

Chapter 5

Lesson 2: Features of Earthquakes

Objectives:

1. Explain how earthquake energy travels in seismic waves
2. Distinguish among primary, secondary, and surface waves
3. Describe the structure of Earth's interior

Rough Outline

- I. Seismic Waves
 - A. Origins of Seismic Waves
 - B. Primary Waves
 - C. Secondary and Surface Waves
- II. Locating an Epicenter
 - A. Measuring Seismic Waves
 - B. Seismograph Stations
- III. Basic Structure of Earth
 - A. Earth's Crust
 - B. Mapping Earth's Internal Structure
 - C. Layer Boundaries

**Do not
copy**

I. Seismic Waves

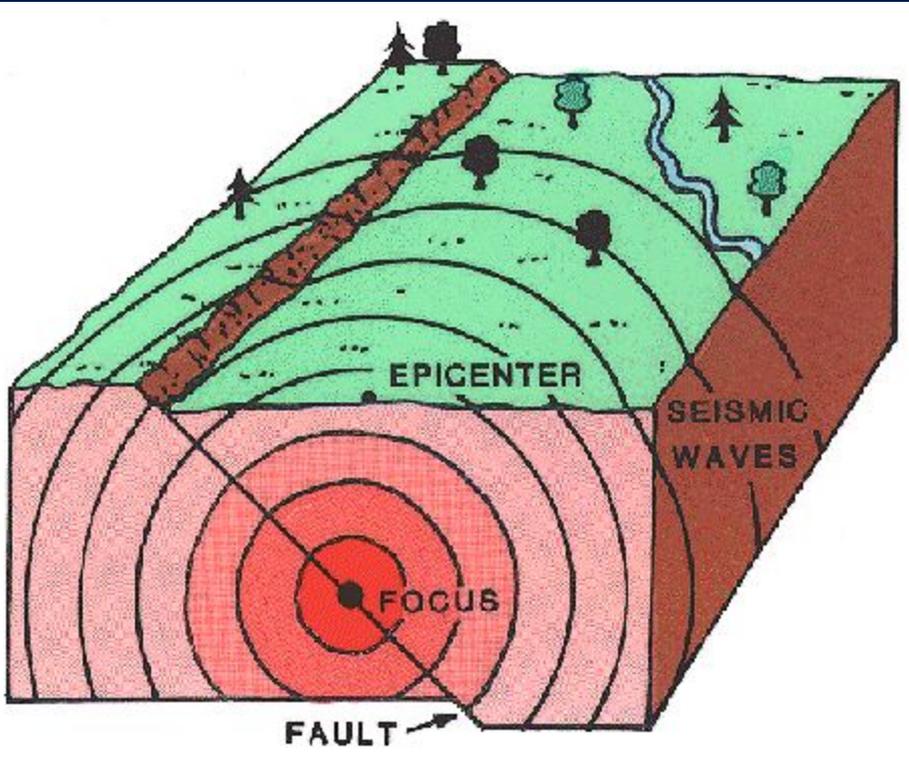
wave generated by an earthquake

A. Origin of Seismic Waves

Focus:

The point where energy is released in an earthquake usually within 65 km of Earth's surface

a few have been recorded as deep as 700 km



3 Types of Seismic Waves!!!

1. Primary (P) Waves

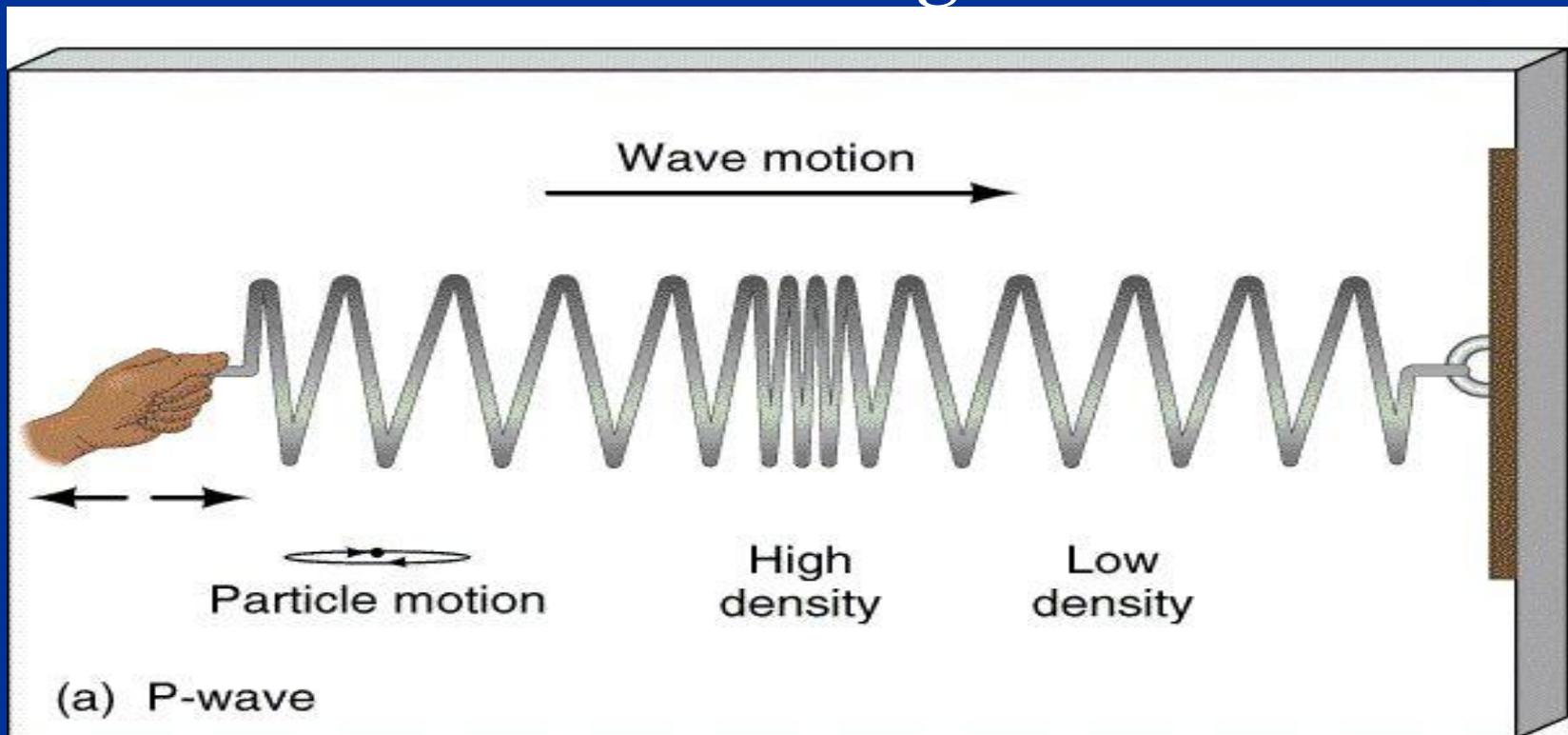
2. Secondary (S) Waves

3. Surface Waves



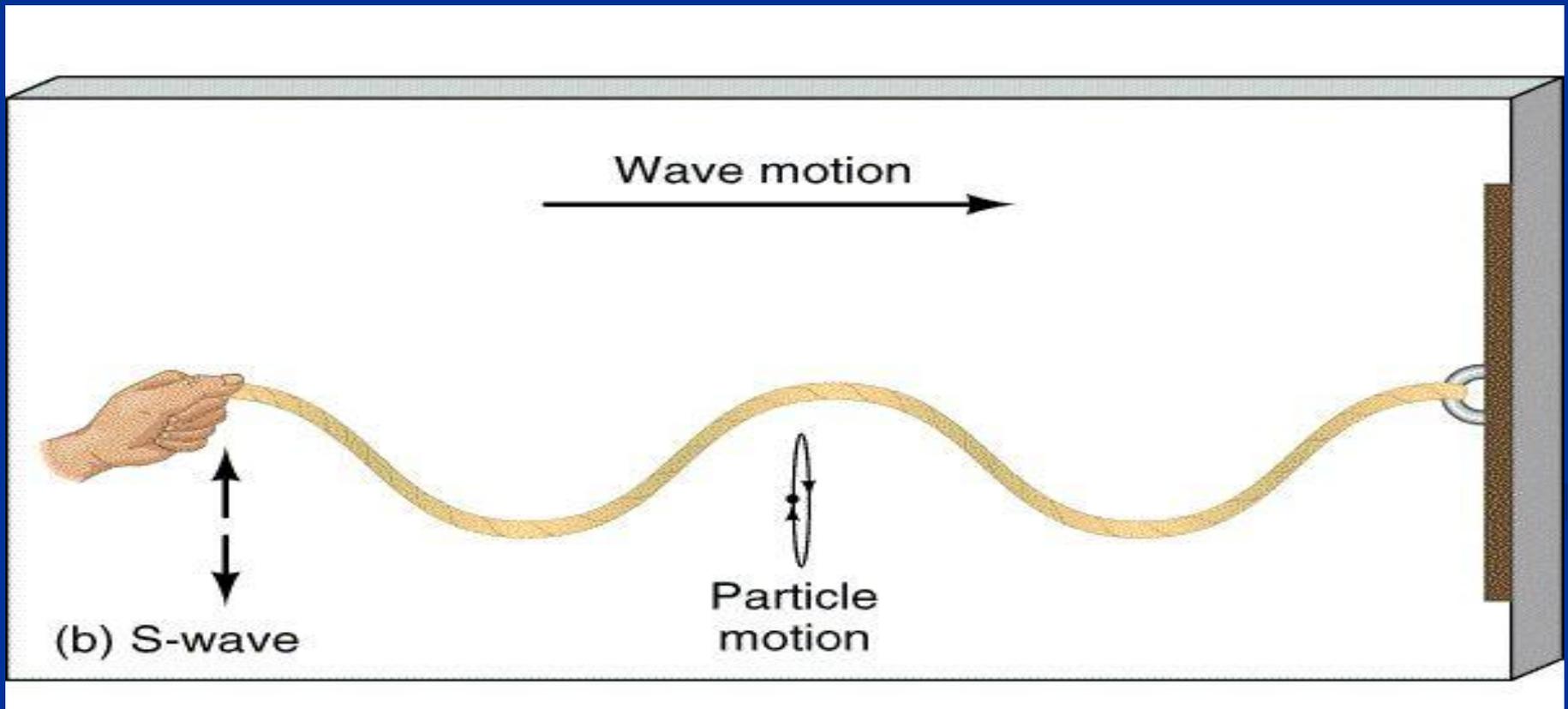
B. Primary Waves (P-Waves)

Travel the fastest and cause particles to move back & forth in the same direction the wave is moving



C. Secondary and Surface Waves

Secondary Waves: (S-Waves) Are slower than primary waves & cause particles to move at right angles to the direction of the waves



S & P WAVES



Surface waves

Form at Earth's surface & cause an elliptical motion with some side to side motion of particles (causes the most damage)

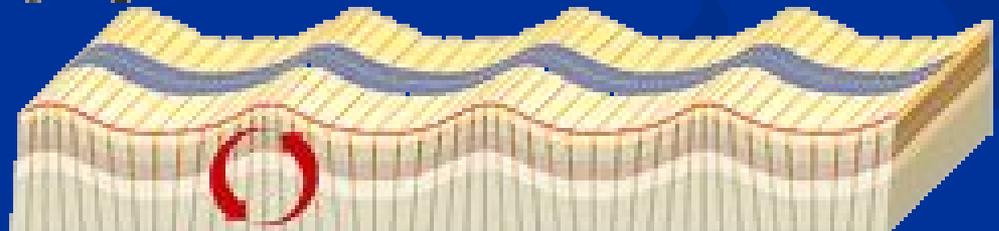
- The fastest surface waves and moves the ground from side-to-side

- Moves the ground up and down, and side-to-side in the same direction that the wave is moving – kind of circular motion. Most of the shaking felt from an earthquake is due to the Rayleigh wave, which can be much larger than the other waves.

Love wave



Rayleigh wave



Primary wave

First one to arrive

Then S-wave

Second, side-to-side

Surface

Is the wave

Primary

It is the

Then S-wave

And it would

Surface

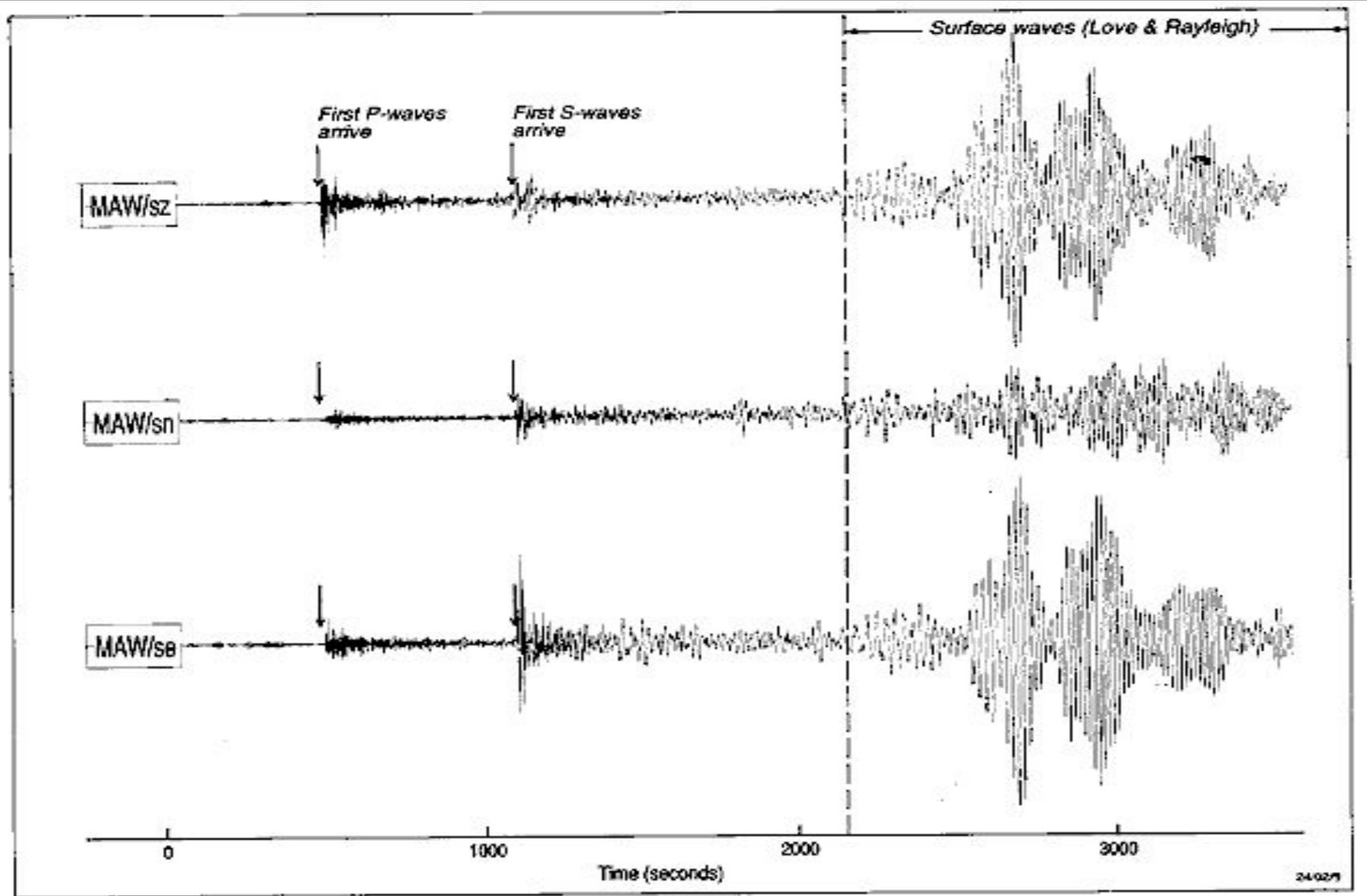
Breaks the

Measuring how the Earth shakes out
Uses Richter scale
Rating the damage and how it's felt.
It's Mercalli



they become





Some Facts About Seismic Waves

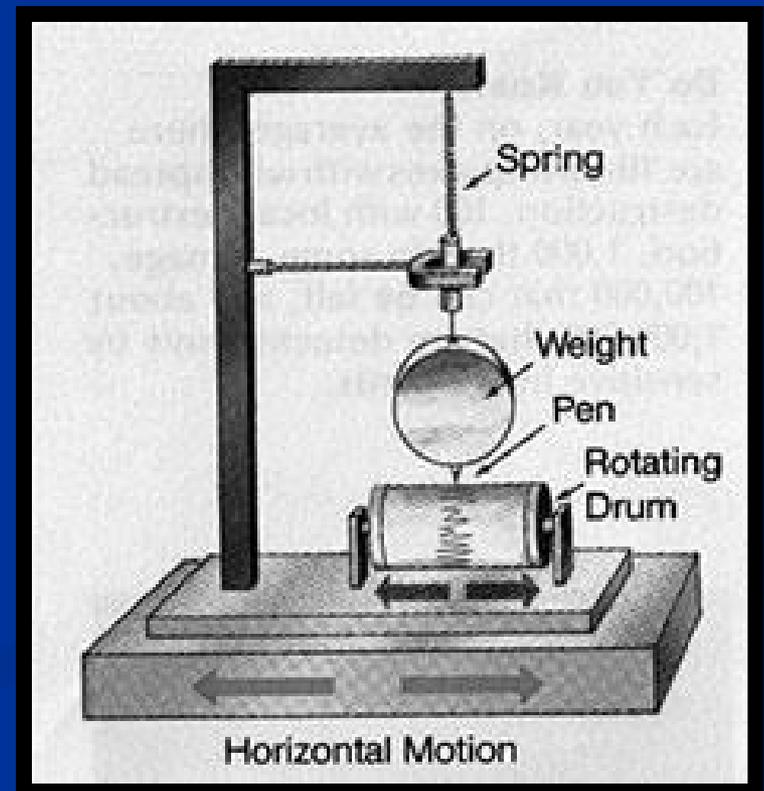
- There's an area on Earth, between 105 and 140 degrees from the focus, where no waves are detected – Known as the Shadow Zone
- Secondary waves are not transmitted through liquid
- Primary waves are slowed and deflected but not stopped by the liquid outer core

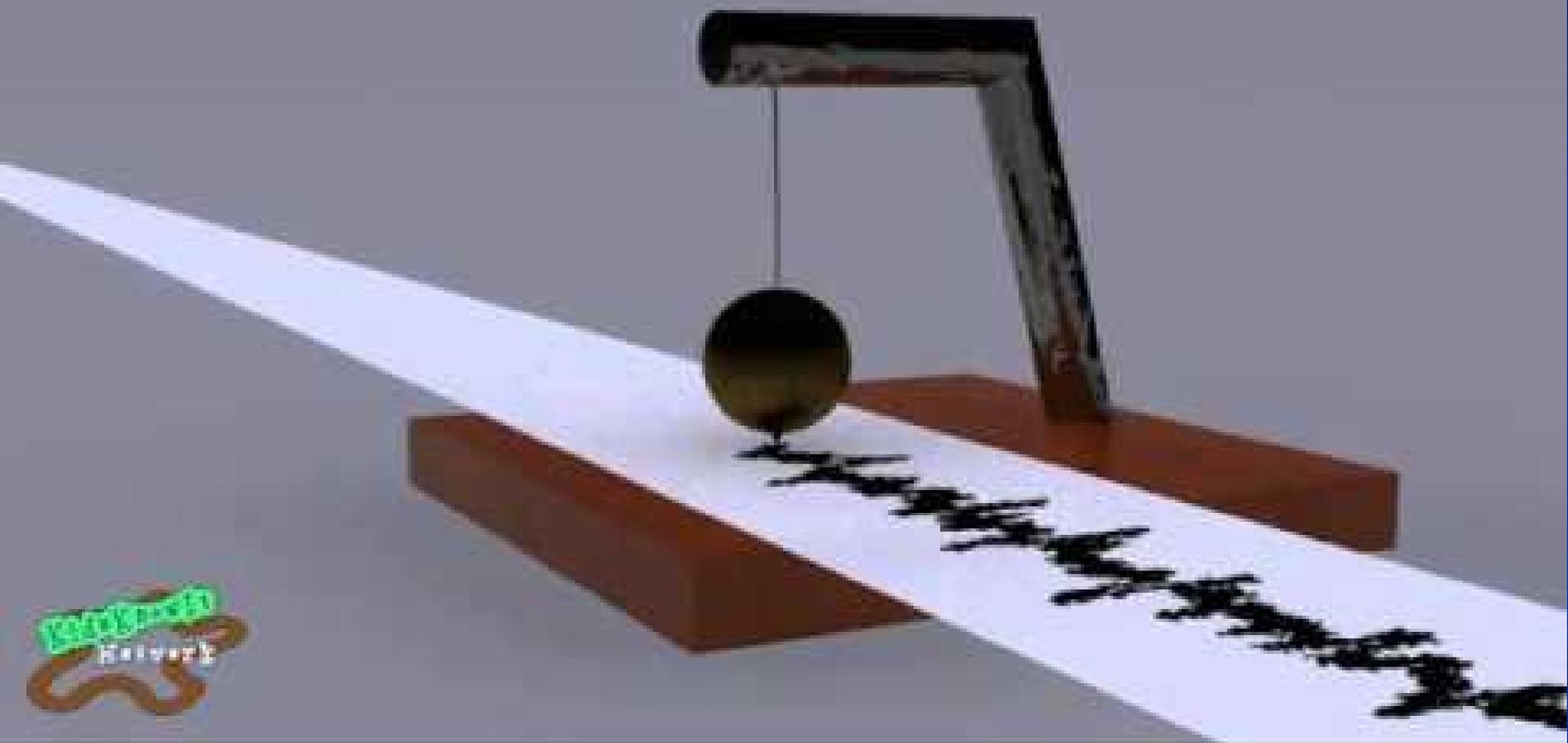
II. Locating an Epicenter

A. Measuring Seismic Waves:

Seismograph: an instrument that measures seismic waves

Seismogram: the paper record of the seismic event

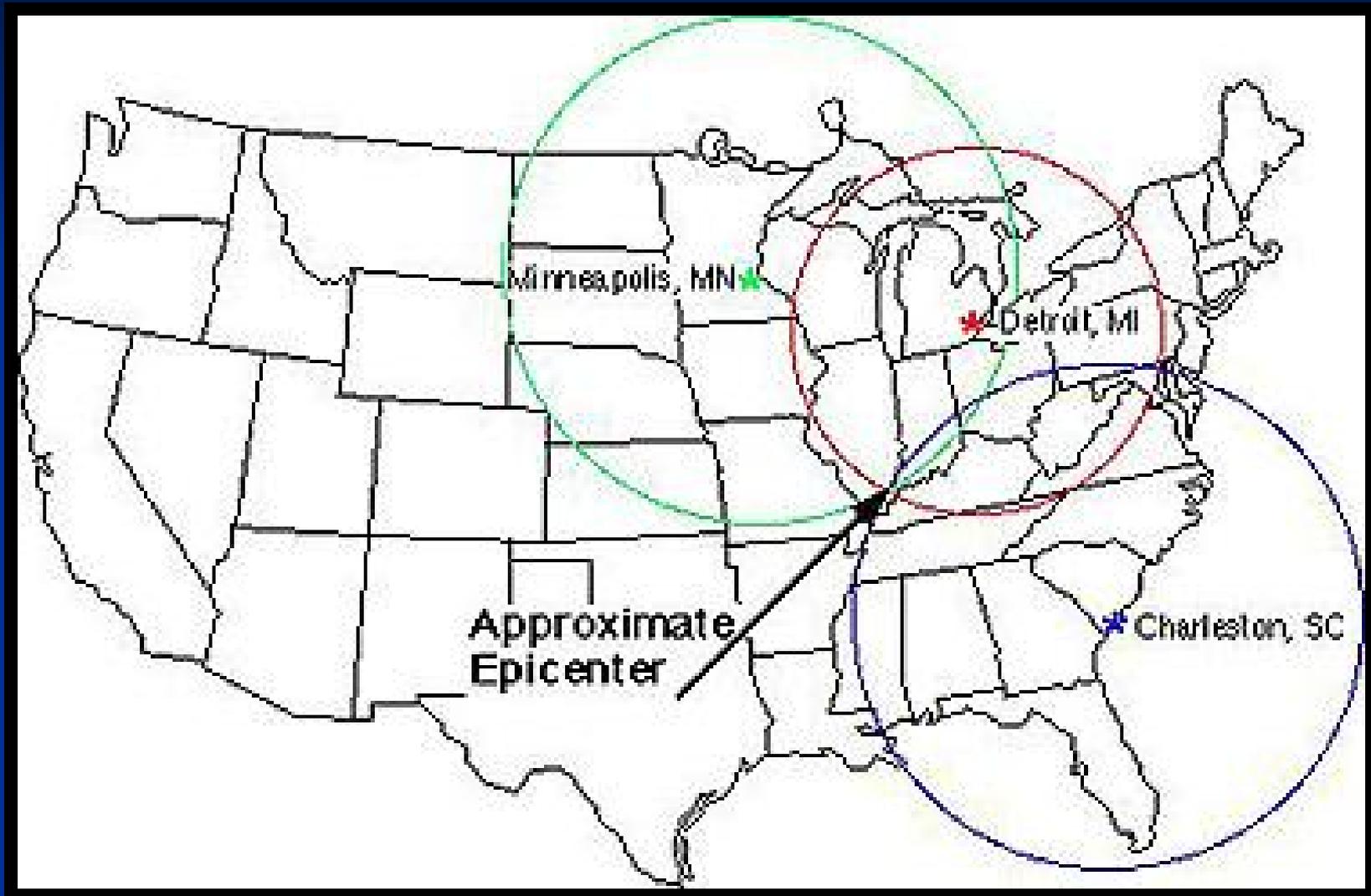




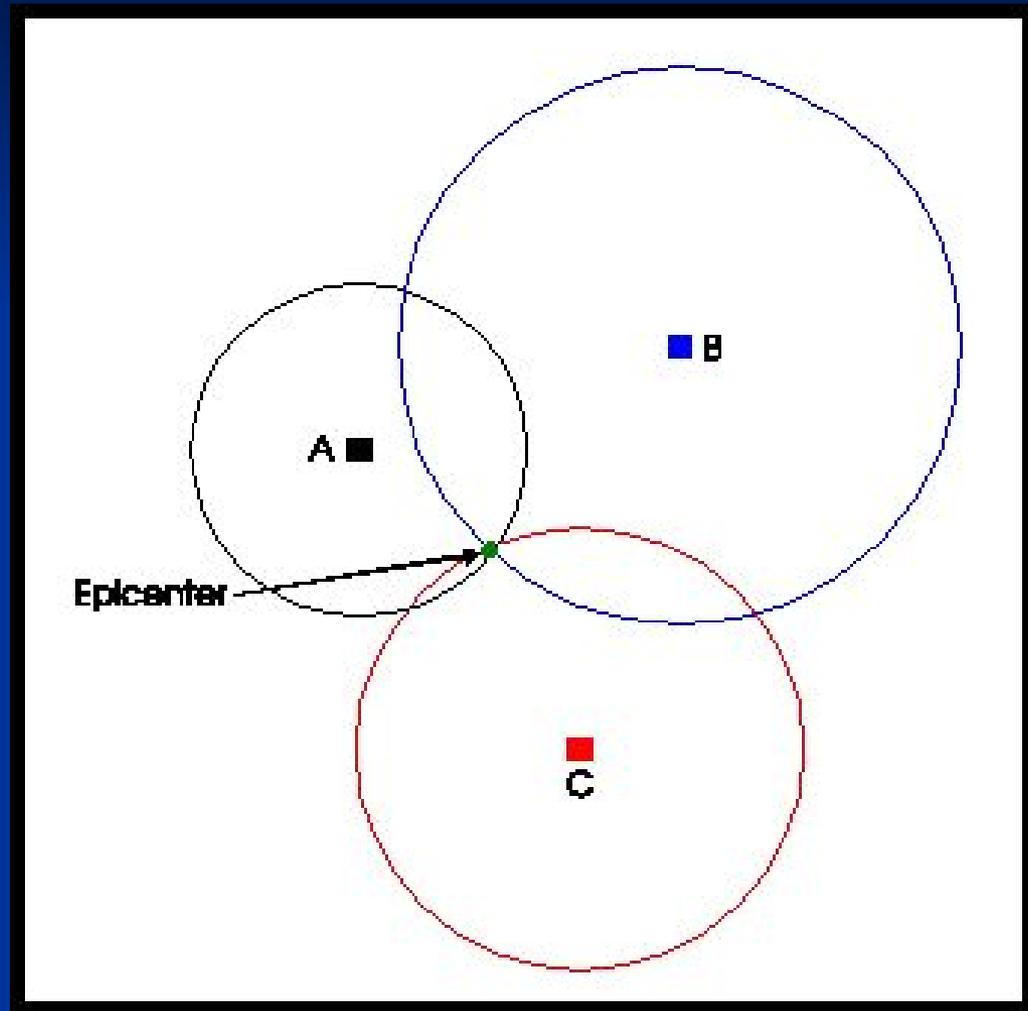
B. Seismograph Stations

- Locate the epicenter
- Each seismic wave reaches a seismograph station at different rates:
 - 1st: Primary Waves
 - 2nd: Secondary Waves
 - 3rd: Surface Waves
- Need 3 stations to locate the epicenter
- Epicenter is located at the intersection
- Radius = distance to epicenter

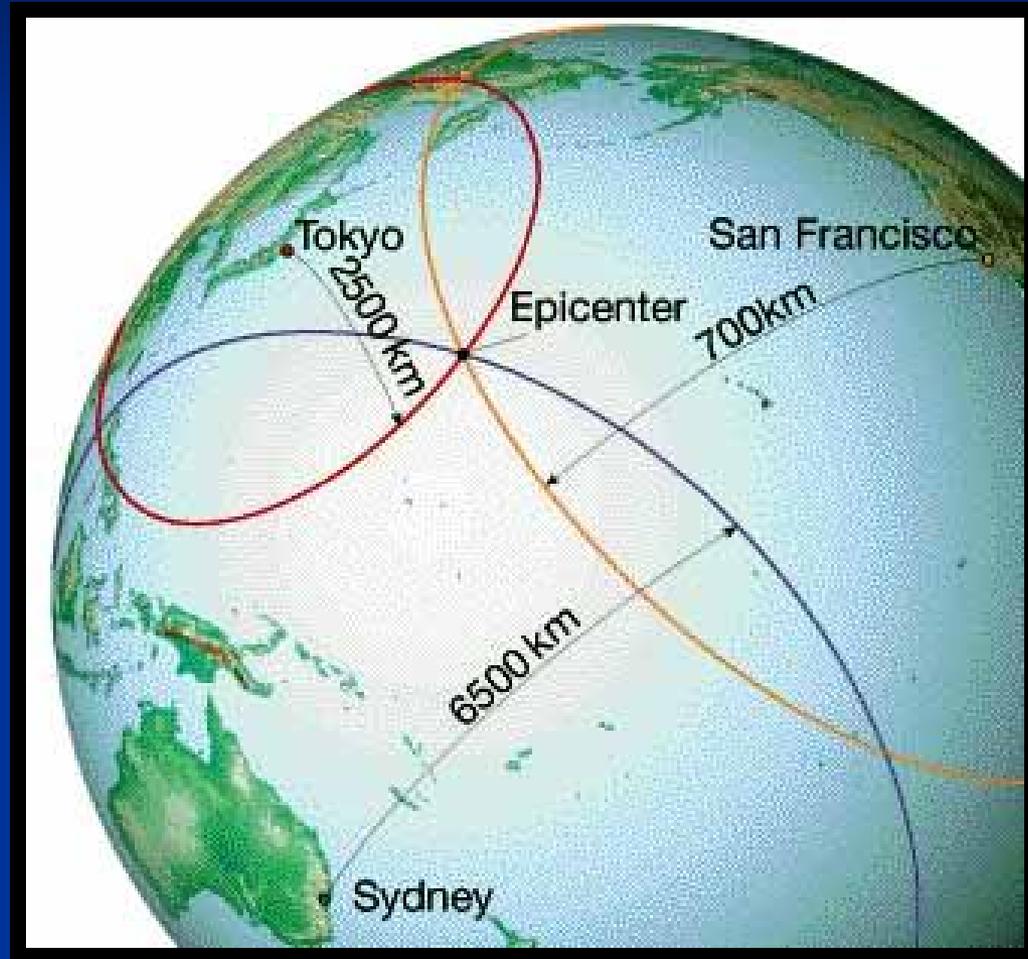
Need 3 Stations to Locate Epicenter



Epicenter is located at the intersection



Radius = distance to the epicenter



CAN WE PREDICT EARTHQUAKES?

Sci Show

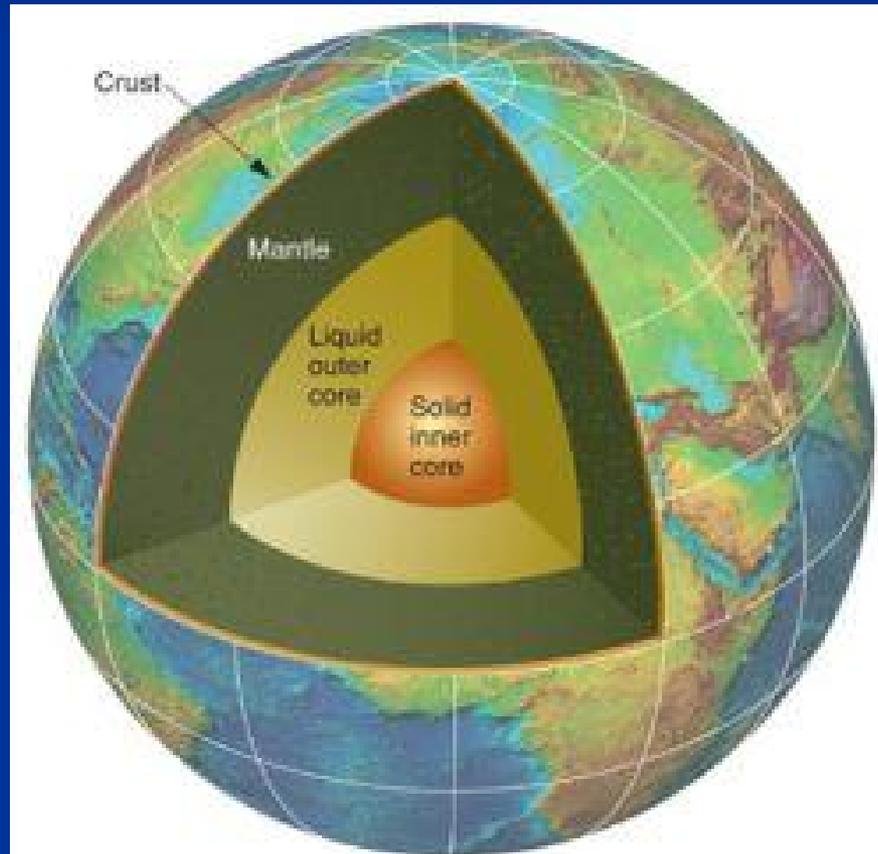
**CASCADIAN
REGION**

A map of the Cascadian region, including parts of British Columbia, Canada, and the Pacific Northwest of the United States. The map is colored in shades of green and yellow. A black line represents the Cascadia Subduction Zone, running from the coast of British Columbia down to the coast of Washington state. Several red triangles are scattered along this zone, indicating the locations of earthquakes. The text 'CAN WE PREDICT EARTHQUAKES?' is overlaid on the left side of the map, and 'CASCADIAN REGION' is in a white box at the bottom right. The 'Sci Show' logo is in the bottom left corner.

III. Basic Structure of Earth

A. Earth's Crust

Crust + upper mantle = lithosphere

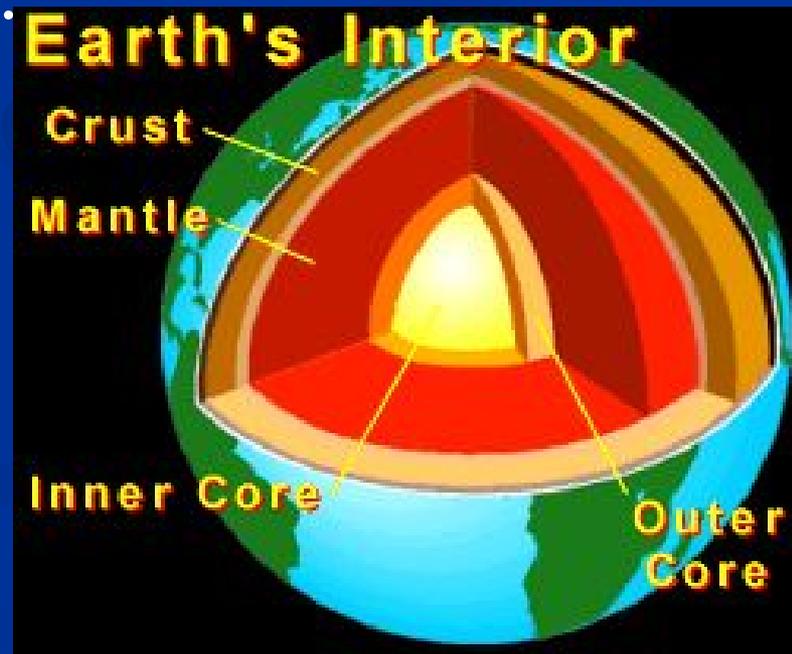


B. Mapping Earth's Internal Structure

Shadow Zone: The area in the Earth between 105-140 degrees from the earthquake focus that does not detect waves.

Secondary Waves: Do not travel through liquid

Primary Waves: are slowed and bent but not stopped by the liquid outer core. Speed up as they move through the solid inner core.



C. Layer Boundaries

Mohorovicic Discontinuity: (MOHO)

Boundary between the crust and the mantle

1909 - Earthquake
Uniform

+ Andrija Mohorovičić



MOHO SEISMIC DISCONTINUITY



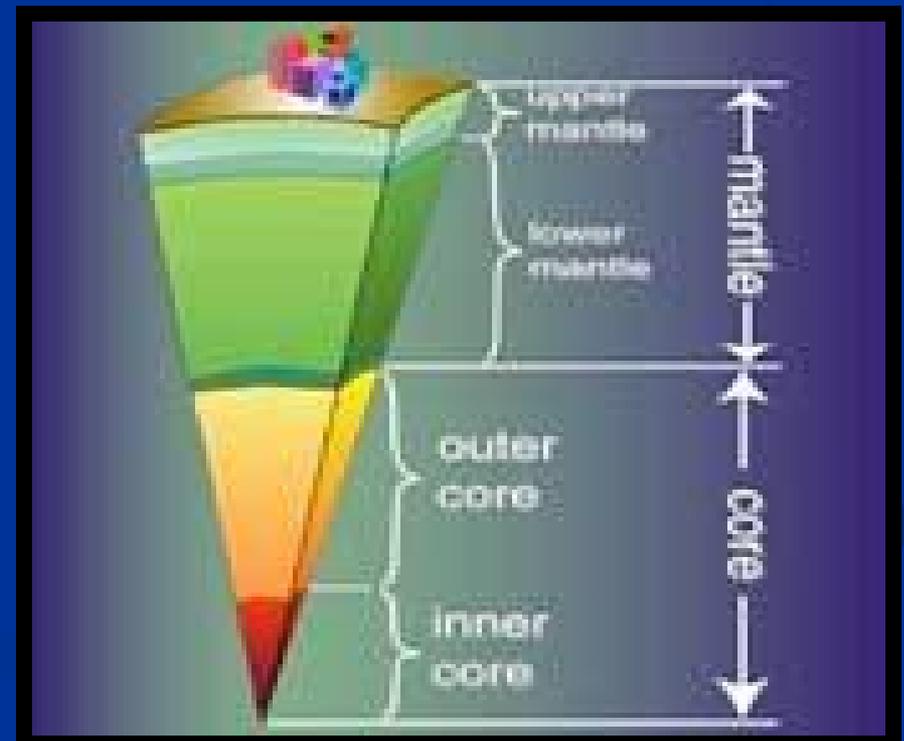
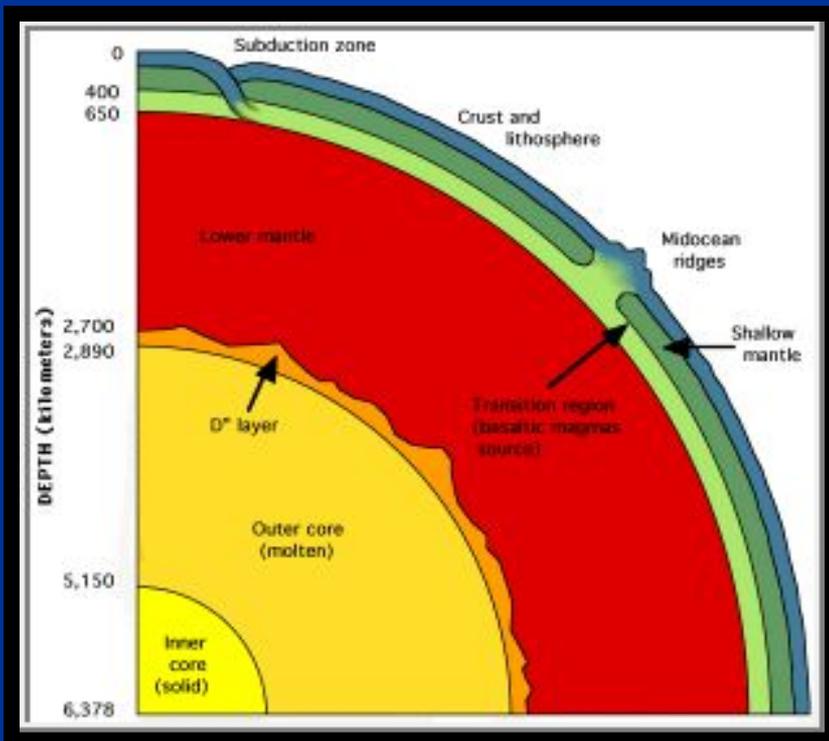
Inner core – iron & nickel (solid)

Outer core – iron & nickel (liquid)

Mantle – largest layer made up of silicon, oxygen, magnesium, & iron

Crust – separated by Moho Discontinuity

*****Seismic waves speed up & slow down due to density*****





STRUCTURE OF THE EARTH



THE DEEPEST HOLE IN THE WORLD



Sci Show







*Vista desde
Satélite*

The Kola Super deep Borehole and other such projects were inspired (and thus predicted by) Jules Verne's best known novel: Journey to the Center of the Earth (1864)"



Chapter 5 lesson 3

Destruction by...



Earthquakes

Measuring Earthquakes



www.sciencecourseware.com/eec/Earthquake/

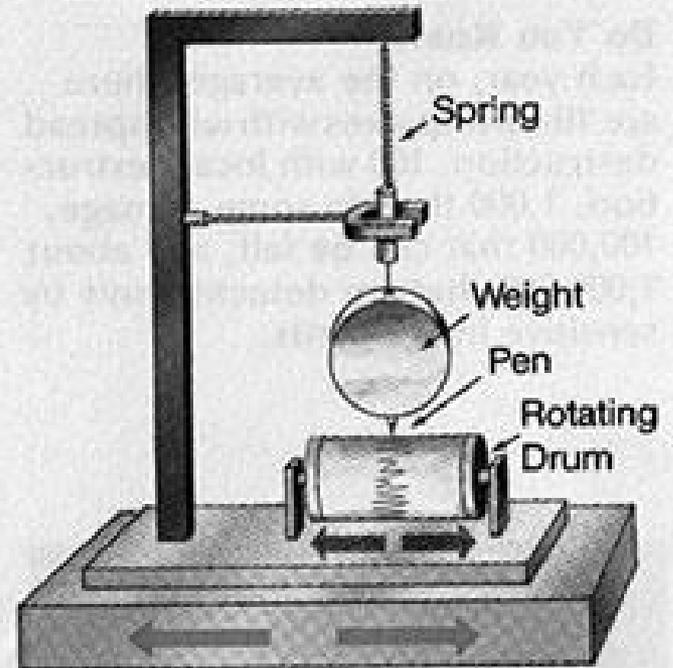
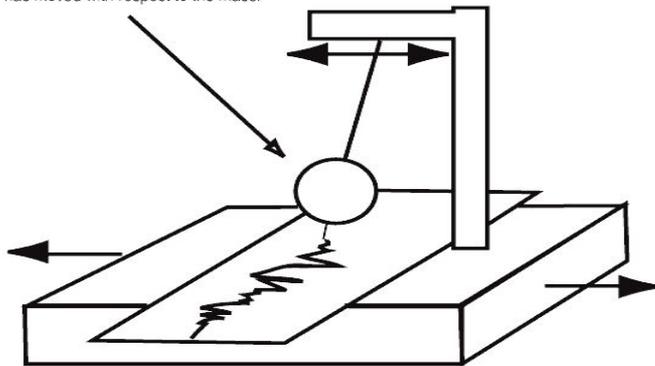
Seismographs - are used to measure P-waves, S-waves, & surface waves



Seismometer

The whole seismometer moves as the earth it is attached to shakes, but the heavy mass does not move because of its inertia.

The recording device measures how far the rest of the seismometer has moved with respect to the mass.



Horizontal Motion

Magnitude

**Richter scale
measures the strength
of the break; describes
how much energy is
released by the
earthquake; an
increase of 1.0 has 32x
as much energy**



© Copyright California Institute of Technology. All rights reserved.
Commercial use or modification of this material is prohibited.

Richter Scale – 1.0 to 8.9

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

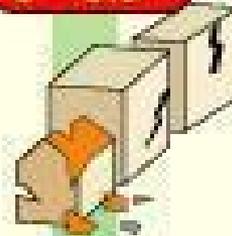
Comparable to the vibrations of a passing truck



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

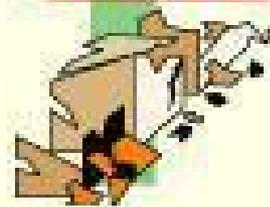


Buildings displaced from foundations; cracks in the earth; underground pipes broken

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

AFP

Tsunamis - a seismic sea wave that
can reach 30m high



Tsunami of 2005



Tsunami of 2005



Earthquake Safety



Quake-Proofing Your Home

- Study the history of a region
- Take heavy objects down from high shelves and place them on the bottom shelves
- To reduce chance of fire from broken gas lines, make sure hot water heaters & gas appliances are held securely in place
- During an earthquake, keep away from windows & sharp edges

Living on a Fault

Seismic-Safe Structures:

- Resist vibrations
- Very expensive

