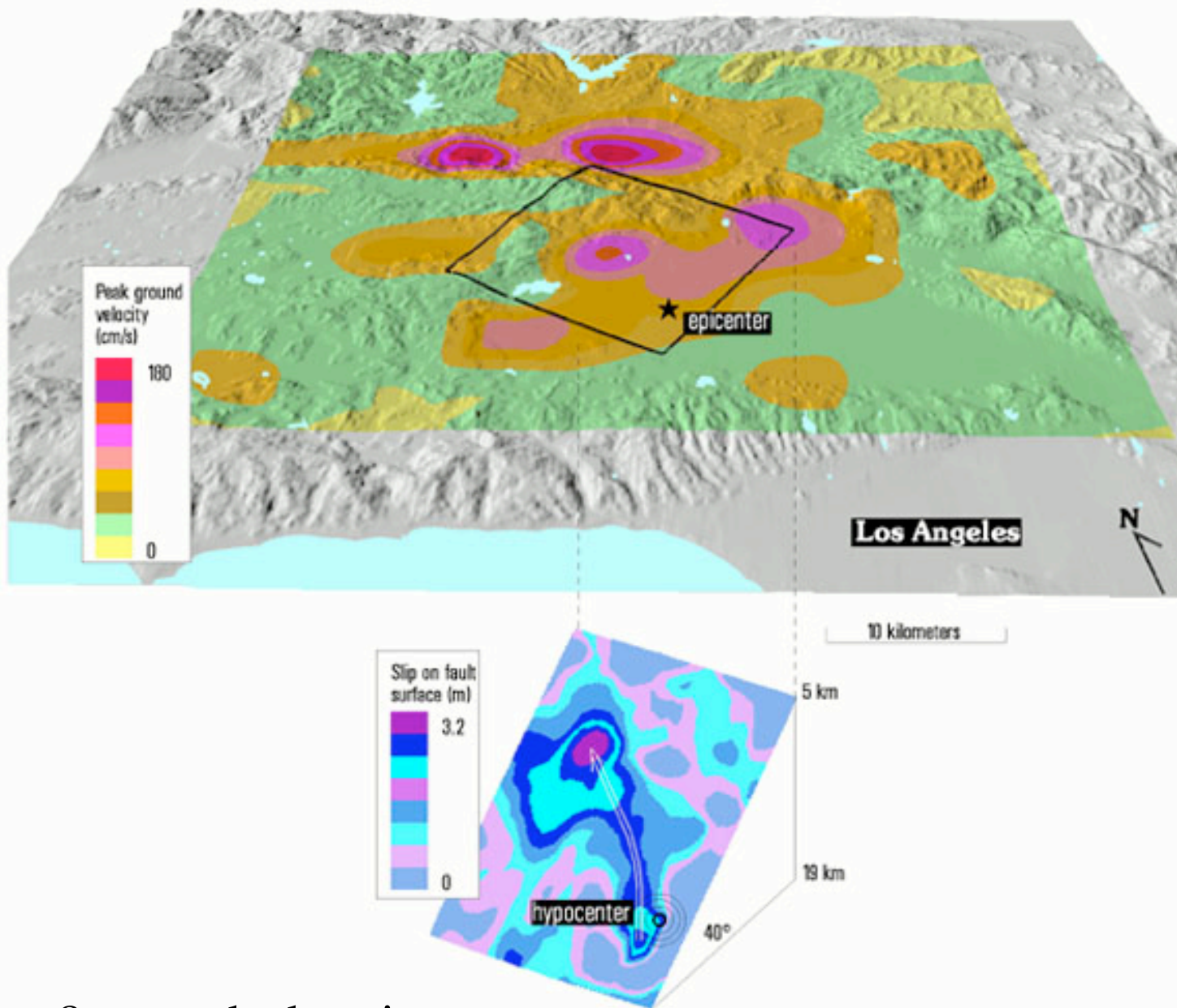   -5100 deaths; 27,000 injured; 100,000 displaced

Primary effects: structural damages (shaking, displacement), landslides

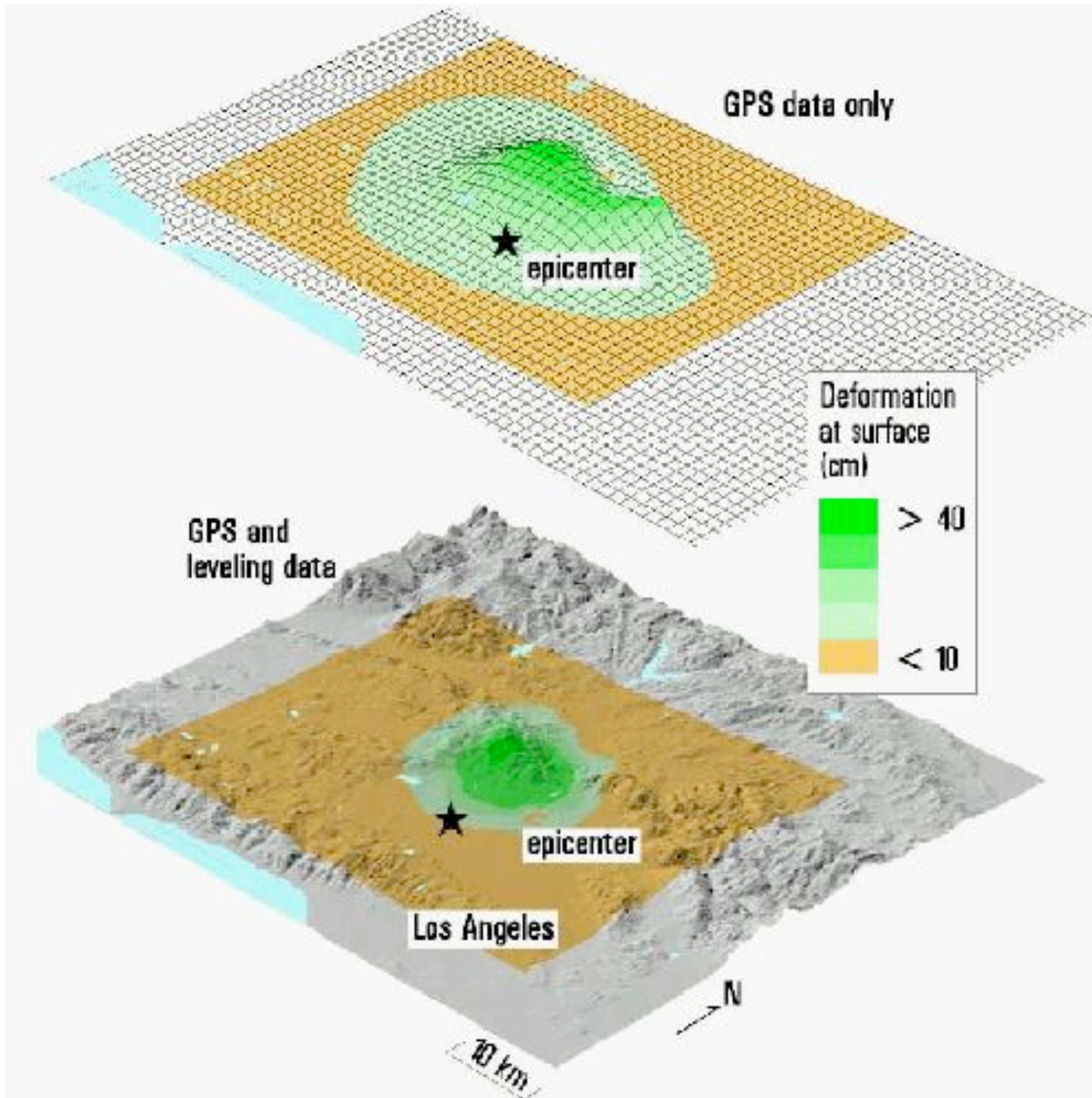Secondary effects: dust disease, sediment debris flows

Peak ground velocity (cm/s)
180
0

Los Angeles

N

epicenter

10 kilometers

Slip on fault surface (m)
3.2
0

5 km

19 km

hypocenter

40°

8 seconds duration

Blind thrust fault?

Why so dangerous?

GPS data only

epicenter

GPS and
leveling data

Deformation
at surface
(cm)

> 40

< 10

epicenter

Los Angeles

N

10 km

Why is the deformation not centered around the epicenter?
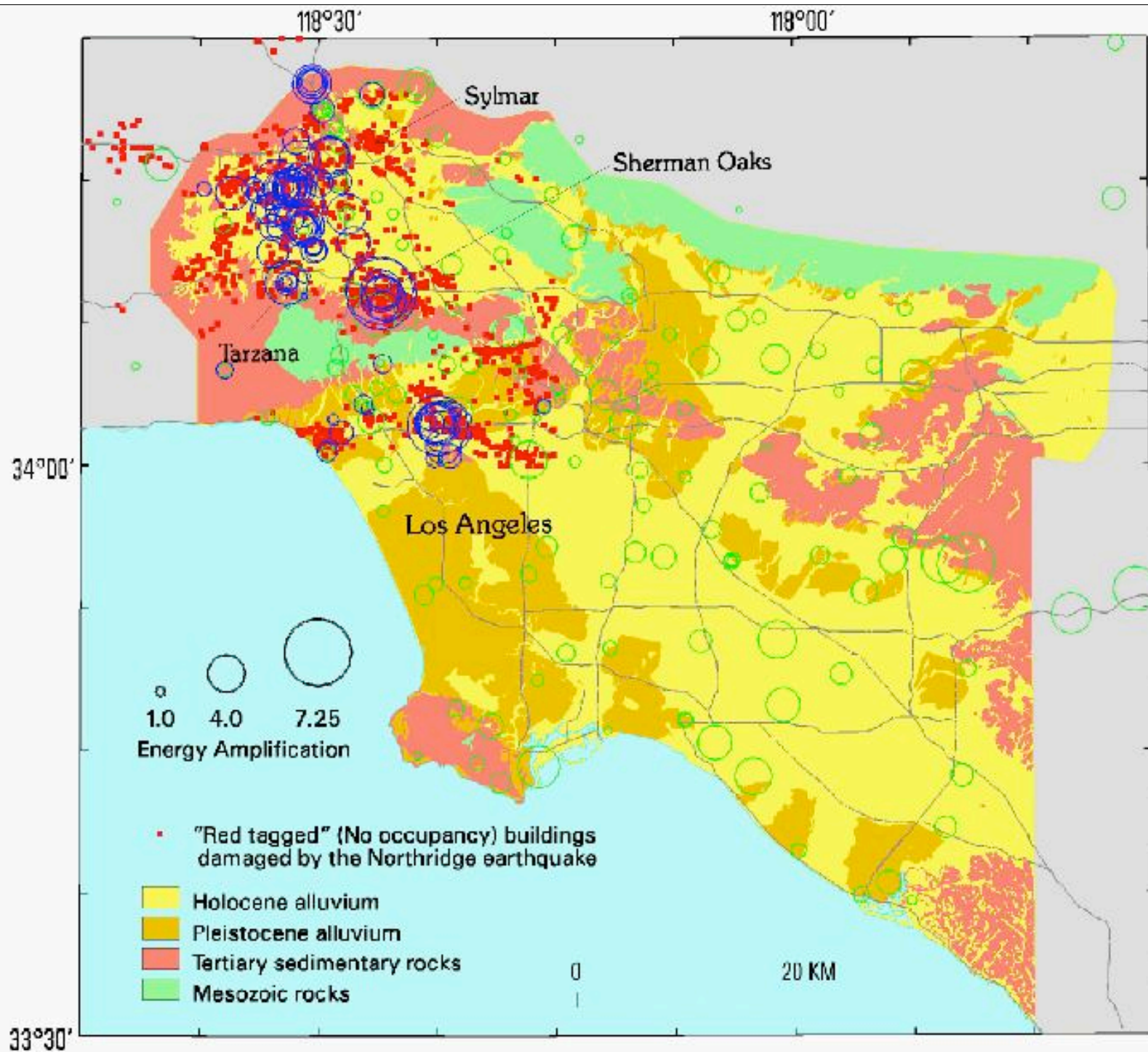
Circles are in 2-6 Hz range

1.0   4.0   7.25
Energy Amplification

"Red tagged" (No occupancy) buildings damaged by the Northridge earthquake

Holocene alluvium
Pleistocene alluvium
Tertiary sedimentary rocks
Mesozoic rocks
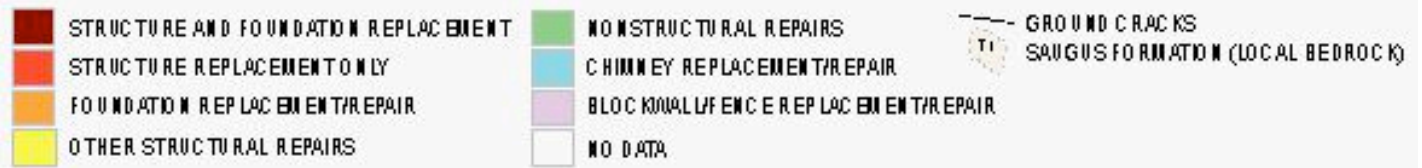
0   20 KM
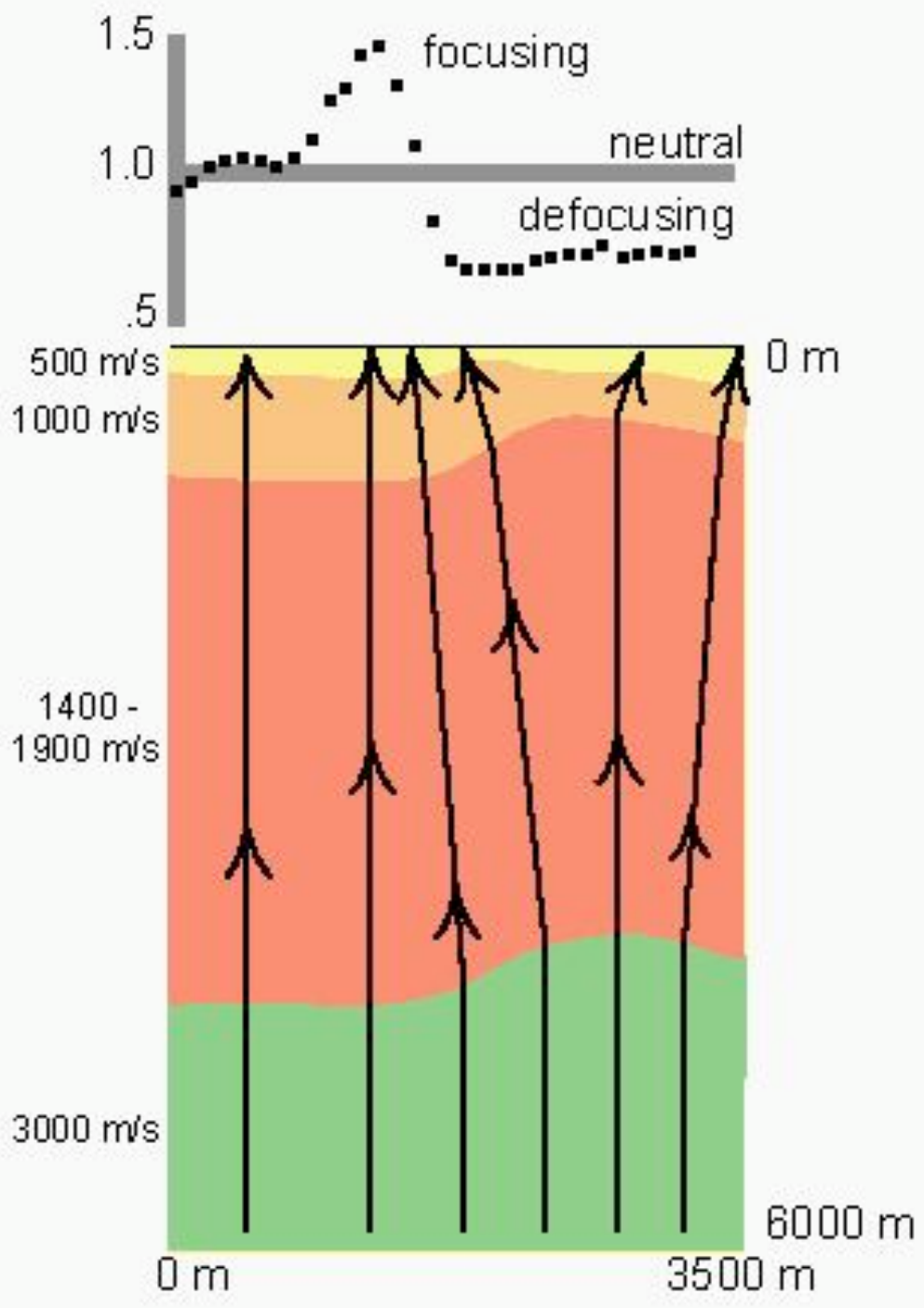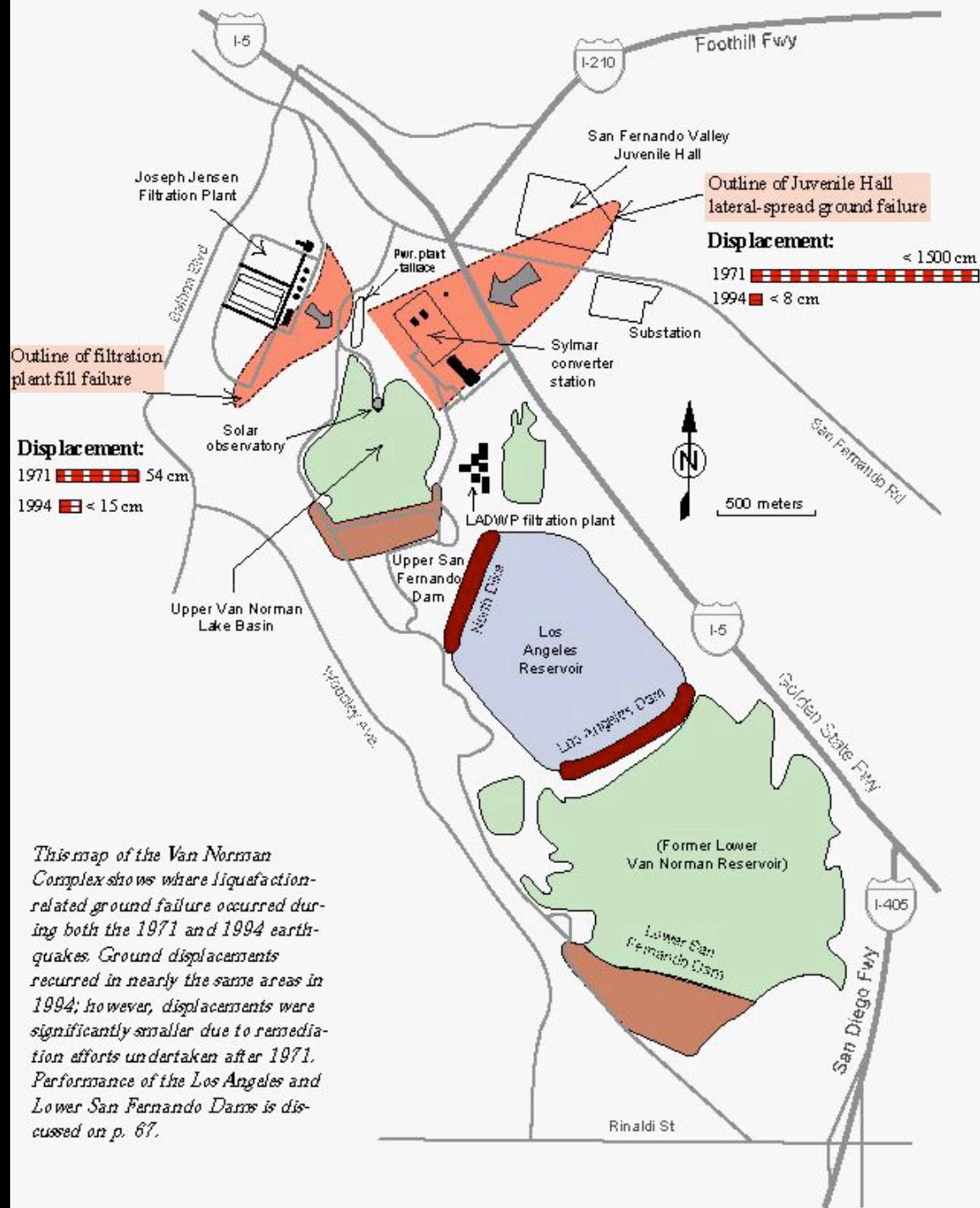
This map of the Van Norman Complex shows where liquefaction-related ground failure occurred during both the 1971 and 1994 earthquakes. Ground displacements recurred in nearly the same areas in 1994; however, displacements were significantly smaller due to remediation efforts undertaken after 1971. Performance of the Los Angeles and Lower San Fernando Dams is discussed on p. 67.

Earthquake repair data for the Balboa Blvd. area show repairs relative to the zones of ground-failure cracks and the shallow ground water mapped by USGS scientists. Most property loss is coincident with these zones.

ZONE OF SHALLOW GROUNDWATER

Flanders St.

Flanders St.1

Rinaldi St.

STATE HIGHWAY 118

Balboa Blvd.

Balboa Blvd.

Transmission Line Right-of-Way

| 0 | 0.25 | 0.5 Mile |
| 0 | 0.25 | 0.5 Kilometer |

STRUCTURE AND FOUNDATION REPLACEMENT
STRUCTURE REPLACEMENT ONLY
FOUNDATION REPLACEMENT/REPAIR
OTHER STRUCTURAL REPAIRS

NONSTRUCTURAL REPAIRS
CHIMNEY REPLACEMENT/REPAIR
BLOCKWALL/FENCE REPLACEMENT/REPAIR
NO DATA

GROUND CRACKS
SAUGUS FORMATION (LOCAL BEDROCK)

Summary

-local site amplification very important for damage severity
-soil type, topography, building type/construction affected damage levels
-sedimentary basins (old lakes) act as convex lenses to focus seismic waves
-structure, such as faults and folds
-groundwater (water table levels)
-landfill or unconsolidated sediments