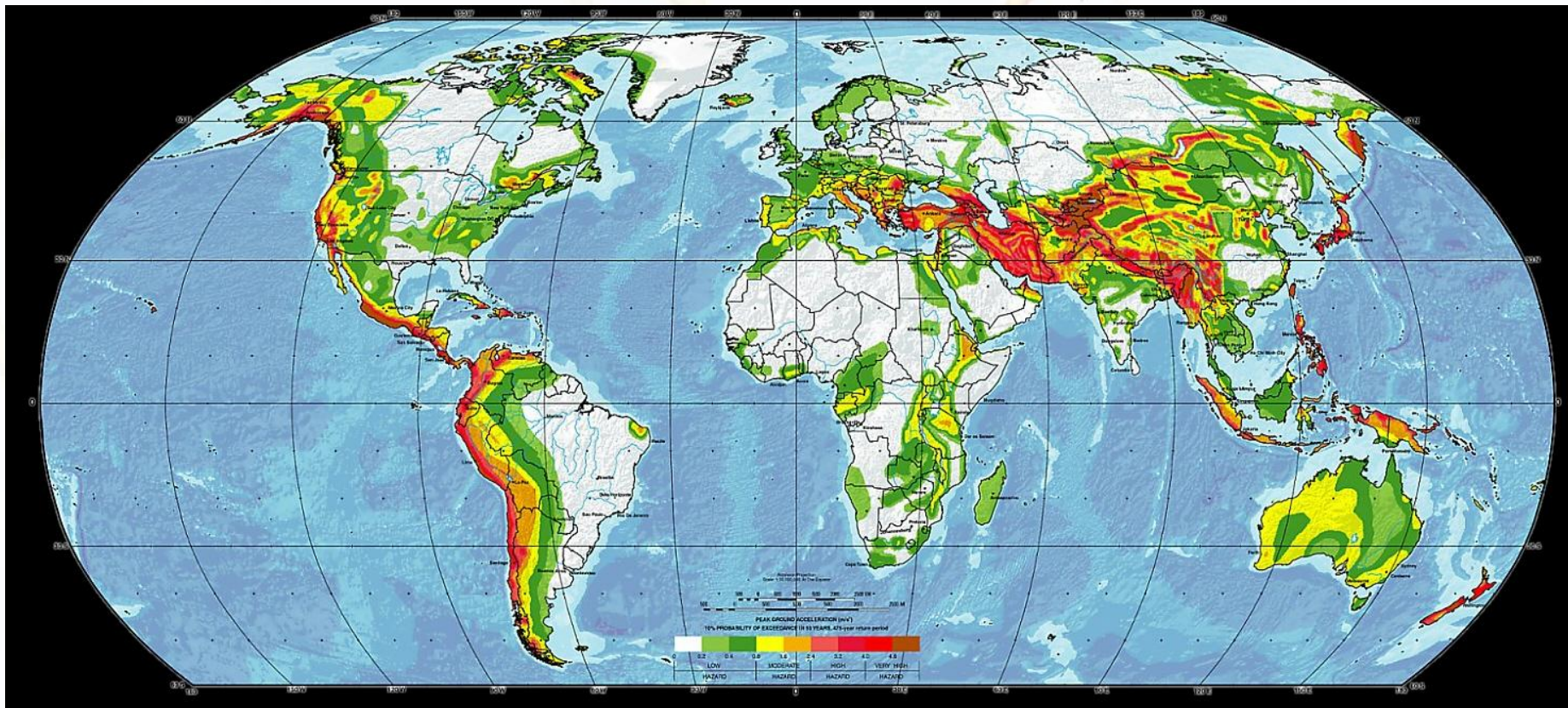


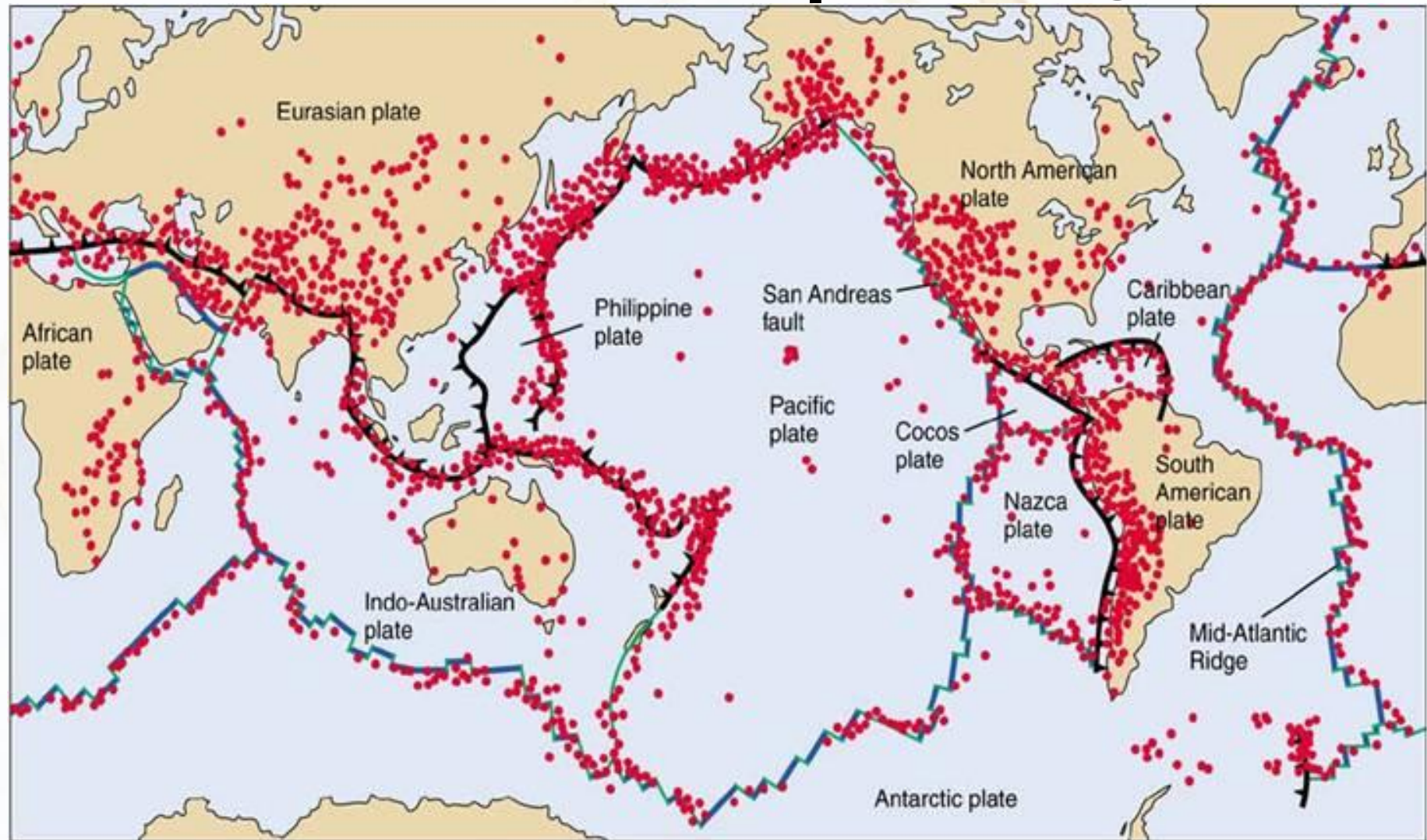
Earthquakes




What are Earthquakes?

- Ground shaking caused by the sudden release of energy in earth's crust.
- Associated with plate boundaries and active faults
- Continuing adjustment of position results in aftershocks

Where Do Earthquakes Occur?




Convergent
boundary


Divergent
boundary

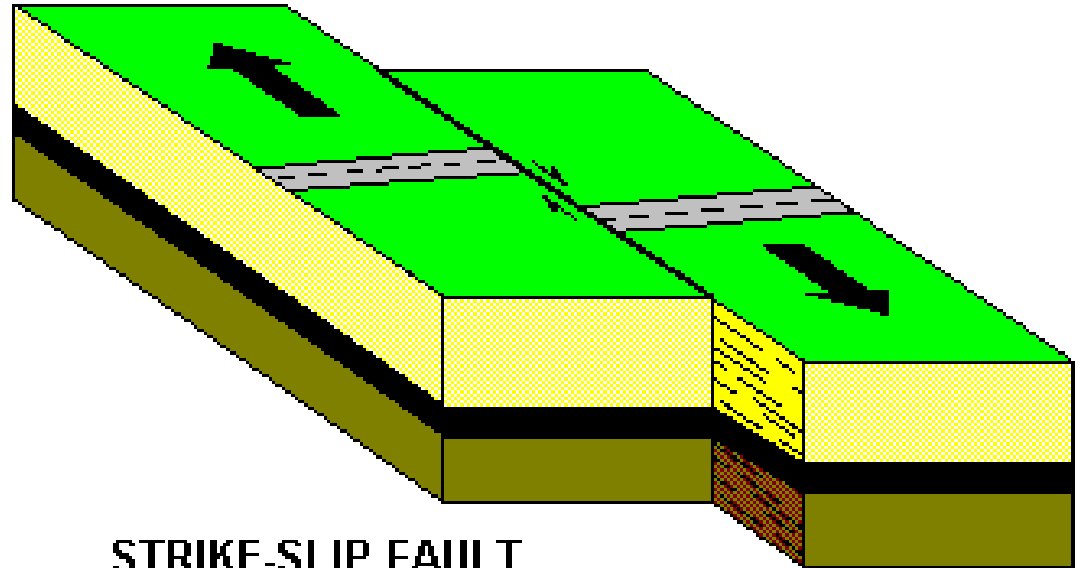

Transform
boundary

3 types Faults

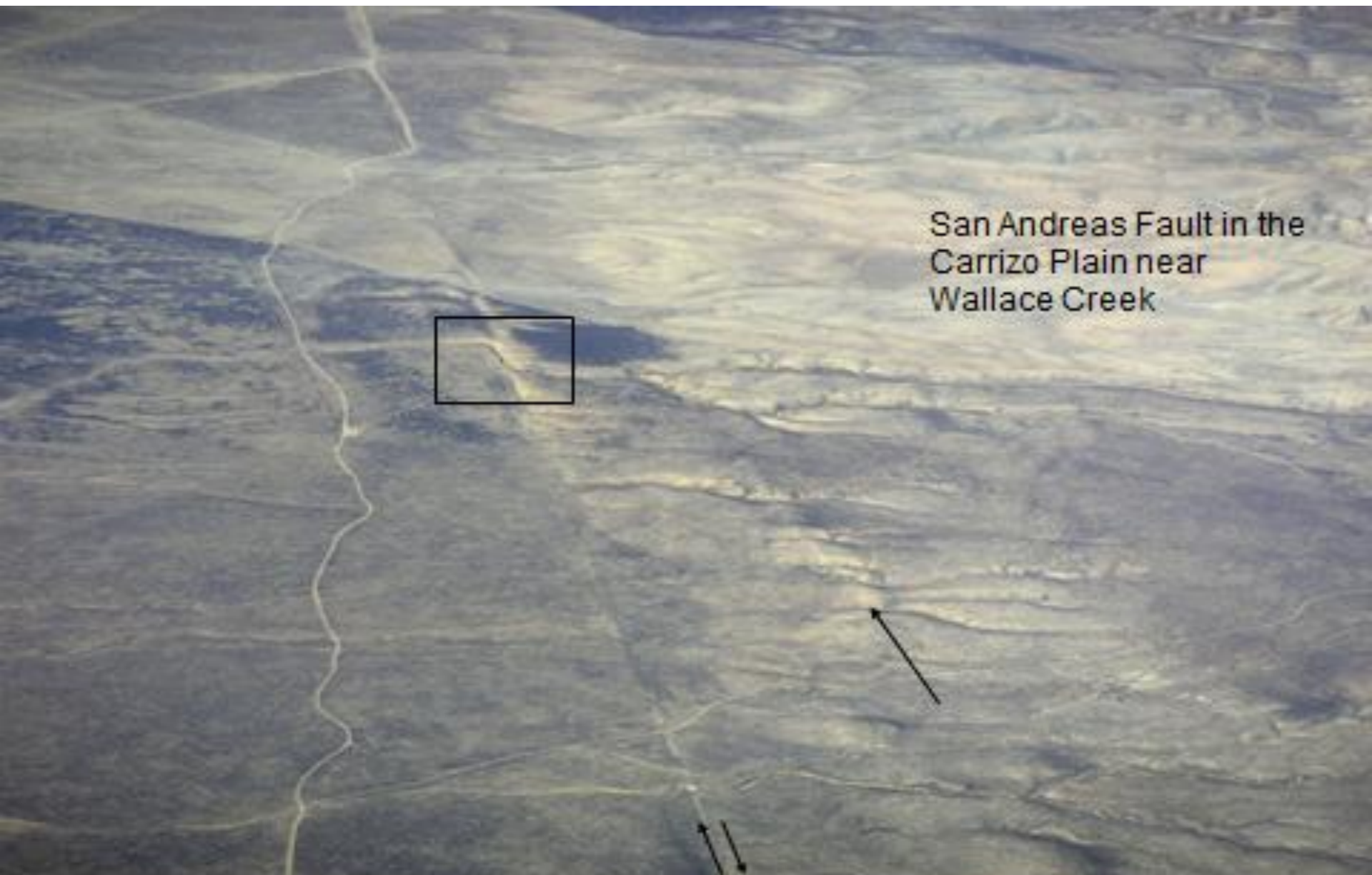
- **Transform - strike-slip**
- **Convergent - reverse**
- **Divergent - normal**

Strike-Slip

- Medium earthquakes
- Shallow



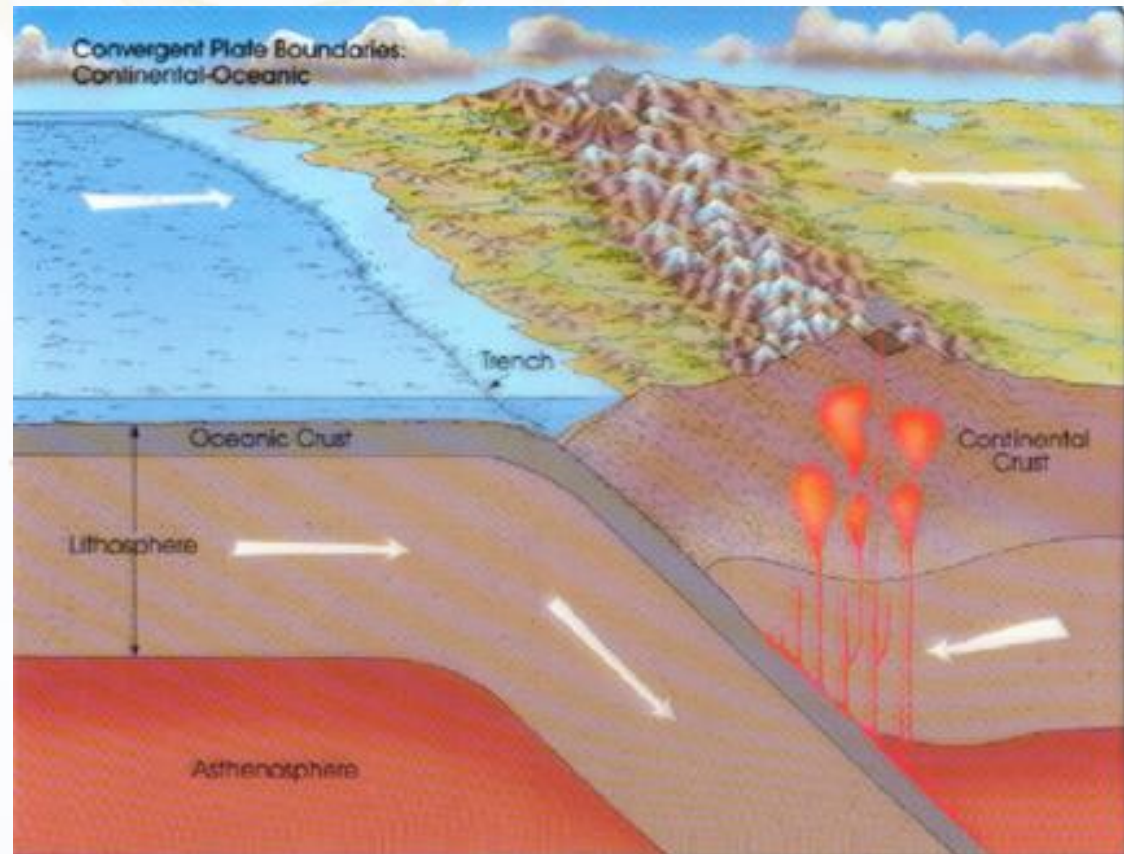
Strike-Slip



San Andreas Fault in the
Carrizo Plain near
Wallace Creek

Reverse

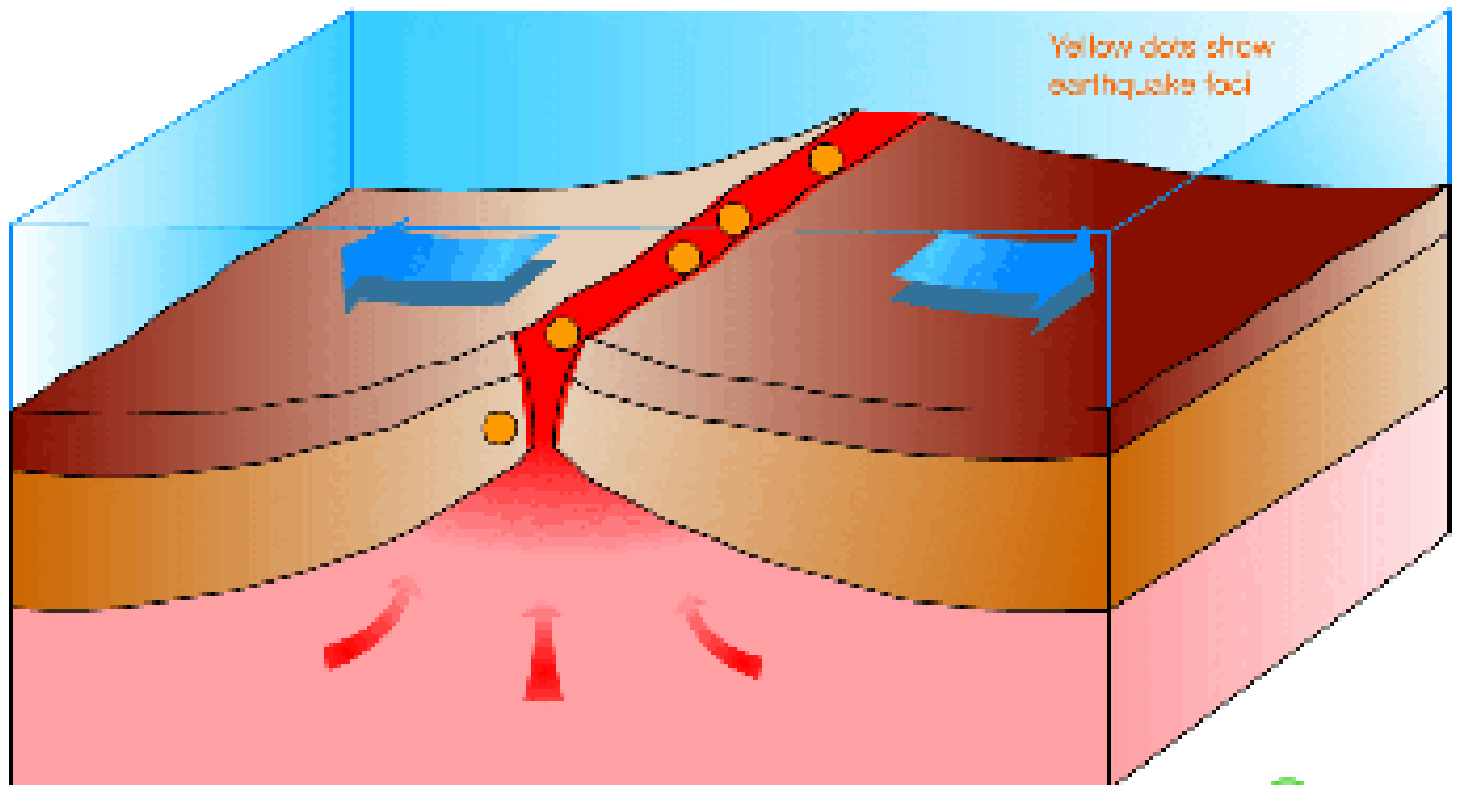
- Strongest quakes
- Cause tsunamis
- Deep

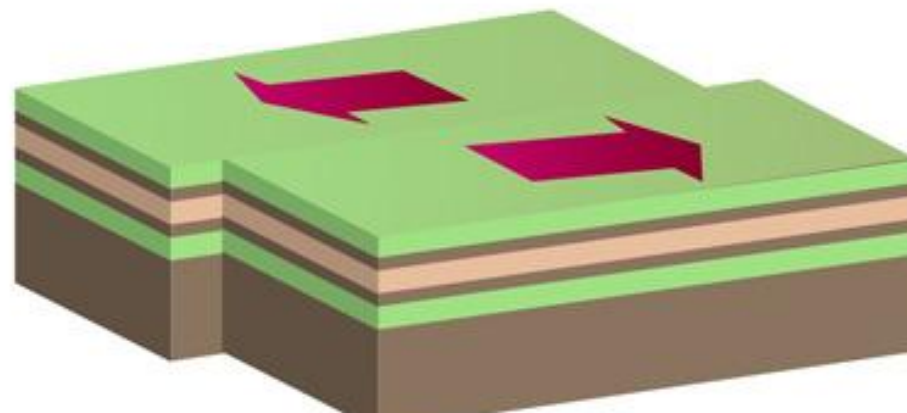
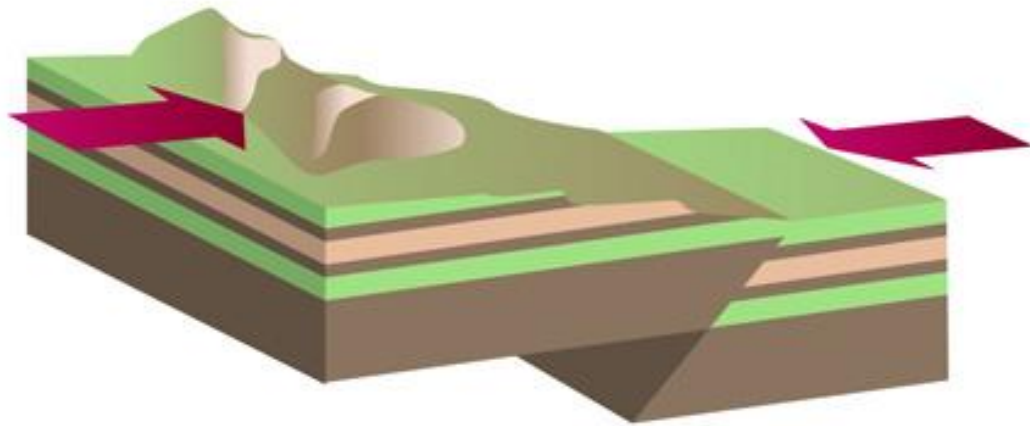
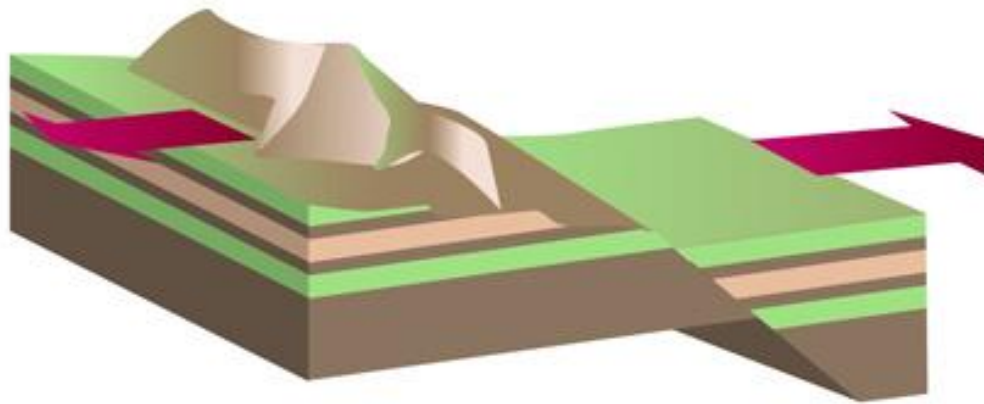


Normal

- Small quakes
- Shallow

Seafloor spreading at a divergent margin





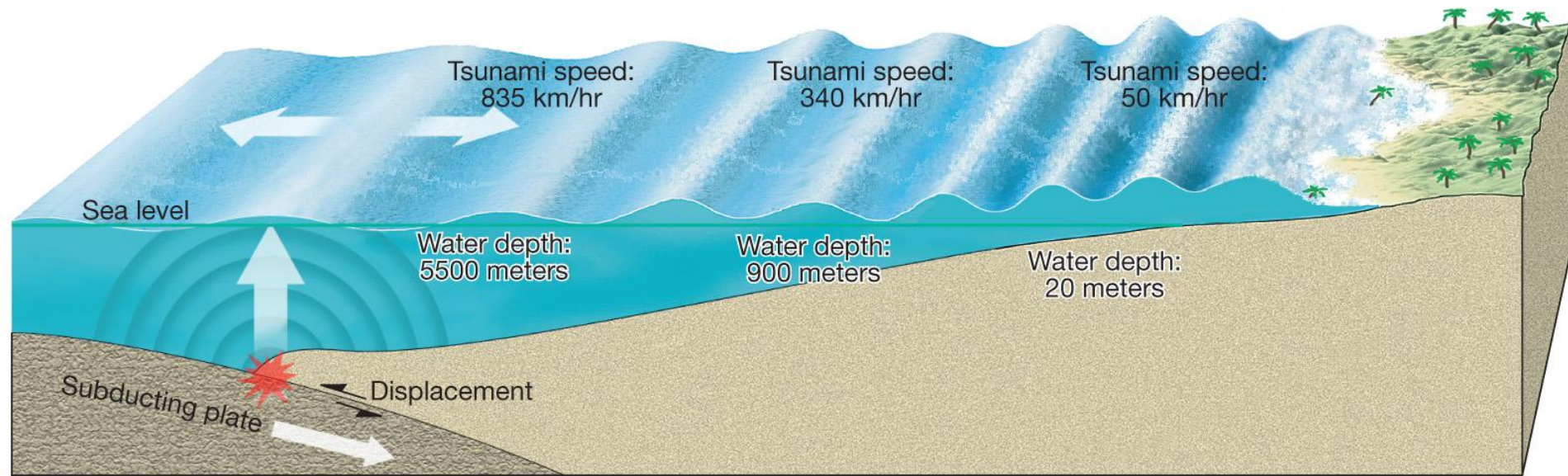
Effects of Earthquakes?



Tsunami of 2004

- Indonesia, Sri Lanka, India, and Thailand were the hardest hit.
- Magnitude of 9.1 or 9.3 (second largest earthquake in recorded history)
- Killed nearly 230,000 people in eleven countries
- Triggered other earthquakes as far away as Alaska

Figure 11.20



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A.



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B.



What are the waves?

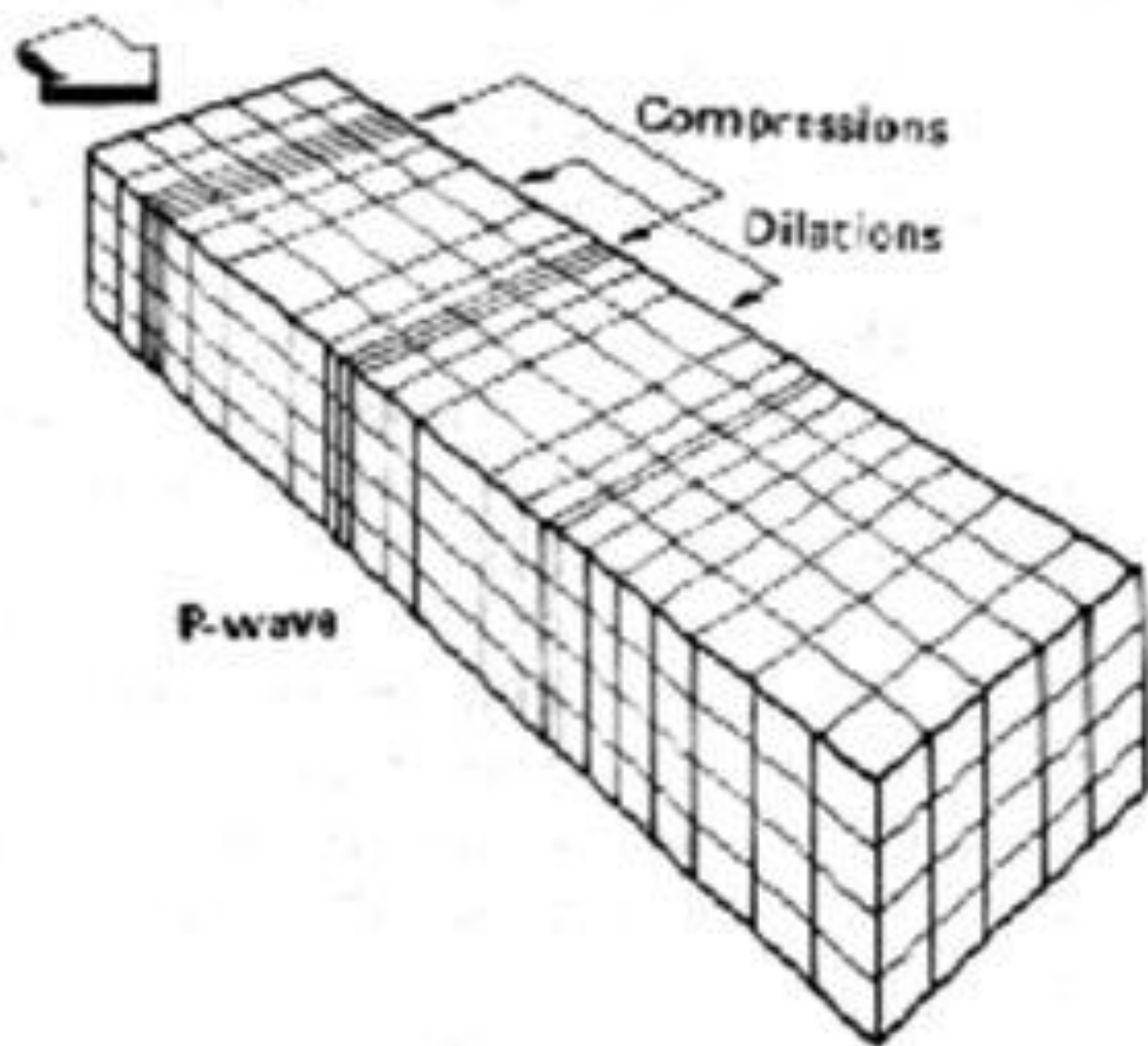
- ◉ Waves are started because of initial tension or compression in the rock
- ◉ Path of waves are curved because different rock types at different depths change speed at which waves travel
- ◉ There are three different types of waves involved with Earthquakes

Three different types of waves

- **P-waves**
- **S-waves**
- **Surface waves**

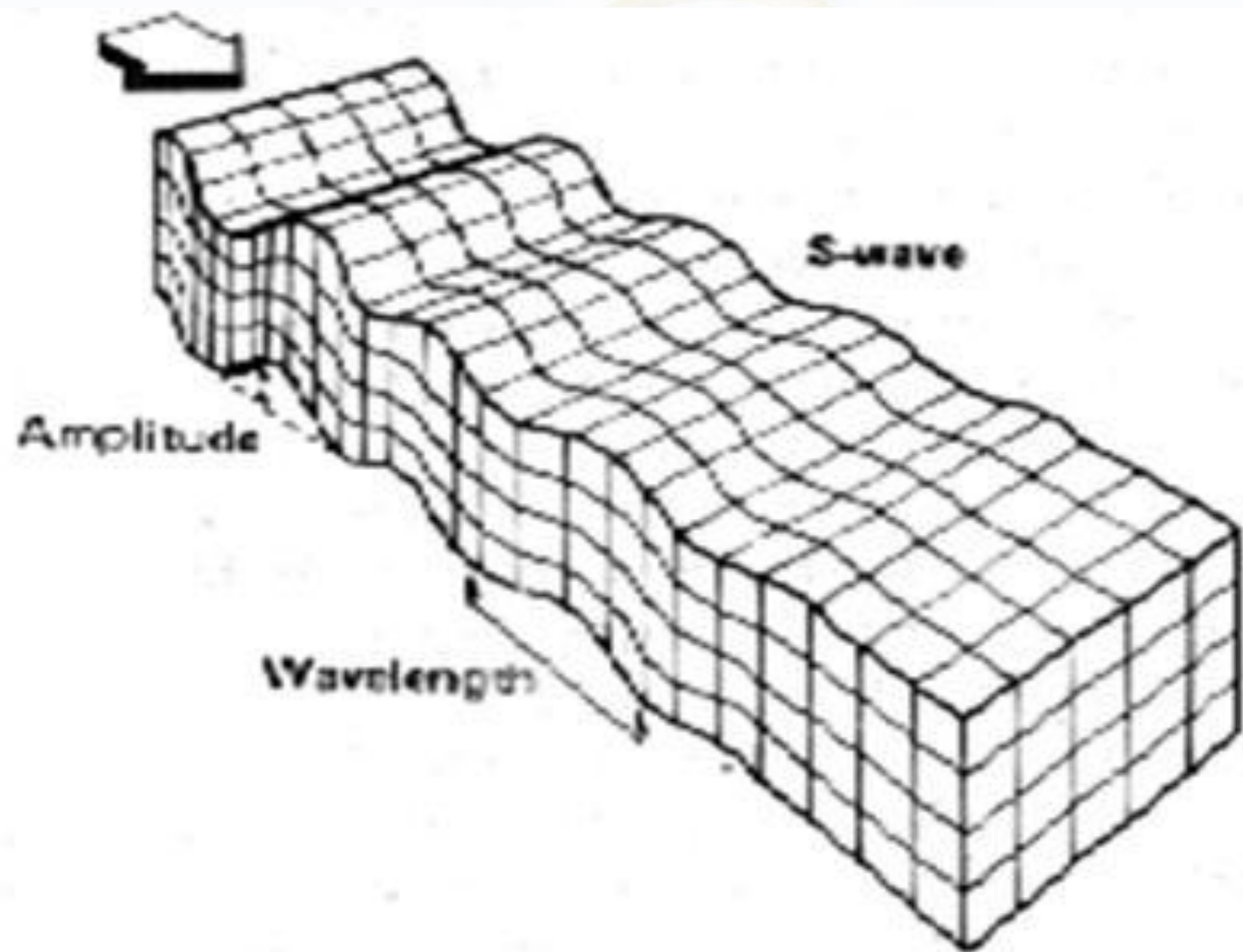
P-Waves

- One of the body waves
- Travel the fastest
- Travel through solids, liquids, and gases
- Motion: squeezing or stretching
- Because they are detected first, they are called the Primary waves



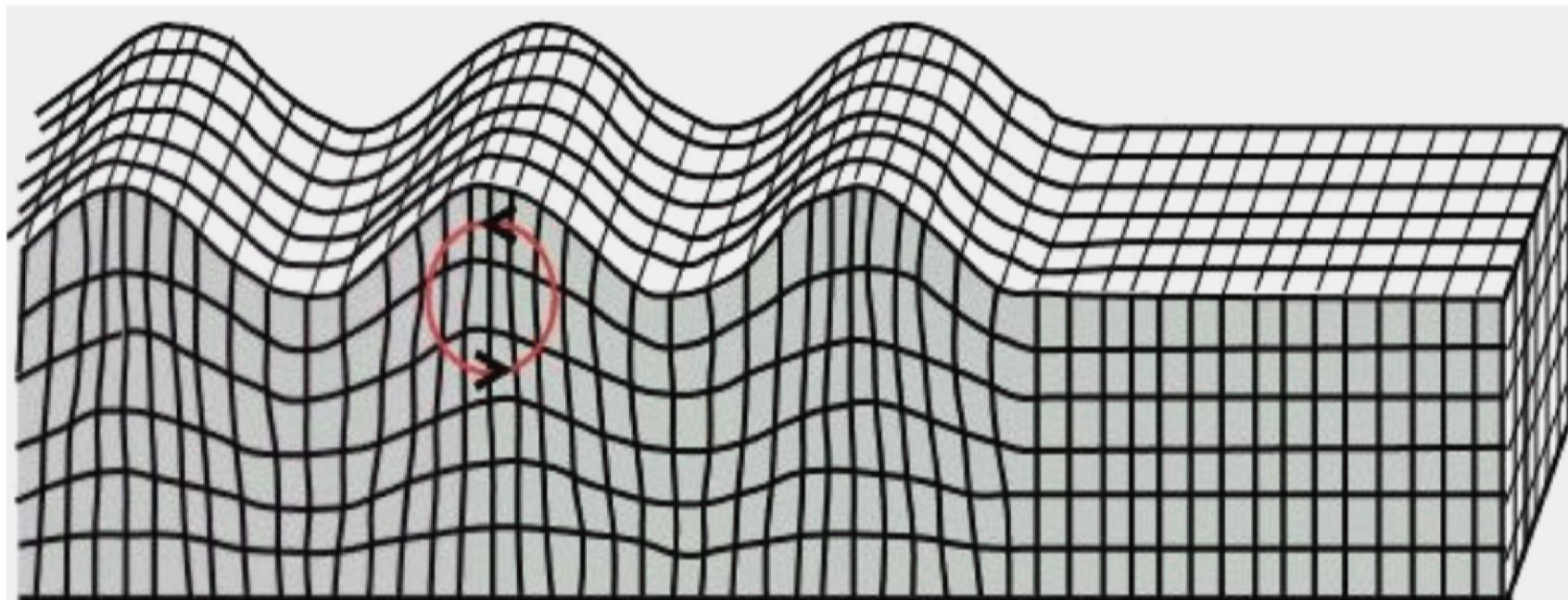
S-Waves

- The other body wave
- Travels the second fastest
- CANNOT travel through liquids
- Motion: rock back and forth (side to side)
- These travel slower than P-Waves and always arrive second, so these are called Secondary waves

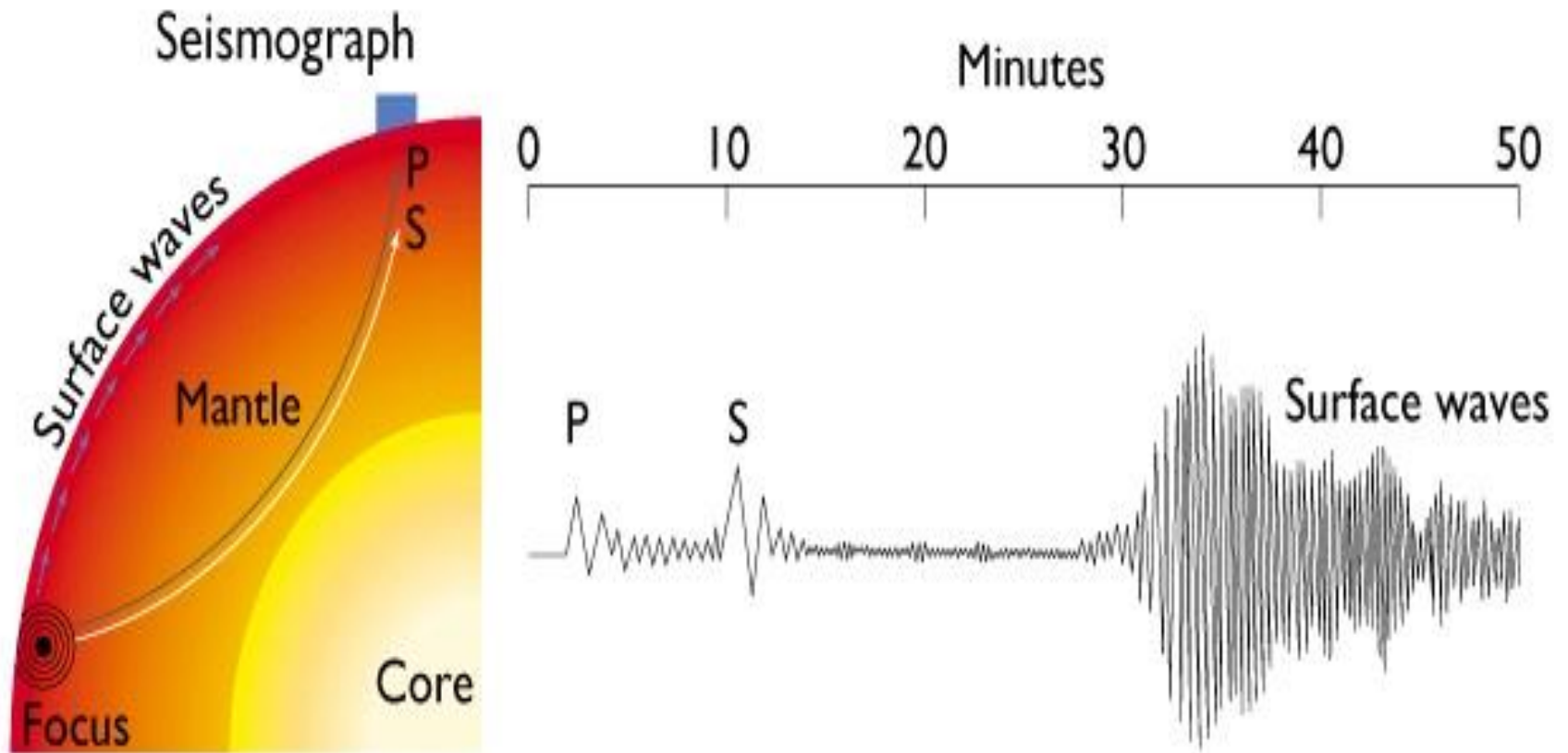


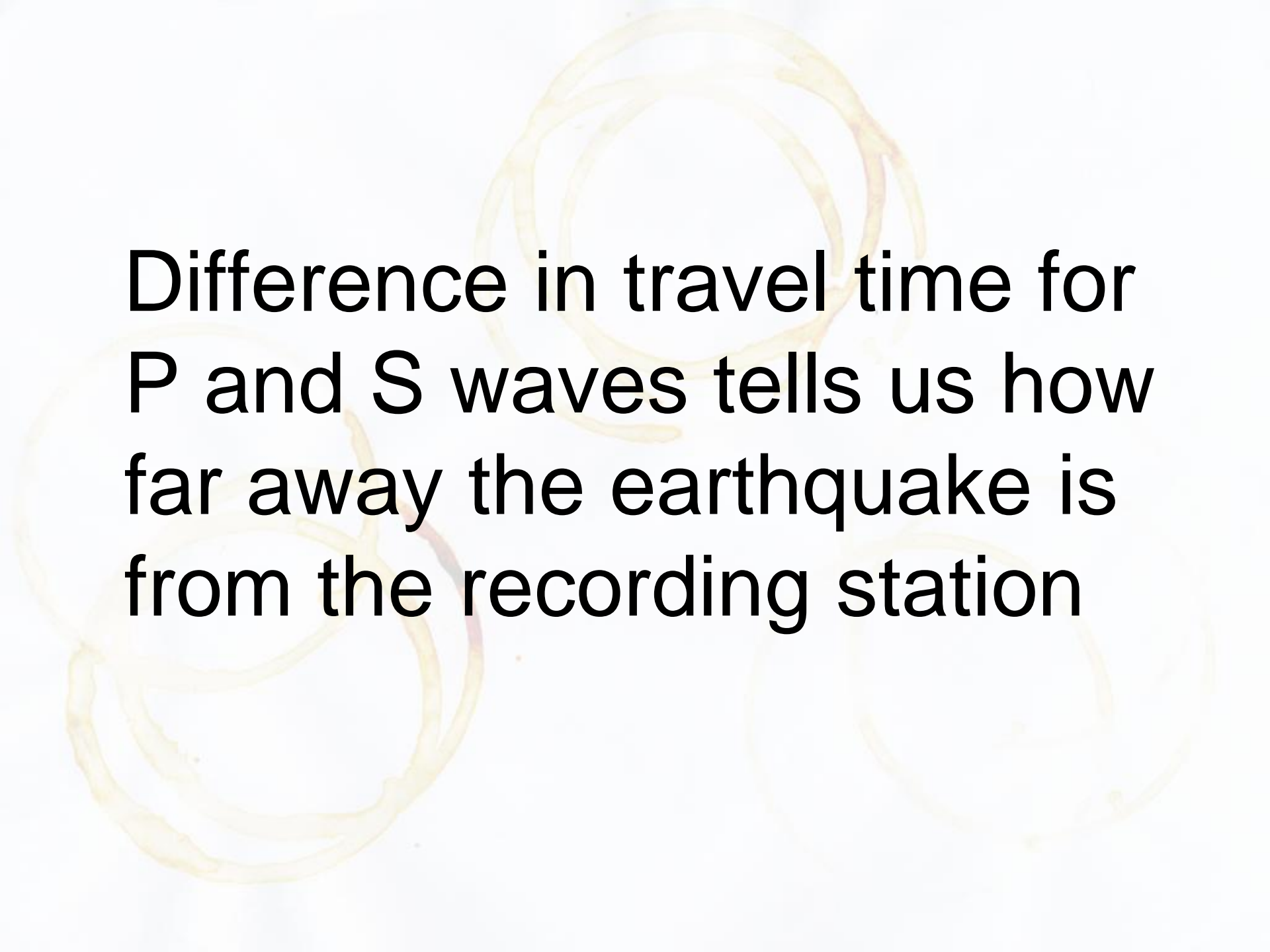
Surface Waves

- Moves the ground in circles
- Motion: up and down
- Travels slower than body waves and only on the surface
- Most damage comes from these waves

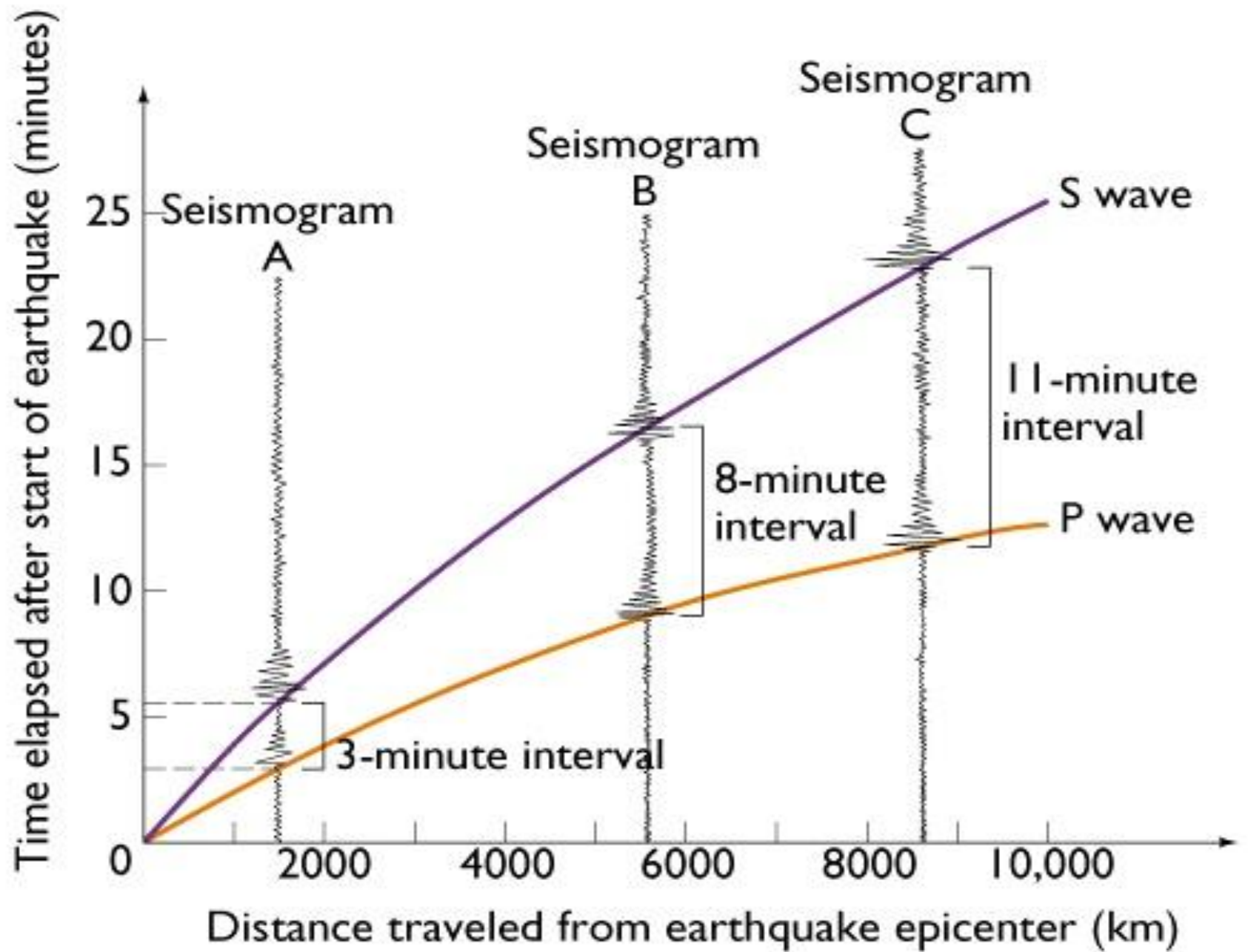


The three types of waves



The background features faint, stylized illustrations of seismic waves. These are represented by concentric, overlapping circles in a light yellow or cream color, suggesting the propagation of waves from a central point. The circles are of varying sizes and are positioned behind the main text.

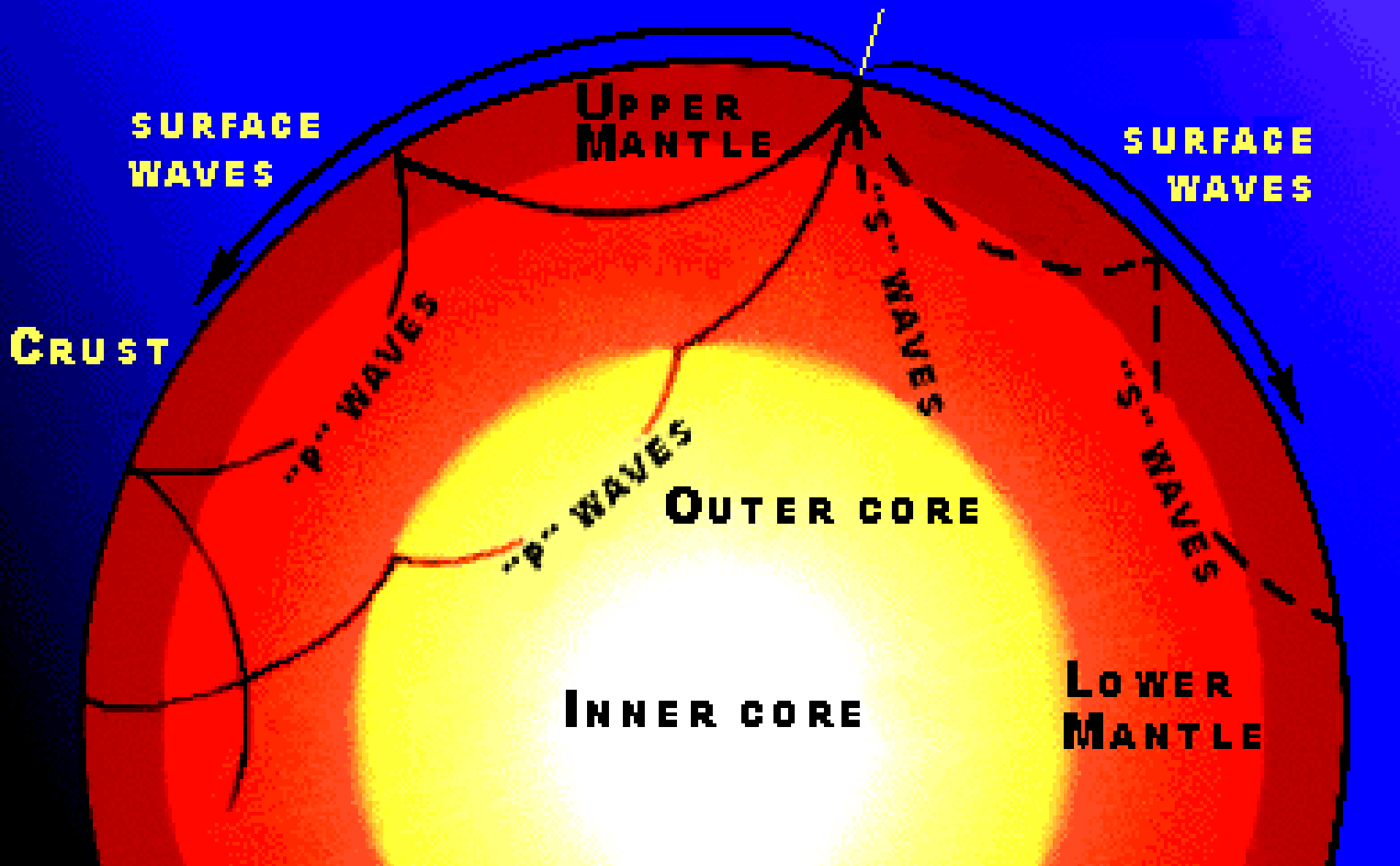
Difference in travel time for
P and S waves tells us how
far away the earthquake is
from the recording station



Other uses of knowing the three waves

- Seismic velocity (how fast earthquake waves travel through rocks) depends on the composition of material and pressure.
- We can use the behavior of seismic waves to tell us about the interior of the Earth.

Focus of Earthquake

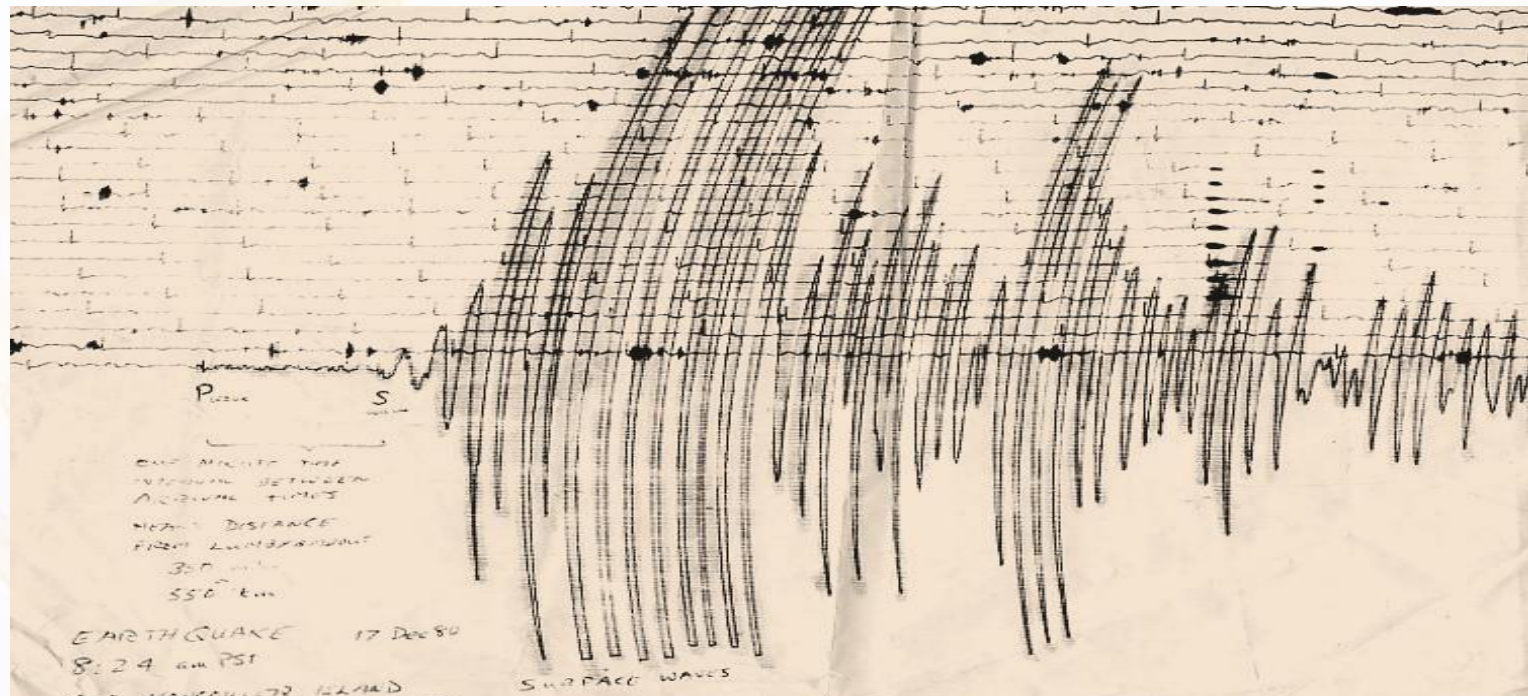


Review

- Three types of waves
 - P-Waves: primary and travel through anything
 - S-Waves: secondary and cannot travel through liquids
 - Surface Waves: last but does the damage and only travels on the surface of the Earth

Locating Earthquakes

- When did it happen?
 - Seismologists use seismograms to calculate when an earthquake started.



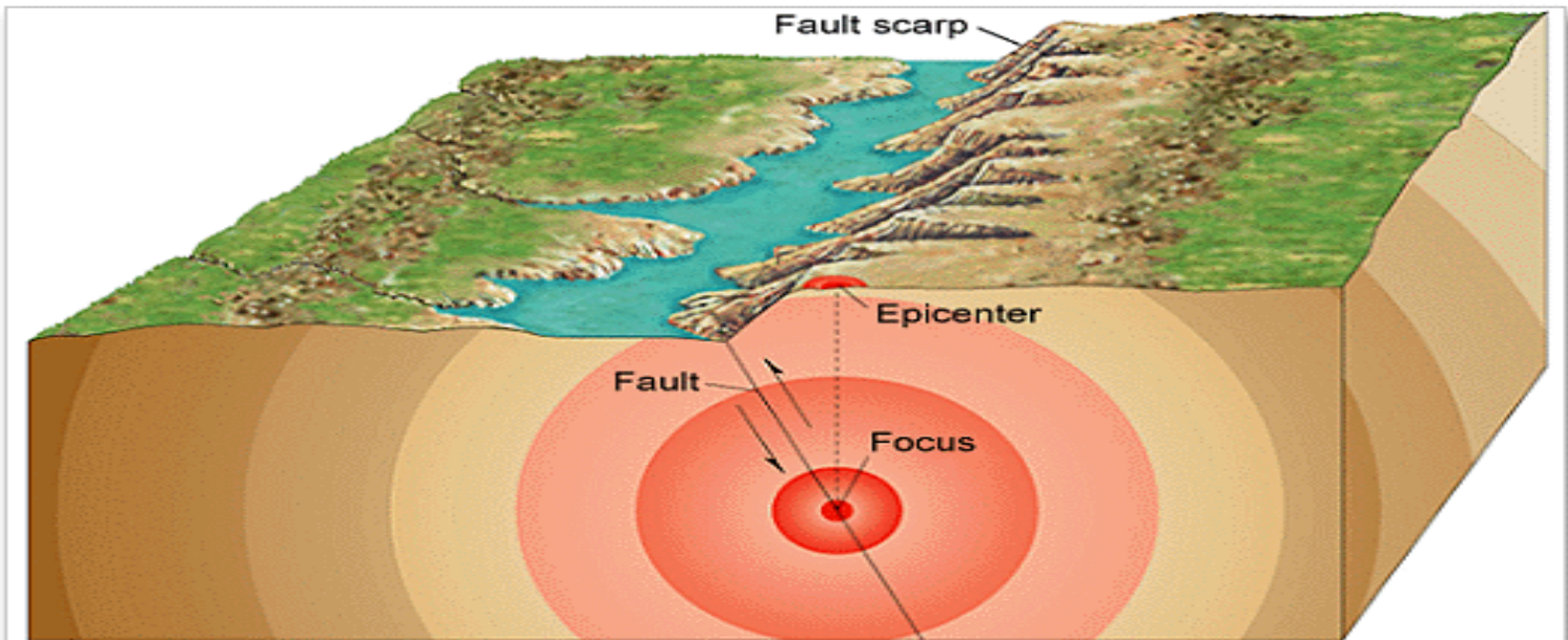
An Earthquake's Epicenter

Where did it start?

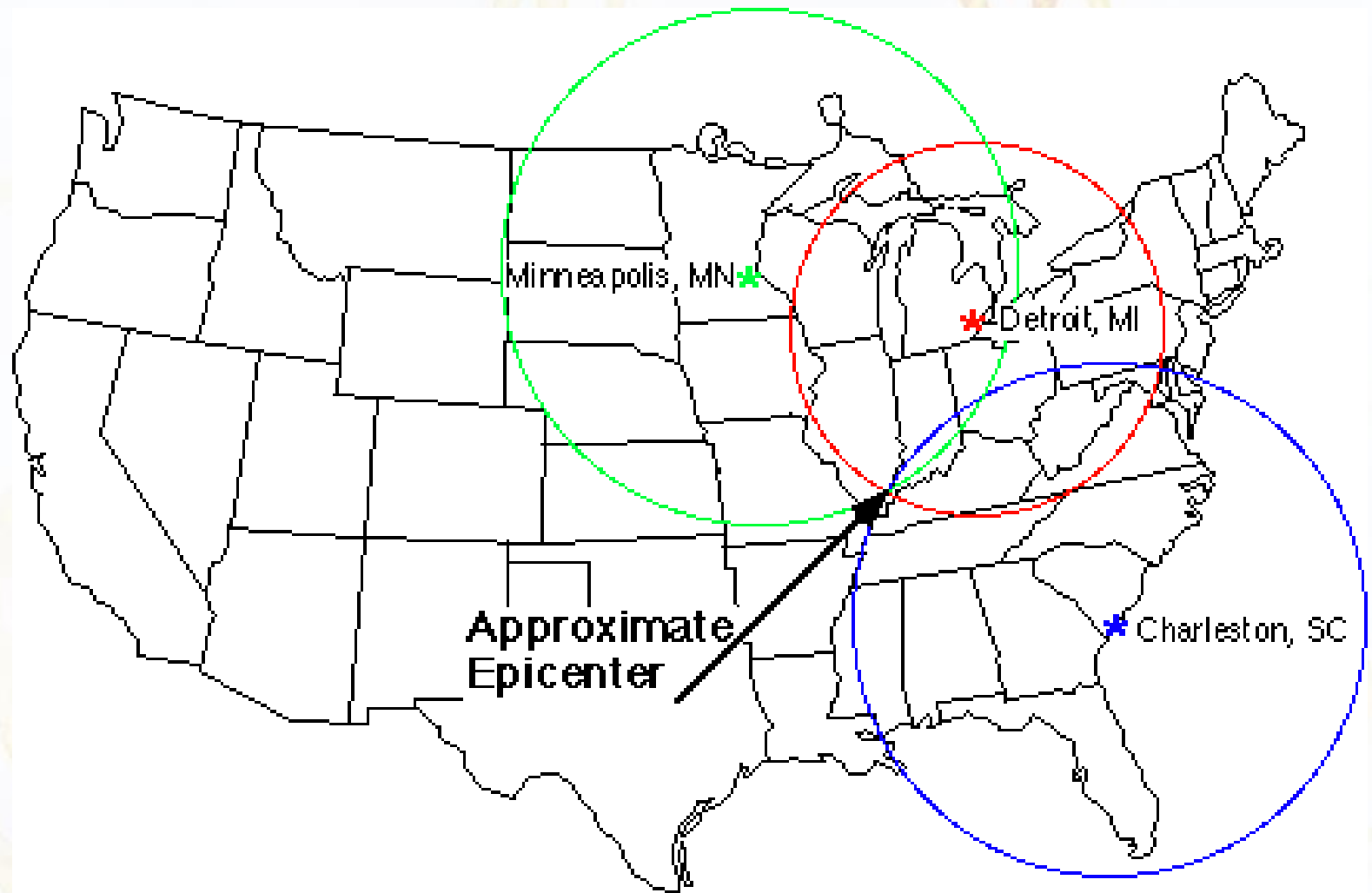
- A seismic station records the waves
- We can estimate the distance by measuring the time between P and S wave arrivals
- With three stations we can triangulate the location

Locating Earthquakes

- Epicenter: the point on the Earth's surface directly above an earthquake's starting point.
- Focus: point inside the Earth where an earthquake begins



Finding the Epicenter



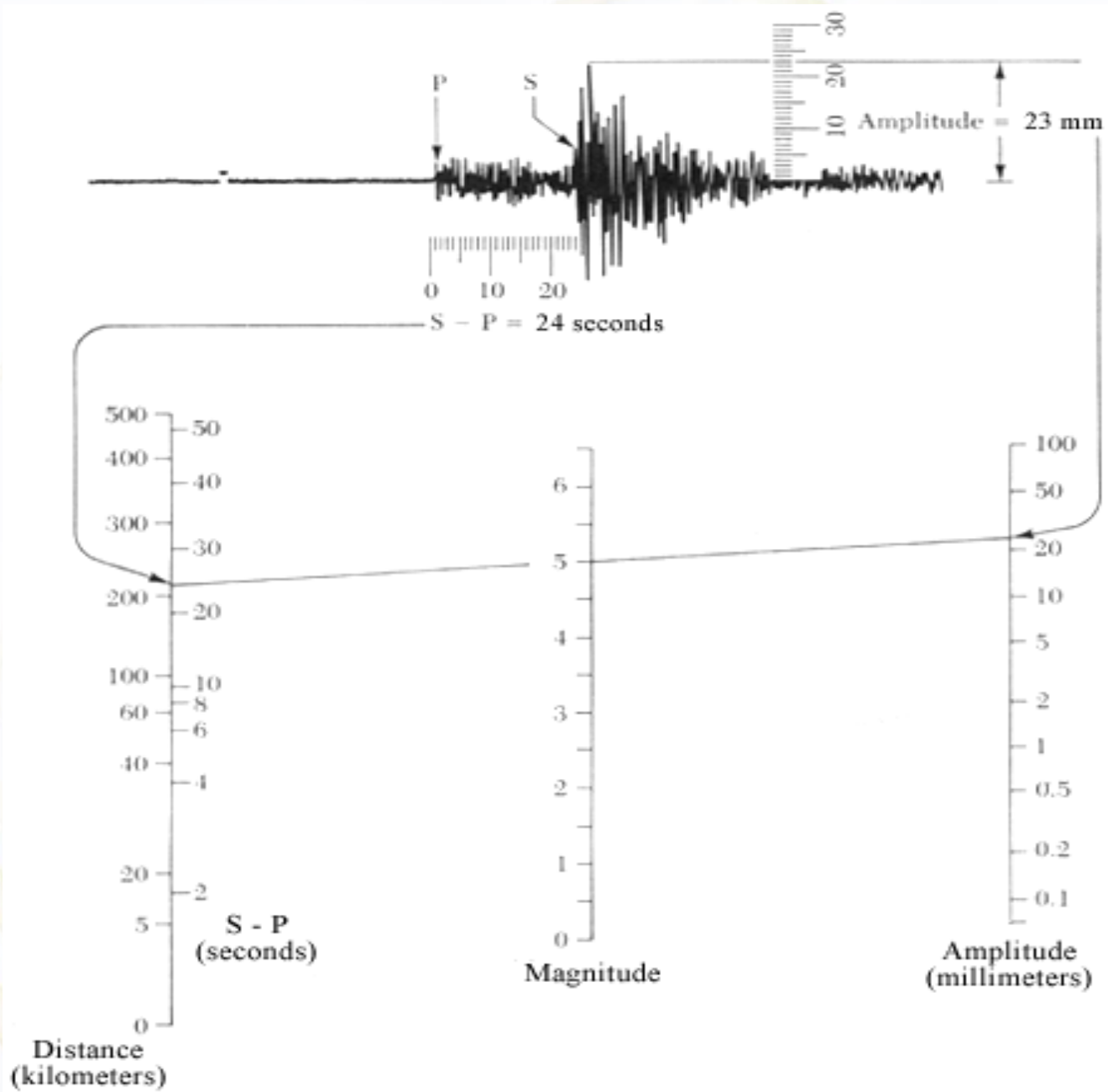
Earthquake Magnitude

1. The Richter Scale

- Named after Charles Richter who developed the scale in the 1930s
- Has been modified since
- measures the amount of energy an earthquake releases
- Each number of magnitude is 10x stronger than the number below it.

Understanding the Richter Scale

Richter Magnitude	Feels like KG of TNT	Extra Information
0-1	0.6 -20 kilograms of dynamite	We can not feel these.
2	600 kilograms of dynamite	Smallest quake people can normally feel.
3	20,000 kilograms of dynamite	People near the epicenter feel this quake.
4	60,000 kilograms of dynamite	This will cause damage around the epicenter. It is the same as a small fission bomb.
5	20,000,000 kilograms of dynamite	Damage done to weak buildings in the area of the epicenter.
6	60,000,000 kilograms of dynamite	Can cause great damage around the epicenter.
7	20 billion kilograms of dynamite	Creates enough energy to heat New York City for one year. Can be detected all over the world. Causes serious damage.
8	20 billion kilograms of dynamite	Causes death and major destruction. Destroyed San Francisco in 1906.
9	20 trillion kilograms of dynamite	Rare, but would causes unbelievable damage!



2. The Mercalli Scale

- Measures the amount of damage from an earthquake
- Ranges from I to XII
- Based on common earthquake occurrences such as "noticeable by people" "damage to buildings" chimneys collapse"

The Mercalli Scale

Earthquake Intensity	Earthquake Effects
I-II	Almost unnoticeable
III-IV	People notice vibrations like those from a passing truck. Unstable objects disturbed.
V-VI	Dishes and windows rattle. Books knocked off shelves. Slight damage.
VII-VIII	People run outdoors. Moderate to heavy damage.
IX-X	Buildings jolted off foundations or destroyed. Cracks appear in ground and landslides occur.
XI-XII	Severe damage. Wide cracks appear in ground. Waves seen on ground surface.

What contributes to a high earthquake hazard?

1. The level of shaking
 - Energy released from the earthquake
 - Distance from the earthquake
 - How the land is
2. Building design
3. Proximity to population centers
4. Saturation of soils
5. Aftershocks

Damage?



Damage?

