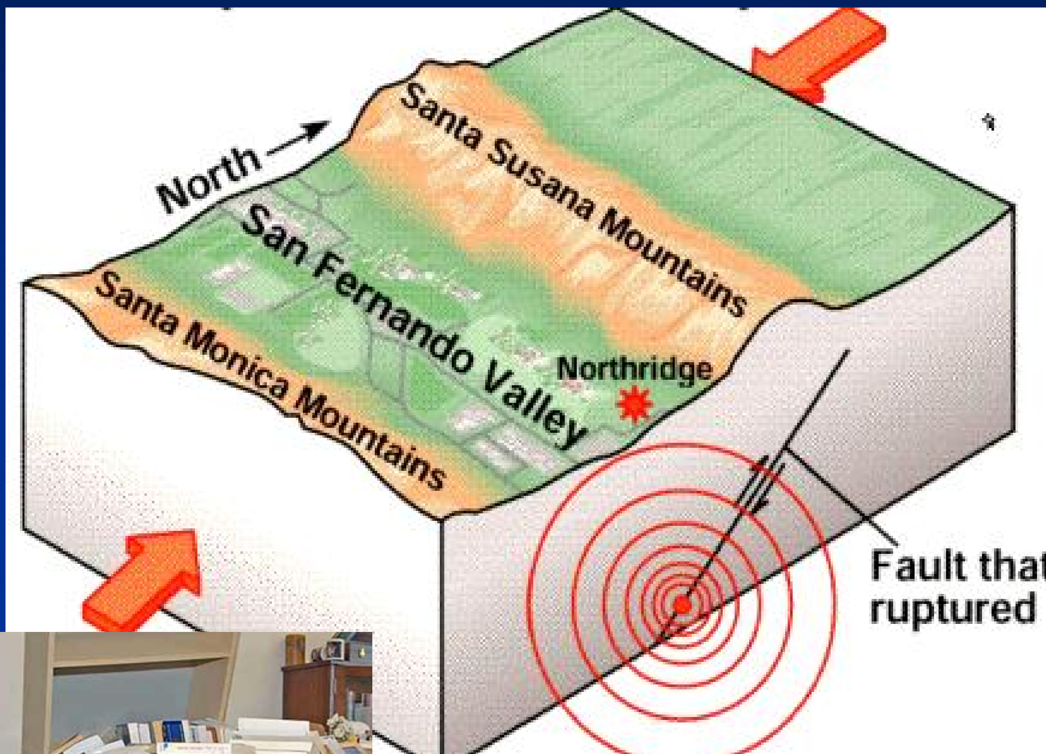
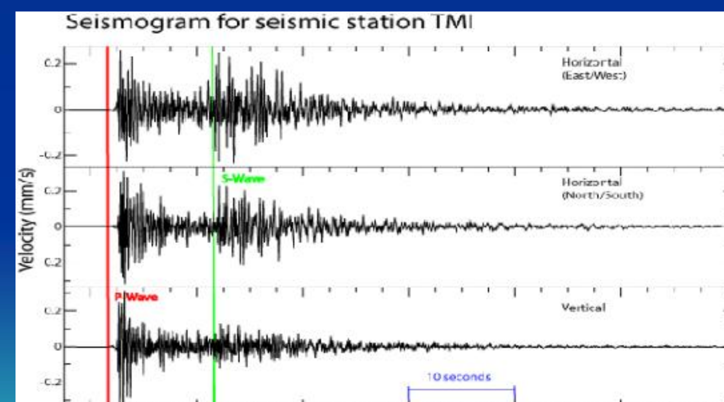
Earthquake!

Principles and Consequences

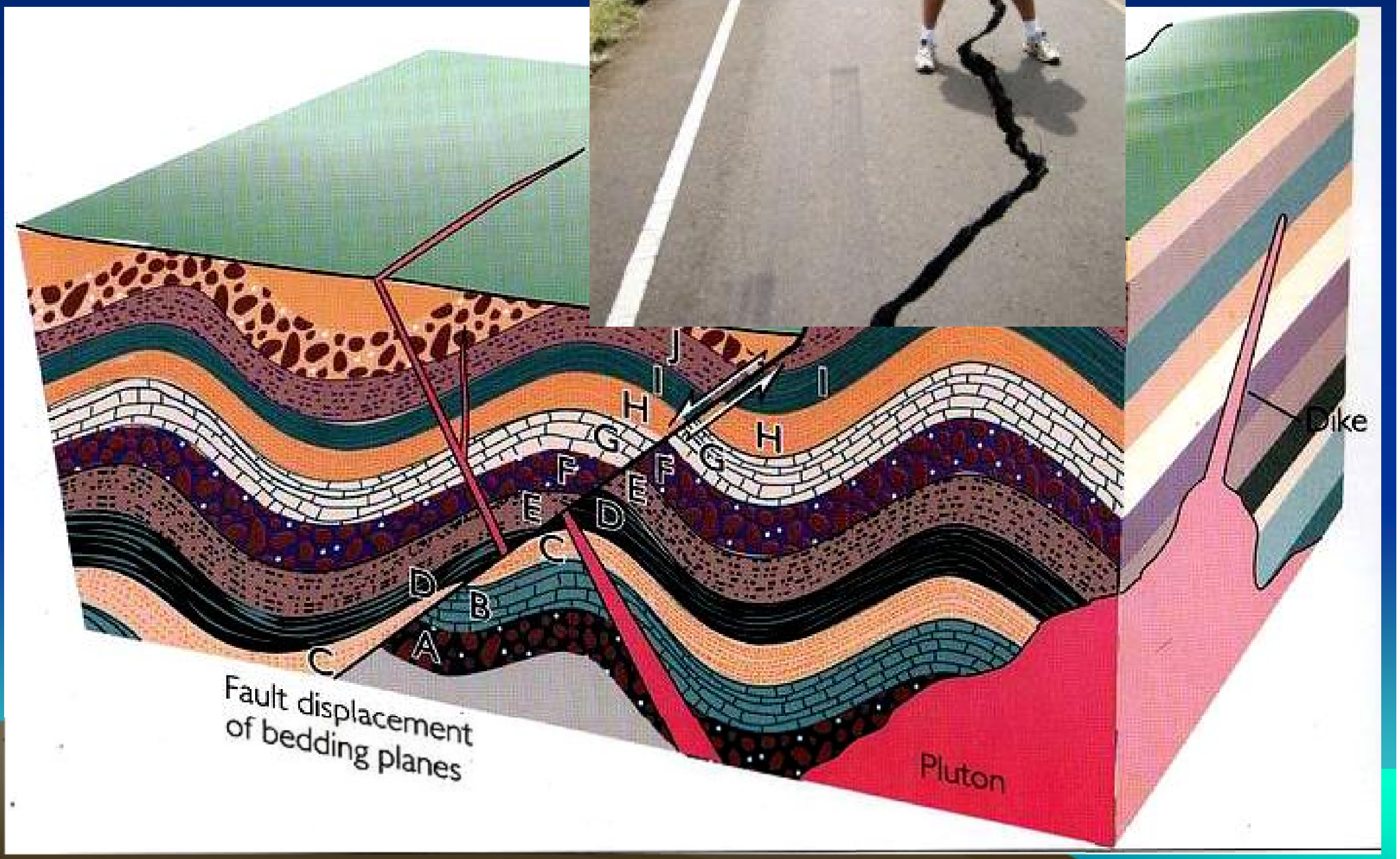




General Geology - GEOL 100

Ray Rector - Instructor

Earthquakes Occur Along Active Fault Zones



Earthquake Topics

What are Earthquakes?

Where and How do Earthquake Form?

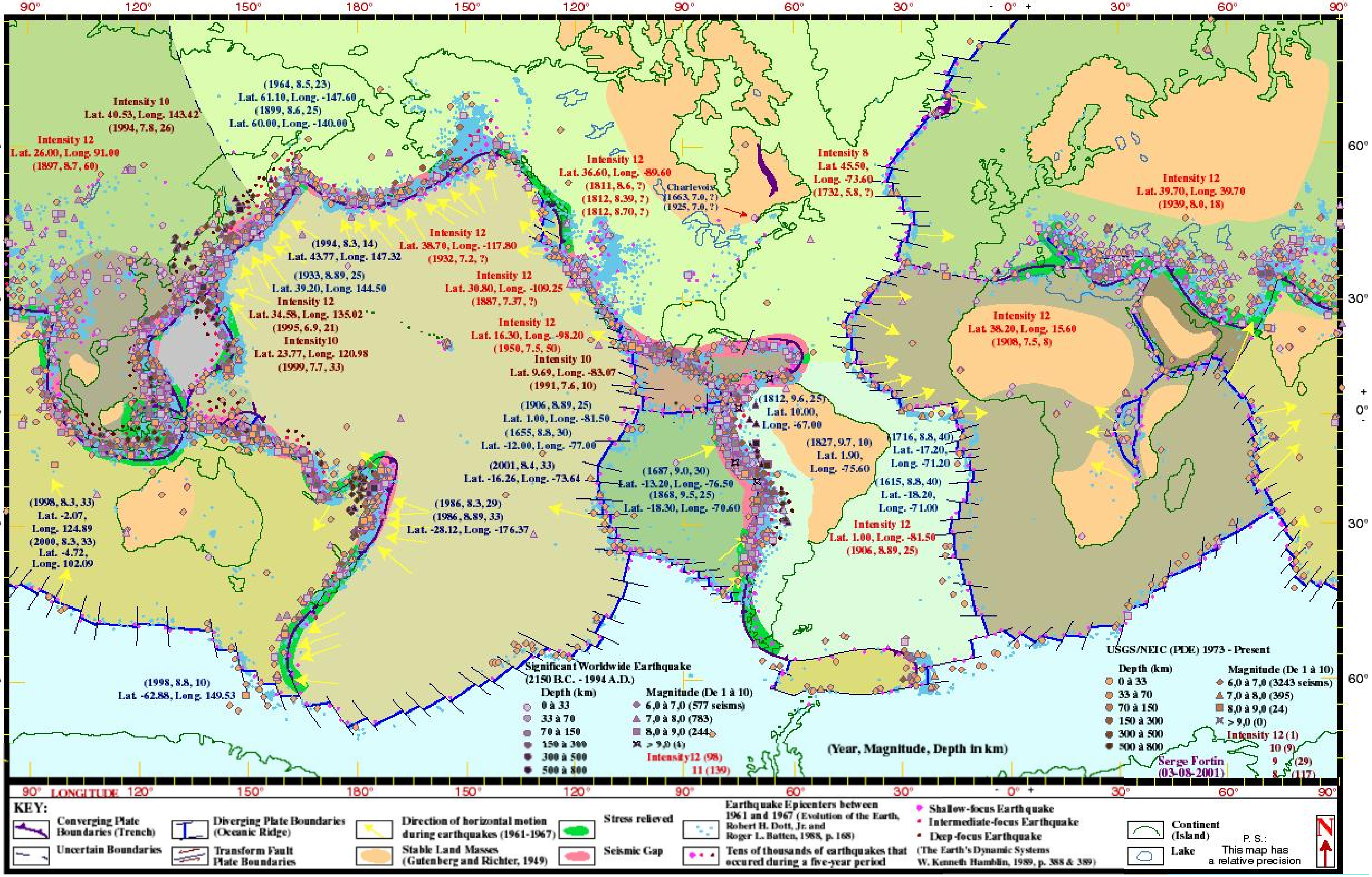
How are Earthquakes Measured?

What are the Effects of Earthquakes?

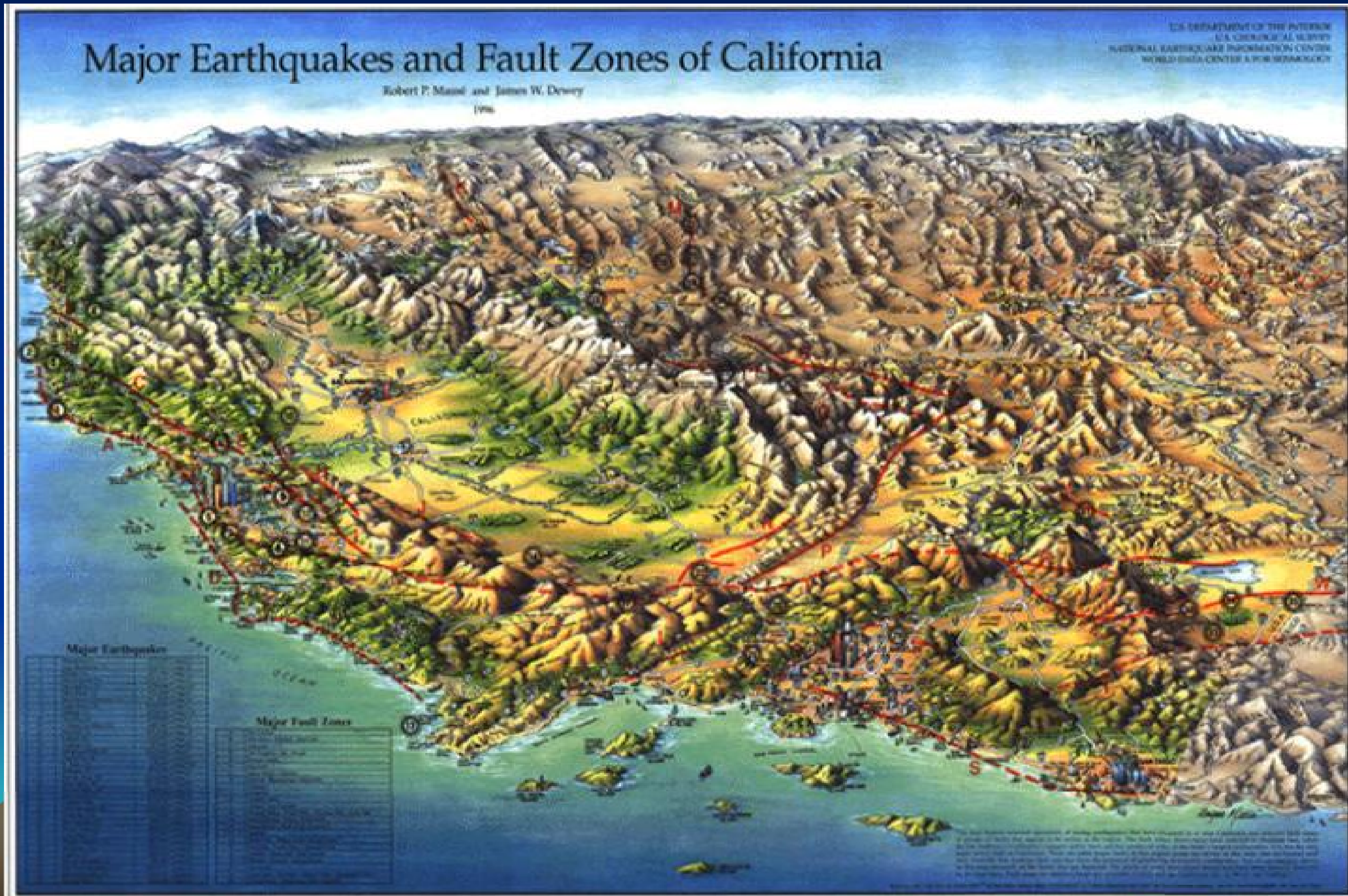
Can we Predict Earthquakes?

How can we Prepare for an Earthquake?

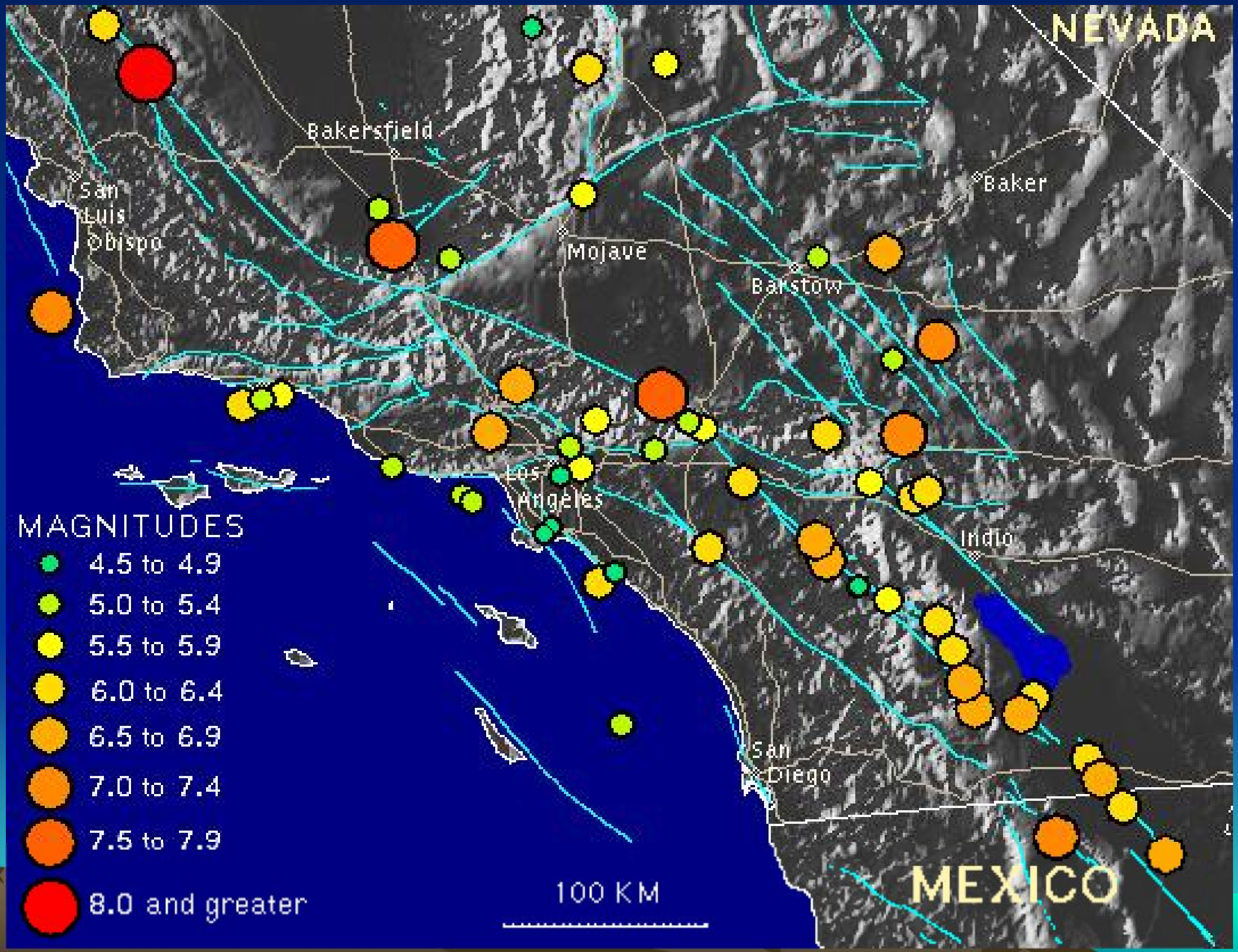
Major Earthquakes and Fault Zones of the World



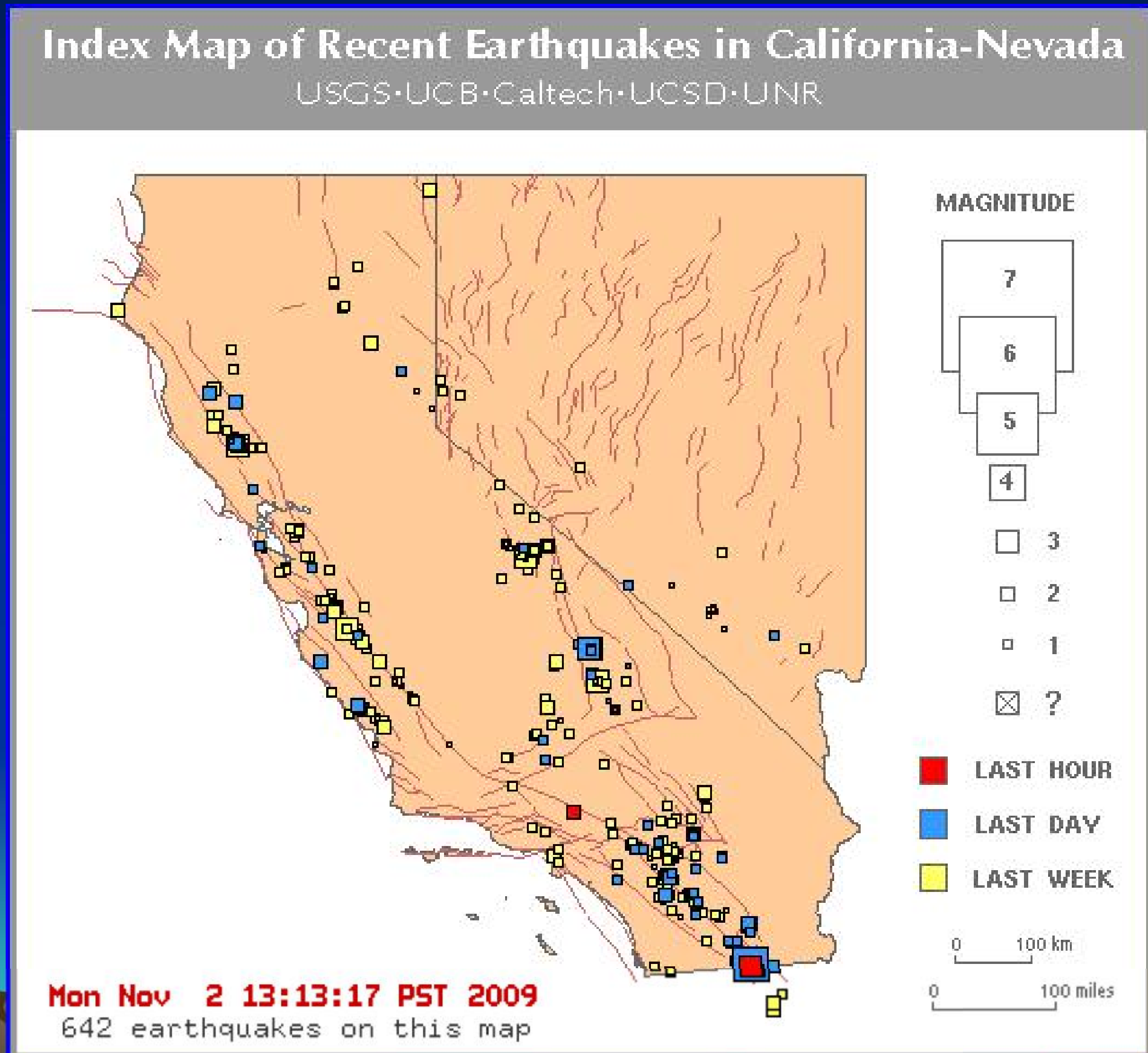
Major Earthquakes and Fault Zones of Southern California



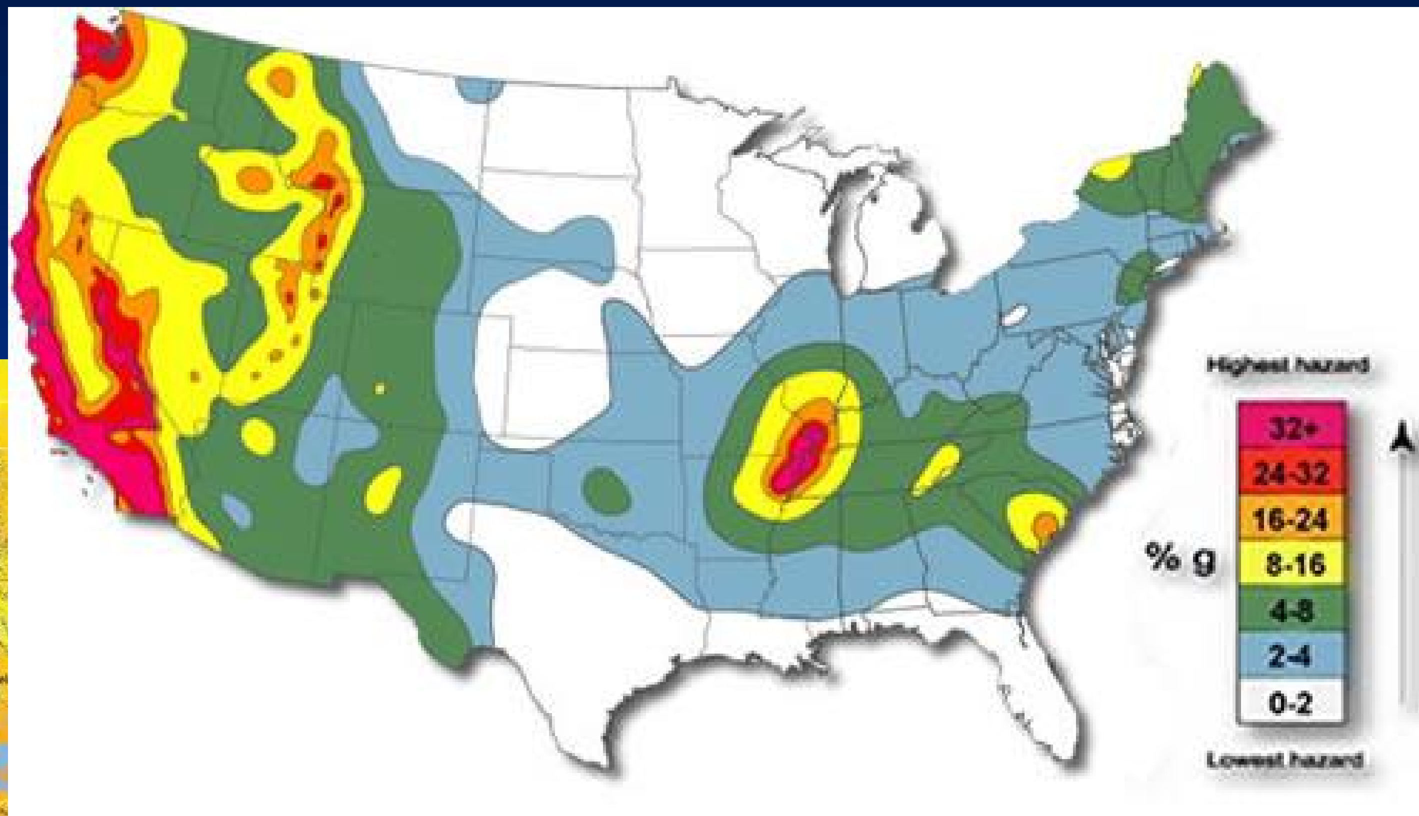
Major Earthquakes and Fault Zones of Southern California

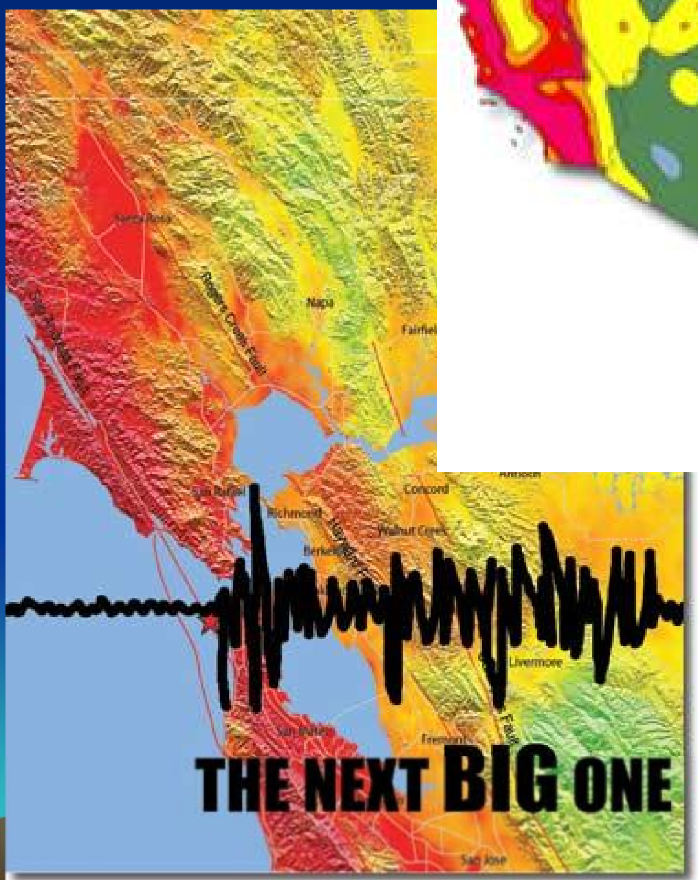


Most Recent Earthquakes in California



Earthquake Probability in USA





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Anatomy of an Earthquake

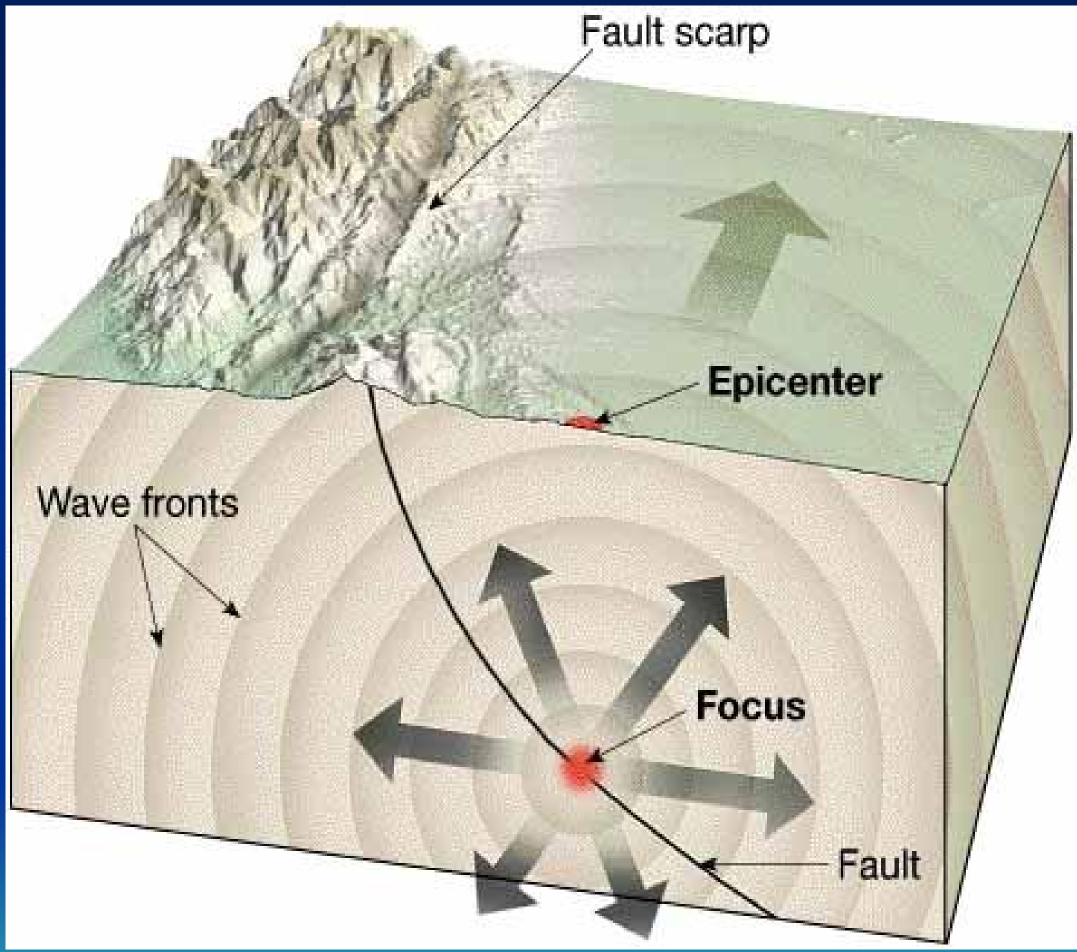
1) Fault rupture

2) Fault scarp

3) Focus

4) Epicenter

5) Seismic Waves



What Causes an Earthquake?

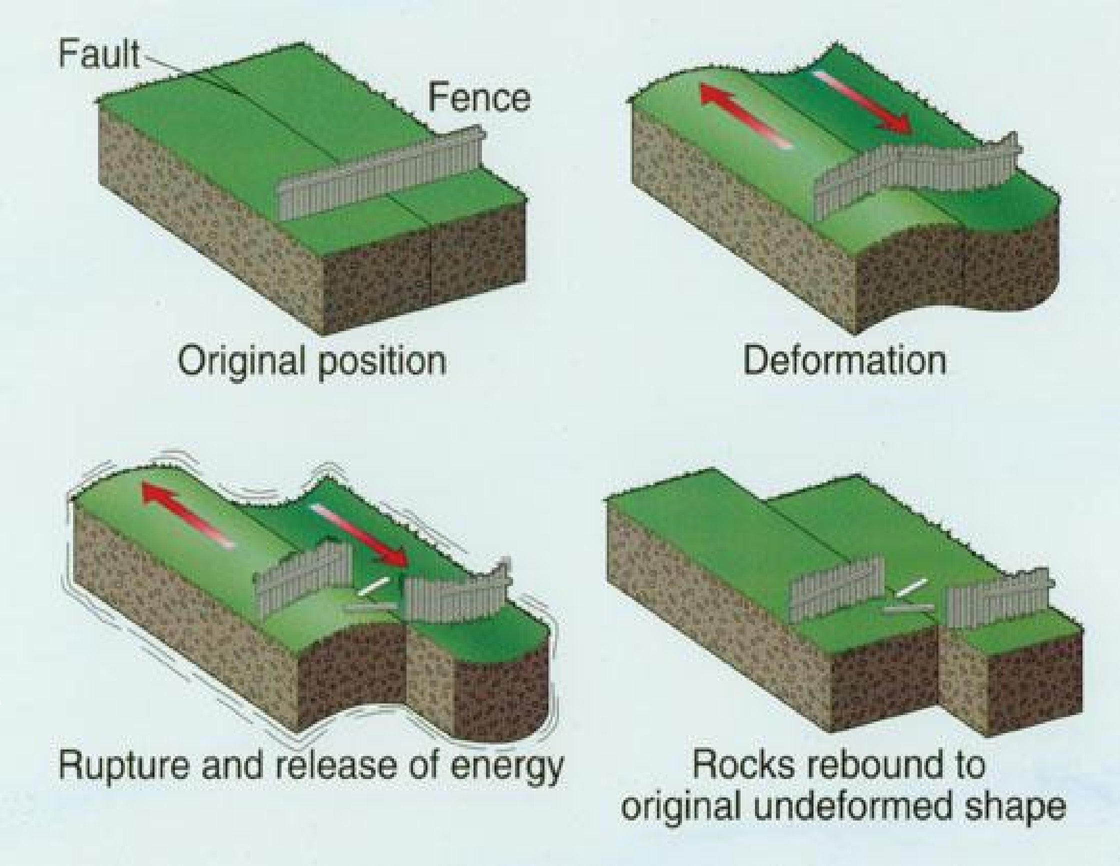
1) Pre-load Period
- No Stress
- No Deformation

2) Bending Period
- Slow Stress Loading
- Elastic Deformation

3) Rupture Period
- Instant Stress Release
- Brittle Deformation/Offset

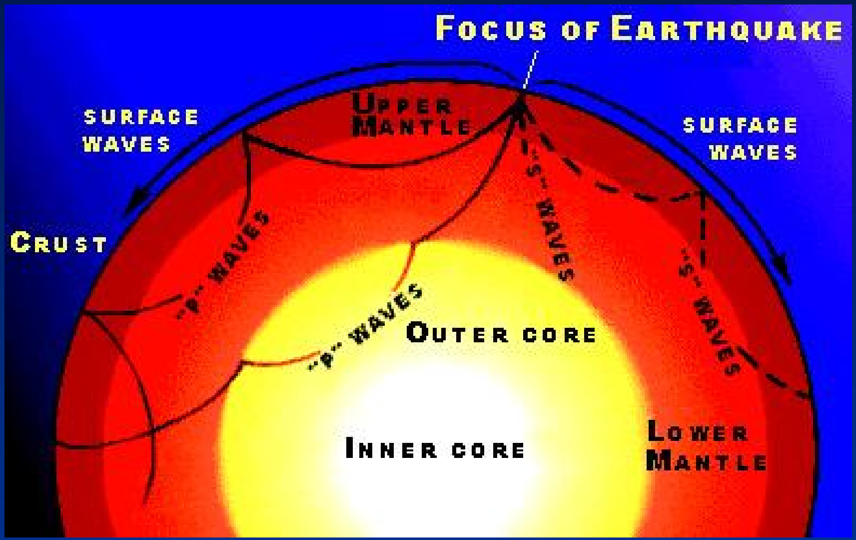
4) Rebound Period
- Removal of Bending
- Stress Relieved

Reid's Elastic Rebound Theory



Four Stages

Types of Seismic Waves



Body Waves

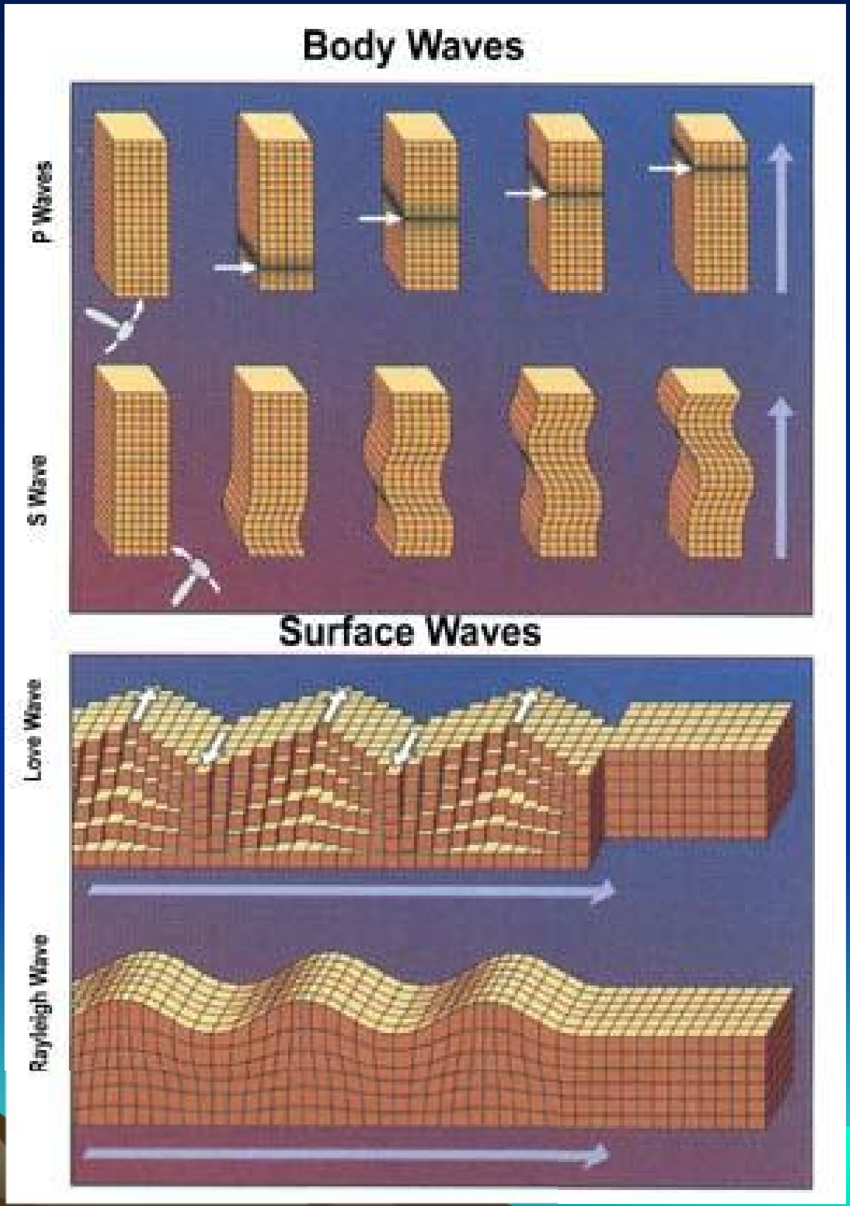
1) P-waves

2) S-waves

Surface Waves

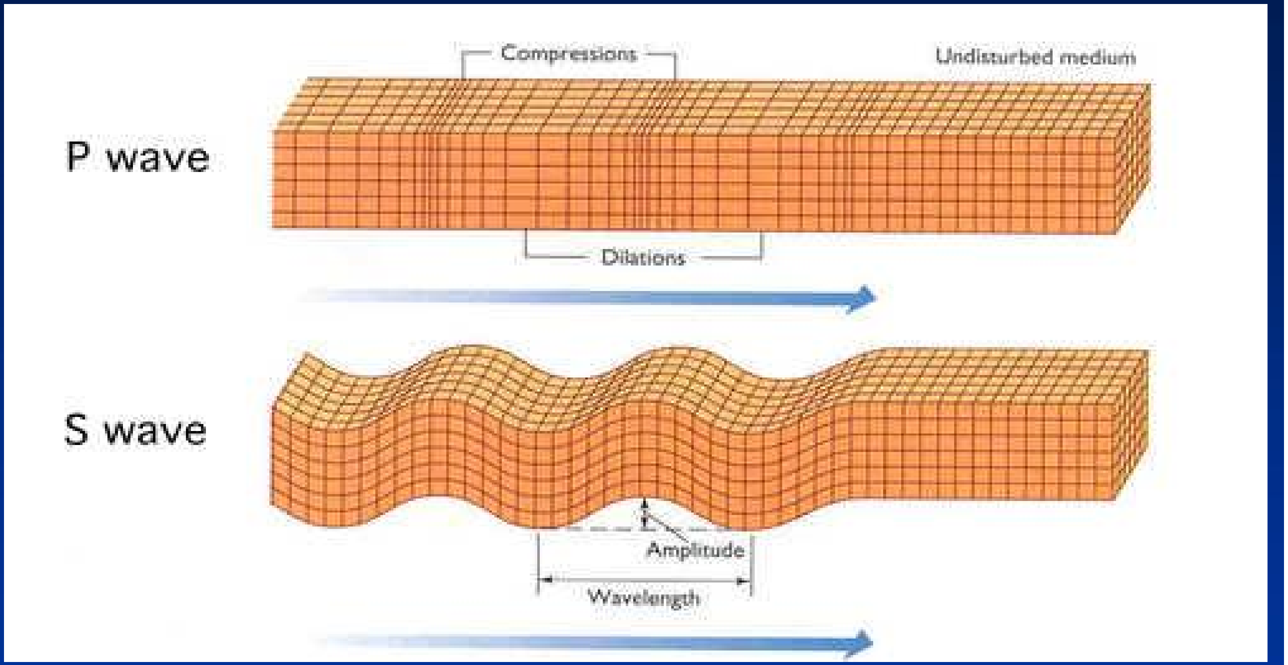
1) Love-waves

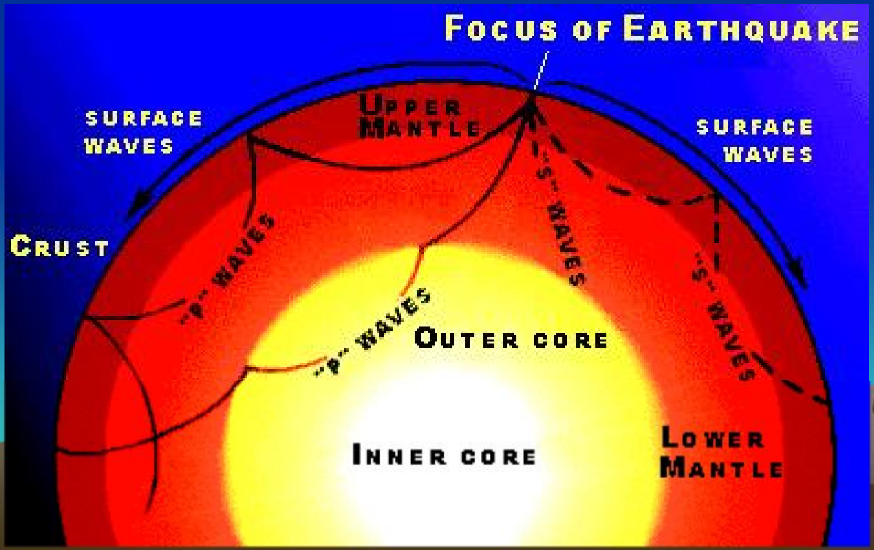
2) Raleigh-waves



Two Types of Body Waves

1) **P-waves**
   - Compressional
   - Fast
2) **S-waves**
   - Shear
   - Slow





P-waves are twice as fast as S-waves

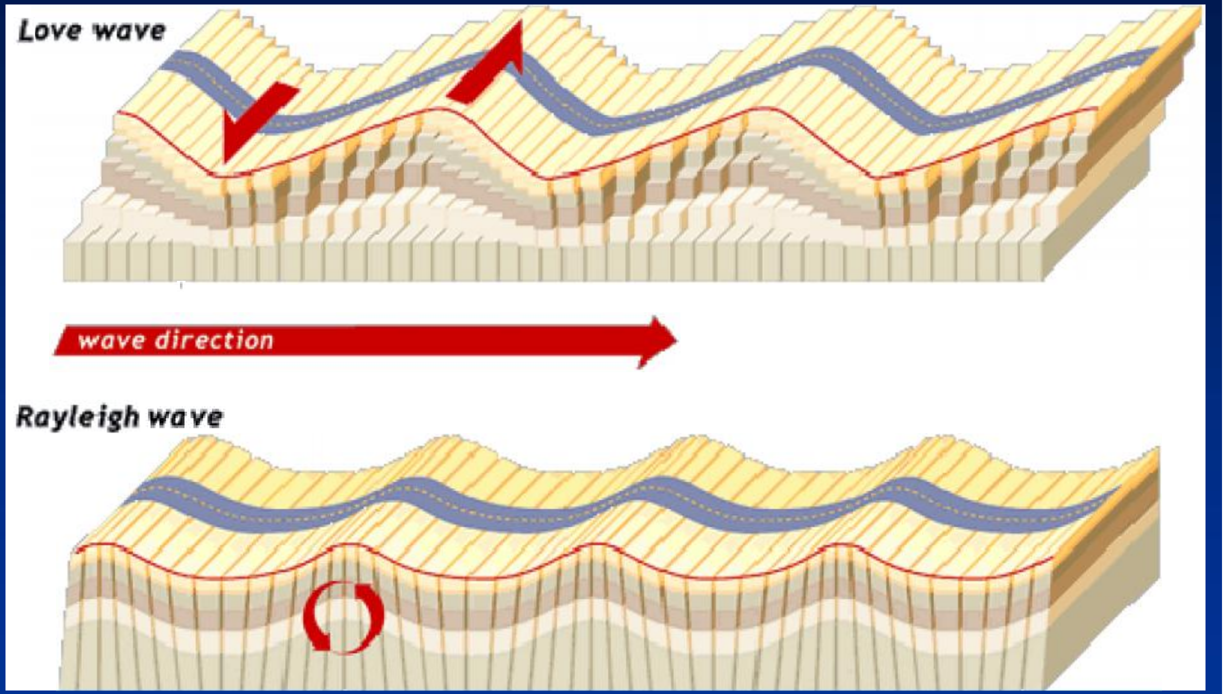
Two Types of Surface Waves

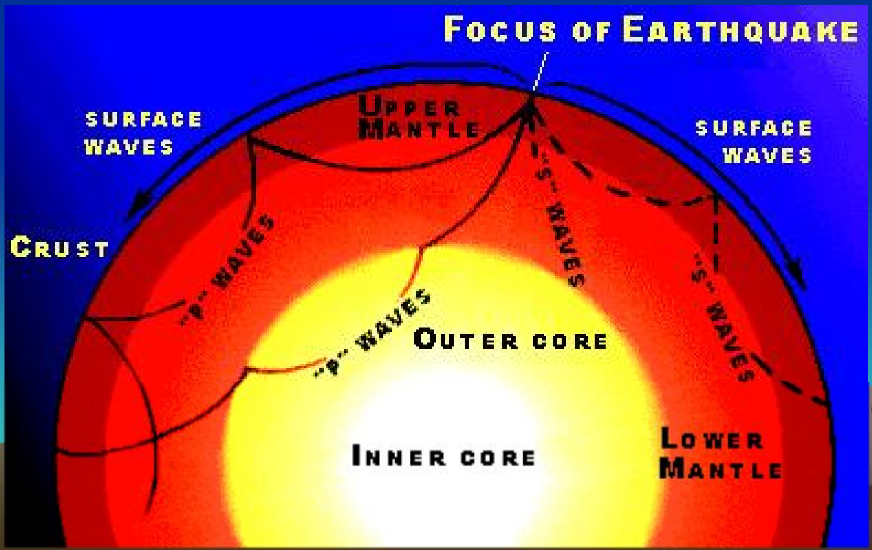
1) Love-waves

- Side-to-side Shear Motion

2) Raleigh-waves

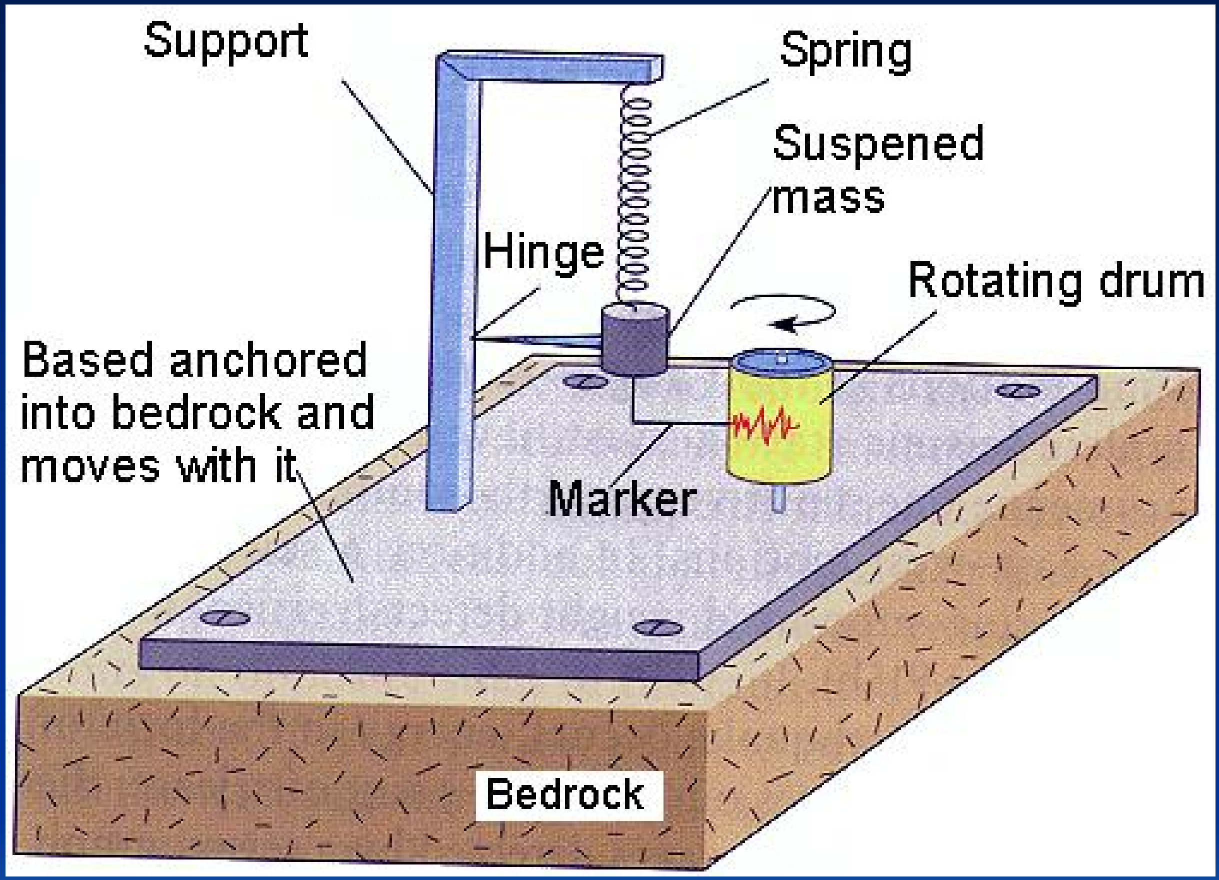
- Orbital Rolling Motion





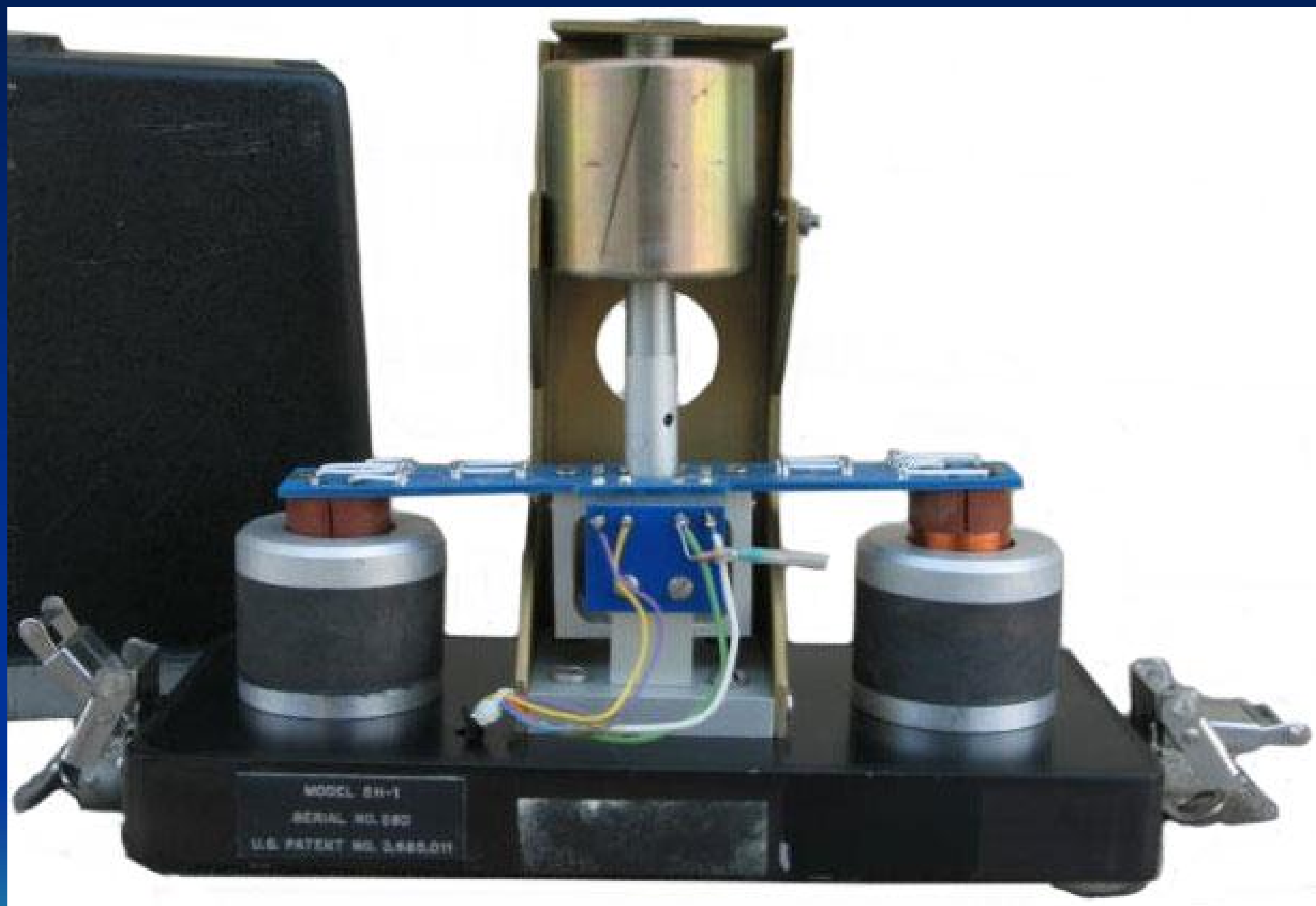
Surface waves are very destructive to building, dams, and bridges

Recording Seismic Activity



A Simplistic Seismometer

Recording Seismic Activity



A Real Seismometer

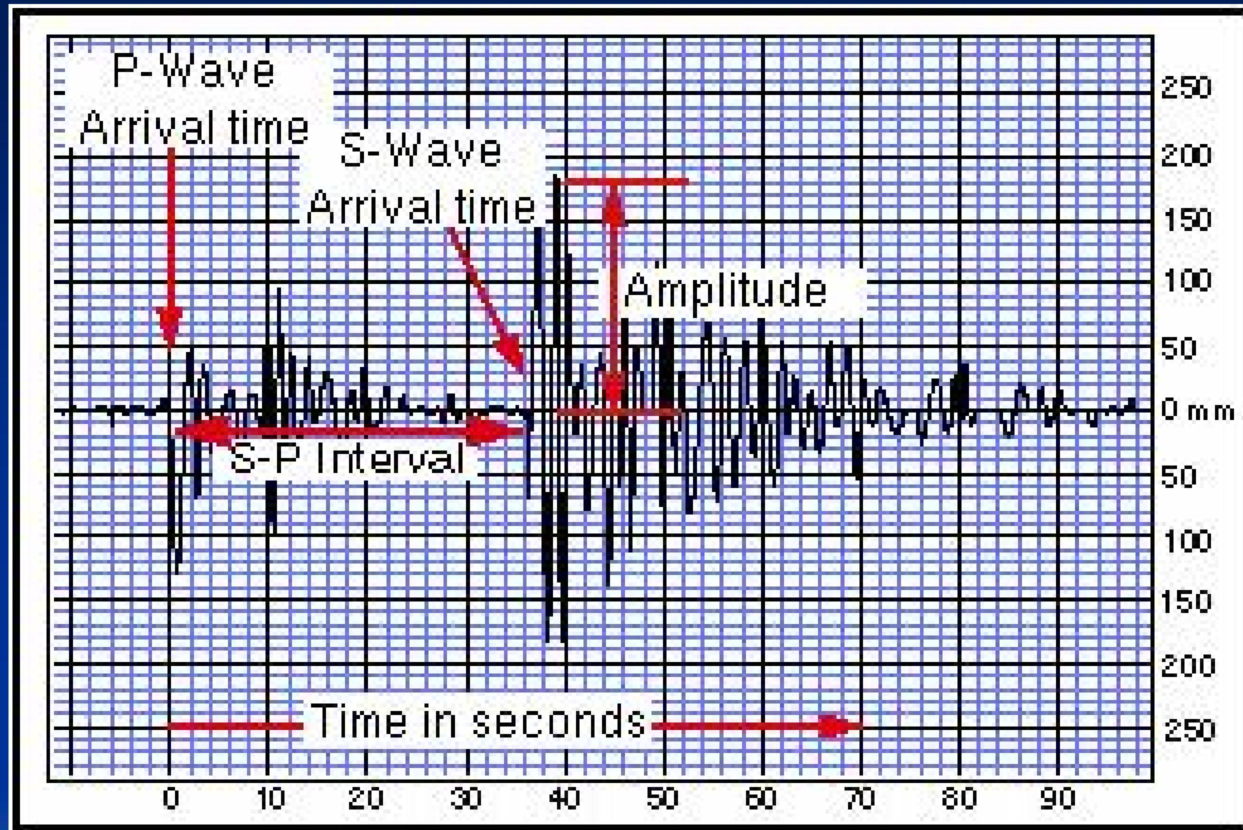
Fundamentals of a Seismogram

1) P-wave Arrival time

2) S-wave Arrival time

3) S-P Interval

4) Amplitude



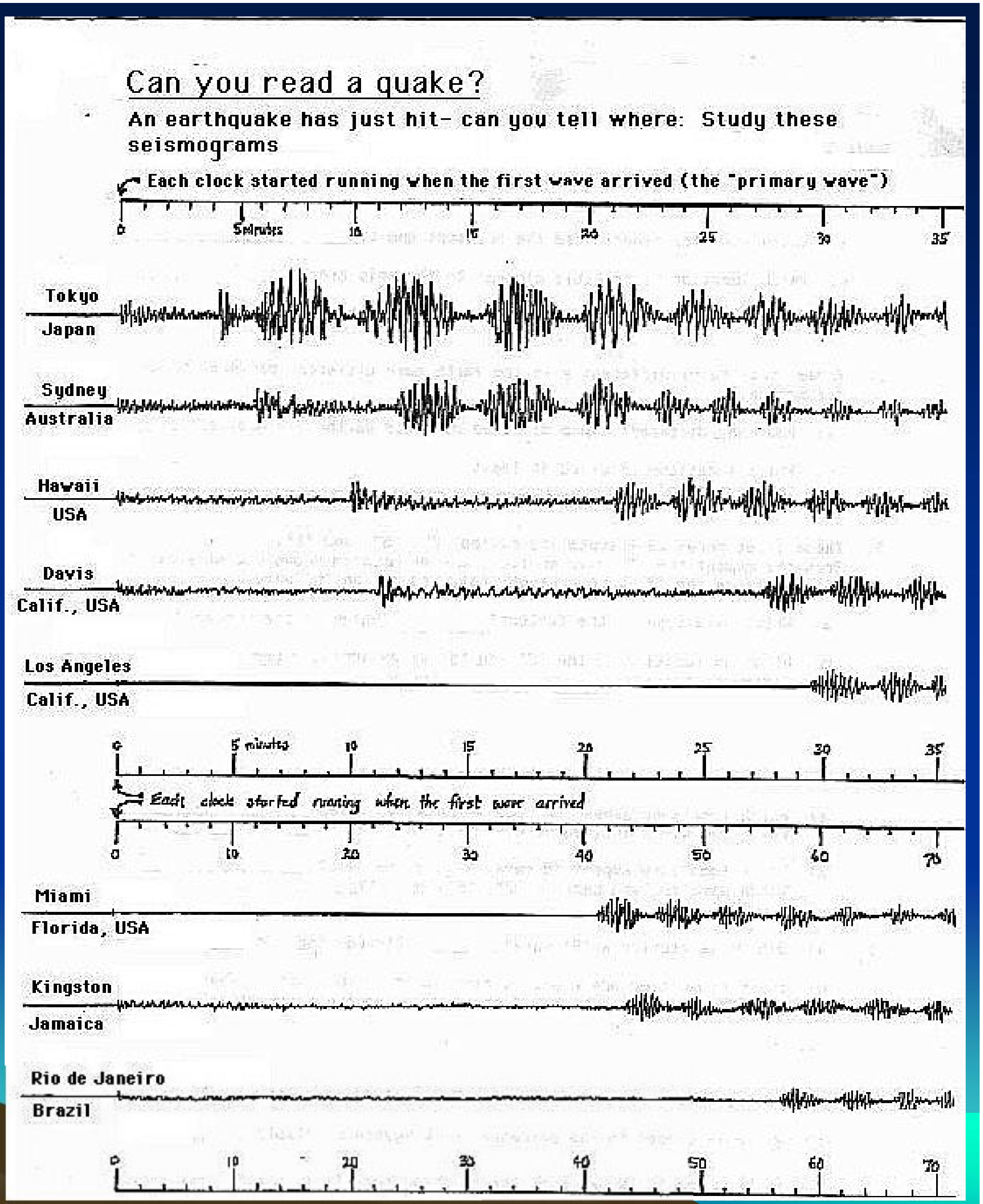
Reading a Seismogram

1) P-wave Arrival time

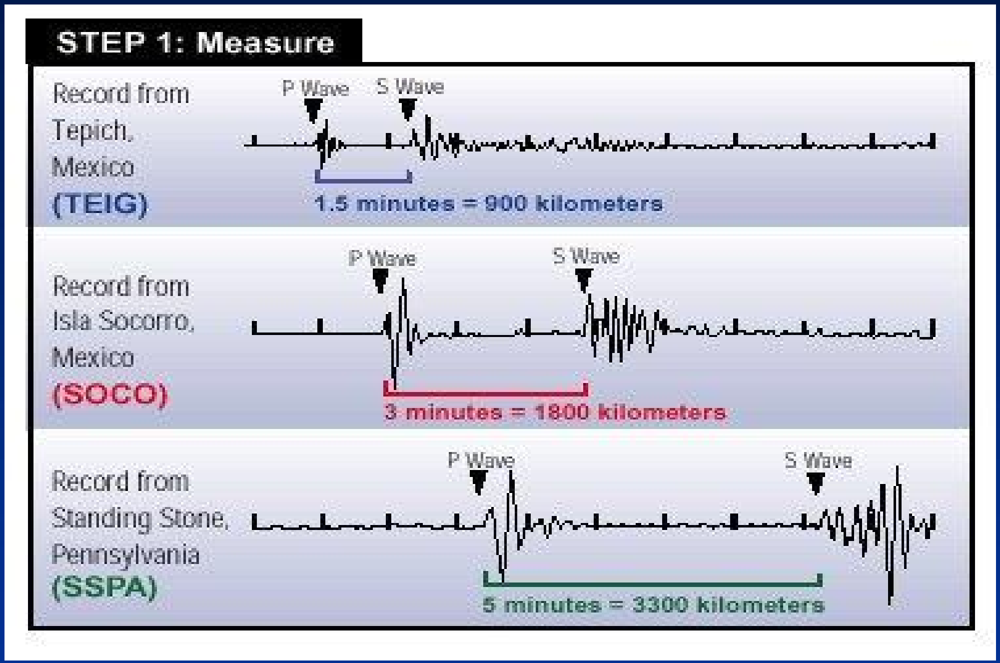
2) S-wave Arrival time

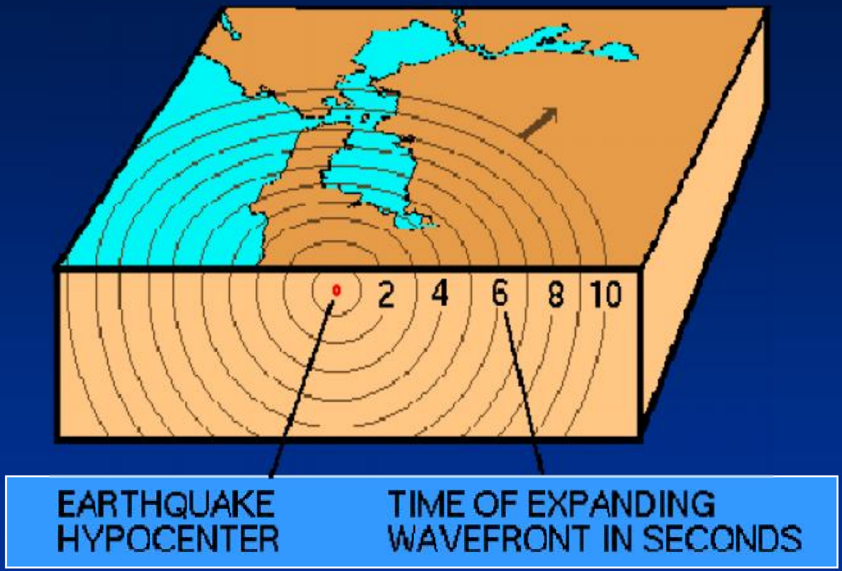
3) S-P Interval

4) Amplitude



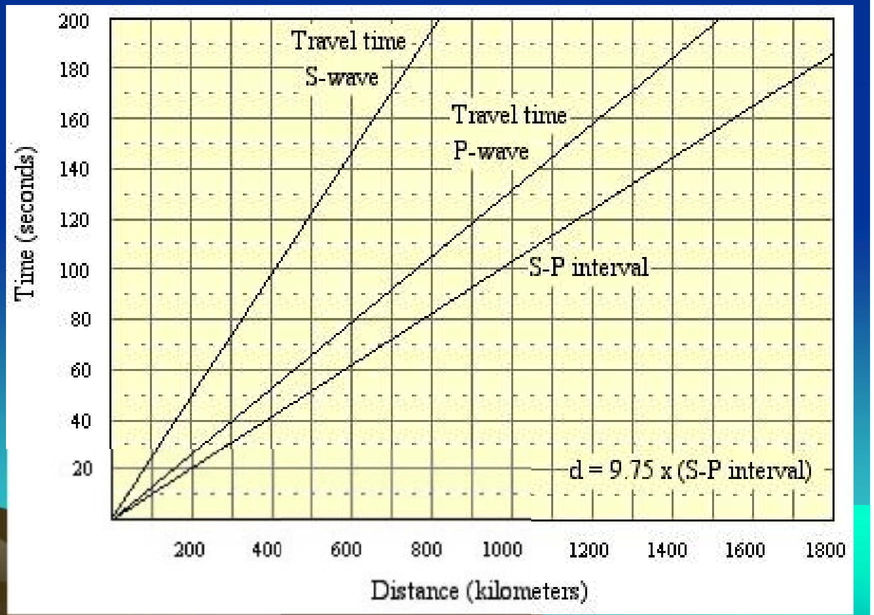
Determining Distance to Epicenter





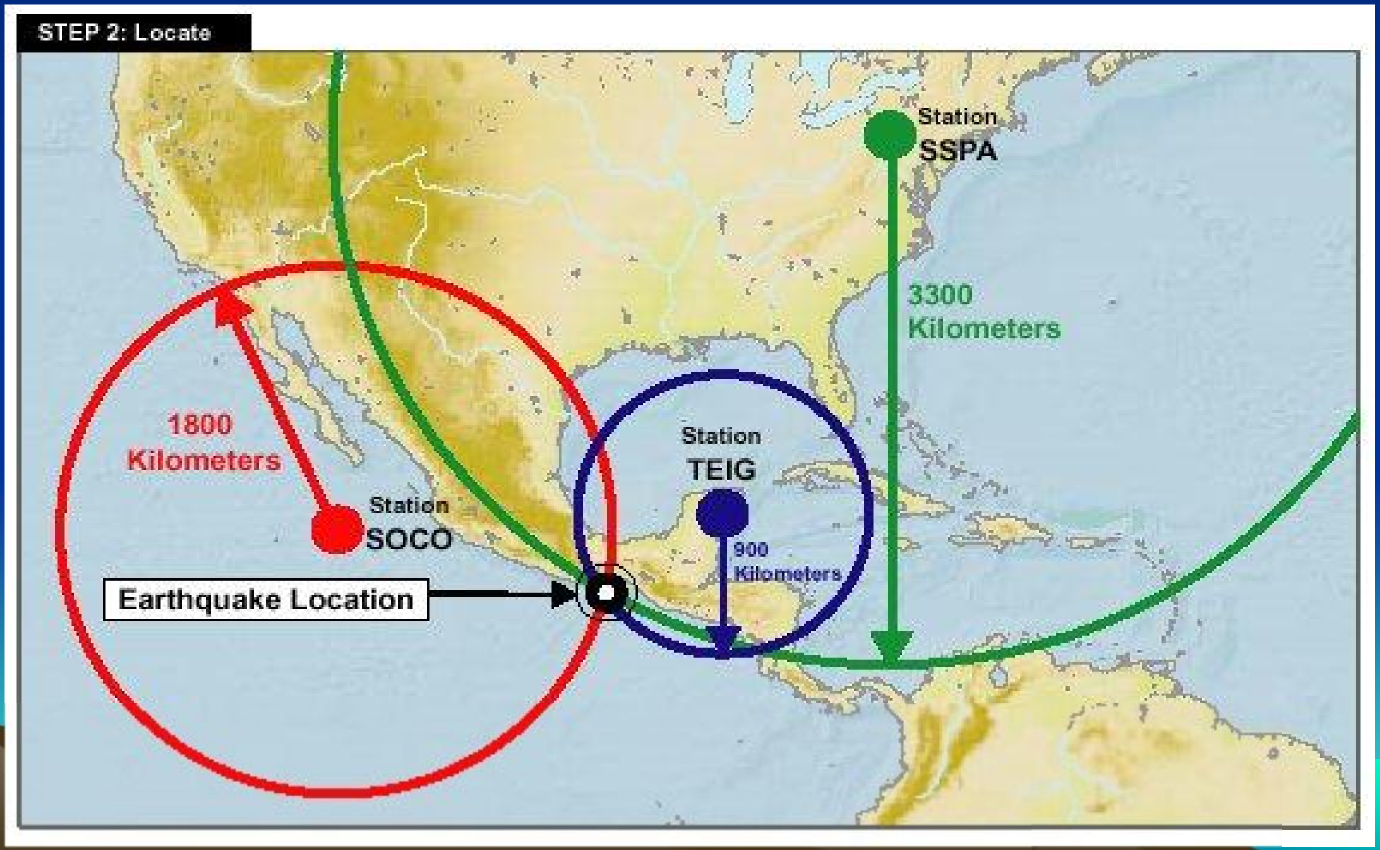
1) Measure S-P Interval for each station

2) Convert S-P Interval time into ground distance from epicenter using conversion chart



Determining Earthquake Epicenter

1) Need at least three seismograph stations
2) Find distance from station to epicenter for each station
3) Plot distance circles for each station
4) Epicenter located where all three circles intersect

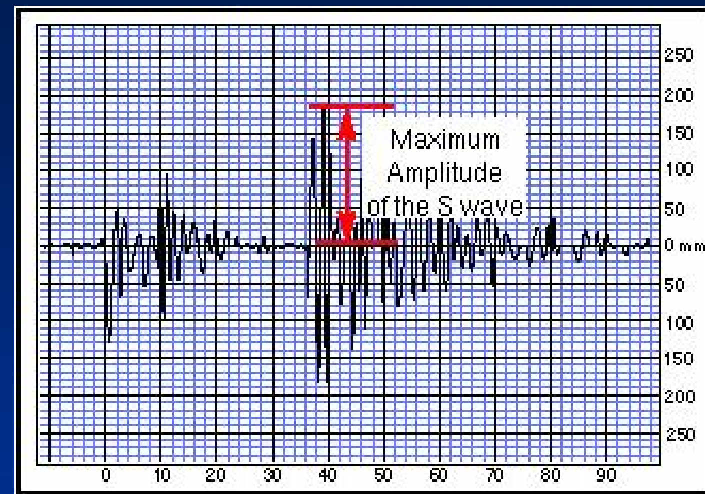


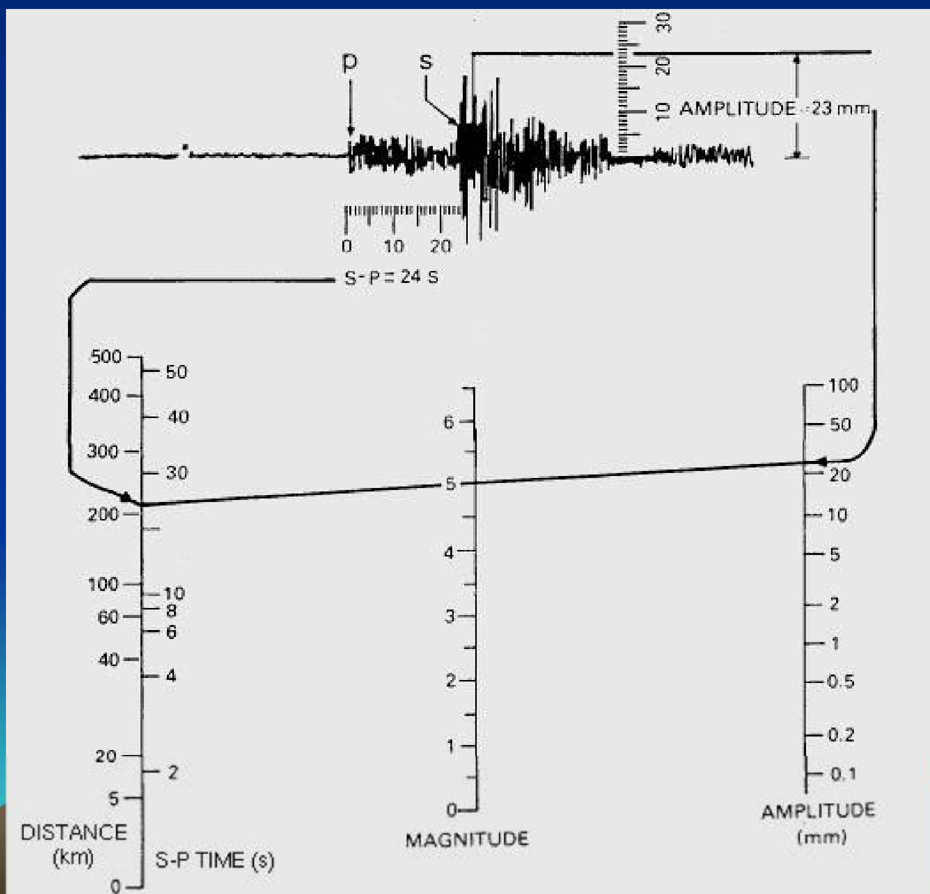
Determining Earthquake Magnitude

1) Measure amplitude of largest S-wave

2) Plot line from distance to amplitude

3) Magnitude is read from center scale





Earthquake Epicenter and Magnitude Internet Exercise

[Virtual Earthquake Internet Exercises]

Ground Shaking

Modified Mercalli Intensity Scale

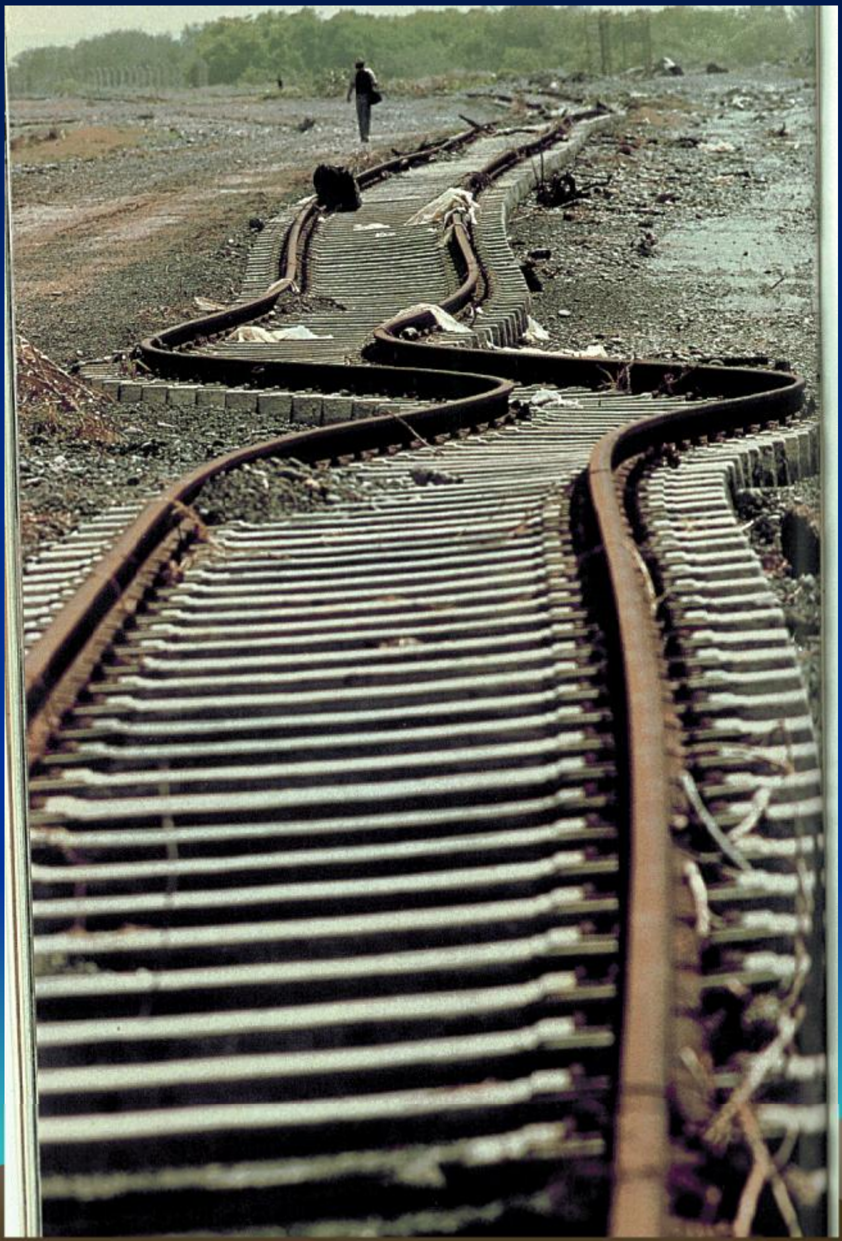
I	Not felt
II	Felt only by persons at rest
III–IV	Felt by persons indoors only
V–VI	Felt by all; some damage to plaster, chimneys
VII	People run outdoors, damage to poorly built structures
VIII	Well-built structures slightly damaged; poorly built structures suffer major damage
IX	Buildings shifted off foundations
X	Some well-built structures destroyed
XI	Few masonry structures remain standing; bridges destroyed
XII	Damage total; waves seen on ground; objects thrown into air

Banda Aceh, Indonesia Video

Earthquake and Tsunami Footage

Ground Rupturing Effects and Hazards

Surface Displacement Along Active Faults



Surface Displacement Along Active Faults

Houses Collapse Due to Ground Shaking

Poorly-constructed homes are easily damaged in big quakes

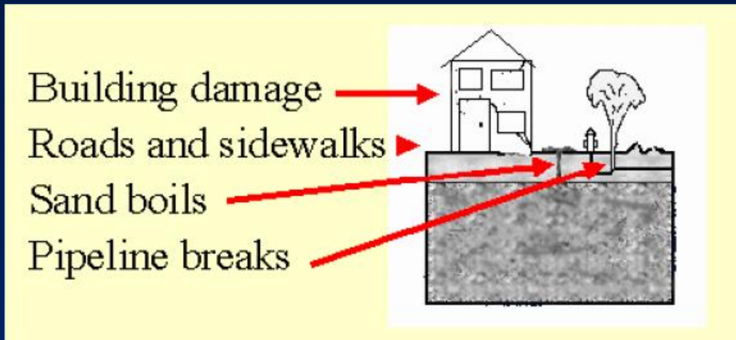
Building Collapse Due to Ground Shaking

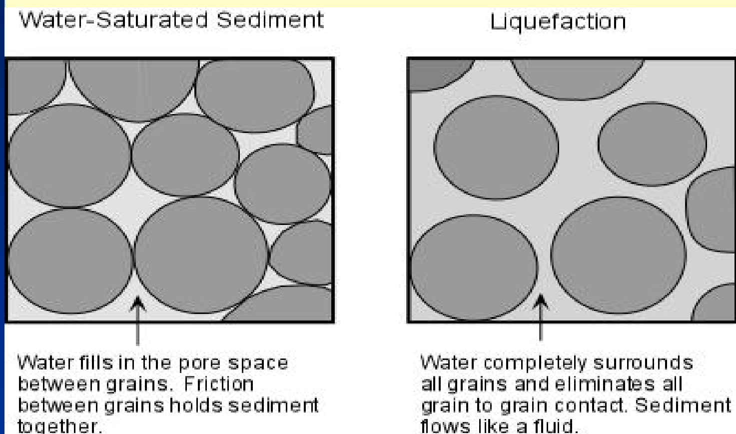
Weak foundation supports are easily damaged in big quakes

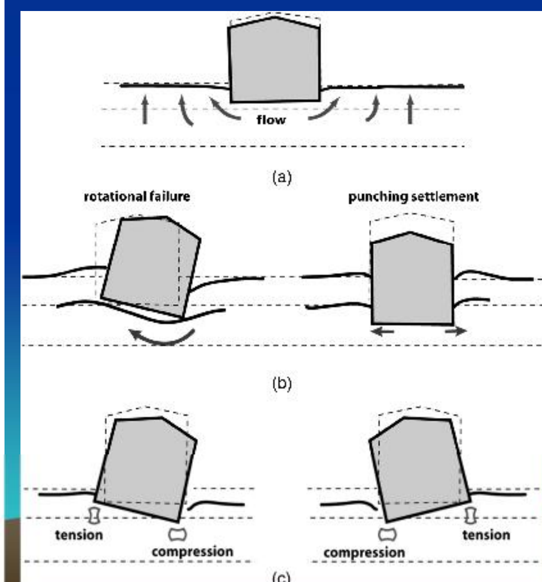
Bridge Collapse Due to Ground Shaking

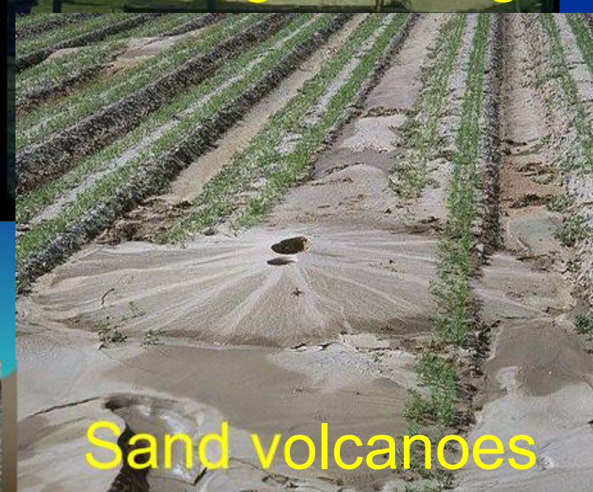
Poorly-constructed bridges are easily damaged in big quakes

Liquifaction!









Liquifaction!

Liquefaction during the 1964 Niigata M7.6 earthquake, Honshu, Japan caused major foundation failure in these apartment blocks.
Image from WikiCommons.

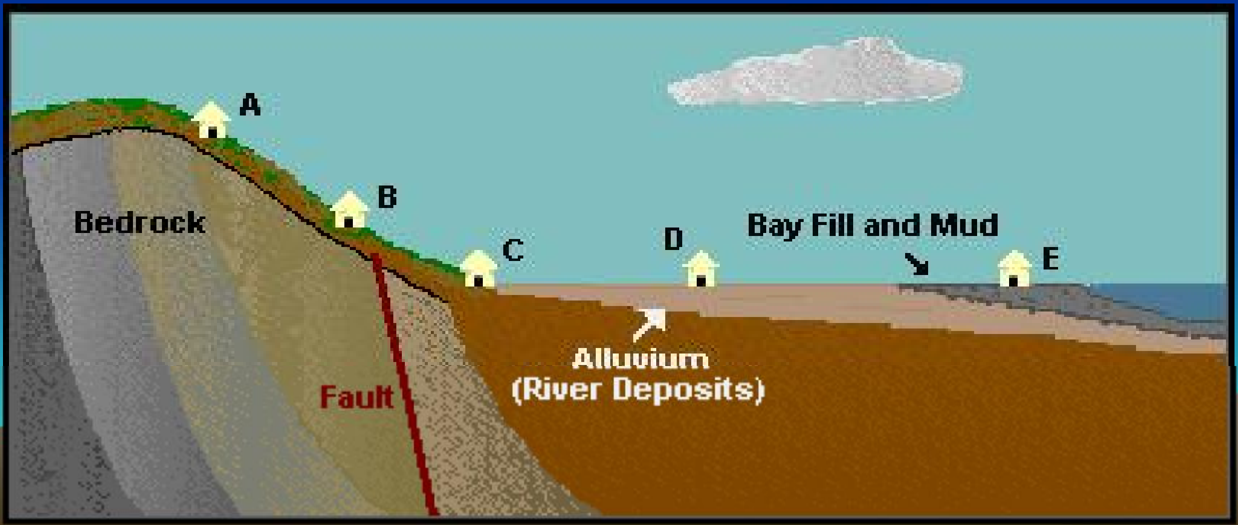
Earth Shaking: Ground Effects

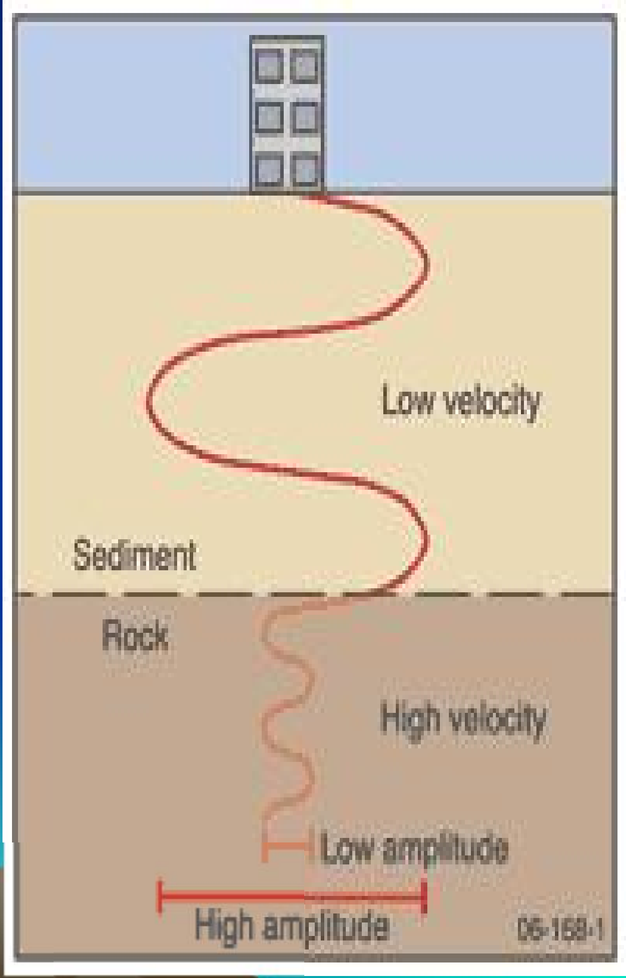
Different types of ground materials behave differently to seismic waves: the softer the ground material, the greater the shaking.

Solid rock is favorable over sediment

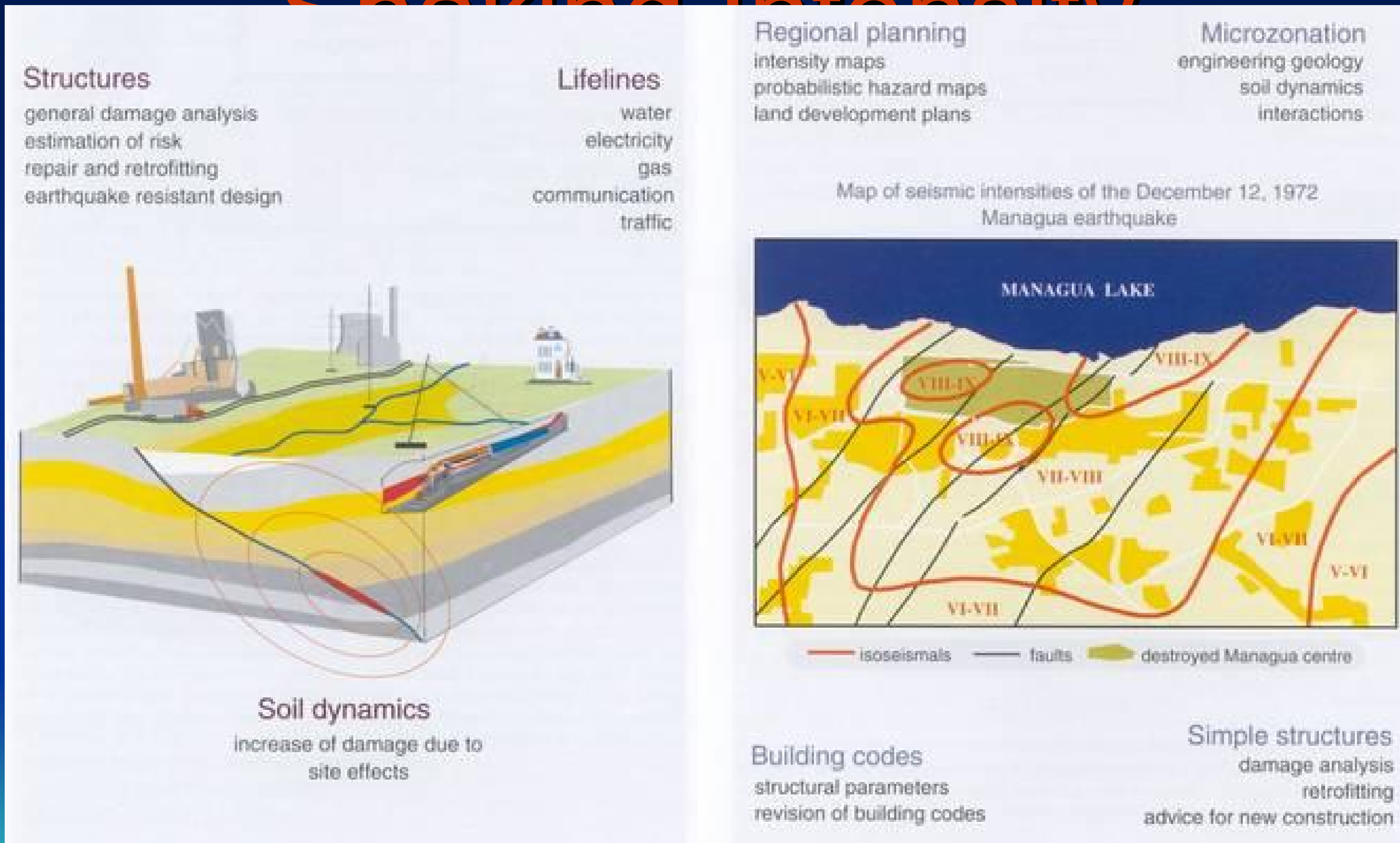
Dry sediment favorable over saturated

Different types of building material and structural designs give different failure results for a given level of shaking.

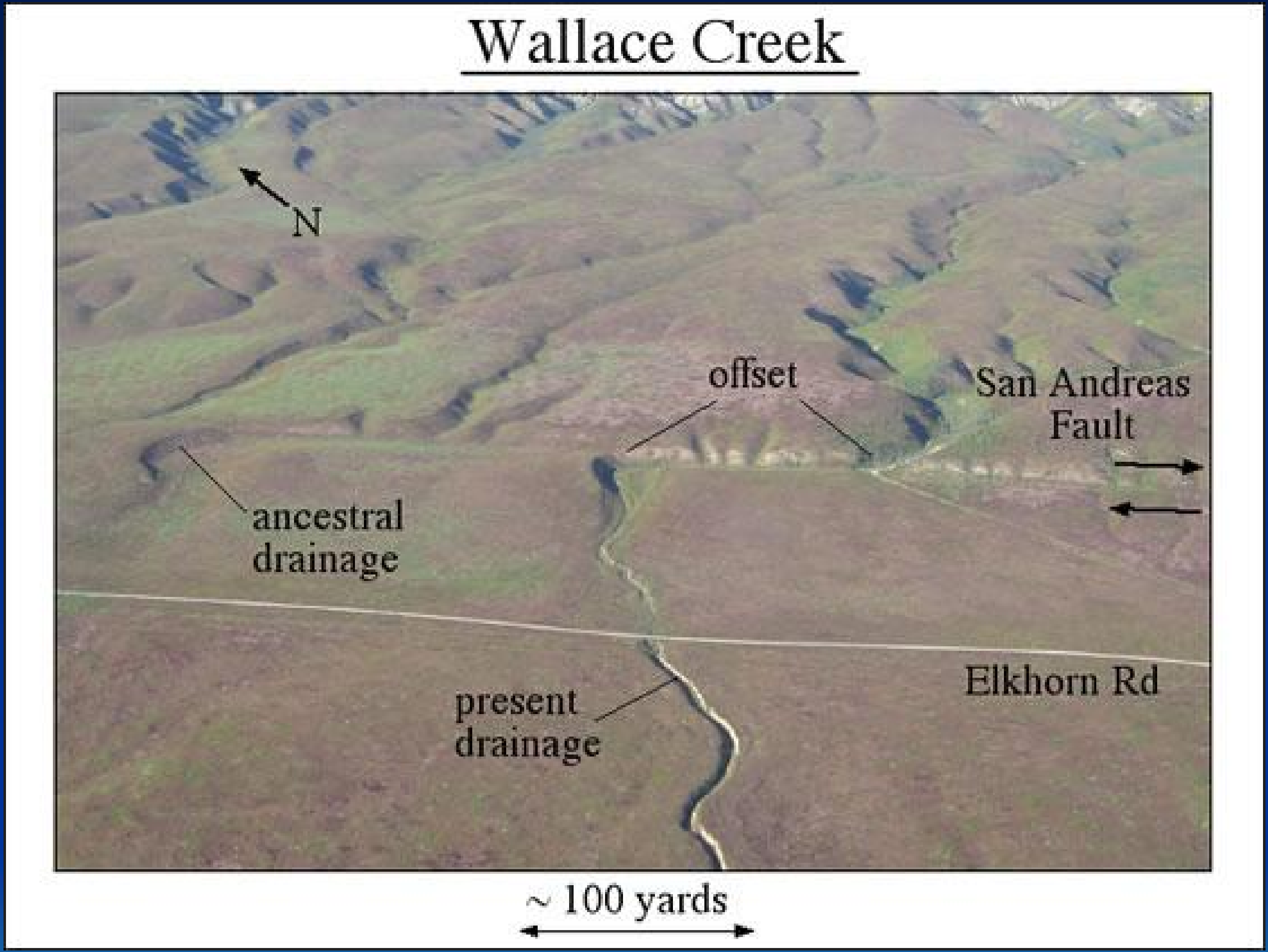




Substrate Type Versus Shaking Intensity



Using Aerial Photos to Interpret Fault Movement



Surface Displacement
Along San Andreas Fault

Earthquakes on the Net

Earthquake Research Exercises

Part I. Active Faults and Recent Earthquakes in California and Nevada

http://quake.wr.usgs.gov/recenteqs/latest.htm

Part II. Create and Analyze Your Own Earthquake – Virtual Earthquake Computer Program

http://www.sciencecourseware.com/eec/Earthquake/

Part III. Earthquake Preparedness Information