



USGS Earthquake Hazards Program

Earthquakes 101 (EQ101)

Lisa Wald
USGS Pasadena

Global Distribution of Earthquakes

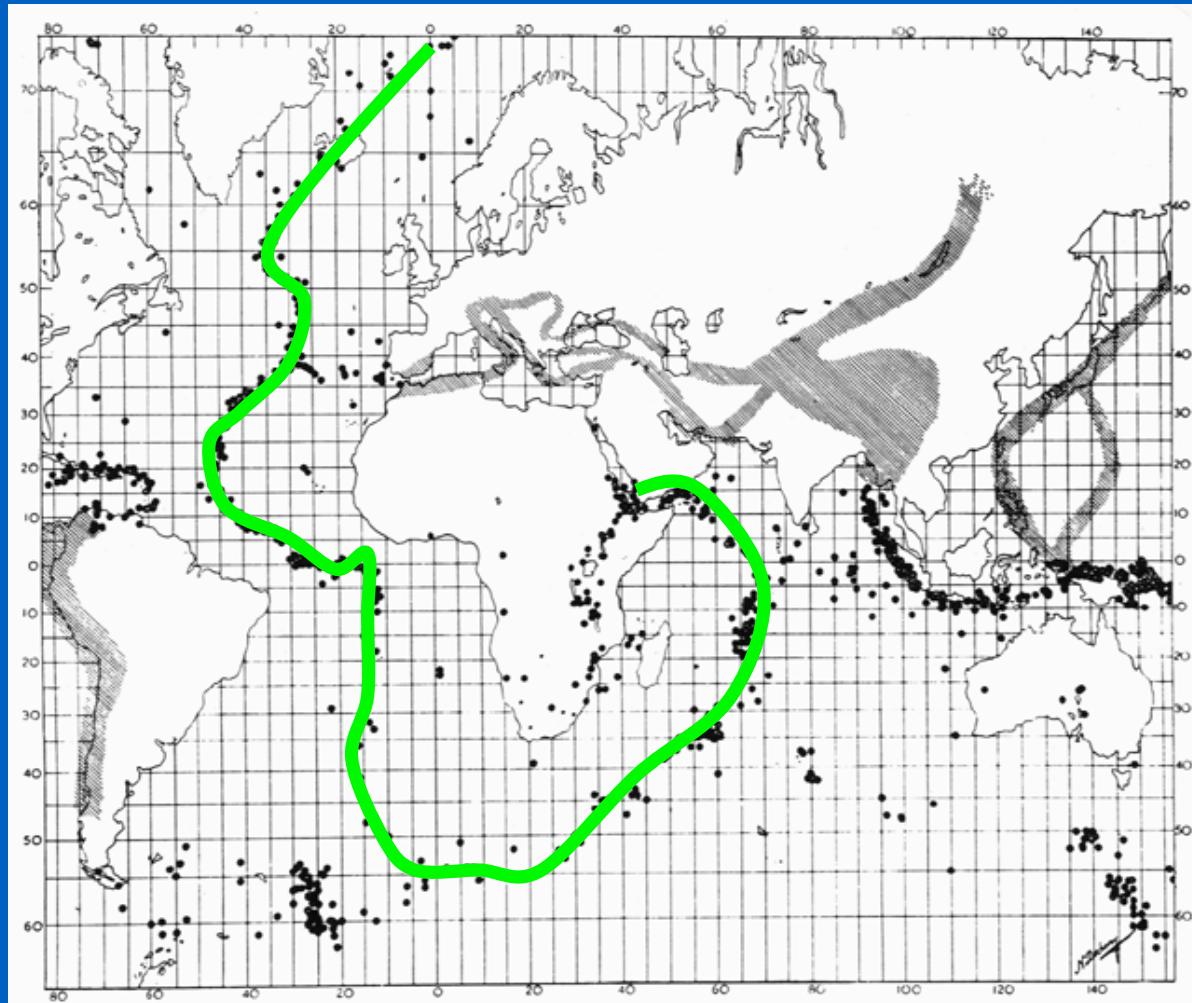


Plate Tectonics

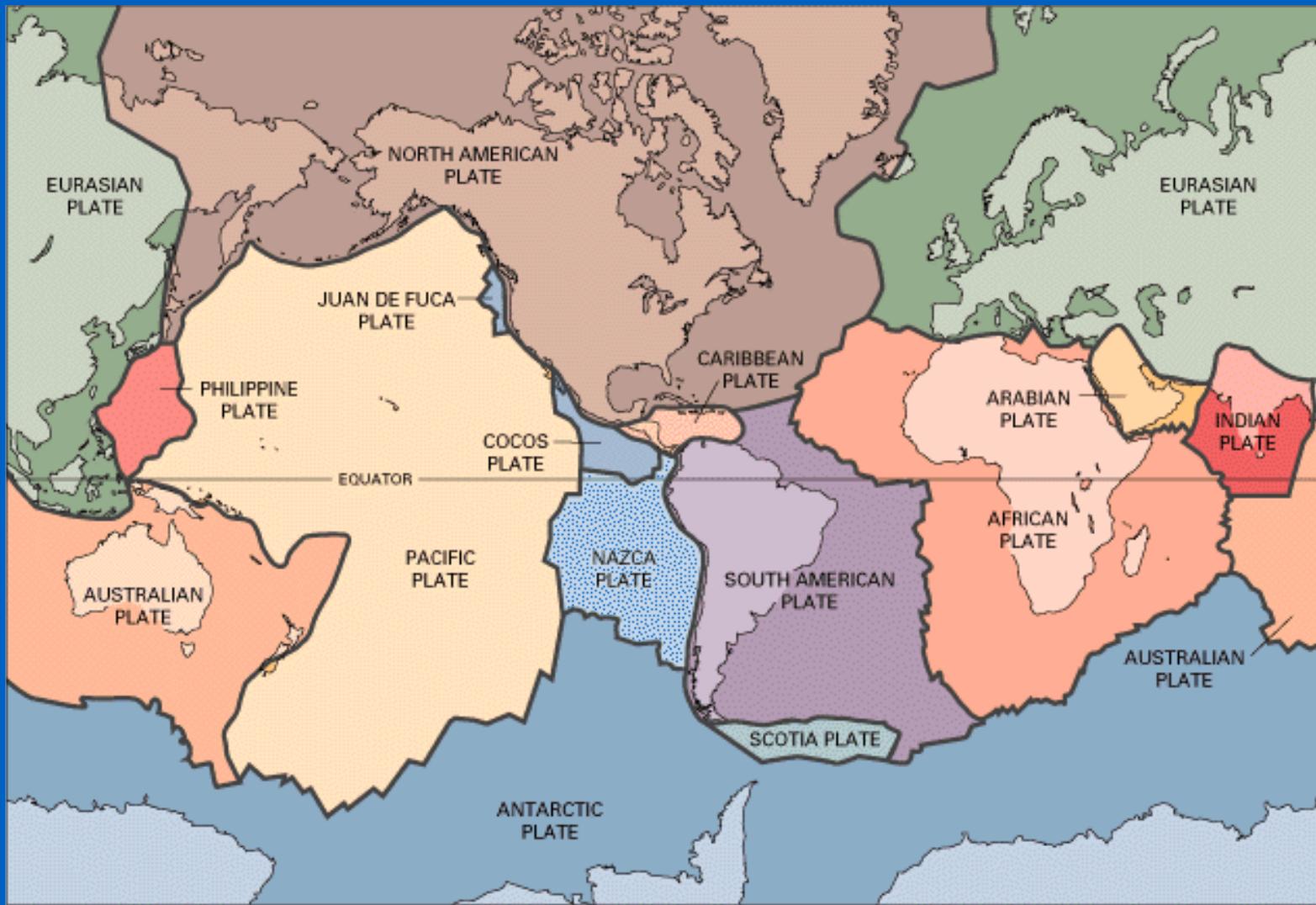
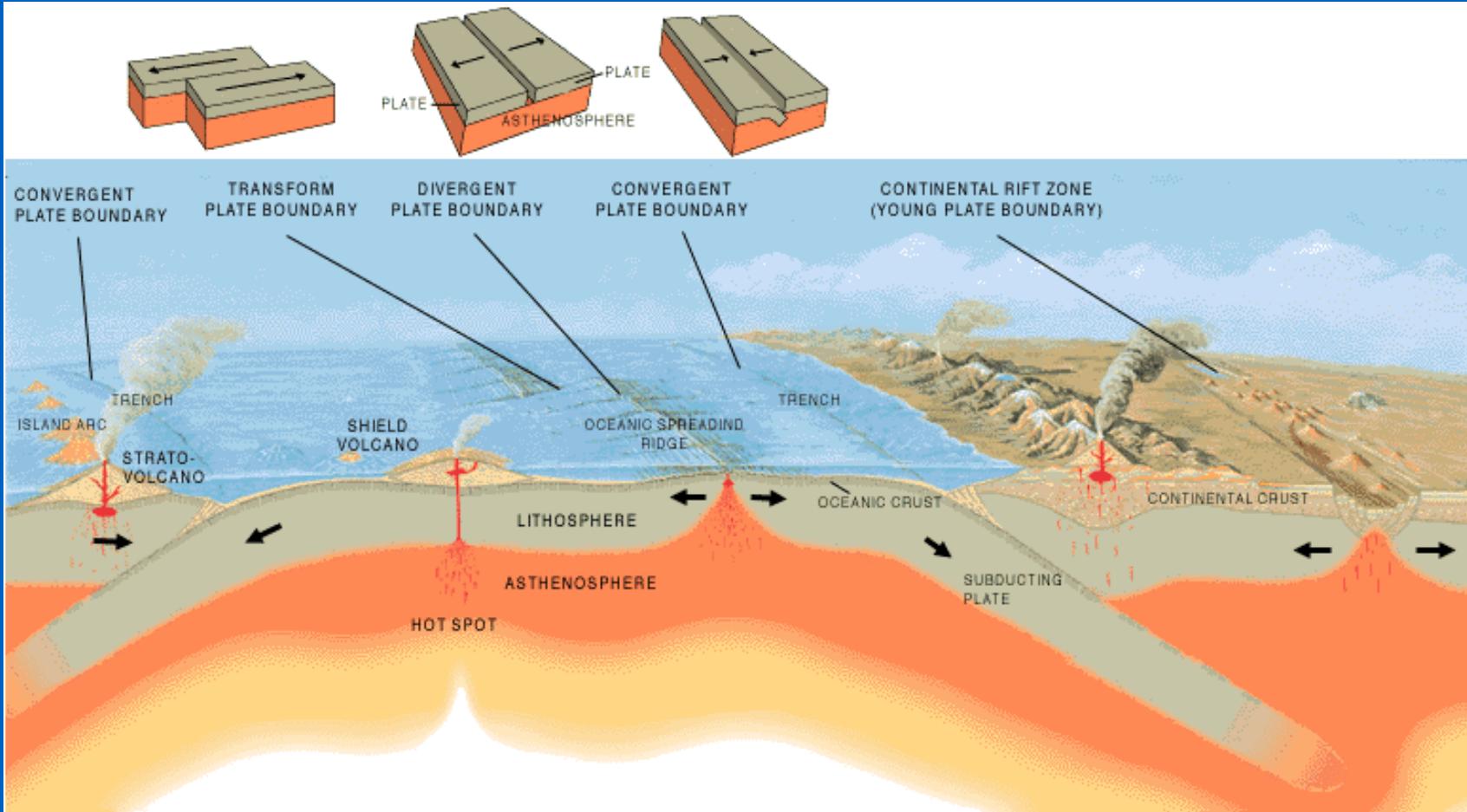
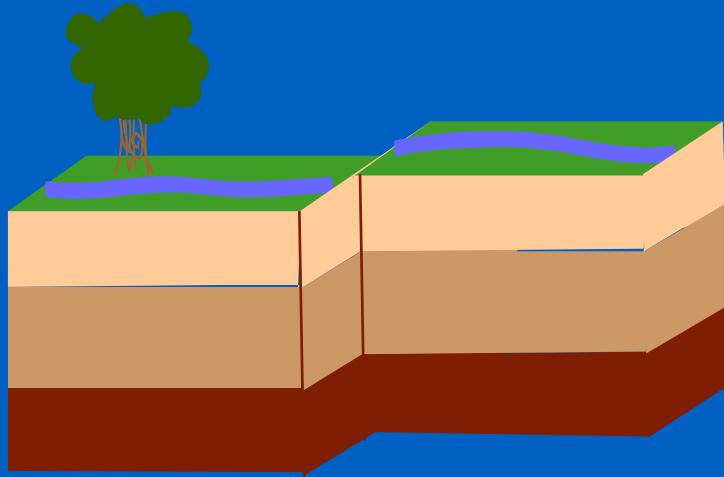


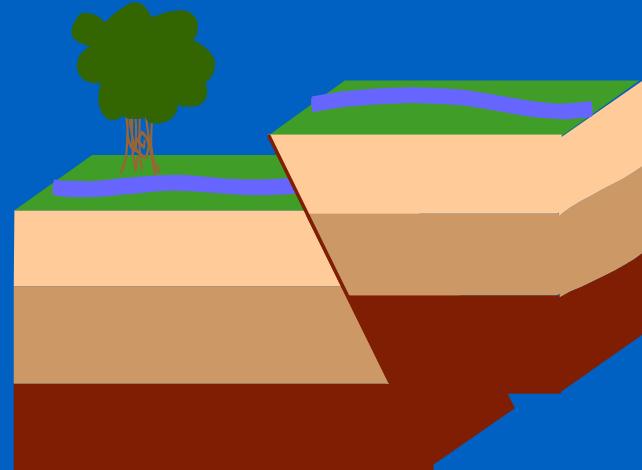
Plate Boundaries



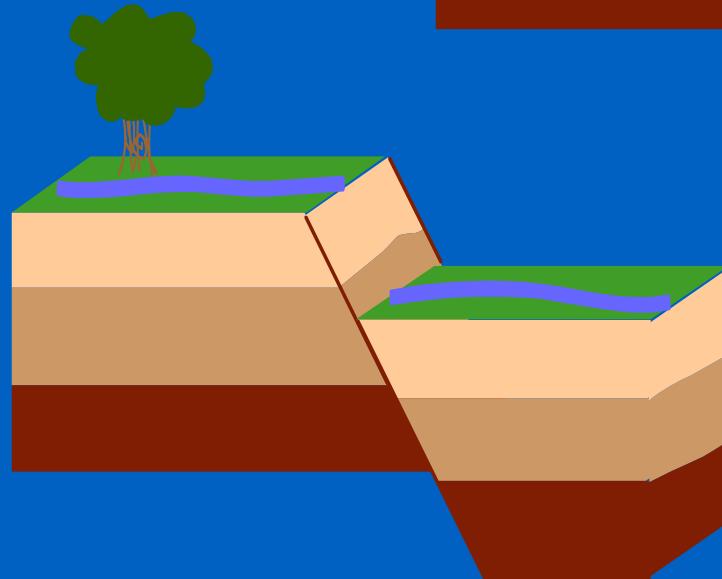
Three Types of Faults



Strike-Slip



Thrust

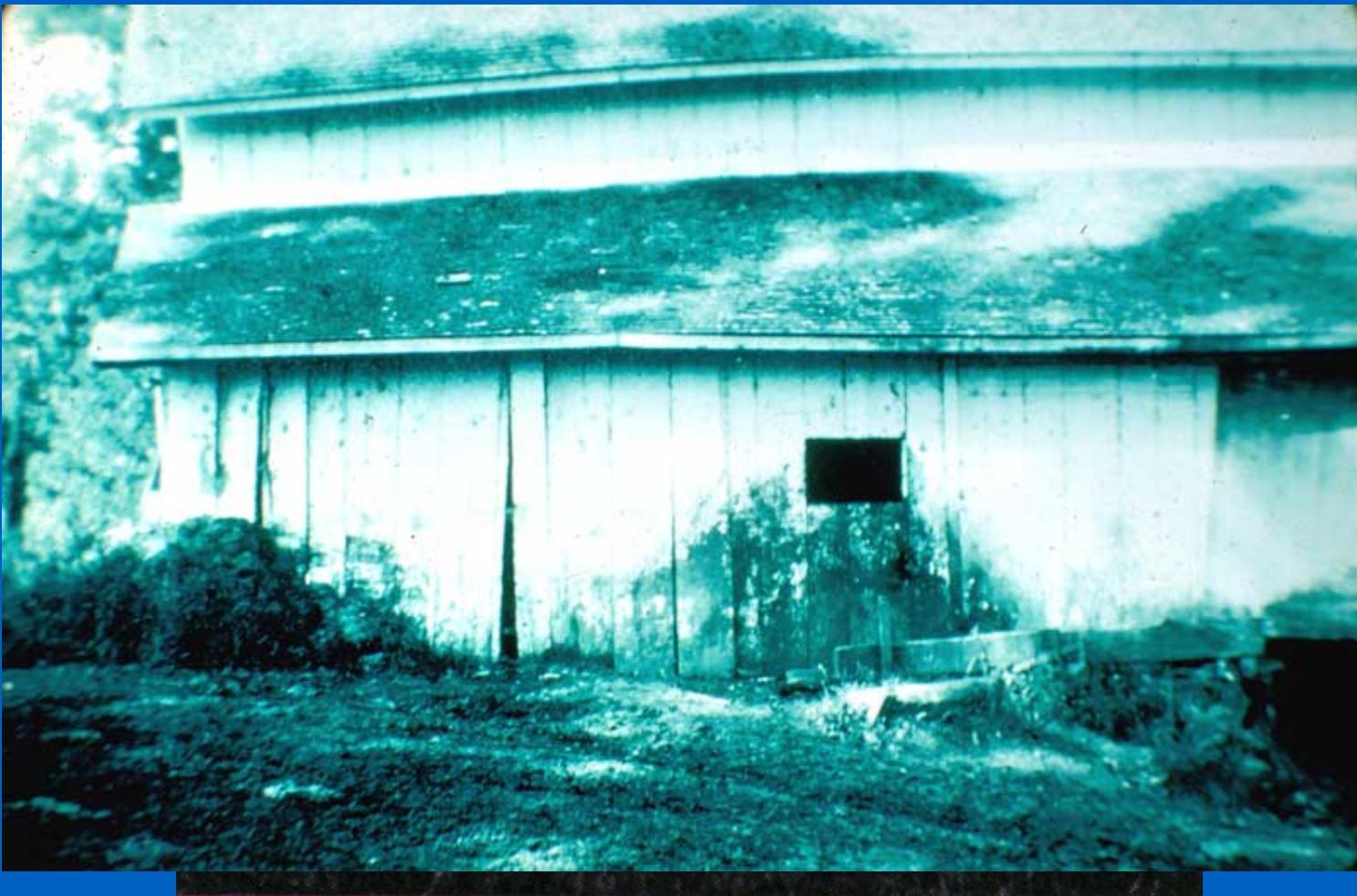


Normal

Strike-slip Fault Example



Strike-slip Fault Example



1906 San Francisco Earthquake

Normal Fault Example



Dixie Valley-Fairview Peaks, Nevada earthquake
December 16, 1954

Thrust Fault Example

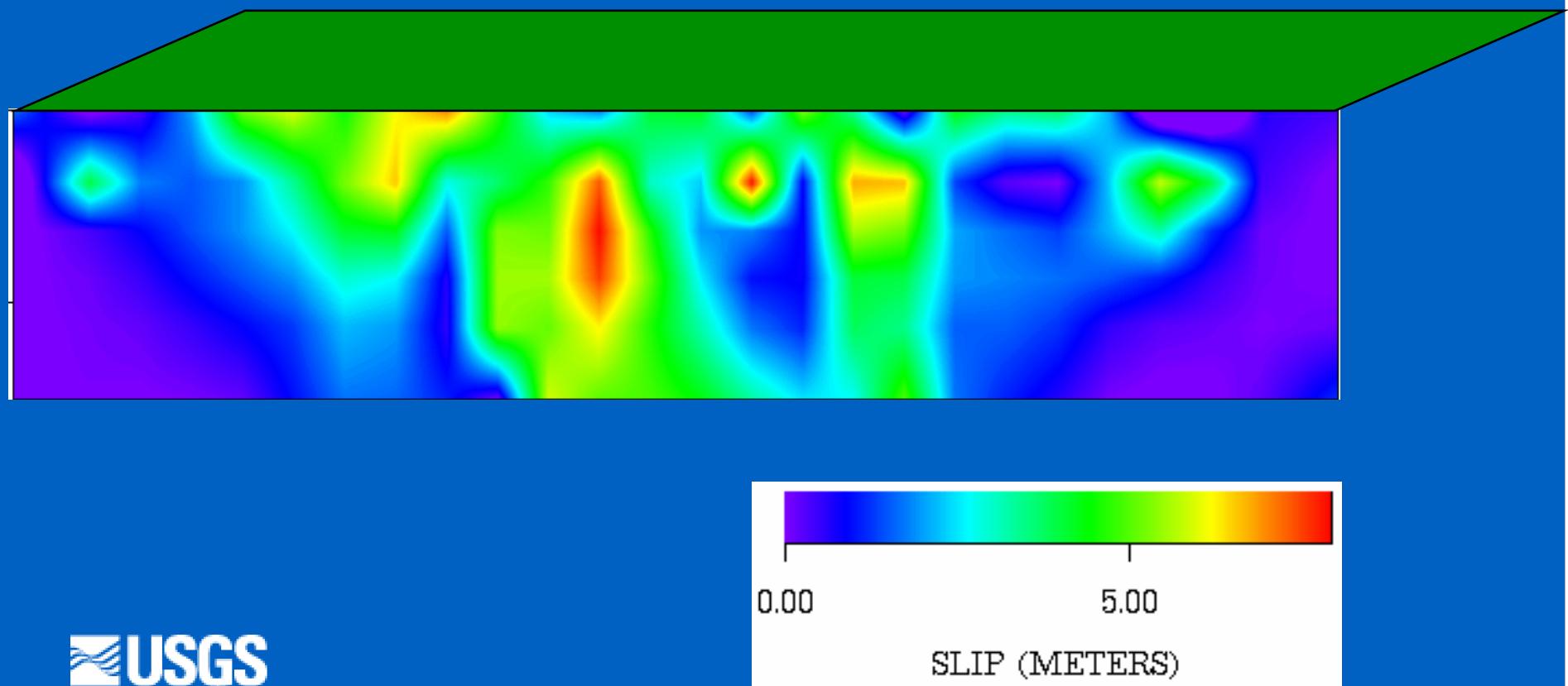


Thrust Fault Example



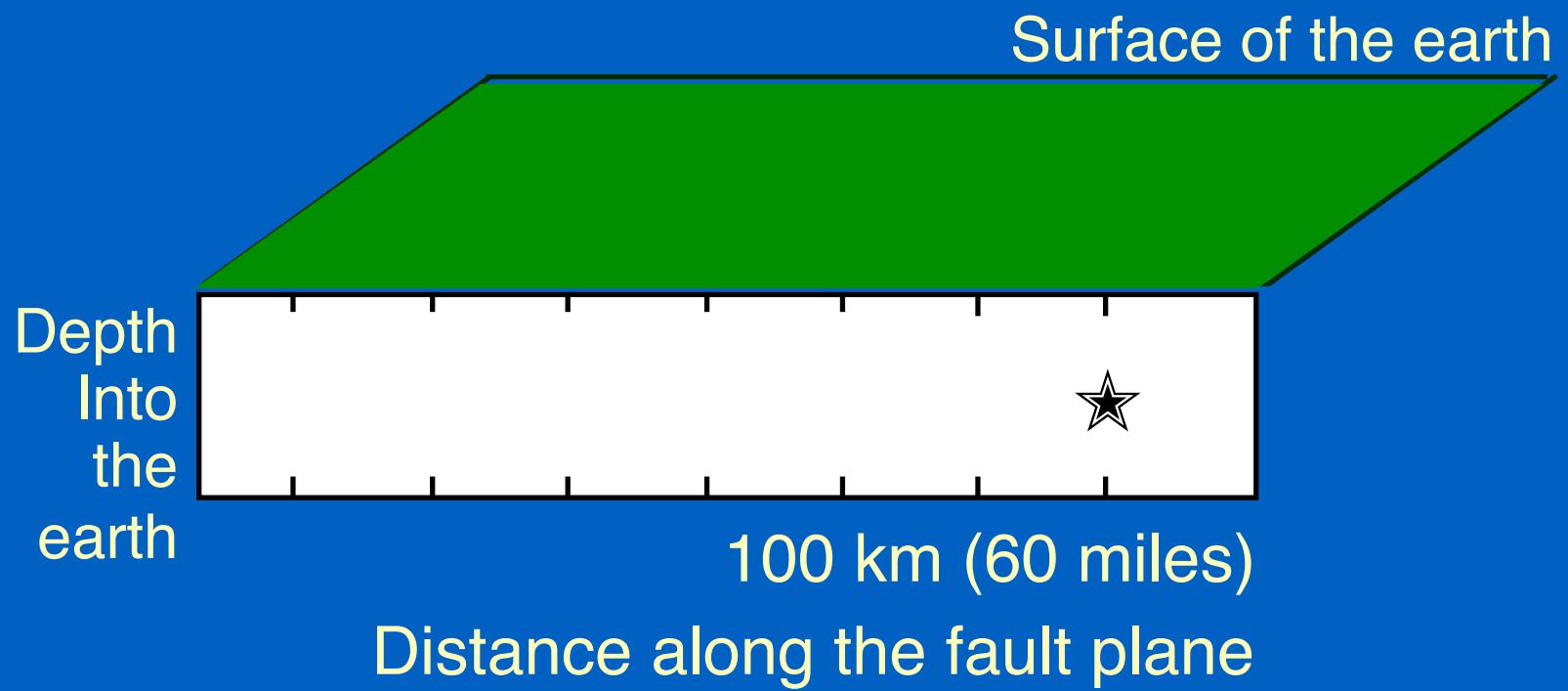
Rupture on a Fault

Total Slip in the M7.3 Landers Earthquake

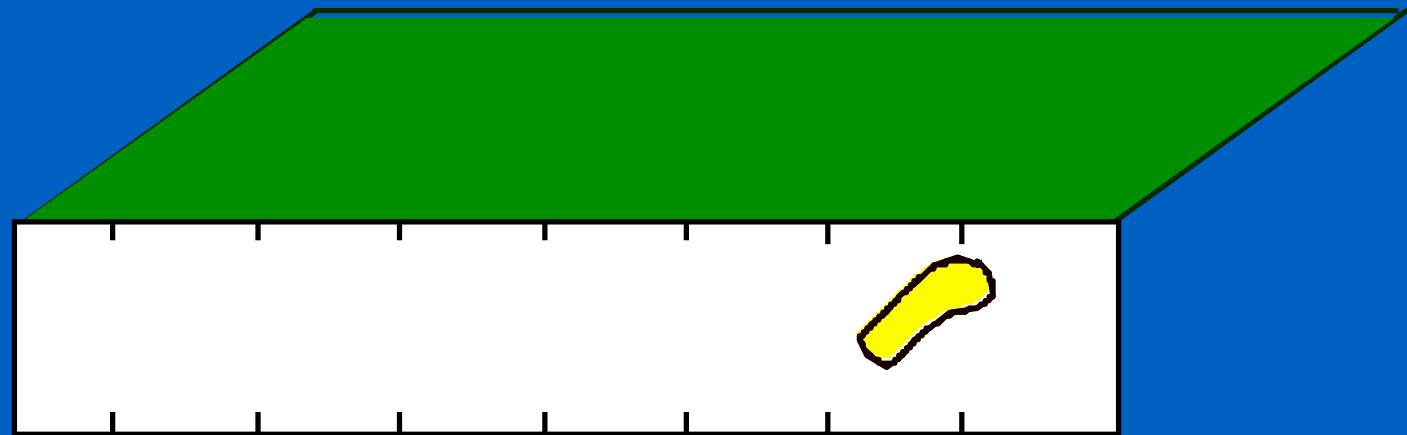


Slip on an earthquake fault

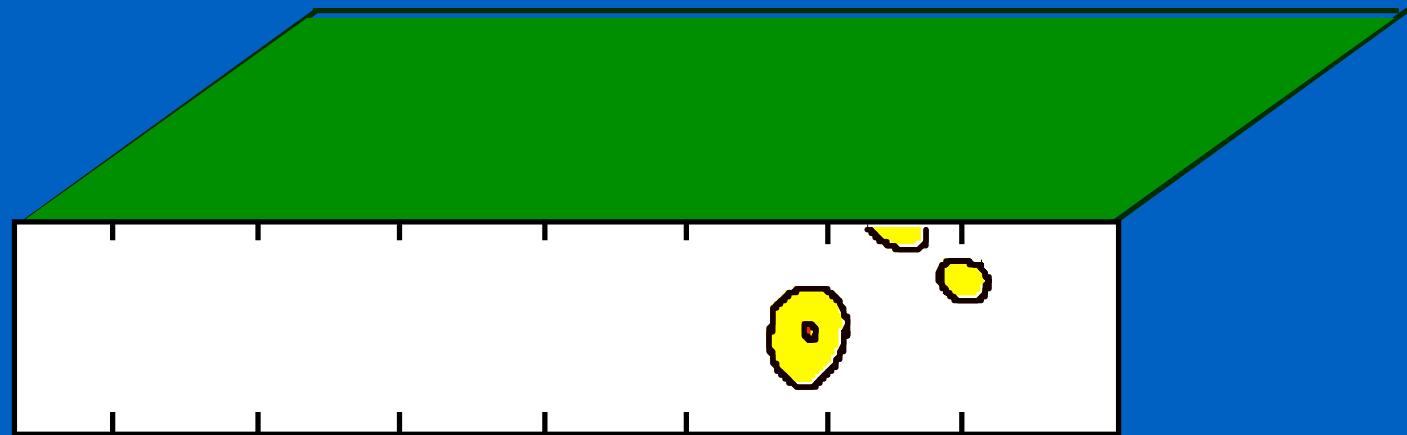
START



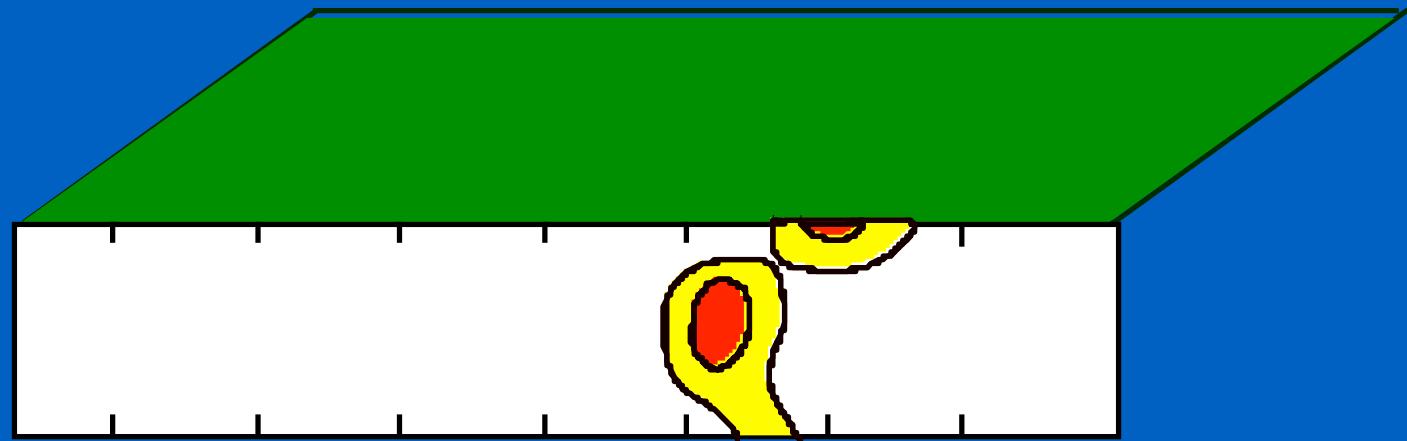
Slip on an earthquake fault Second 2.0



Slip on an earthquake fault Second 4.0

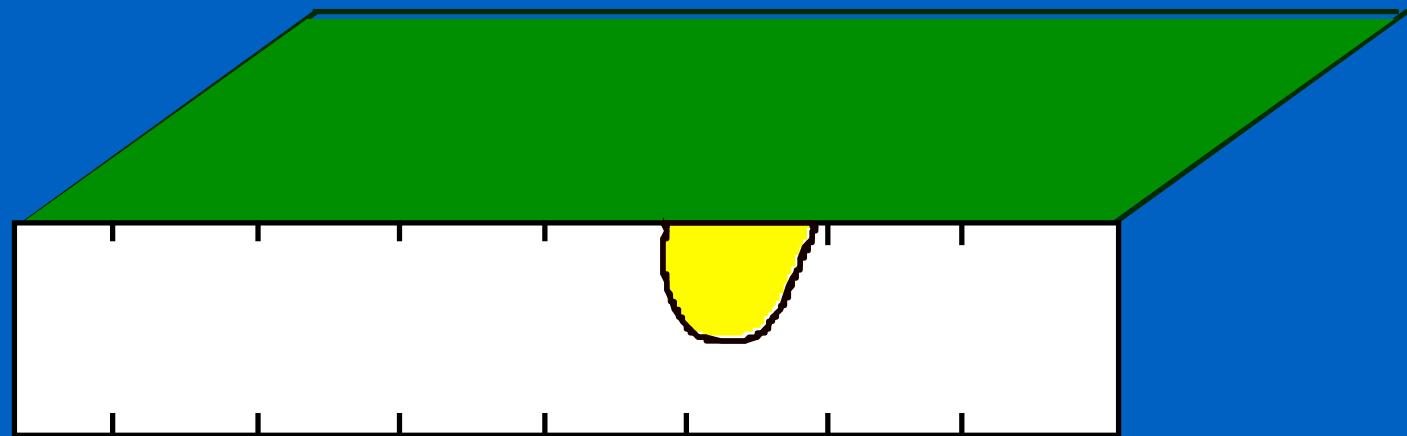


Slip on an earthquake fault Second 6.0



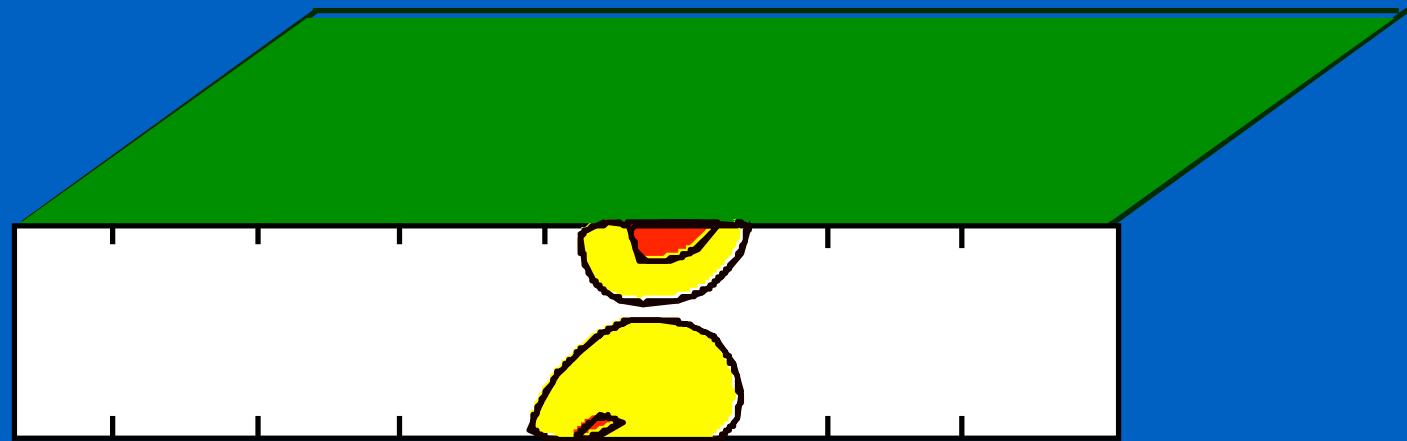
Slip on an earthquake fault

Second 8.0



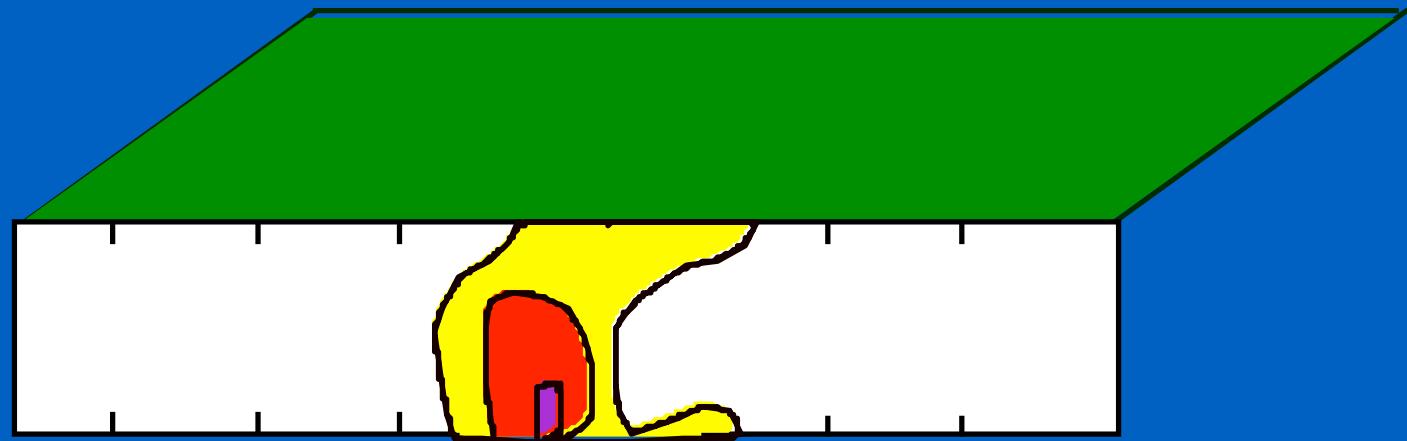
Slip on an earthquake fault

Second 10.0



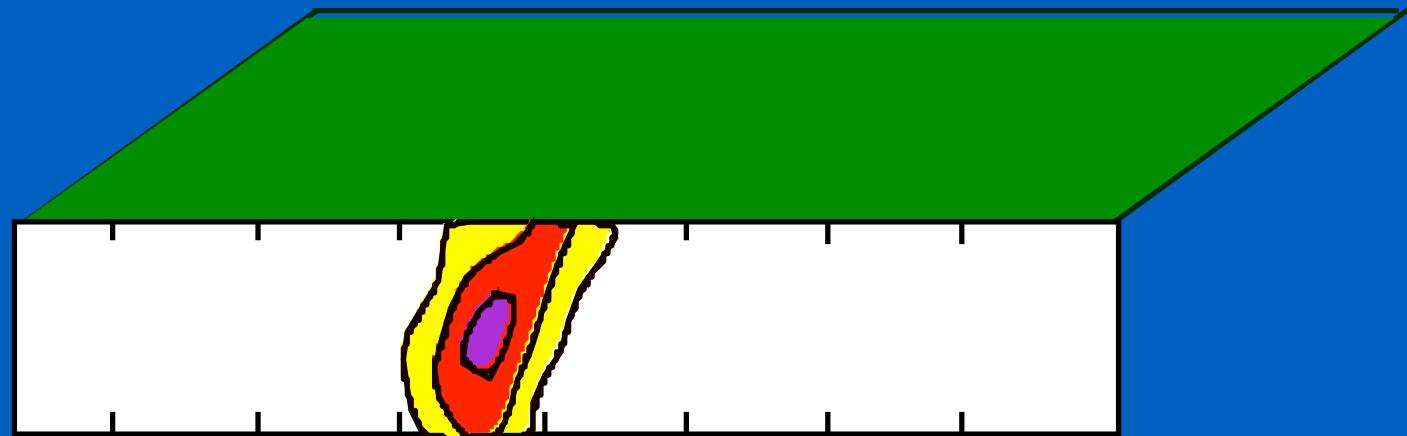
Slip on an earthquake fault

Second 12.0



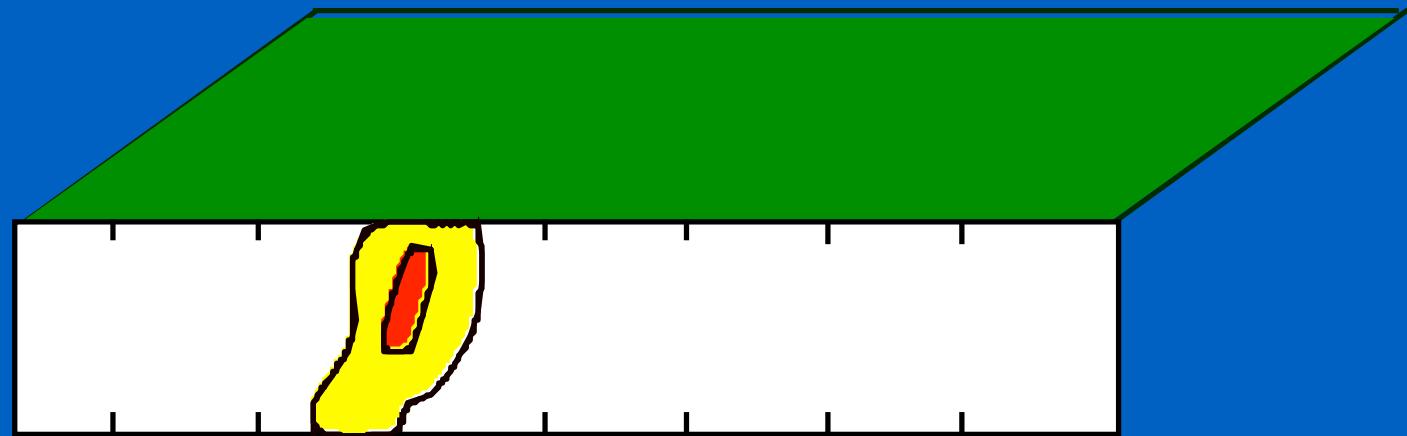
Slip on an earthquake fault

Second 14.0



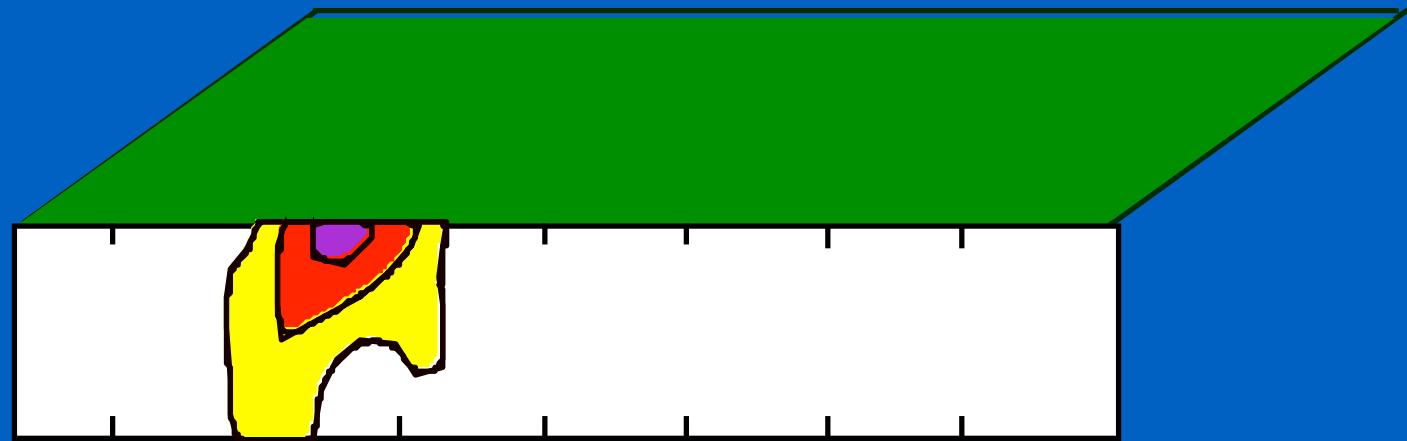
Slip on an earthquake fault

Second 16.0



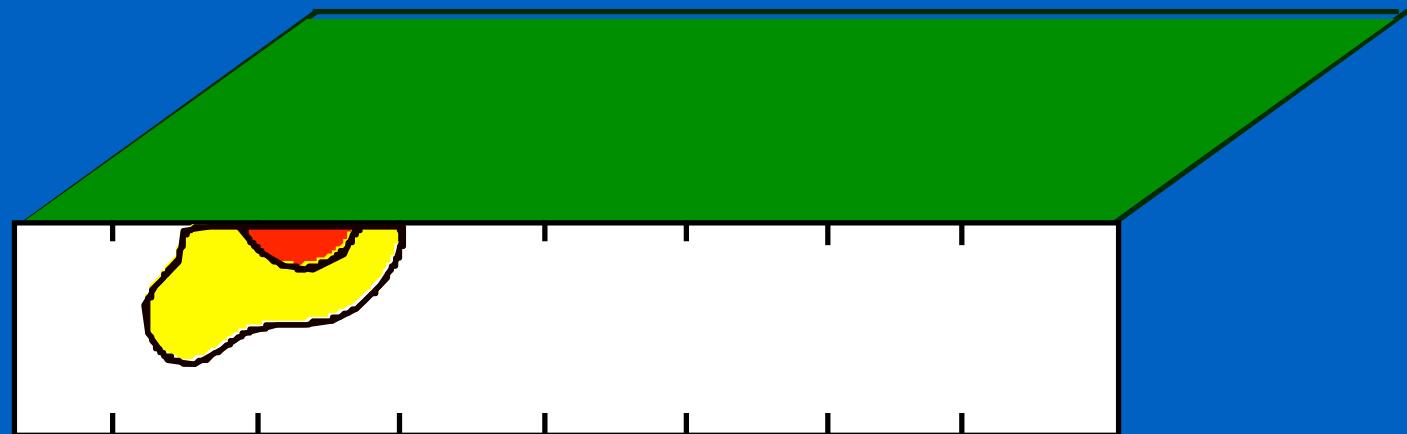
Slip on an earthquake fault

Second 18.0



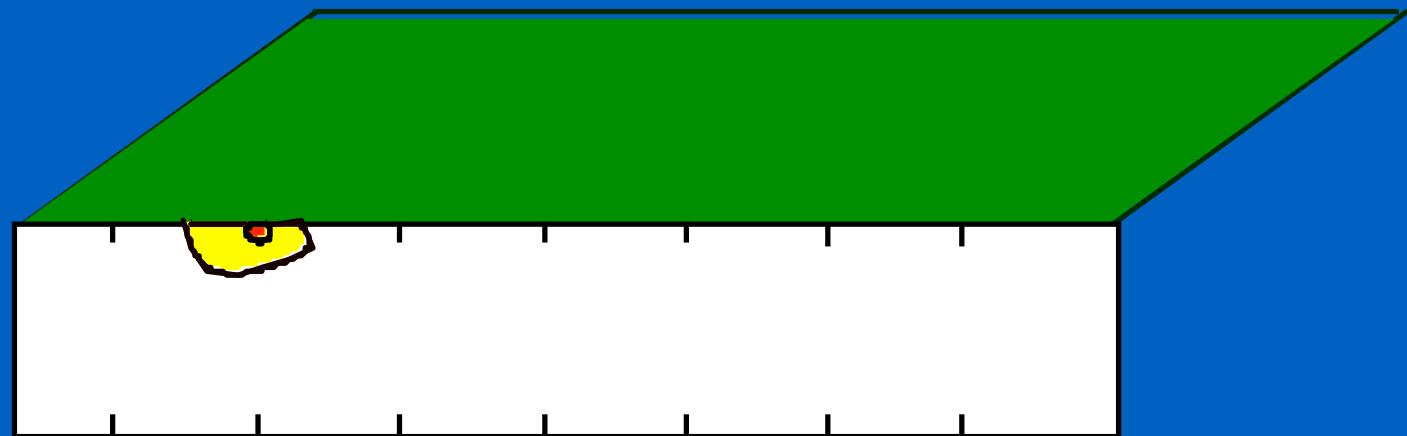
Slip on an earthquake fault

Second 20.0



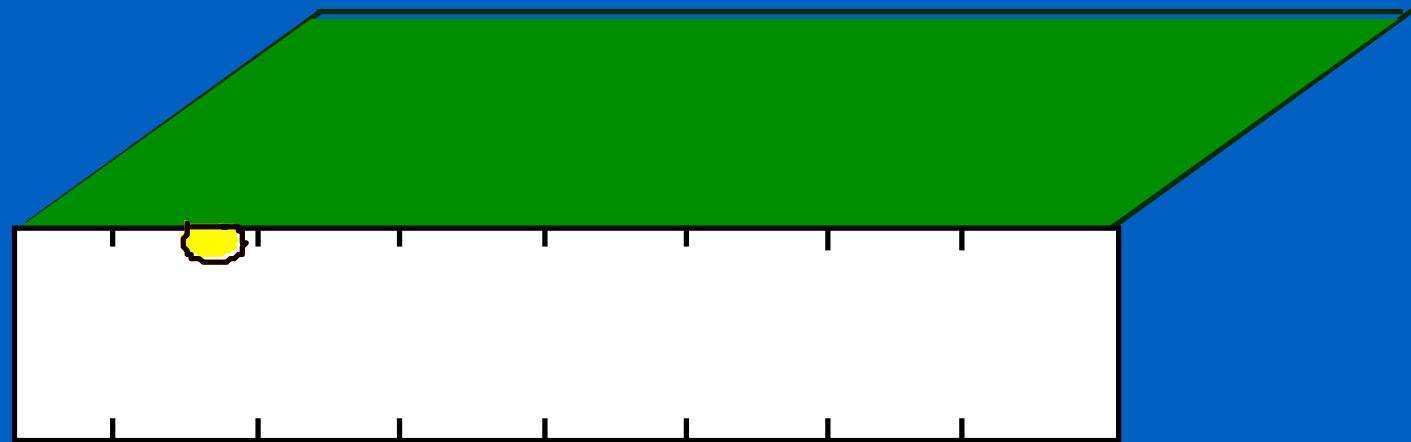
Slip on an earthquake fault

Second 22.0

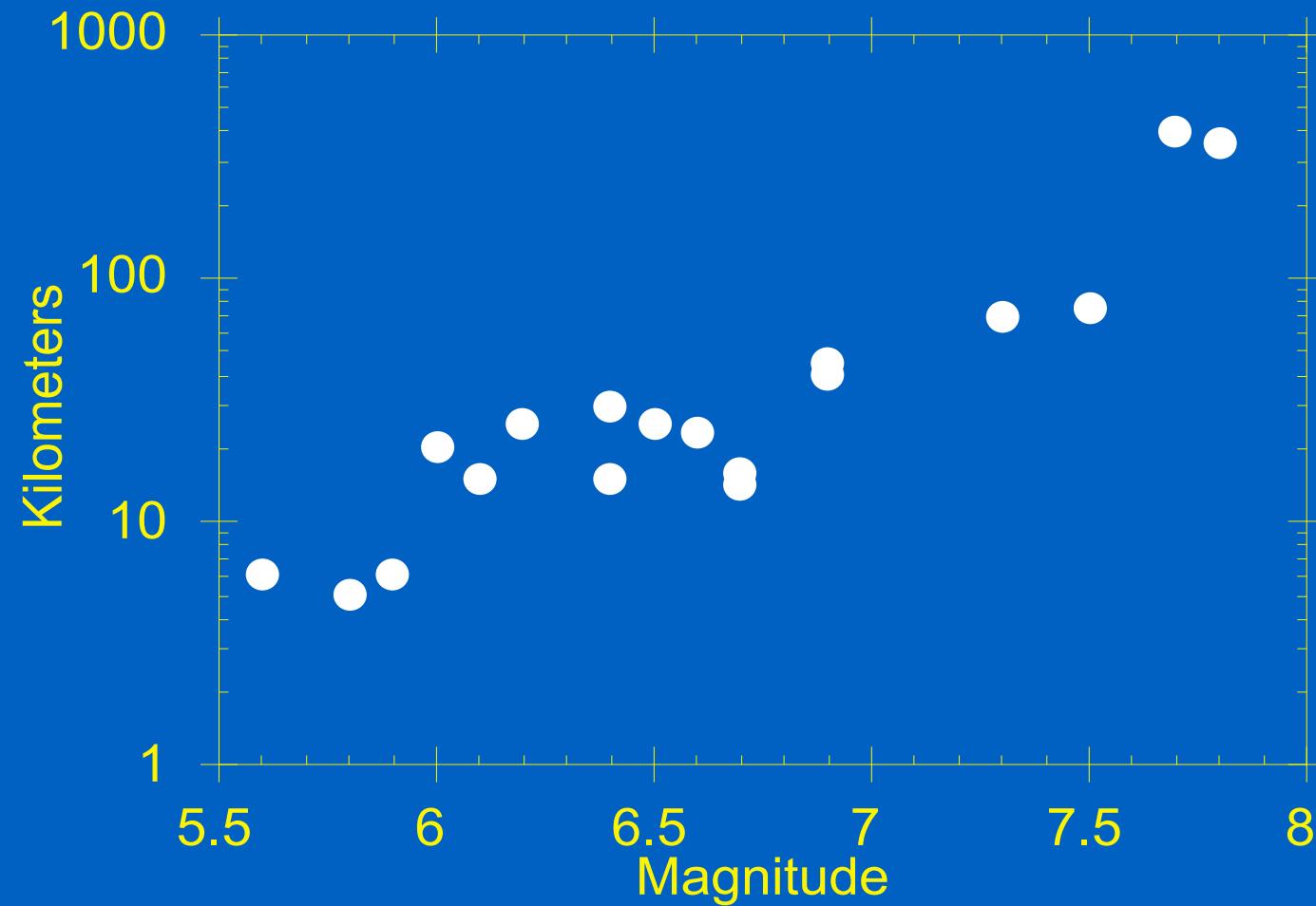


Slip on an earthquake fault

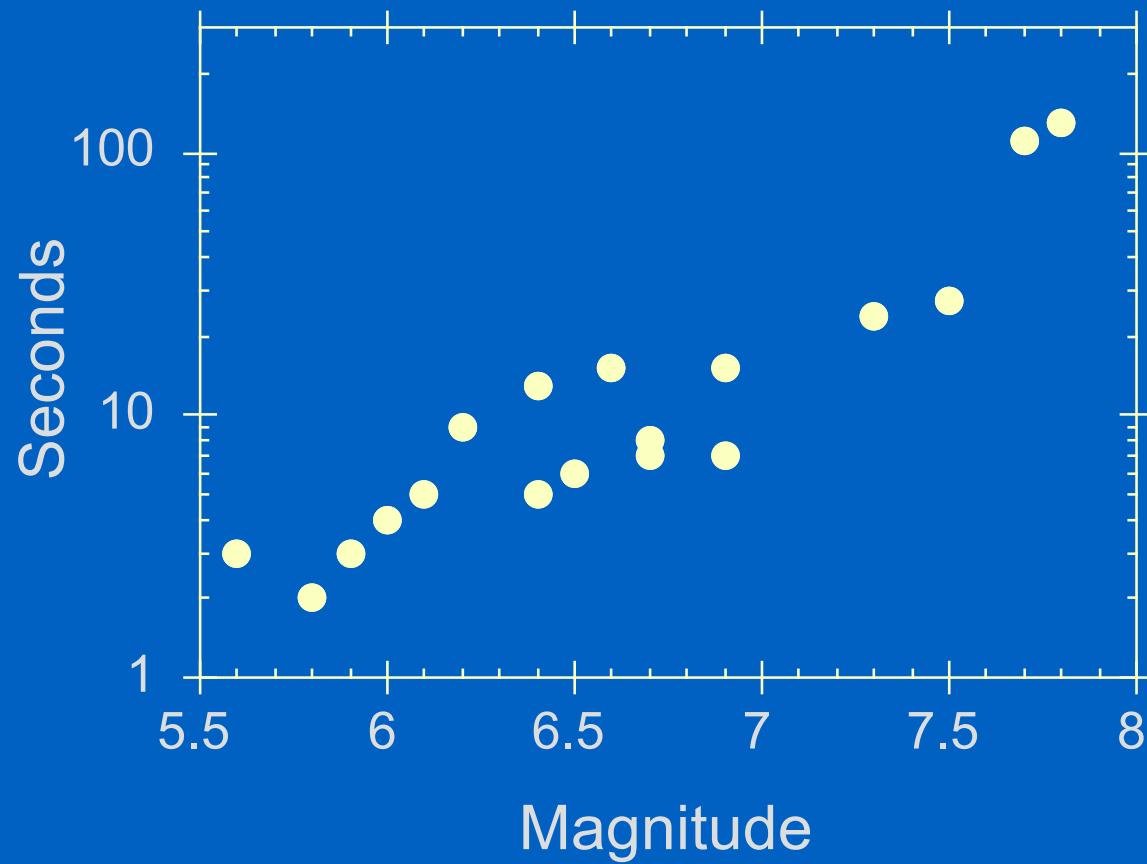
Second 24.0



Bigger Faults Make Bigger Earthquakes



Bigger Earthquakes Last a Longer Time



What Controls the Level of Shaking?

- **Magnitude**
 - More energy released
- **Distance**
 - Shaking decays with distance
- **Local soils**
 - amplify the shaking





Is there such a thing as
“Earthquake Weather”???

No!



Earthquake Effects - Ground Shaking



Northridge, CA 1994

Earthquake Effects - Ground Shaking



Northridge, CA 1994



Earthquake Effects - Ground Shaking



Loma Prieta, CA 1989



KGO-TV News ABC-7

Earthquake Effects - Ground Shaking



Kobe, Japan 1995



Earthquake Effects - Ground Shaking



Kobe, Japan 1995

Earthquake Effects - Surface Faulting



Landers, CA 1992



Earthquake Effects - Liquefaction



Source: National Geophysical Data Center



Niigata, Japan 1964

Earthquake Effects - Landslides



Source: National Geophysical Data Center



Turnagain Heights, Alaska, 1964 (upper left inset);
Santa Cruz Mtns, California , 1989

Earthquake Effects - Fires



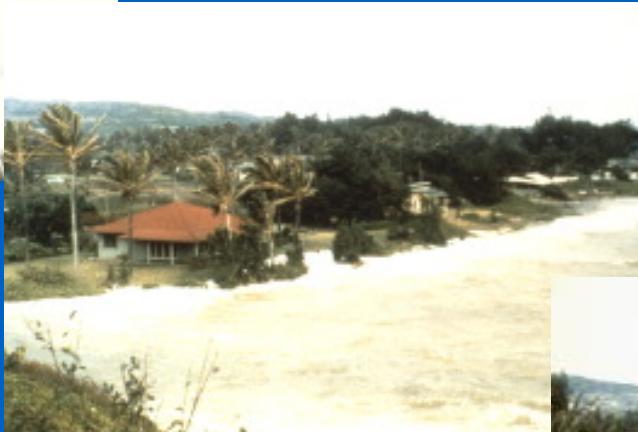
Loma Prieta, CA 1989



KGO-TV News ABC-7

Earthquake Effects - Tsunamis

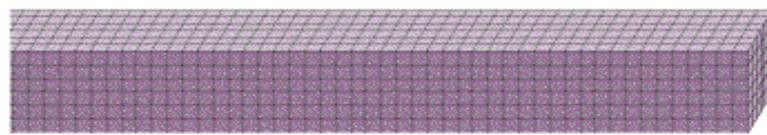
1957 Aleutian Tsunami



Photograph Credit: Henry Helbush. Source: National Geophysical Data Center

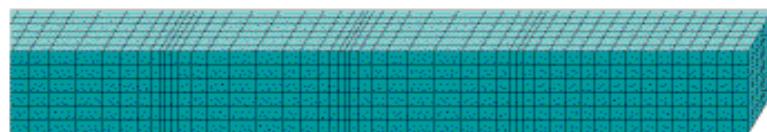
Seismic Waves

Seismic Waves



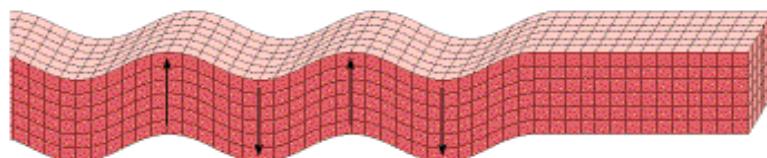
(a) Undisturbed material

Compression Compression Compression
| Expansion | Expansion | Undisturbed
material



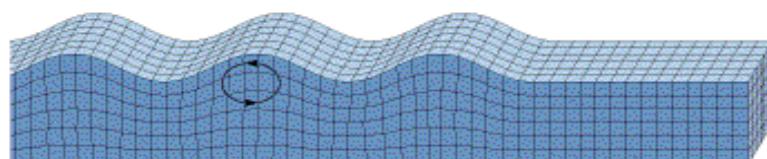
(b) Primary wave

Direction of wave movement →



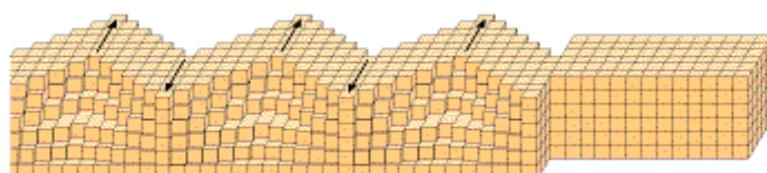
(c) Secondary wave

Wavelength →



(d) Rayleigh wave

→

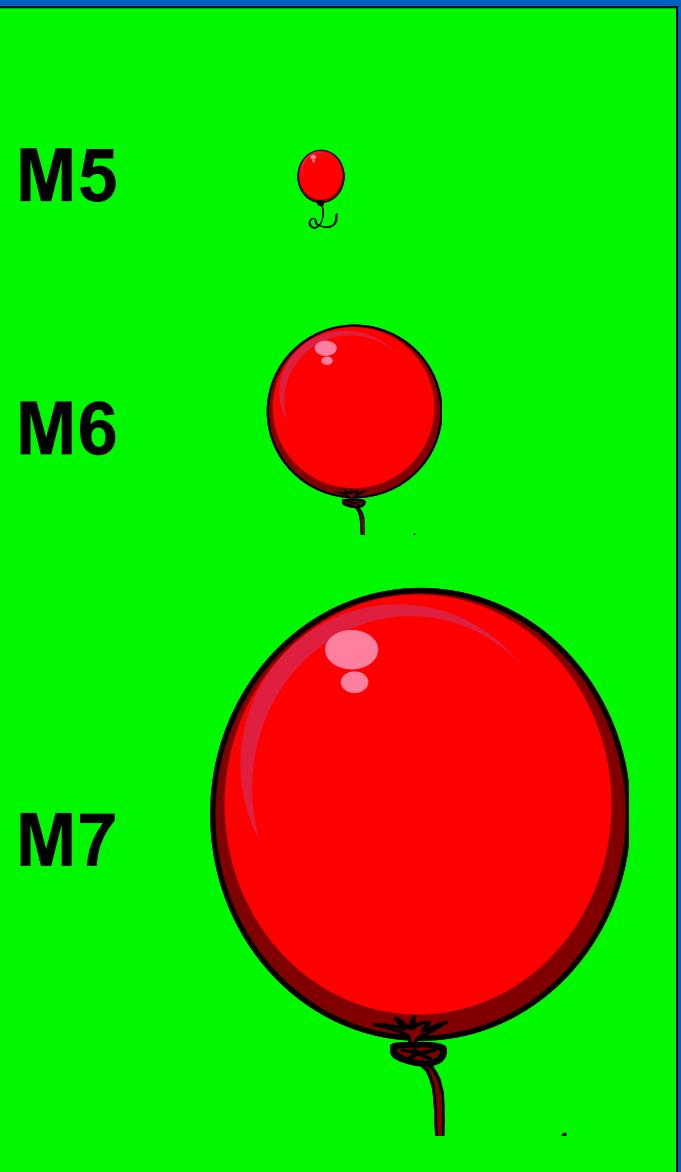
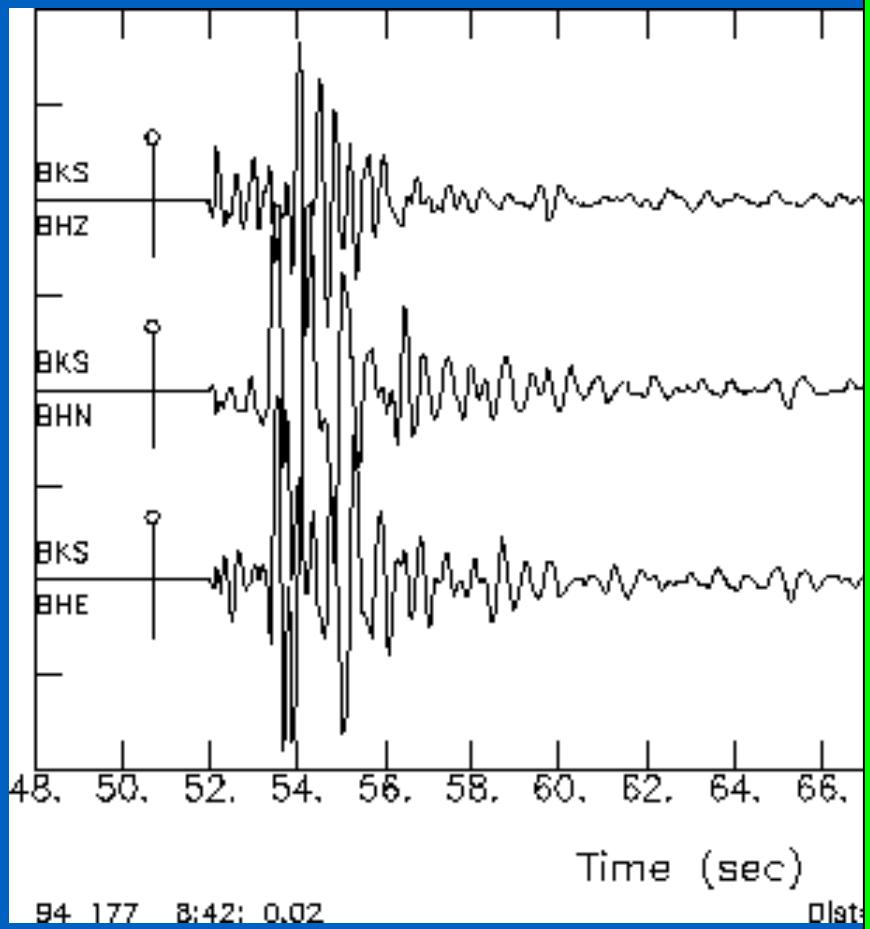


(e) Love wave

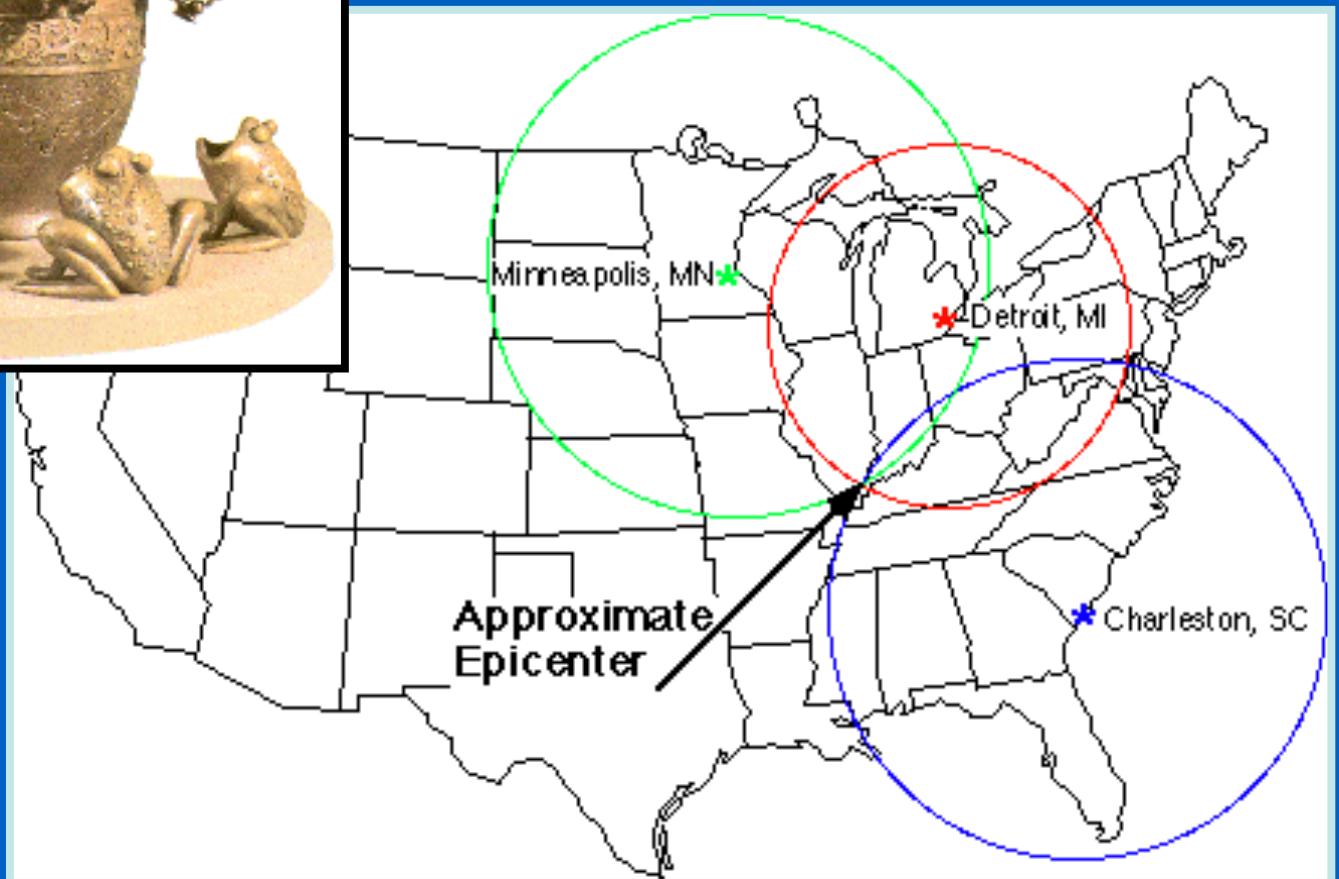
→

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Earthquake Magnitude



Earthquake Location



The San Andreas Fault



Pacific-North American Plate Boundary



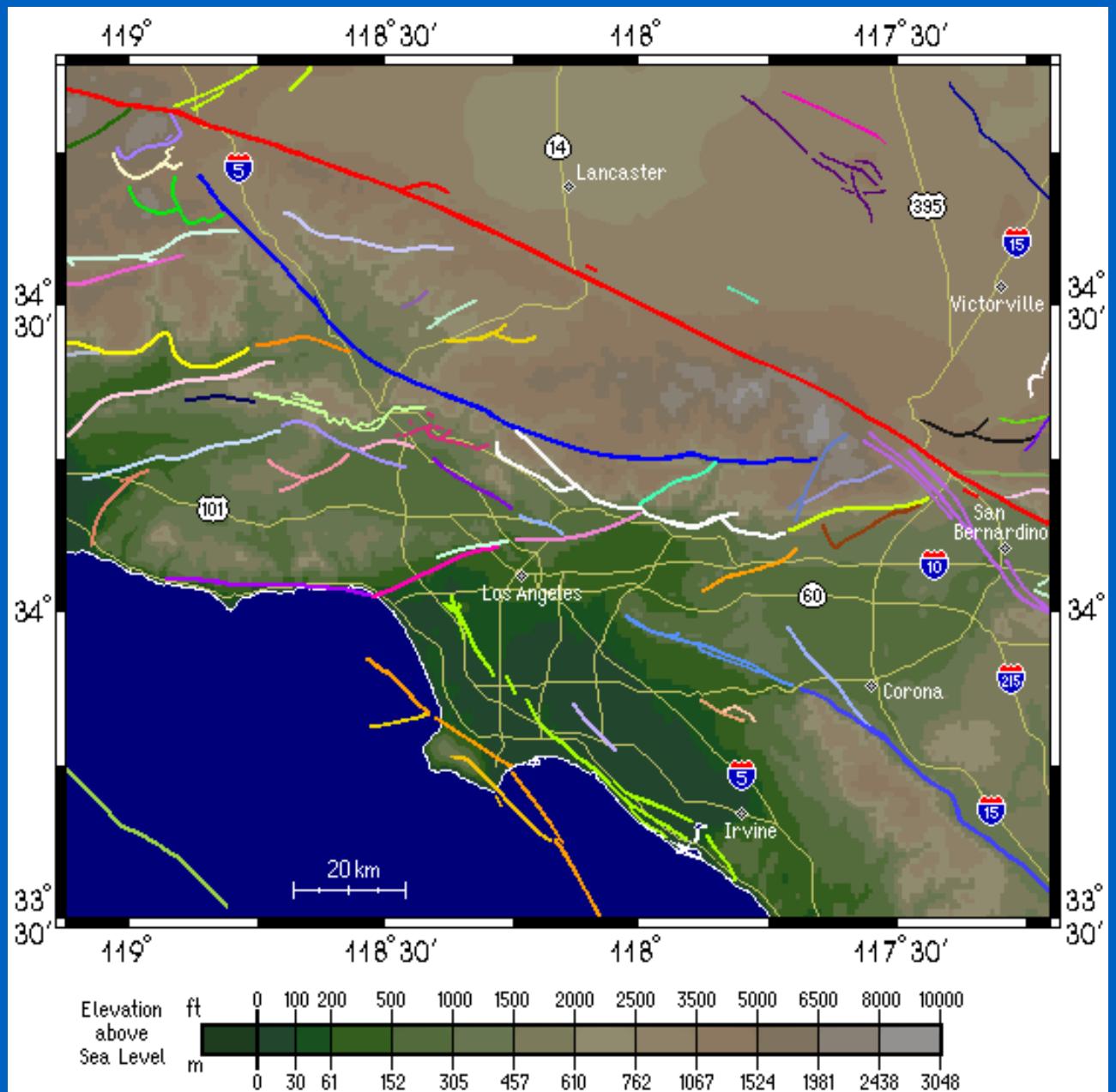


Will California eventually
fall into the ocean???

No!

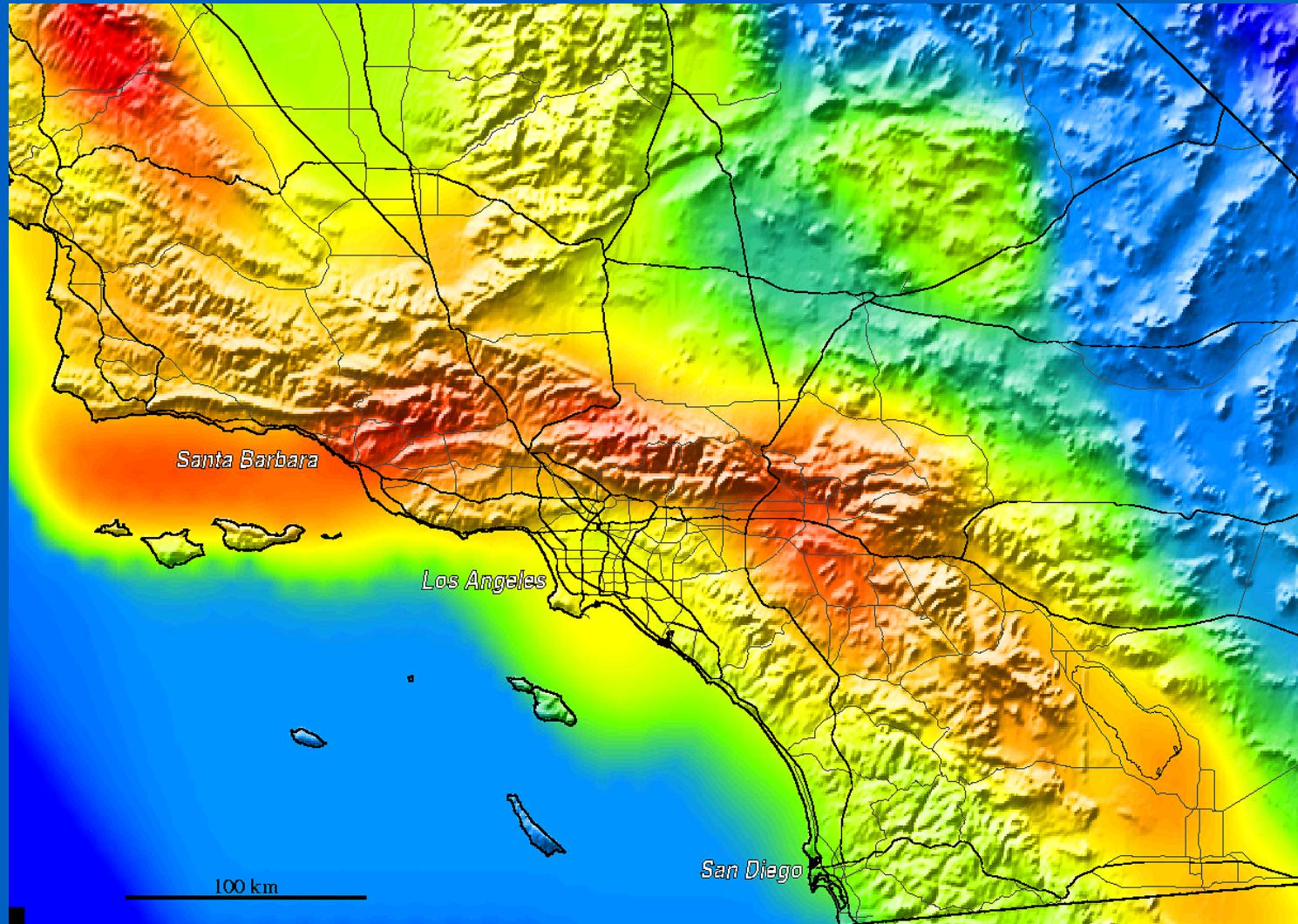


Faults of Southern California



Source: SCEC Data Center

Shaking Hazard in Southern California



Faults in Our Local Area - Arcadia



Sierra Madre Fault Zone

THRUST fault

55 KM long

Last ruptured in last 10,000 YEARS

SLIP RATE: between 0.36 and 4 mm/yr

PROBABLE MAGNITUDES: MW6.0 - 7.0 (?)

Dips to the north



Faults in Our Local Area - Arcadia



Source: SCEC Data Center

Raymond Fault

STRIKE-SLIP fault

26 KM long

Last ruptured in last 10,000 YEARS

SLIP RATE: between 0.10 and 0.22 mm/yr

PROBABLE MAGNITUDES: MW6.0 - 7.0

Dips to the north

At least **eight** surface-rupturing events have occurred along this fault in the last 36,000 years



Faults in Our Local Area - Arcadia



Clamshell-Sawpit Canyon fault

THRUST fault

18 KM long

Last ruptured in last 1.6 million YEARS

SLIP RATE: ???

PROBABLE MAGNITUDES: ???

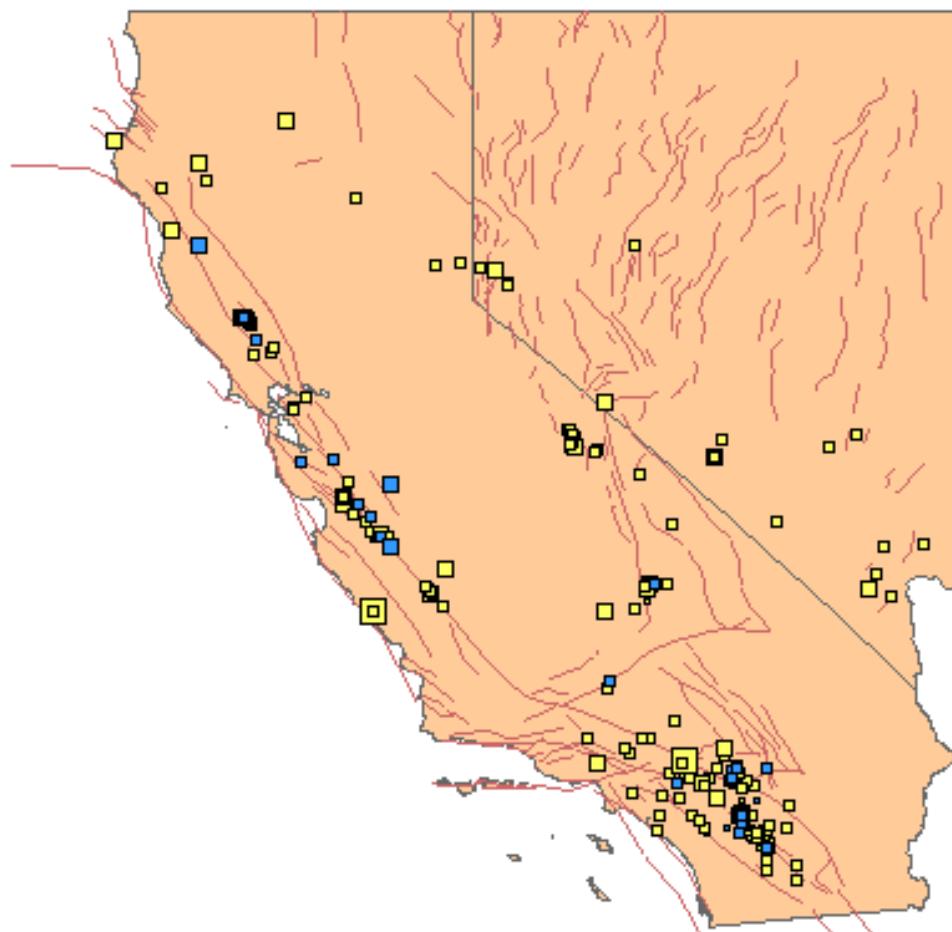
Dips to the north



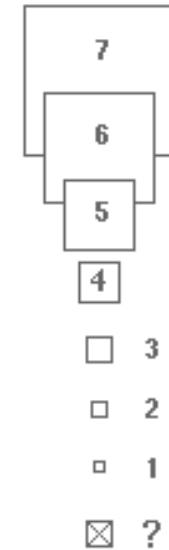
Real-time Earthquake Information

Index Map of Recent Earthquakes in California-Nevada

USGS·UCB·Caltech·UCSD·UNR



MAGNITUDE



- LAST HOUR
- LAST DAY
- LAST WEEK

0 100 km

0 100 miles

Thu May 17 11:00:04 PDT 2001

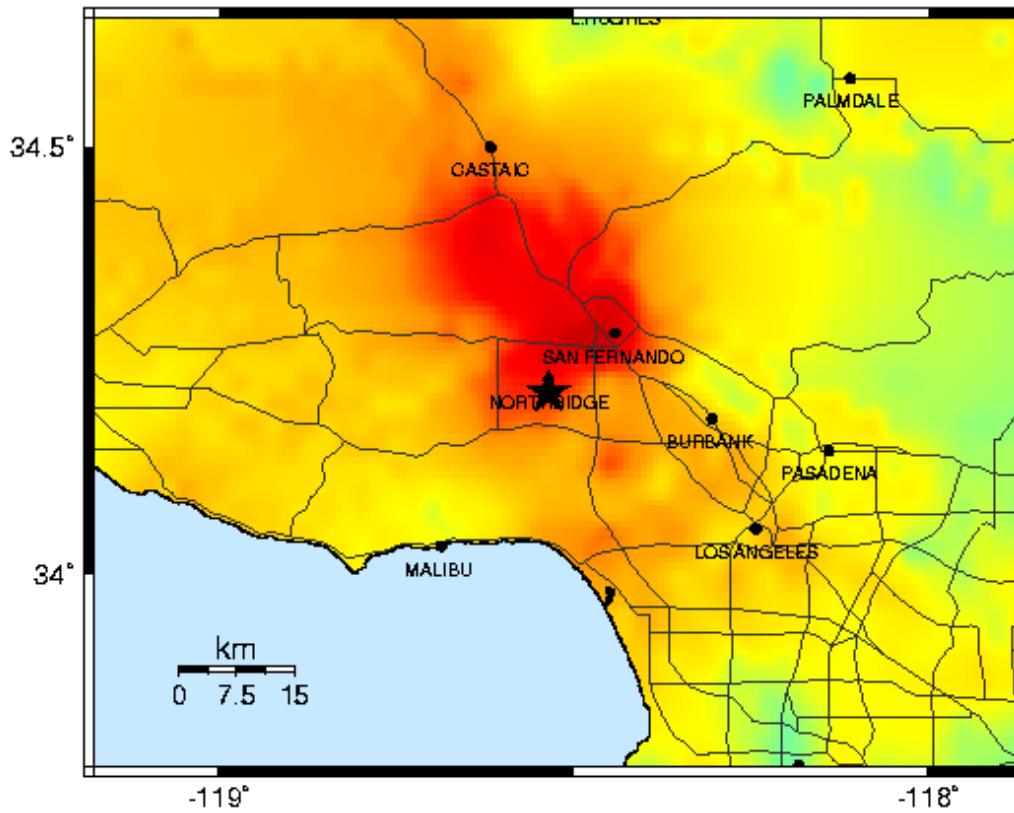
224 earthquakes on this map



ShakeMaps

TriNet Rapid Instrumental Intensity Map for Northridge Earthquake

Mon Jan 17 04:30:55 AM PST M 6.7 N34.21 W118.54 ID:Northridge



PROCESSED: Tue Jul 25 02:36:57 PM PDT, Produced by ShakeMap V2

PERCEIVED SHAKING	No felt	Weak	Light	Moderate	Strong	Very strong	Severe	Violent	Extreme
POTENTIAL DAMAGE	none	none	none	Very light	Light	Moderate	Moderate/Heavy	Heavy	Very Heavy
PEAK ACC.(%g)	< 1.7	1.7-1.4	1.4-3.9	3.9-9.2	9.2-18	18-34	34-65	65-124	>124
PEAK VEL(cm/s)	<0.1	0.1-1.1	1.1-3.4	3.4-8.1	8.1-16	16-31	31-60	60-116	>116
INSTRUMENTAL INTENSITY	I	II-III	IV	V	VI	VII	VIII	IX	X+

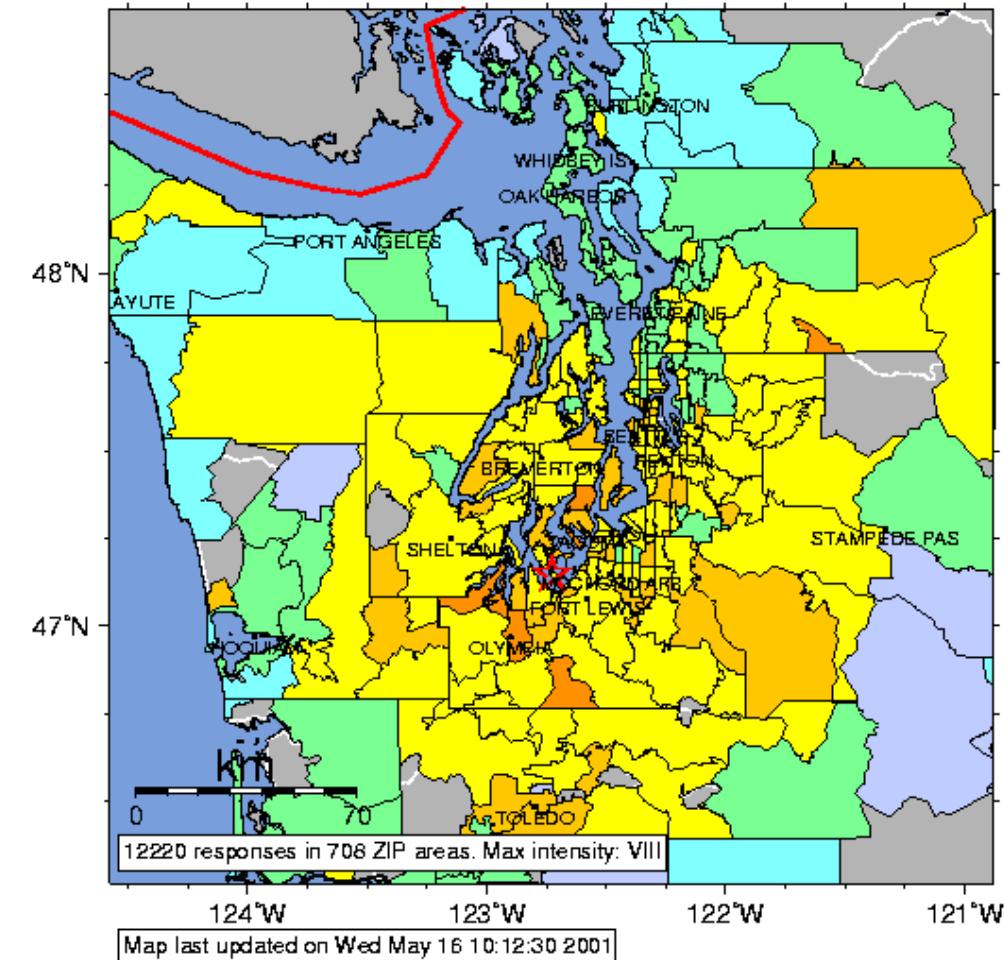


Did You Feel It?

Community Internet Intensity Maps



Community Internet Intensity Map (10 miles NNE of Lacey, Washington)
ID:2261854 10:54:33 PST FEB 28 2001 Mag=6.8 Latitude=N47.15 Longitude=W122.73



INTENSITY	I	II-III	IV	V	VI	VII	VIII	IX	X+
SHAKING	Not felt	Weak	Light	Moderate	Strong	Very strong	Severe	Violent	Extreme
DAMAGE	none	none	none	Very light	light	Moderate	Moderate/Heavy	Heavy	Very Heavy

USGS Earthquake Hazards Program

U.S. Department of the Interior
U.S. Geological Survey

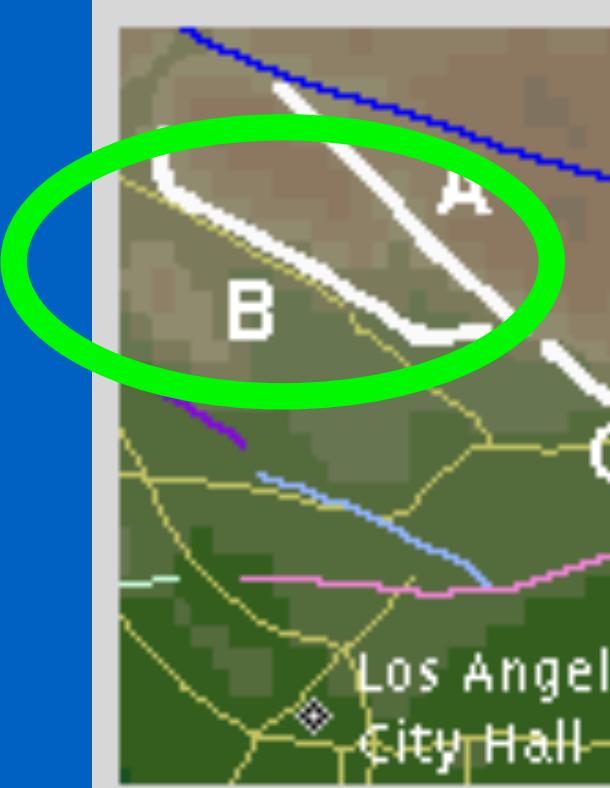
Where to go for more information:

<http://pasadena.wr.usgs.gov/>
<http://earthquake.usgs.gov/>

The End



Faults in Our Local Area - La Canada



TYPE OF FAULTING: reverse

LENGTH: the zone is about 55 km long; total length of main fault segments is about 75 km, with each segment measuring roughly 15 km long

MOST RECENT SURFACE RUPTURE: Holocene, 10,000 years to present

SLIP RATE: between 0.36 and 4 mm/yr

INTERVAL BETWEEN SURFACE RUPTURES: several thousand years (?)

PROBABLE MAGNITUDES: MW6.0 - 7.0 (?)

OTHER NOTES: This fault zone dips to the north.