212 – Earthquakes

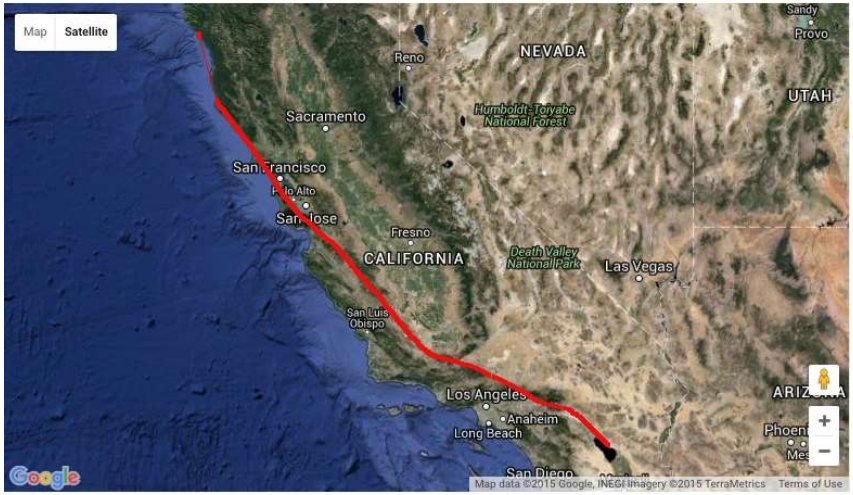
Causes and Effects

Warm-Up Earth Systems @HinzScience92

Question:

Where do you think most earthquakes occur?

Think about where they occur in the United States.



Answer:

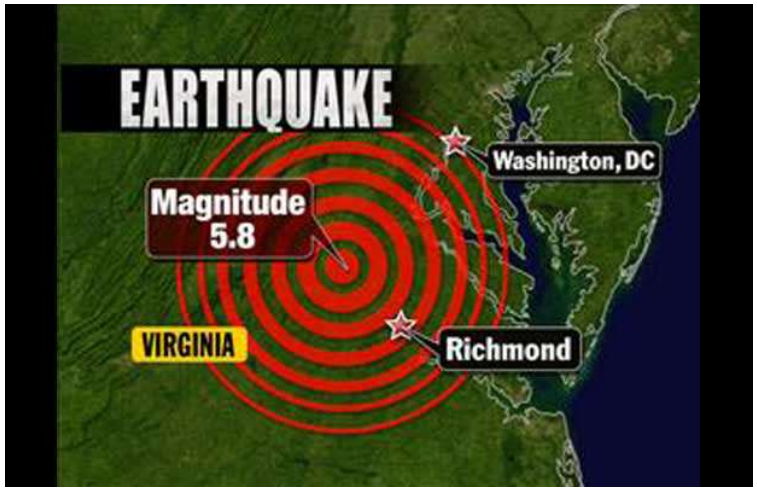
Earthquakes most commonly occur along plate tectonic boundaries.

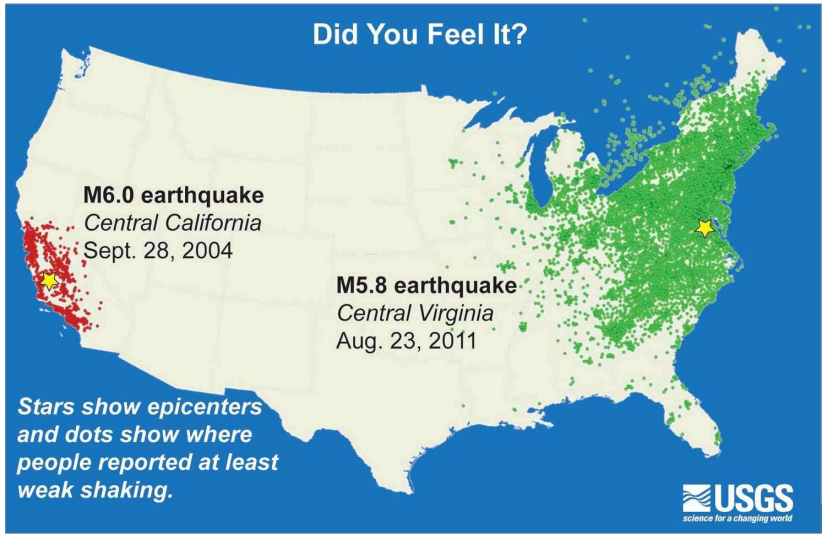
…like the San Andreas fault in California

USGS Latest Earthquake Map

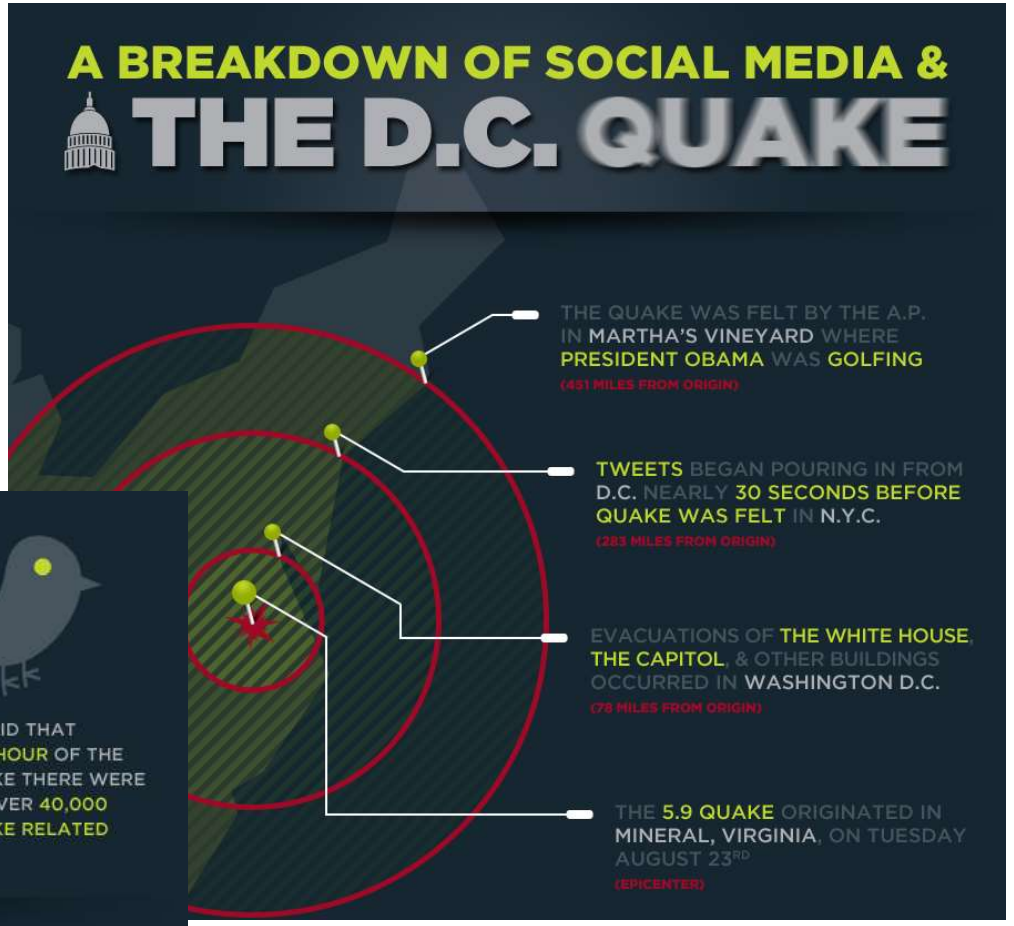
- click here to access the map

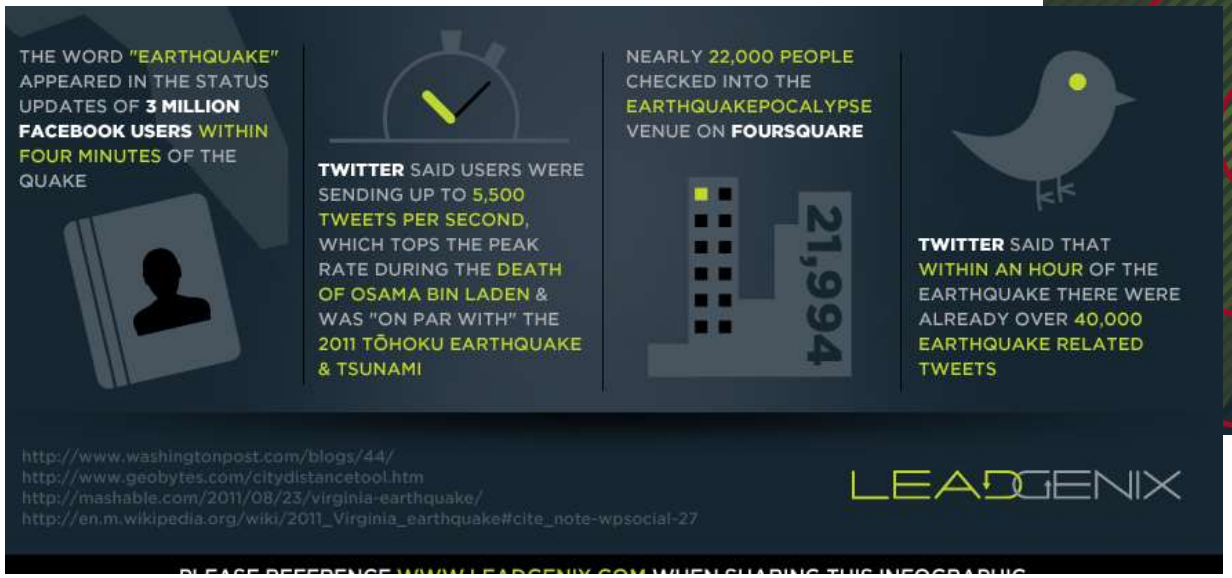
August 2011 East Coast Quake (5.8 Mw)





Earthquakes and Social Media

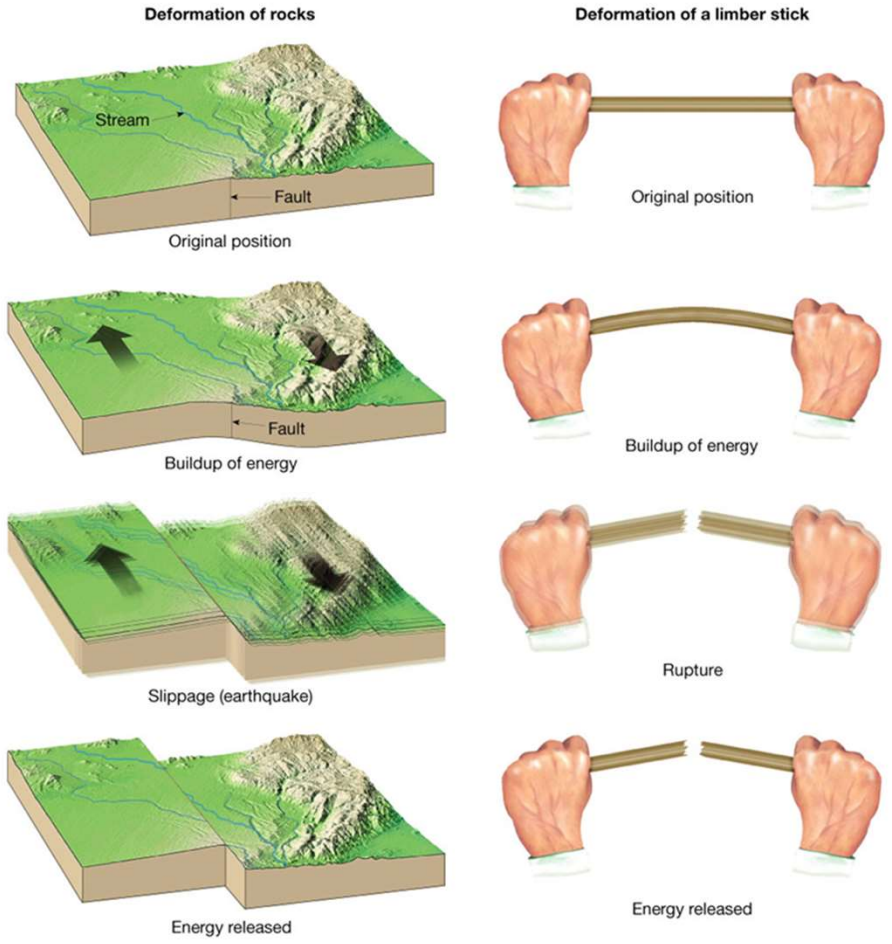





2011 VA EARTHQUAKE
WE WILL REBUILD

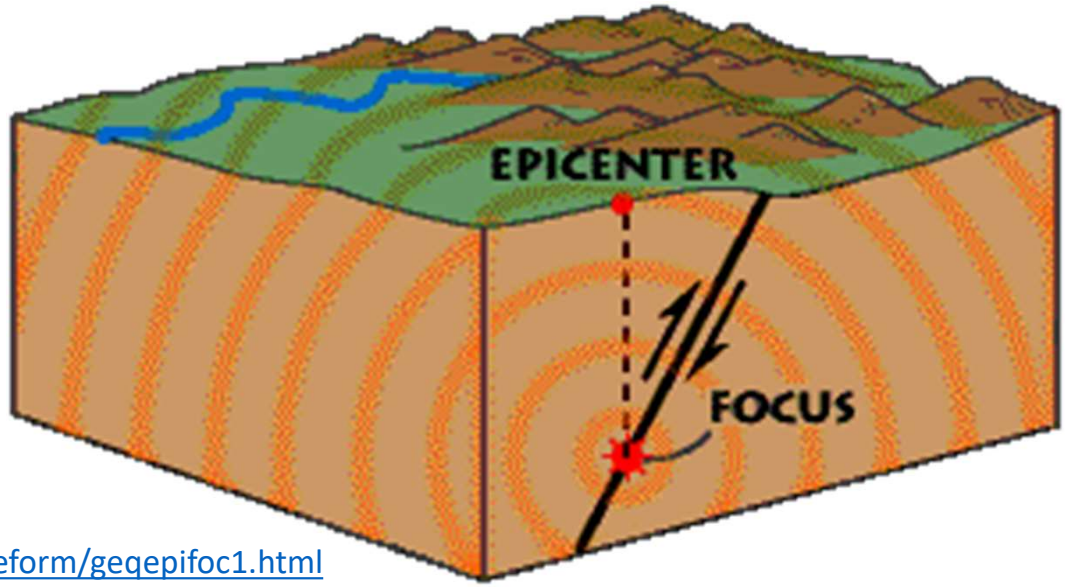
Earthquakes

- An **EARTHQUAKE** is the shaking of the surface of the Earth
- Earthquakes happen anywhere the crust is suddenly shifting and moving…**Elastic Rebound**
- An **aftershock** is a smaller quake as the crust adjusts to the main quake and shock



Earthquake Epicenter and Focus

- **Epicenter**-The point on the Earth's surface located directly above the **focus** of an earthquake.
- **Focus**-The location where the earthquake begins. The ground ruptures at this spot, then seismic waves radiate outward in all directions.



https://geomaps.wr.usgs.gov/parks/deform/geqepifoc1.html

What are Seismic Waves?

- **Seismic waves are the vibrations from earthquakes that travel through the Earth**
  - They are the **waves of energy** suddenly created by **rock fracture** in the earth or an explosion.
  - They are recorded on seismographs

Types of Seismic Waves

- **Body waves-** P waves and S Waves
  Travel through the earth's interior

- **Surface Waves**
  Travel along the earth's surface - similar to ocean waves

Seismic Waves

Body waves

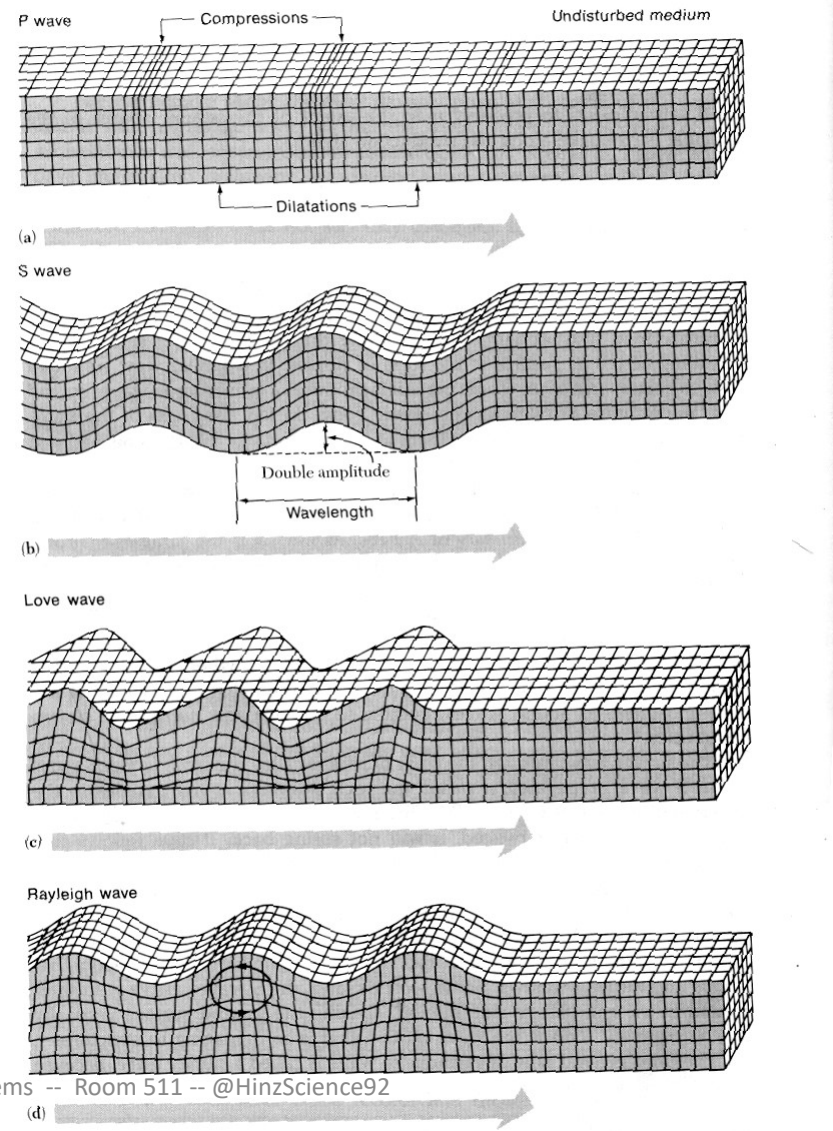
P

S

Surface Waves

Love

"Ground Roll" **Rayleigh**



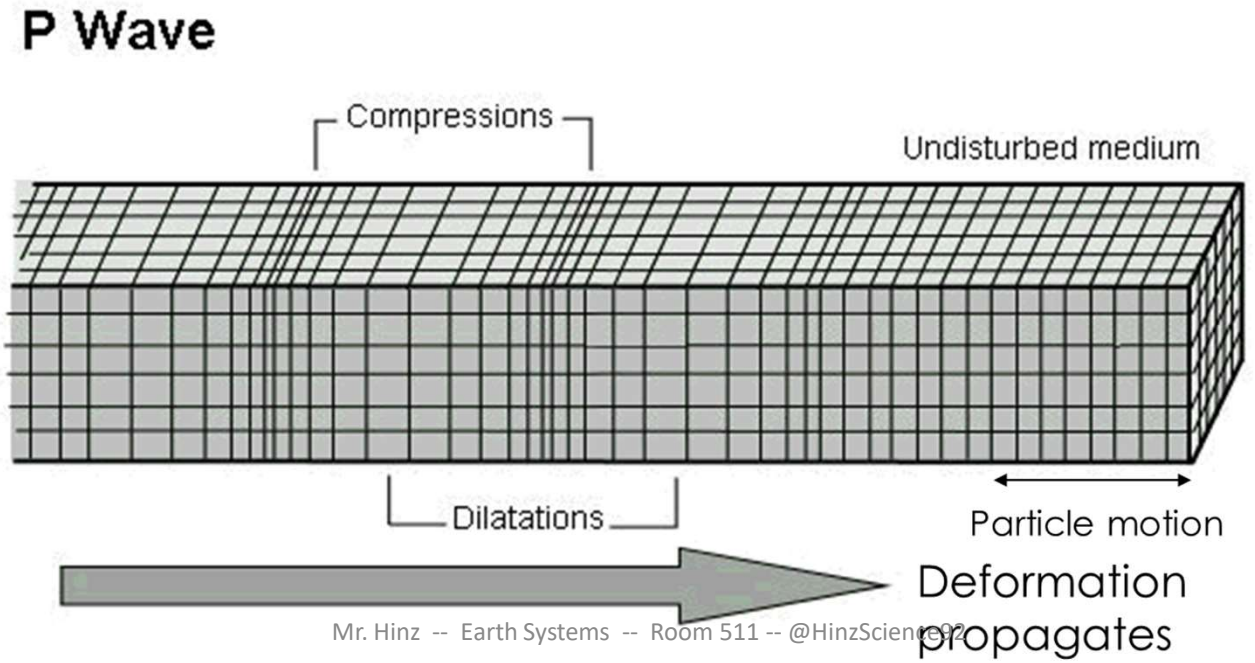
Fastest

Slowest

click here to watch video

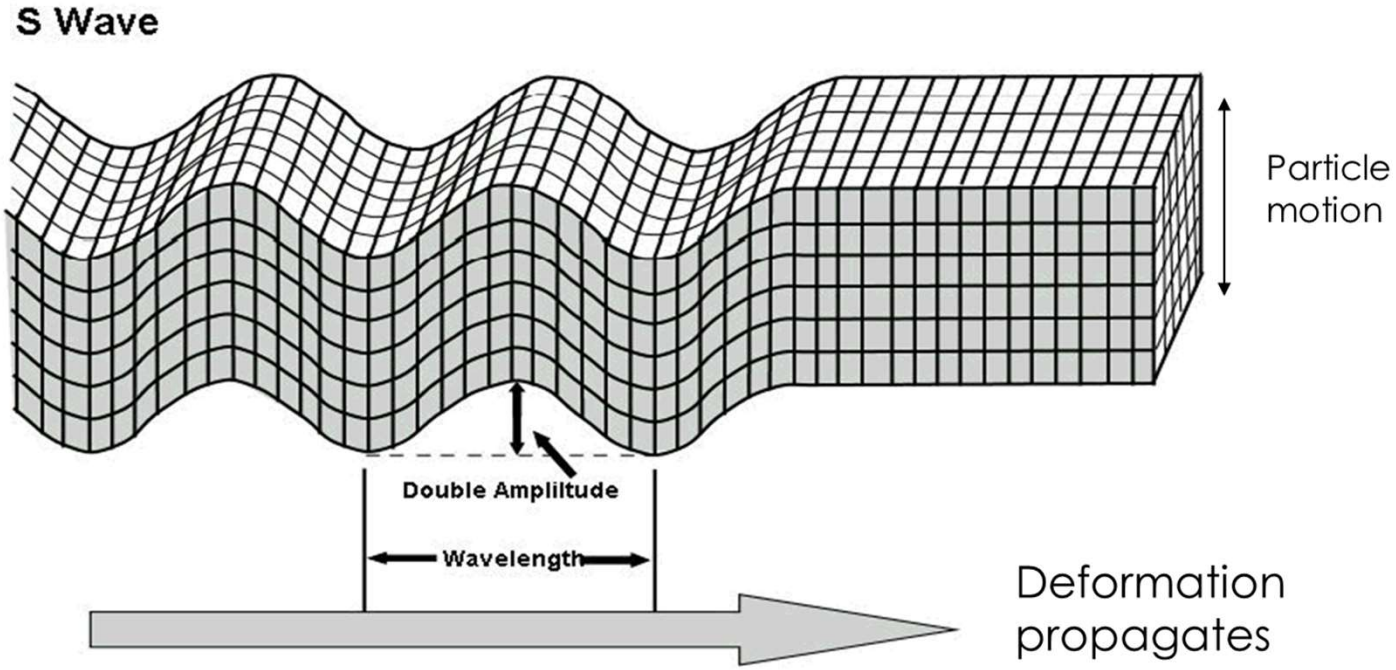
Primary or compressional (P) waves (Body Wave)

- This is the fastest kind of seismic wave. Highest velocity (6 km/sec in the crust)
- It can move through solid rock and fluids, (e.g. water or liquid layers of Earth)
- It pushes and pulls the rock it moves through just like sound waves push and pull the air.



Secondary or shear (S) waves (S Wave)

- The second wave you feel in an earthquake.
- Slower than a P wave and can only move through solid rock. (3.6 km/sec in the crust)
- This wave moves rock up and down, or side-to-side.



What materials can the waves travel through?

- P-waves- Travel through Practically anything!
- S-waves- Travel through SOLIDS only!

Where does an earthquake start?

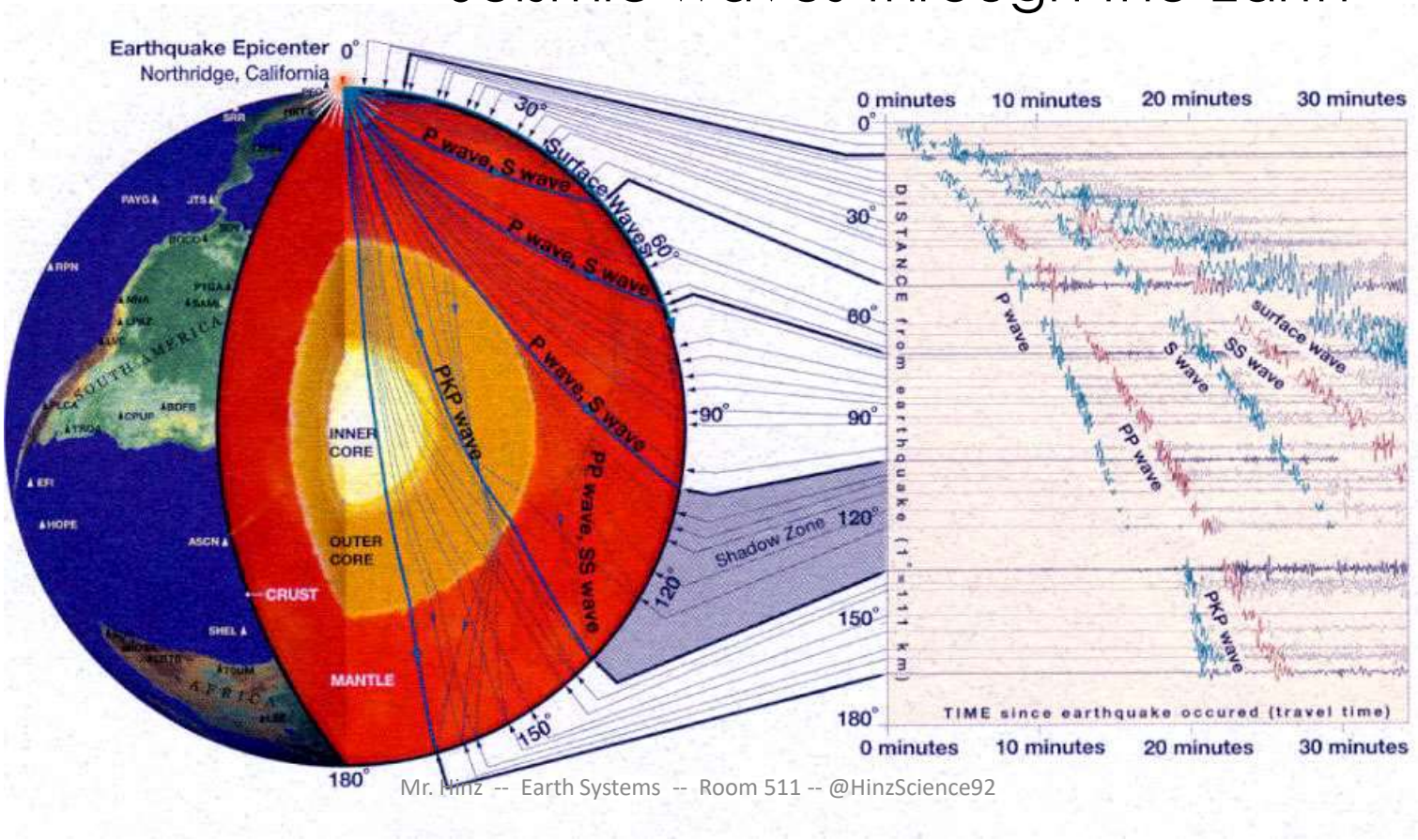
- Focus-Underground origin of Earthquake
- Epicenter-Point on the SURFACE above focus

Can you see the ground move?

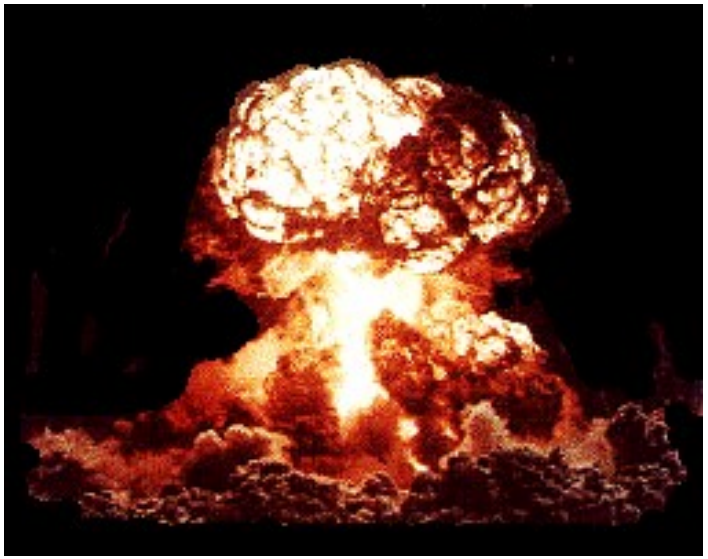
- https://www.youtube.com/watch?v=7lPbCvwbhOg
- https://www.youtube.com/watch?v=rn3oAvmZY8k

Why are seismic waves important?

IRIS Earth's Interior Structure Poster – Seismic waves through the Earth



Why are seismic waves important?



Some things seismic waves are good for include:

- Mapping the Interior of the Earth
- Detection of Contaminated Aquifers
- Finding Prospective Oil and Natural Gas Locations

USGS Latest Earthquake Map

- click here to access the map

212 Part II – Earthquake Recording & Measurement

Warm-Up

What materials can the two seismic wave types travel through?

- **P**-waves- Travel through **Practically anything**!
- **S**-waves- Travel through **SOLIDS only**!

Where does an earthquake start?

- Focus-Underground origin of Earthquake
- Epicenter-Point on the SURFACE above focus

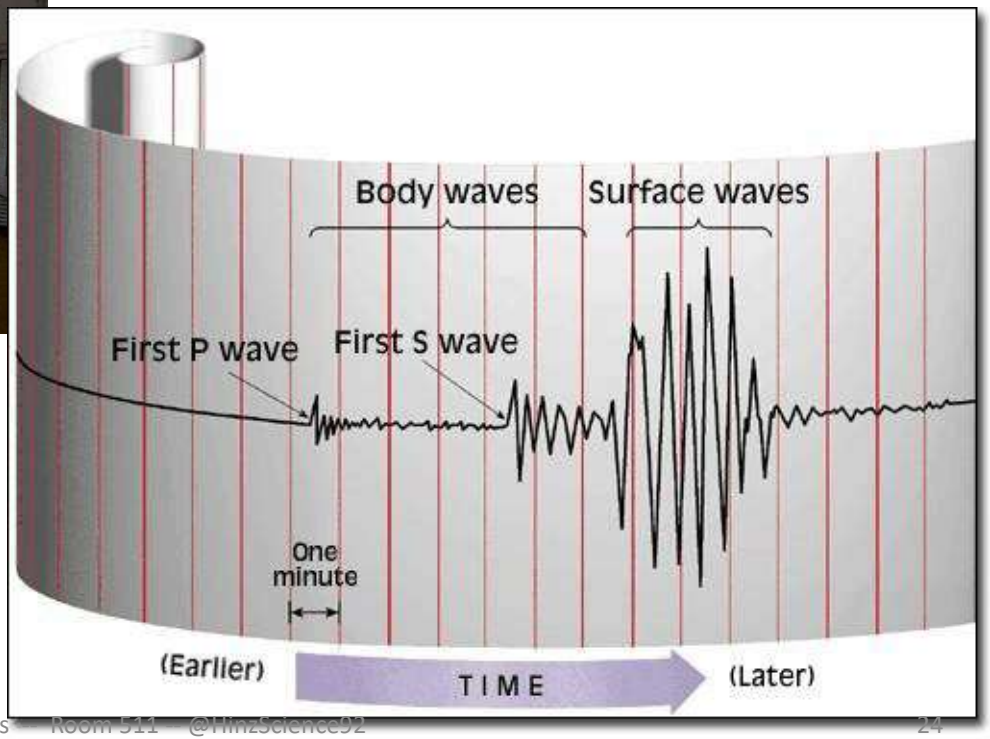
How are Earthquakes Recorded?

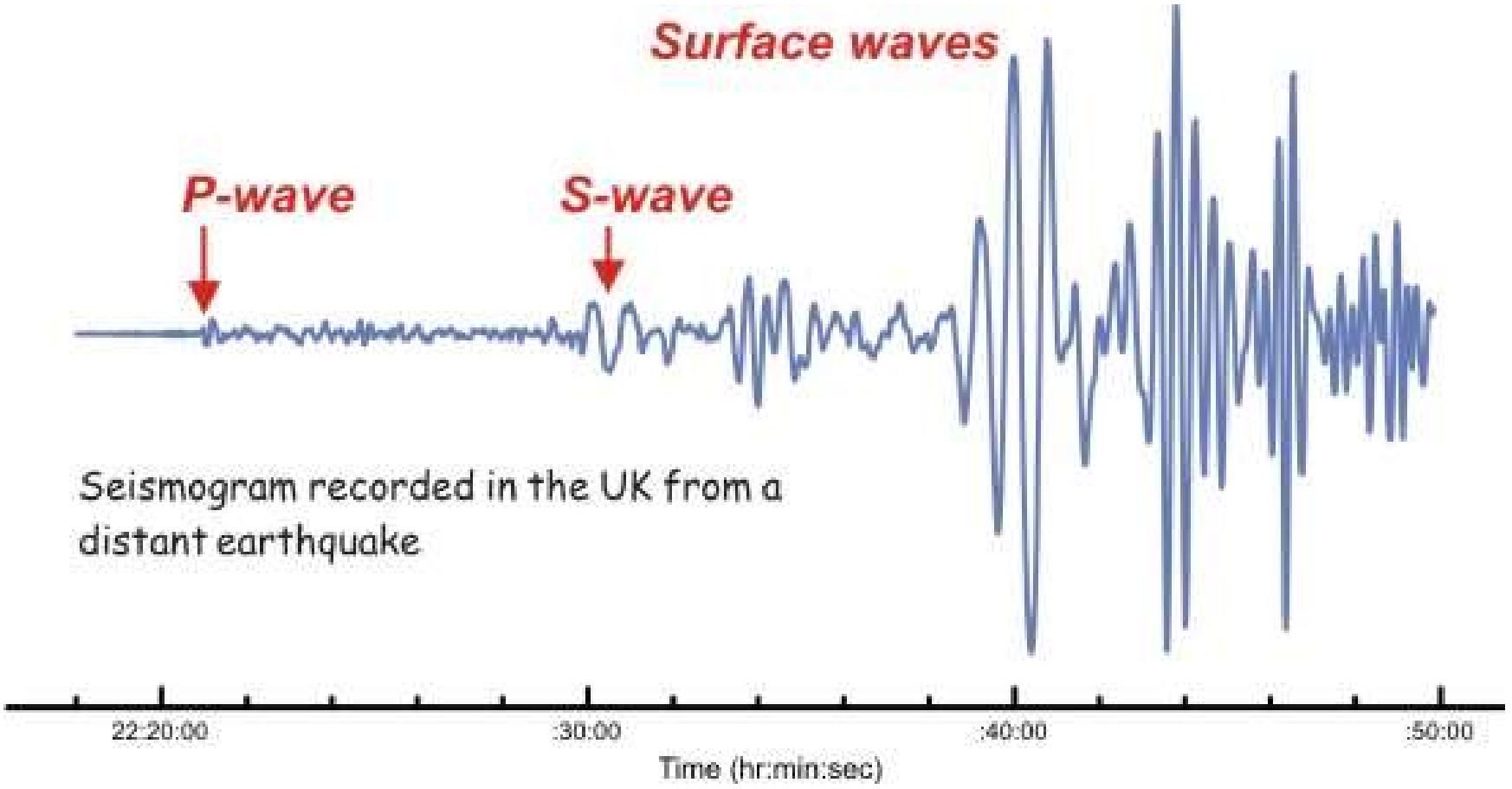
Seismograph: an instrument that measures and records details of earthquakes, such as ~~force~~ and ~~duration~~.

Power Time

- **Which wave will show up to a seismograph first? Second?**
  - P wave then S wave
  - P waves are fastest and S waves are slowest


TELEDYNE BROWN ENGINEERING
Geotech Instruments
HELICORDER / RV-SHB


Body waves
Surface waves
First P wave
First S wave
One minute
(Earlier)
TIME
(Later)


Surface waves
P-wave
S-wave
Seismogram recorded in the UK from a distant earthquake
22:20:00
:30:00
:40:00
:50:00
Time (hr:min:sec)

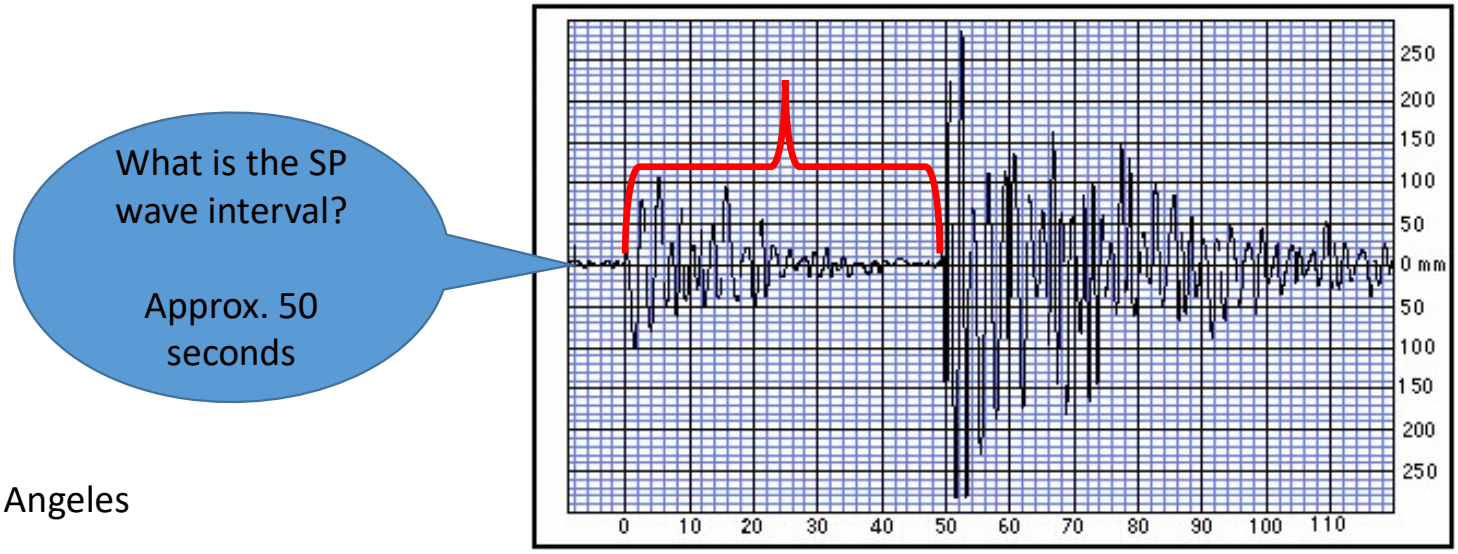
VIDEO INSTRUCTIONS - tutorial

- click here to learn how to locate the epicenter of an earthquake

Determining the SP wave Interval

What is the SP wave interval?

- It is **the amount of time it takes between the arrival of the first P wave and the arrival of the first S wave**.
- It is one piece of information needed in order to determine the epicenter of an earthquake.



Station A: Los Angeles

Converting the SP wave interval into a distance

Station A: 50 seconds

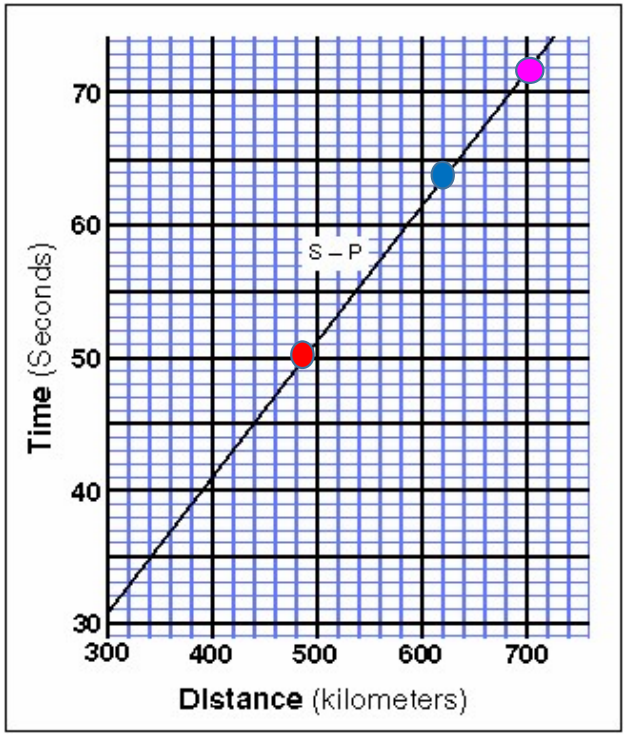
Station B: 72 seconds

Station C: 64 seconds

Distance 1: 480km

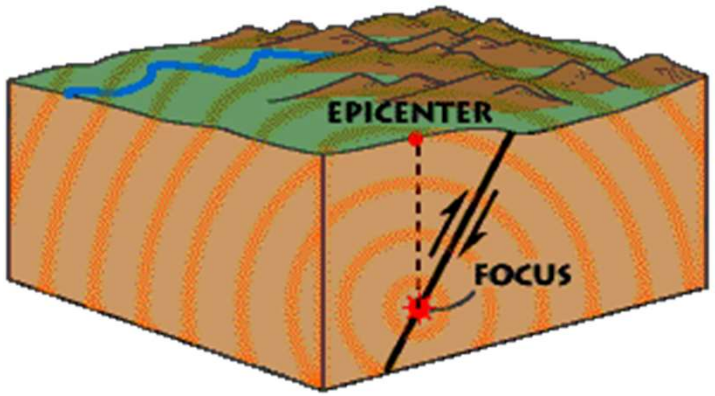
Distance 2: 700km

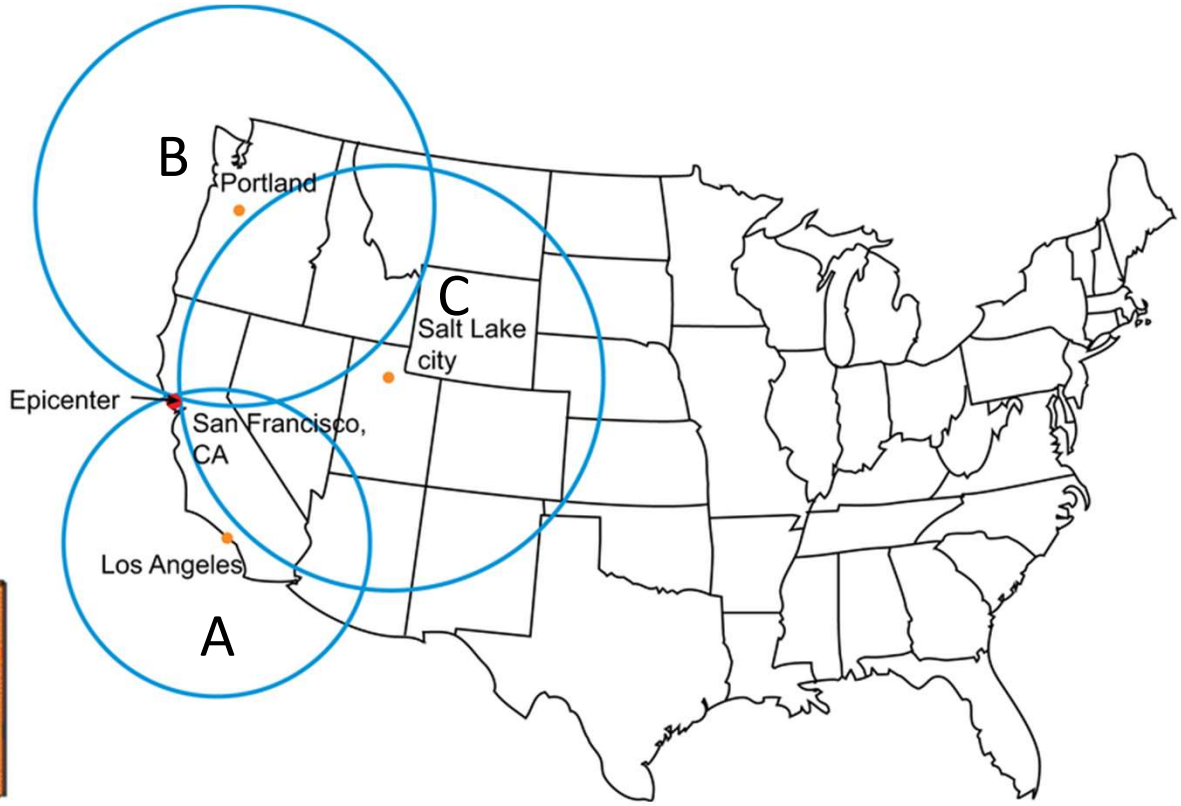
Distance 3: 620km



Using Triangulation to Find the Epicenter

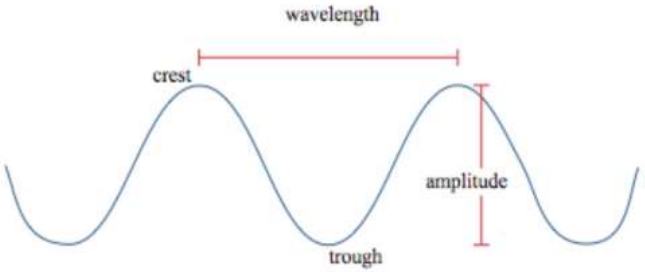
- **Triangulation:** using the intersecting point of three circles to pinpoint a specific location.

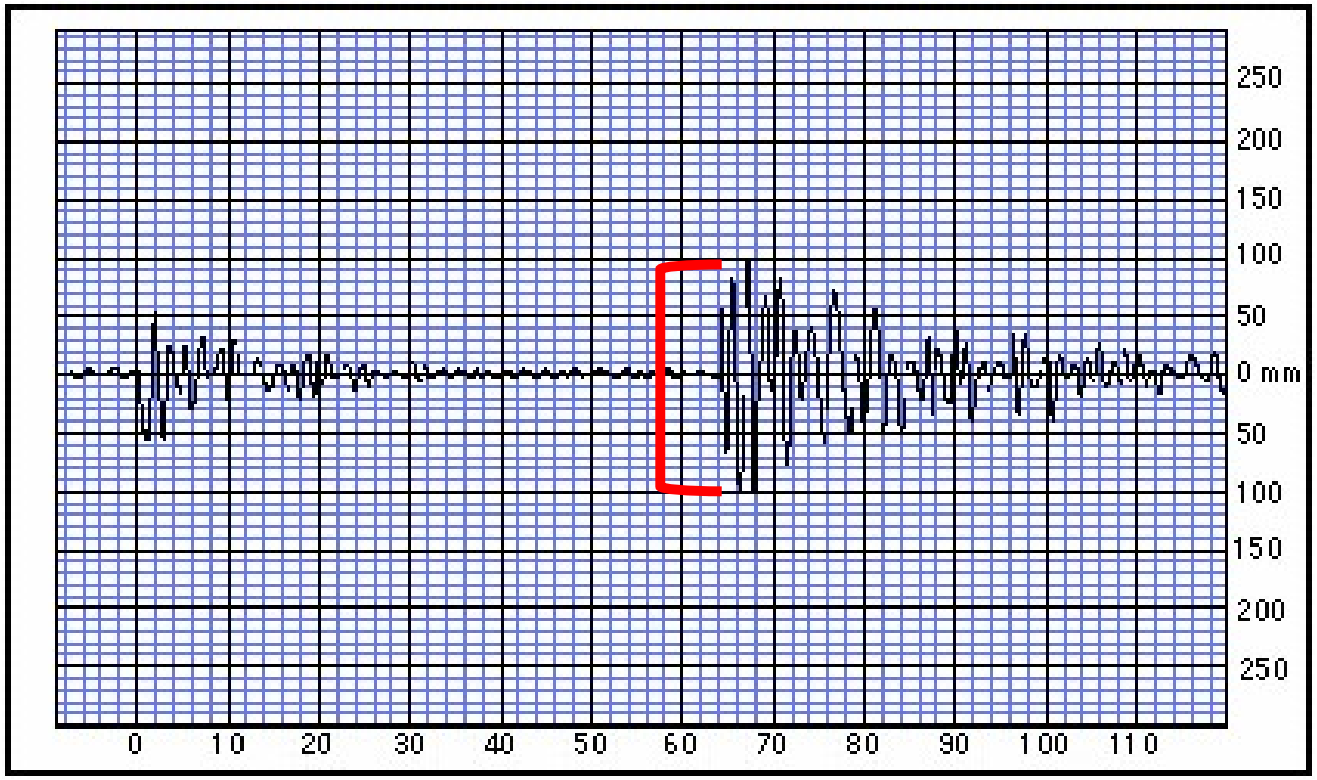




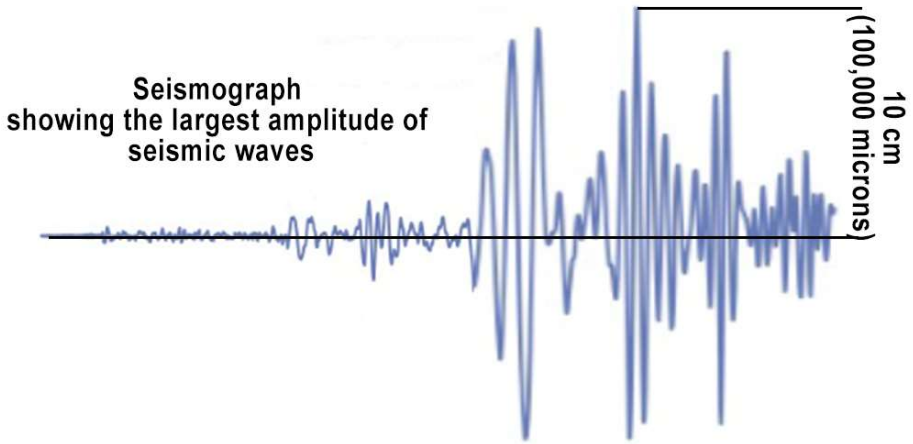
Finding the Amplitude - POWER

- **Amplitude:** the maximum vibration.
- Amplitude = **100mm**
- **Wave height** measures amplitude
- **Wavelength:** Measurement from crest to crest or trough to trough



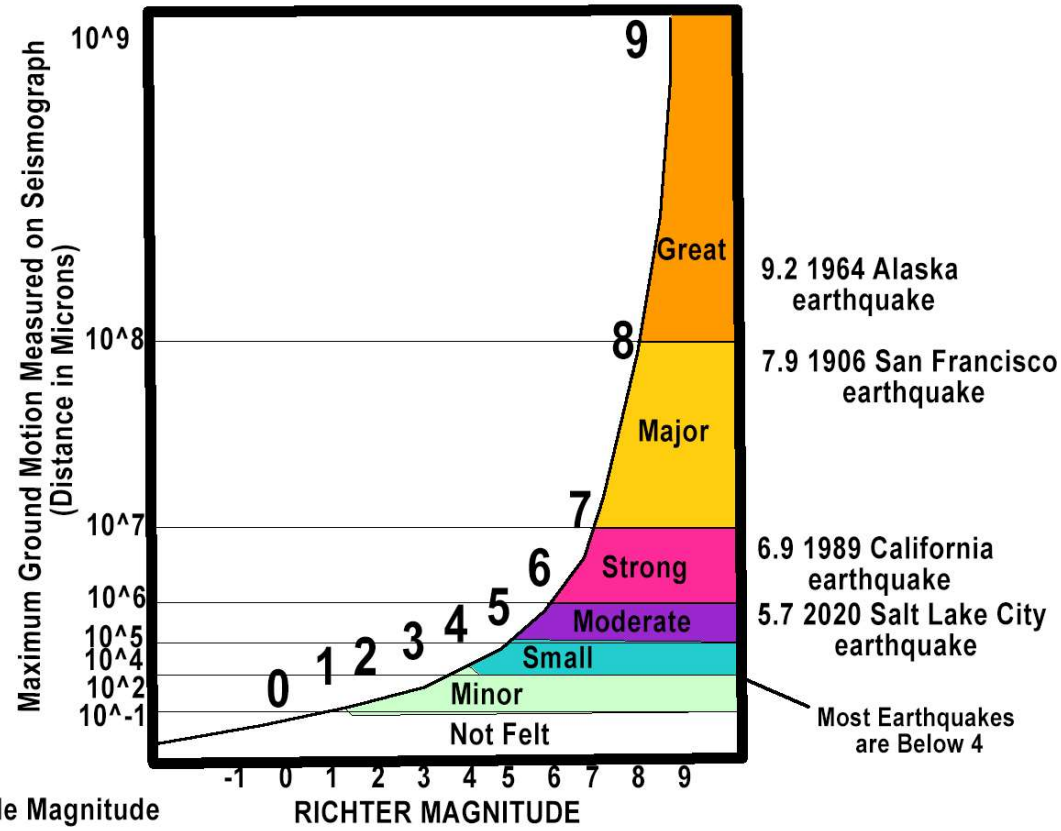


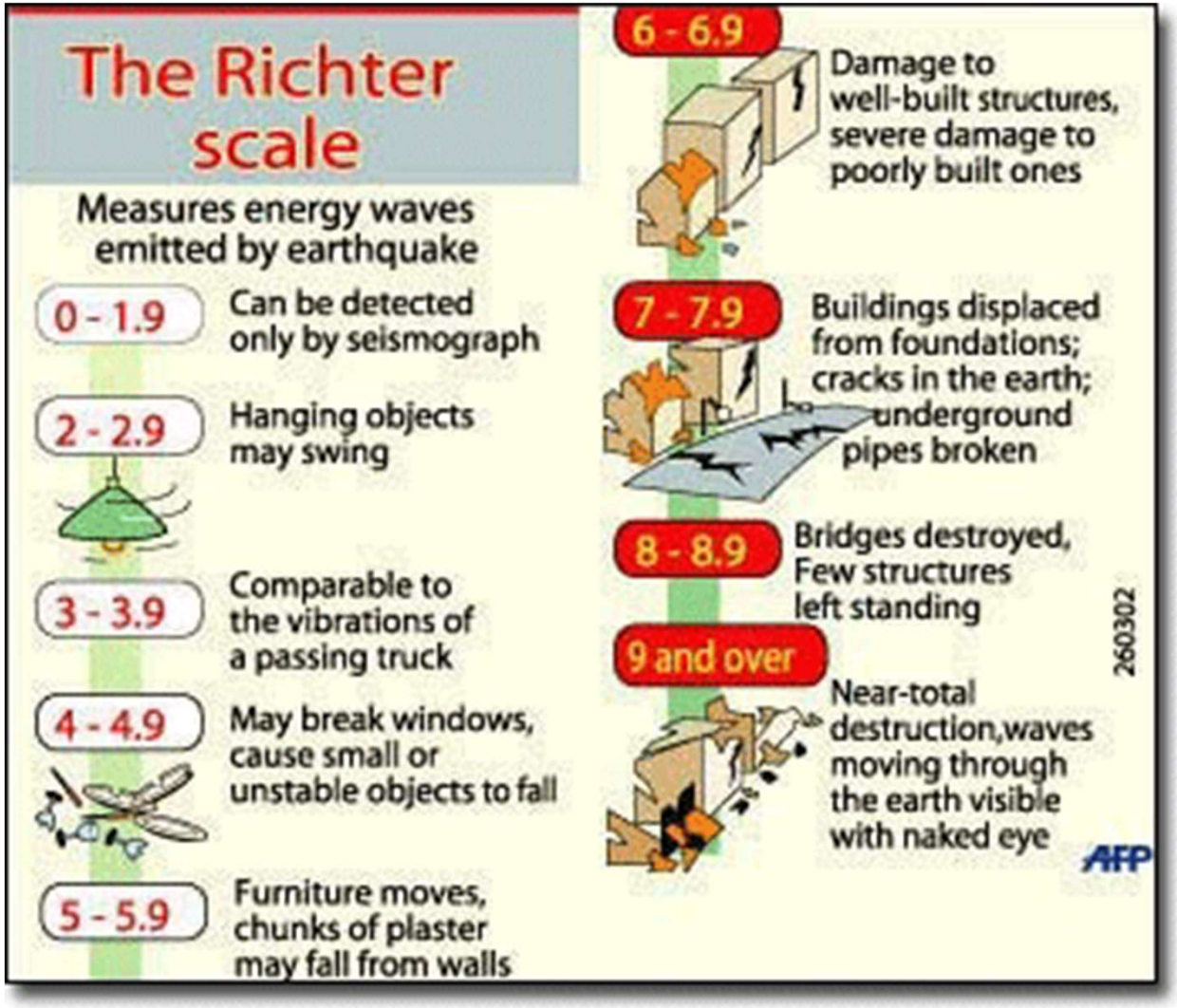
How the Richter Magnitude Scale is determined



log(100,000) = 5

Richter Scale Magnitude




The Richter scale
Measures energy waves emitted by earthquake
0 - 1.9
Can be detected only by seismograph
2 - 2.9
Hanging objects may swing
3 - 3.9
Comparable to the vibrations of a passing truck
4 - 4.9
May break windows, cause small or unstable objects to fall
5 - 5.9
Furniture moves, chunks of plaster may fall from walls
6 - 6.9
Damage to well-built structures, severe damage to poorly built ones
7 - 7.9
Buildings displaced from foundations; cracks in the earth; underground pipes broken
8 - 8.9
Bridges destroyed, Few structures left standing
9 and over
Near-total destruction,waves moving through the earth visible with naked eye
260302
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