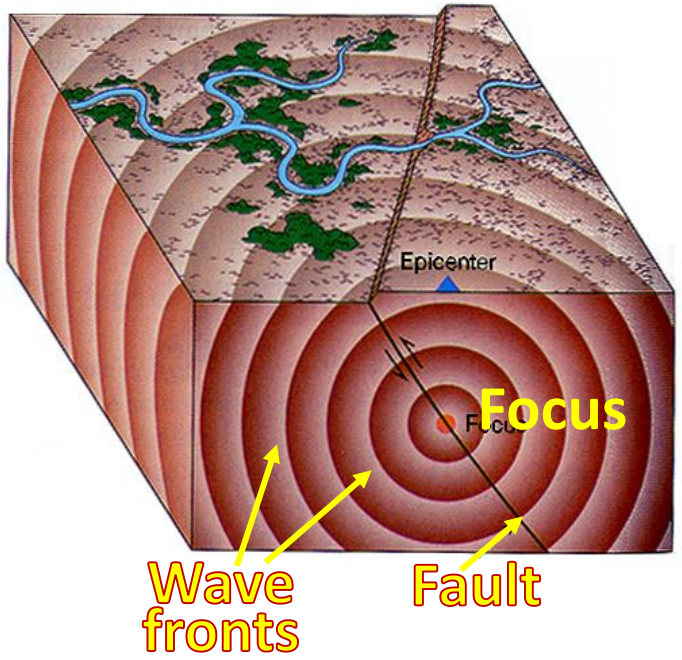
Review: What is an earthquake?

- **Earthquake** is the vibration (shaking) and/or displacement of the ground produced by the sudden release of energy.
- The point inside the Earth where an earthquake begins (*point of initial rupture*) is called *focus*.
- The area on the surface of the Earth directly above the focus where the shaking is usually felt most strongly is called *epicenter*.
- Earthquake strength is usually described by its *intensity* (a measure of the degree of shaking based on the amount of damage) and *magnitude* (an estimate of the amount of energy released at the source of the earthquake; *logarithmic scale*).
- Energy released from the earthquake source (its focus) propagates in the form of waves called *seismic waves*.

Seismic Waves



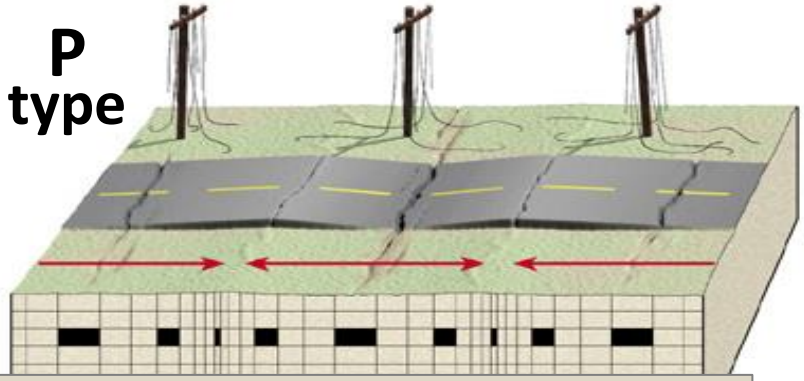
- **<u>Energy</u> released from the earthquake source (its focus) <u>radiates in all directions</u>.**
- **Energy is in the form of *waves* called seismic waves.**
- **Earthquakes create <u>distinct types of seismic waves</u> that travel through the Earth's layers with different velocities:**

1. **<u>Body waves</u> - travel through the Earth <u>interior</u> (*Primary* waves and *Secondary* waves).**
2. **<u>Surface waves</u> - travel on the Earth <u>surface</u> (*Love* waves and *Rayleigh* waves).**

Types of Seismic Waves

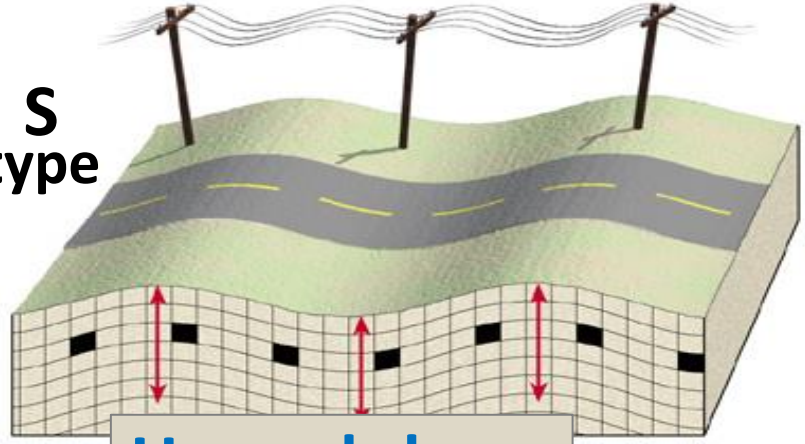
BODY WAVES

P type



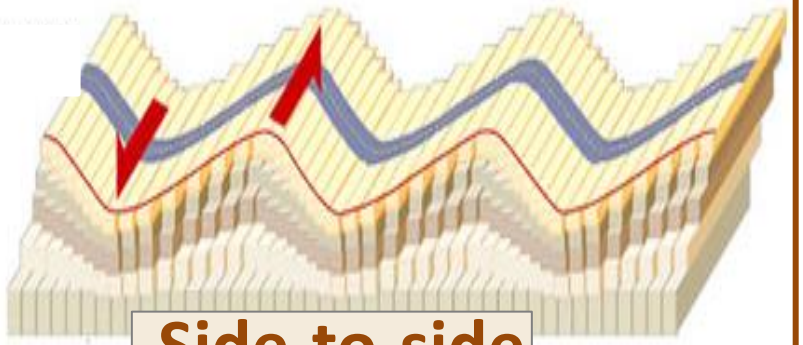
Compression-expansion

S type



Up-and-down

SURFACE WAVES



L type

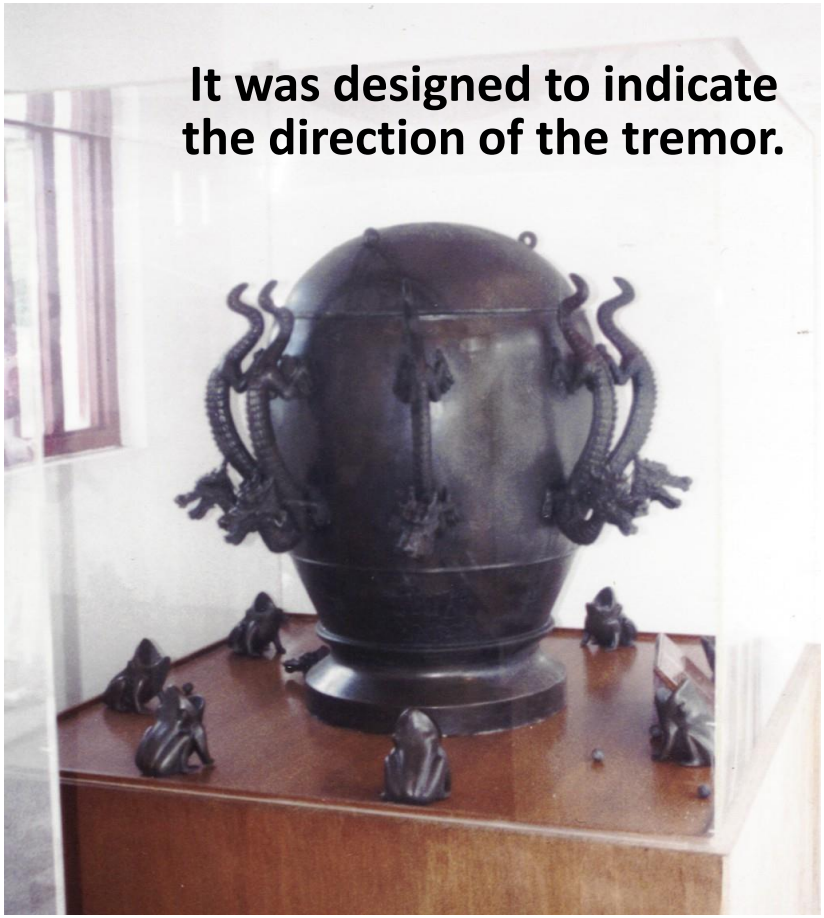
Side-to-side horizontal movement

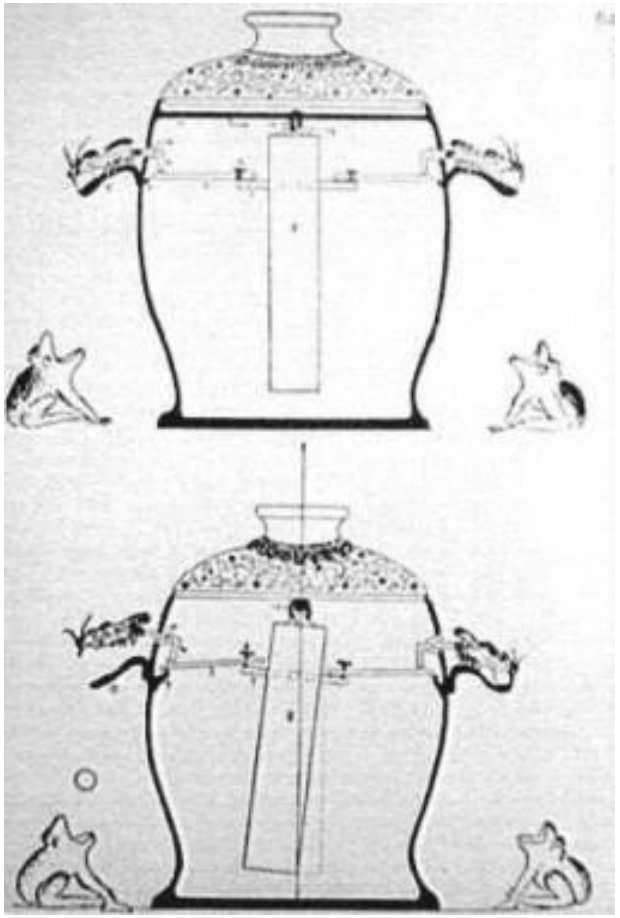
Elliptical roll of the ground oriented vertically

R type

Detecting an Earthquake

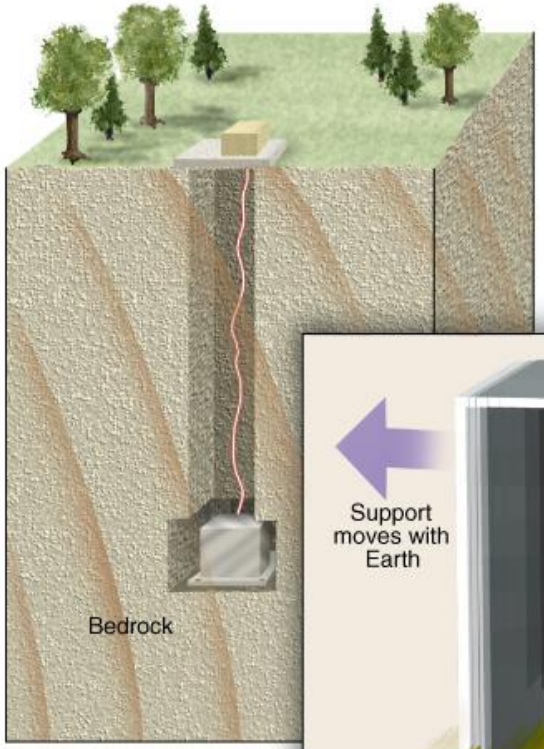
Chinese created <u>the first earthquake detector</u> over 2000 years ago!





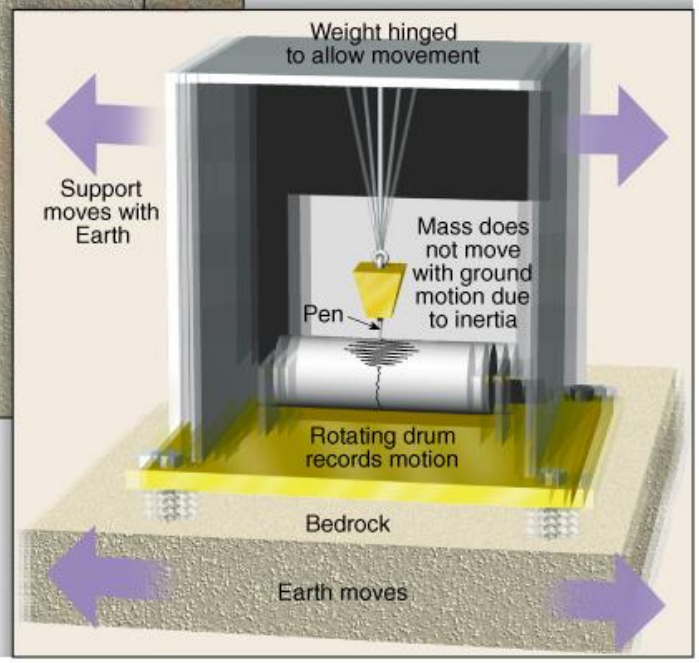
Measuring an Earthquake

Earthquakes are measured using observations from seismographs, instruments that record seismic waves.

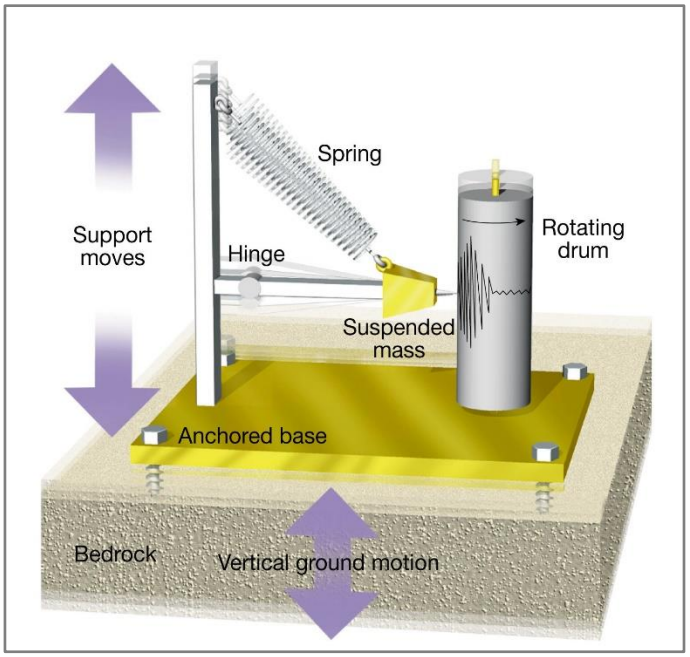


Different *seismograph types* are needed to record both <u>vertical</u> and <u>horizontal</u> ground motion:

Horizontal

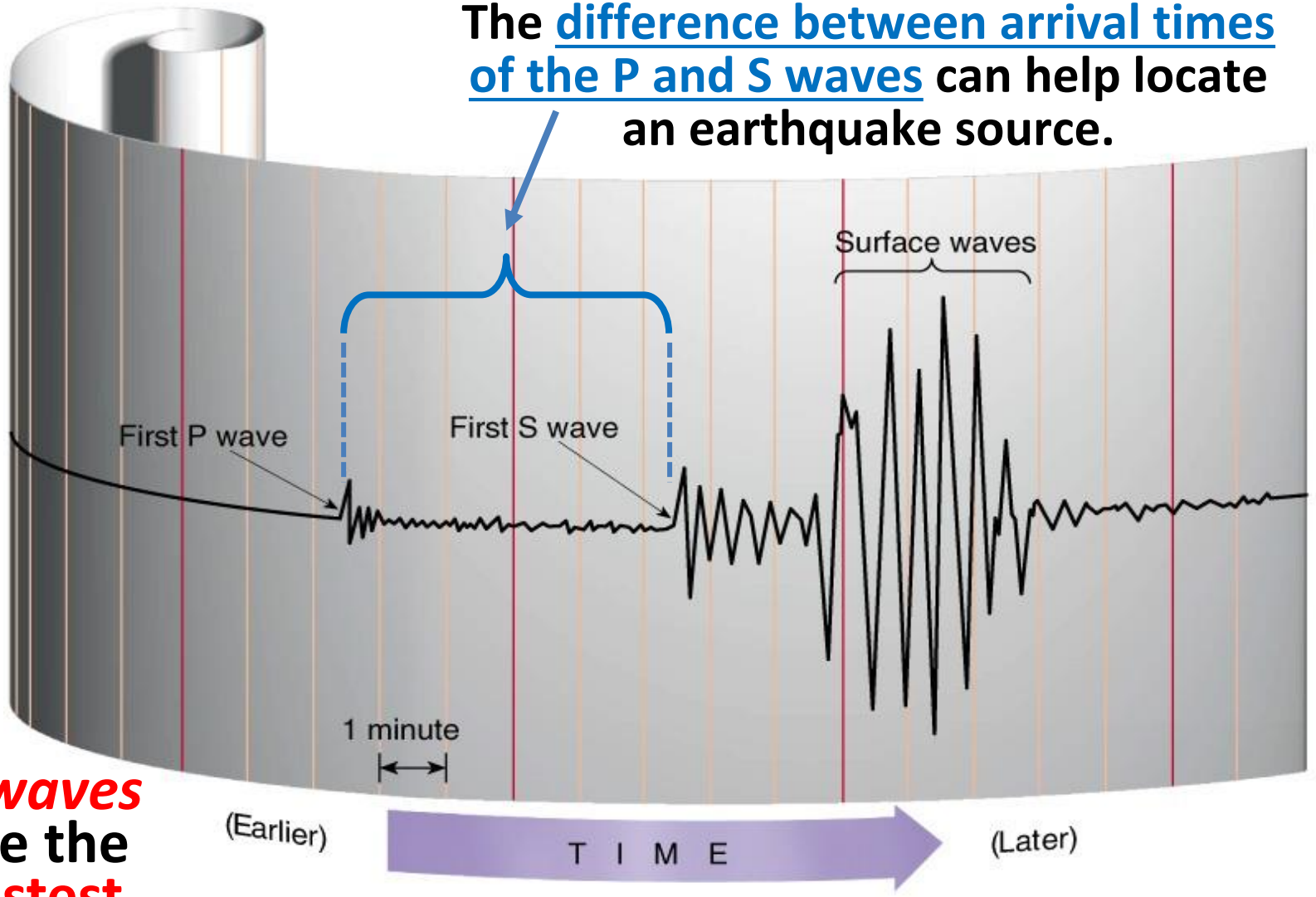


Vertical



Simplified Seismogram

The difference between arrival times of the P and S waves can help locate an earthquake source.

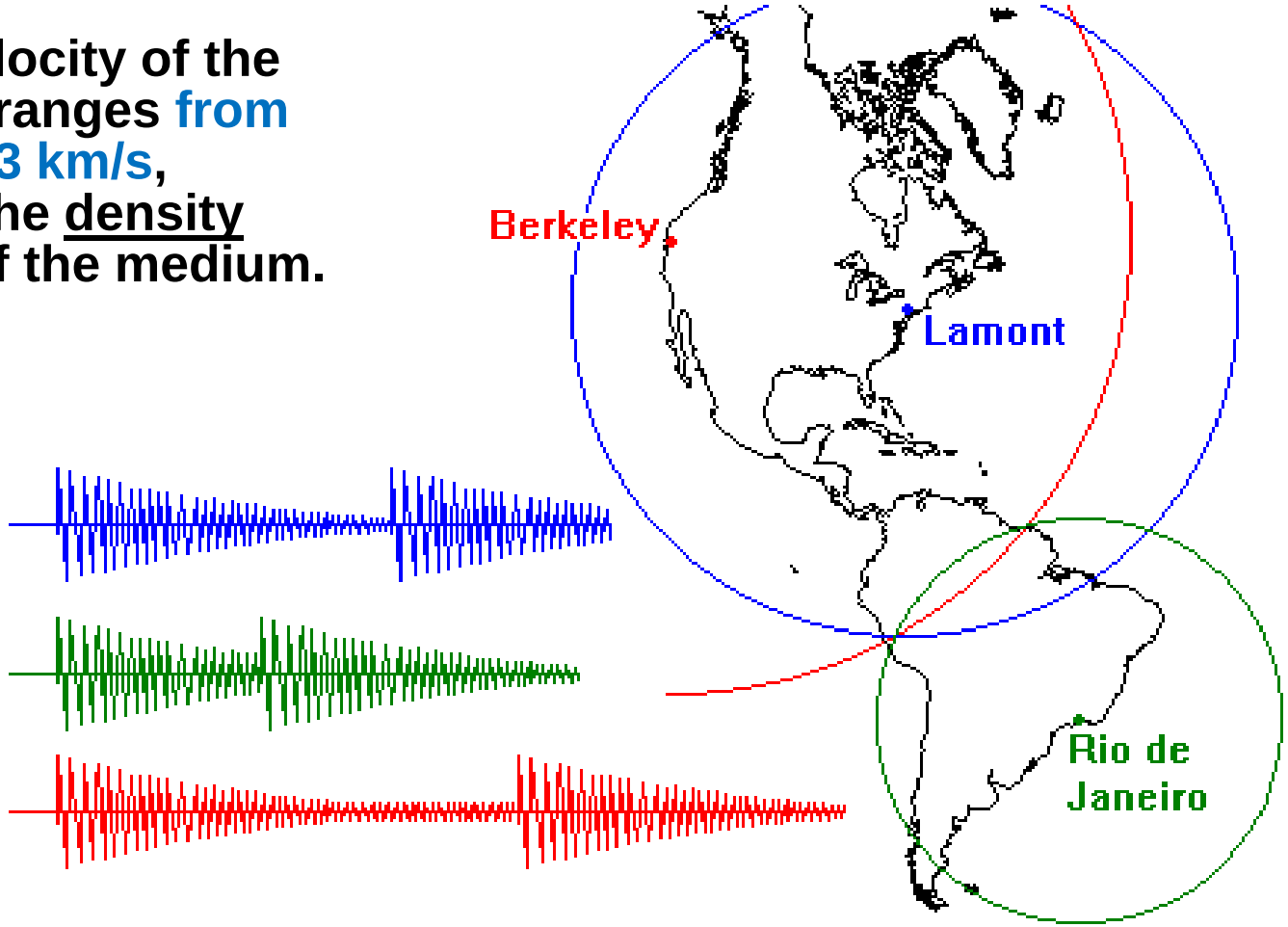


P waves **are the** **fastest**

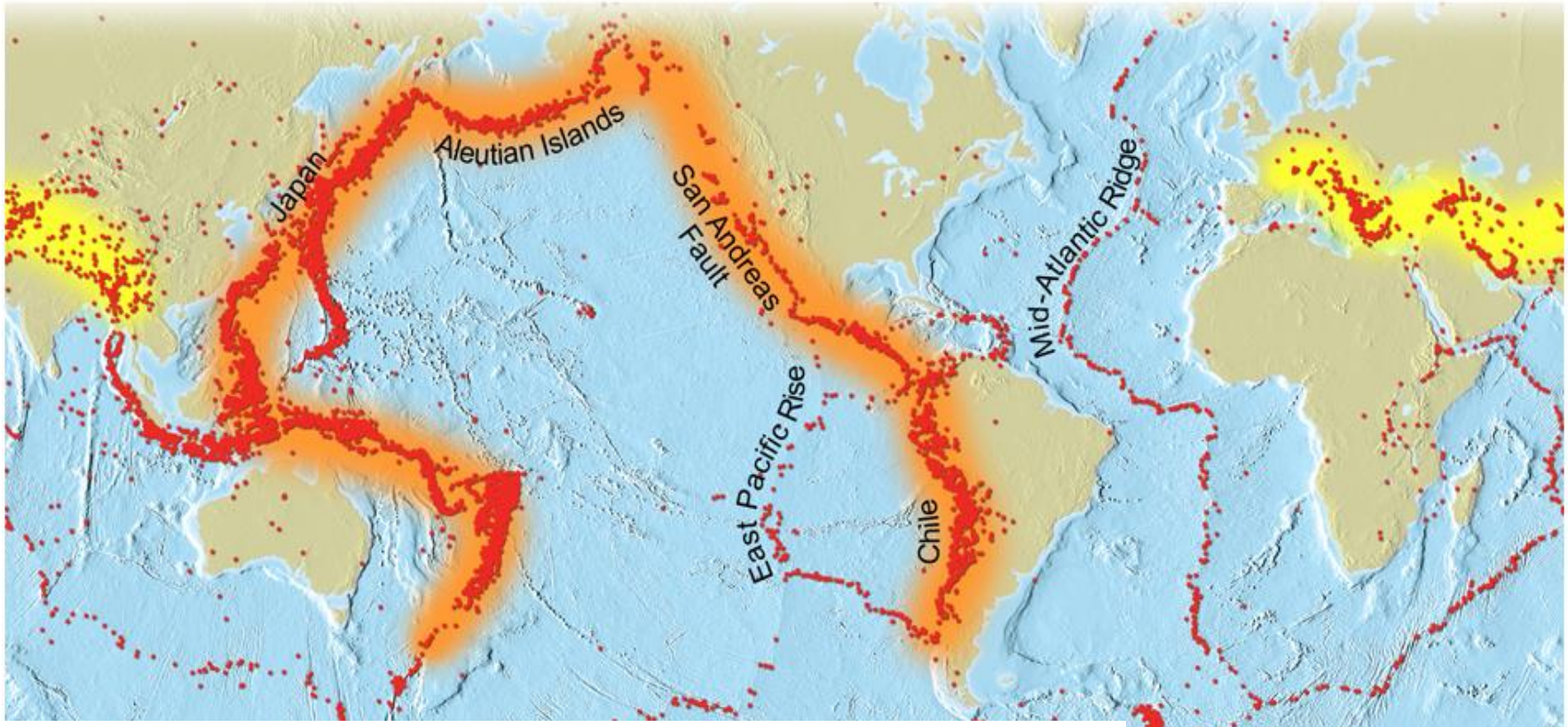
Locating Earthquakes

The further away an earthquake is from the point of detection, the greater the time between the arrival of the P waves and the S waves.

- **Propagation velocity of the seismic waves ranges from ~3 km/s up to 13 km/s, depending on the density and elasticity of the medium.**
- **Data from several different (*at least three*) seismic stations is combined to determine the earthquake epicenter location.**



Earthquakes around the world mostly happen near tectonic plate boundaries



80% - Circum-Pacific Belt, border of the Pacific Ocean.

15% - Alpine-Himalayan Belt, from southern Asia to the Mediterranean region.

5% - parts of the Arctic, Atlantic, and Indian Oceans. Antarctica and Australia experience the least amount of earthquake activity then any other areas of the world.

Graph shows 15,000 larger magnitude (>5) earthquakes over 10-year period.

How *common* are earthquakes?

- **It is estimated that around 500,000 earthquakes occur each year, detectable with current instrumentation.**
- **About 100,000 of these can be felt (*ground shaking* during a moderate to large earthquake typically lasts about *10 to 30 seconds*).**
- **Minor earthquakes occur nearly constantly around the world; larger earthquakes occur less frequently.**
- **While most earthquakes are caused by movement of the Earth's tectonic plates, the following human activities can also produce earthquakes:**
  - **storing large amounts of water behind a dam**
  - **drilling and injecting liquid into wells**
  - **coal mining and oil drilling**