

An aerial photograph captures a long, straight road that has been severely fractured by an earthquake. A massive, vertical crack runs down the center of the road, with the ground on either side appearing to drop significantly. The road surface is a light tan color, and the fractured earth is a darker, more weathered grey. Several people are standing on the road, some near the center crack and others further down the road, providing a sense of scale to the enormous fissure. The surrounding landscape is a mix of dark, leafless trees and patches of snow or light-colored ground cover. The overall scene conveys a sense of the powerful geological forces that can reshape the earth.

# Earthquakes

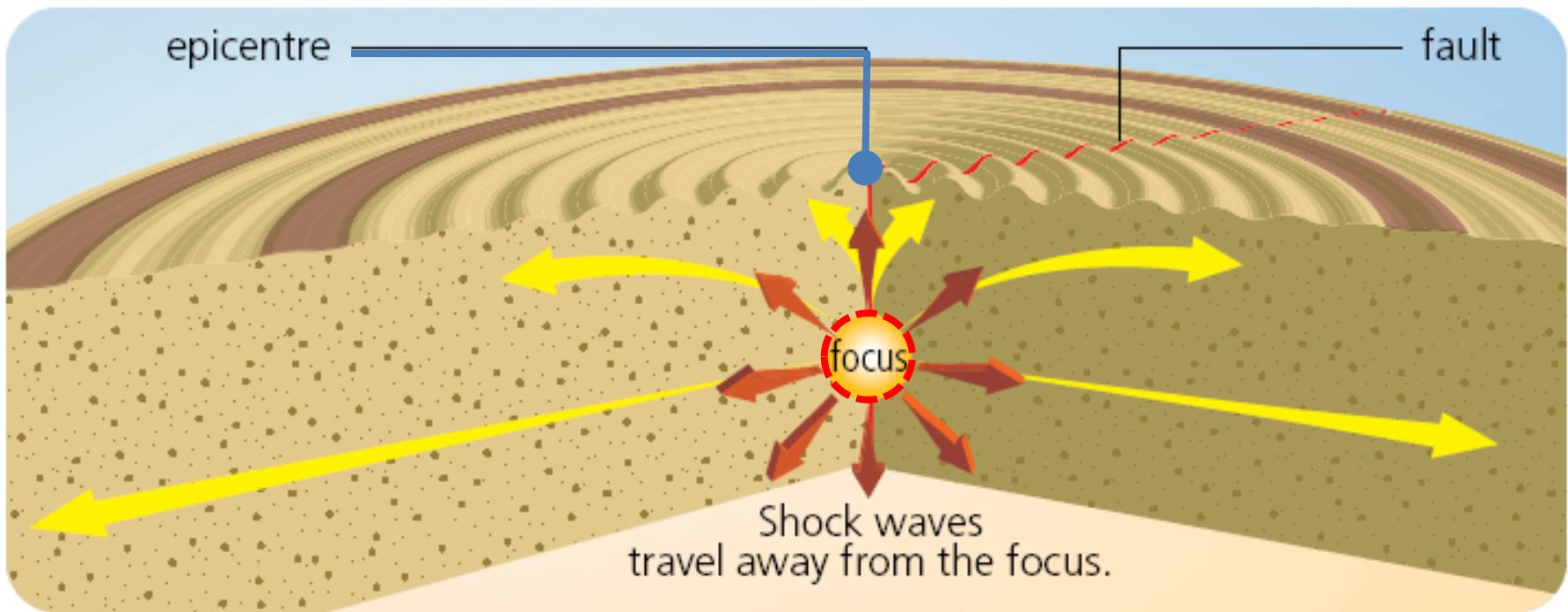
# What is an earthquake?

Earthquake is the **vibration (shaking)** and/or **displacement of the ground** produced by the **sudden release of energy**.

- Rocks under **stress** accumulate **strain energy** over time.
- Stress results from tectonic plate movement, magmatic or volcanic activity.
- When stress exceeds strength of rocks, rock breaks and slips.
- Rock slippage/rupture occurs at the weakest point (fault).
- Strain energy is released as **seismic waves**.



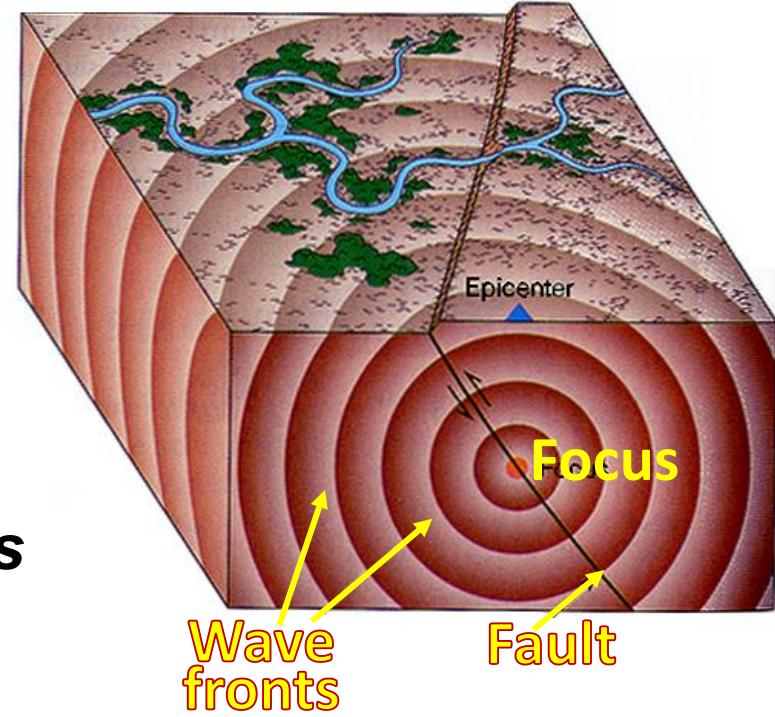
# Focus and Epicenter



- **Focus** – point inside the Earth where an earthquake begins (*point of initial rupture*). The majority of tectonic earthquakes originate in depths not exceeding tens of kilometers.
- **Epicenter** – point on the surface of the Earth directly above the focus where the shaking is usually felt most strongly.

# Seismic Waves

- Energy released from the earthquake source (its focus) radiates in all directions.
- Energy is in the form of waves called **seismic waves**:

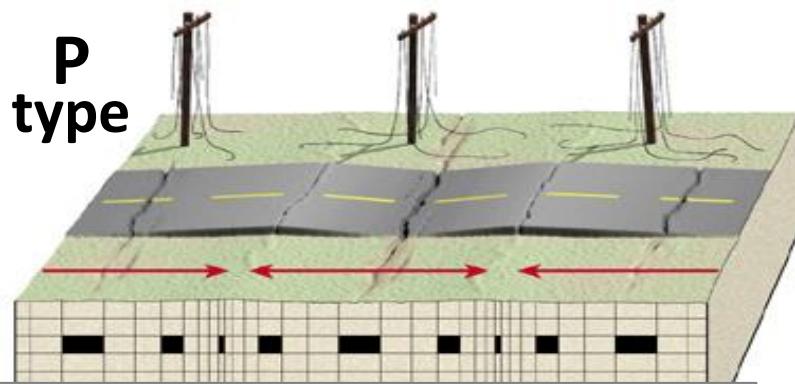


1. Body waves (*Primary waves and Secondary waves*) - travel fast through the Earth interior.
2. Surface waves (*Love waves and Rayleigh waves*) - travel on the Earth surface; have lower frequency and travel more slowly than body waves - **more destructive**.

# Types of Seismic Waves

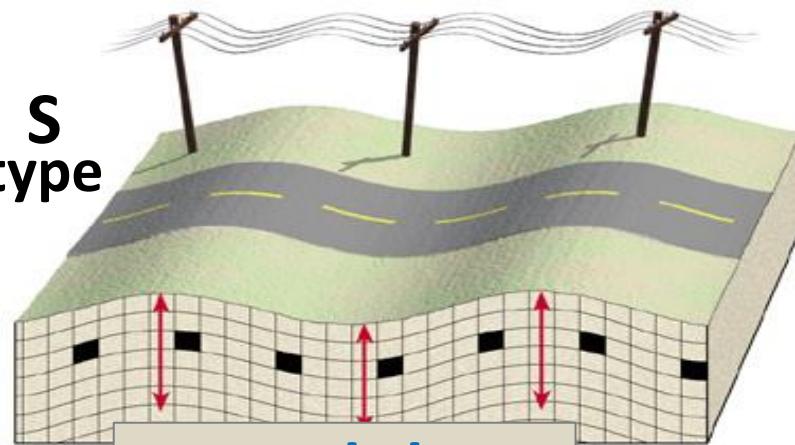
## BODY WAVES

P type



Compression-expansion

S type



Up-and-down

## SURFACE WAVES

L type

Side-to-side horizontal movement

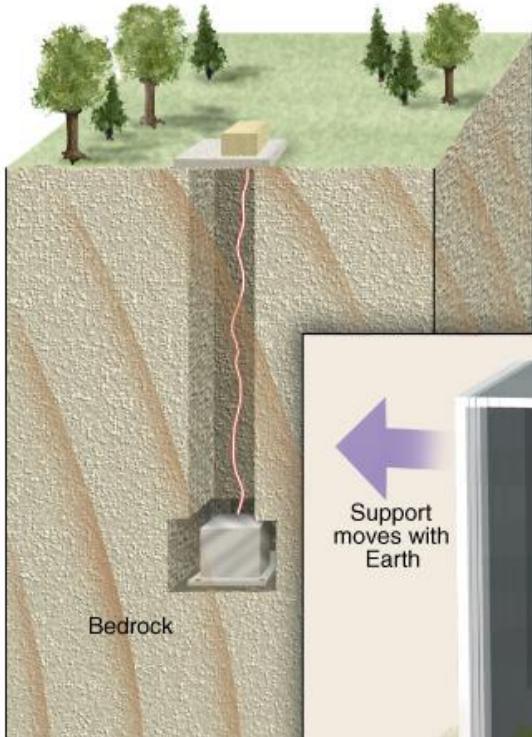


Elliptical roll of the ground oriented vertically

R type

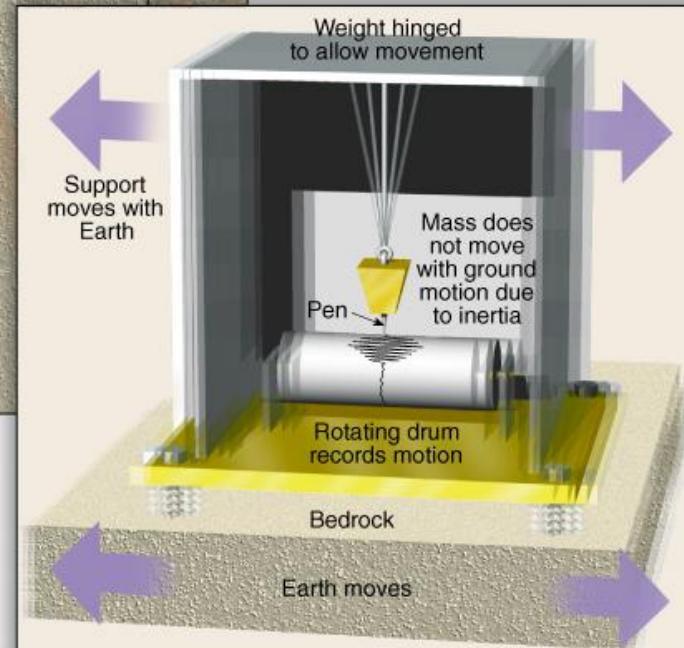
# Measuring an Earthquake

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

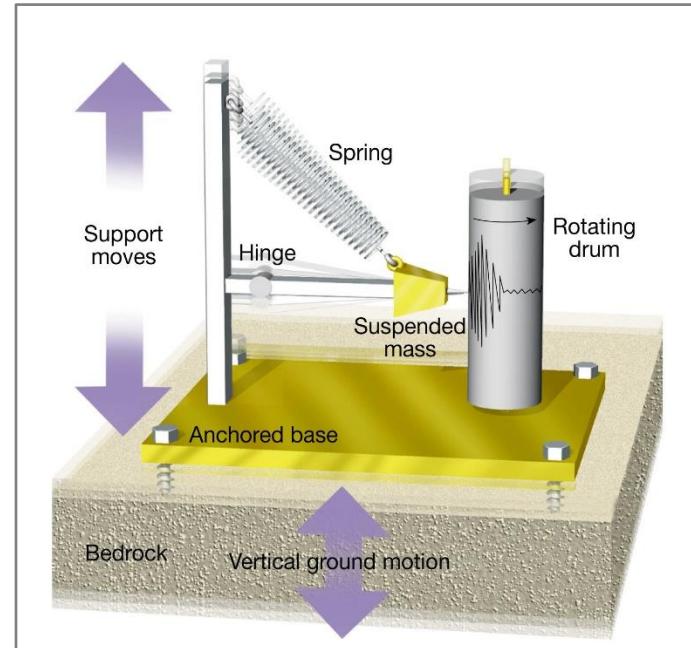


Different *seismograph types* are needed to record both vertical and horizontal ground motion:

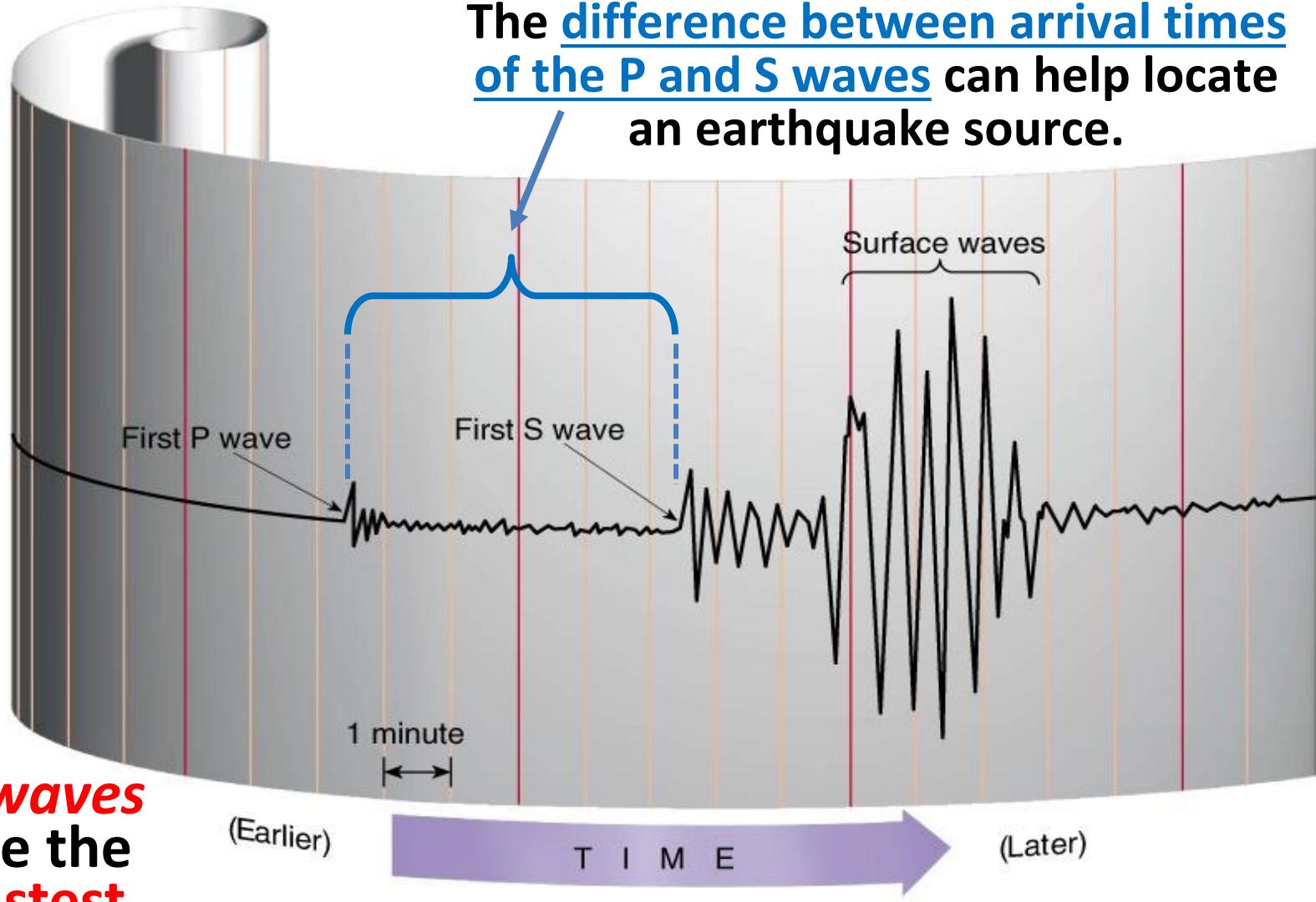
## Horizontal



## Vertical



# Simplified Seismogram

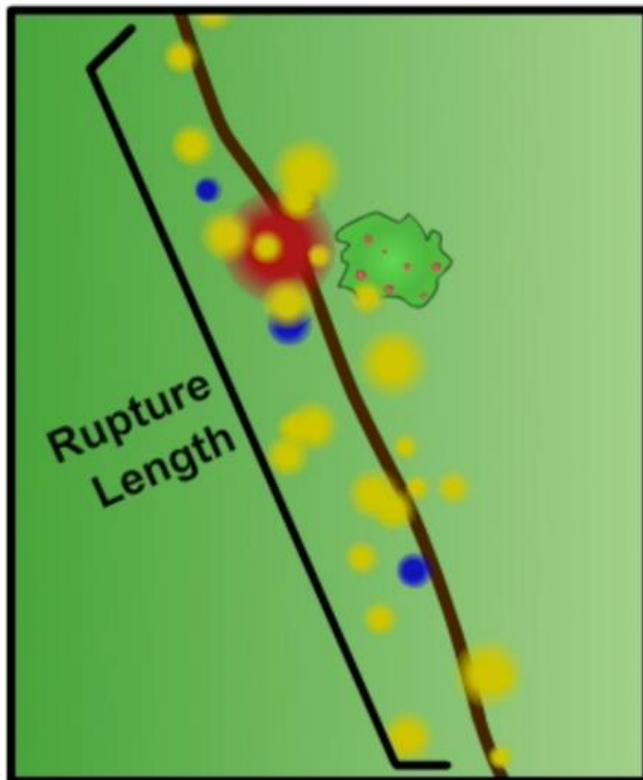


# Earthquakes often occur as a sequence rather than individual events

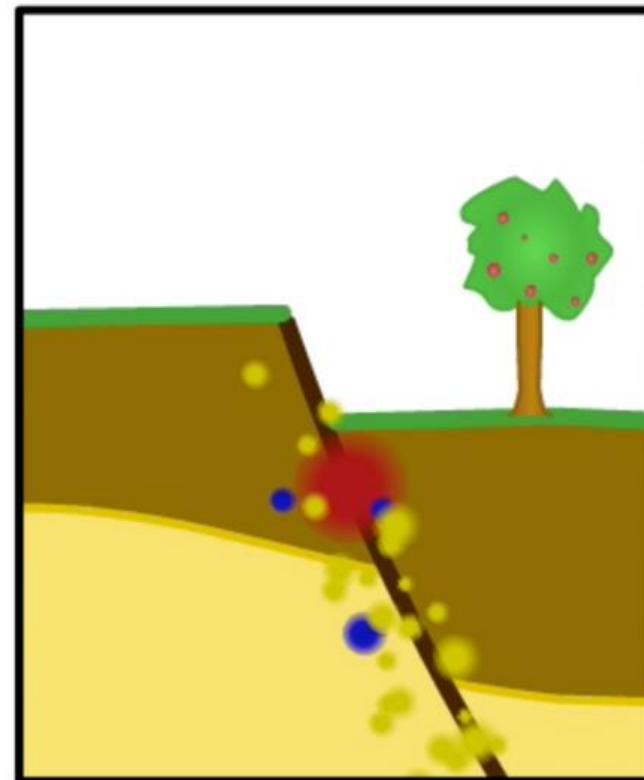
● Foreshock

● Mainshock

● Aftershock

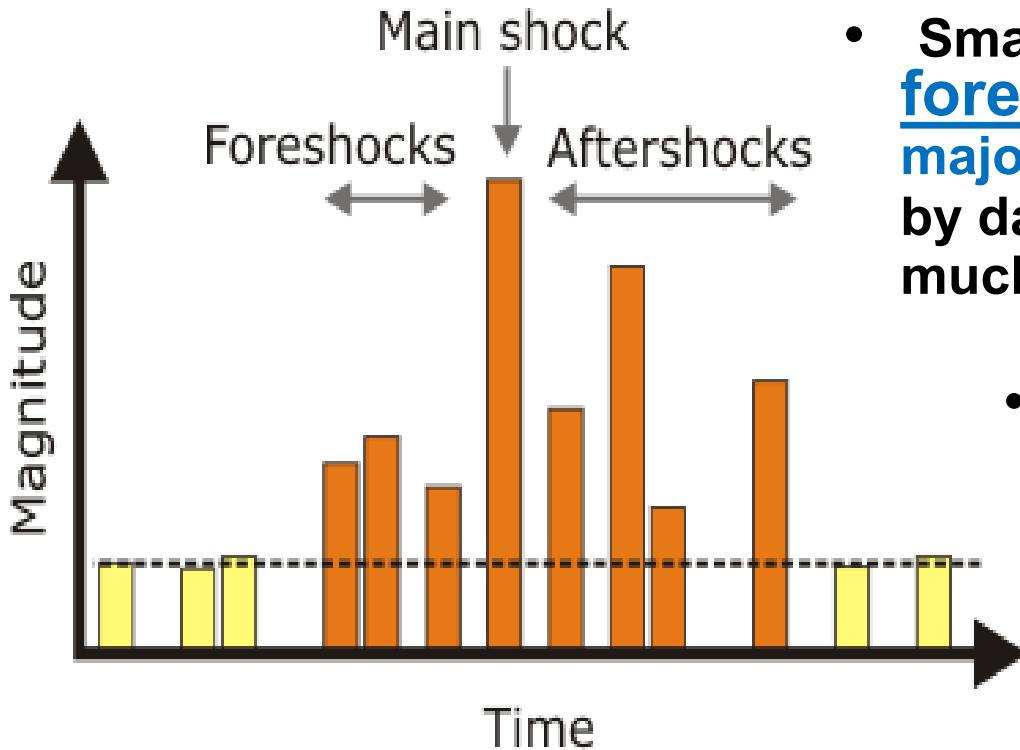


Map View



Cross-Section View

# Foreshocks and Aftershocks



- Small earthquakes, called **foreshocks**, often precede a major earthquake (**main shock**) by days or, in some cases, by as much as several years.
  - Adjustments of crust (redistribution of stress on the fault) that follow a major earthquake often generate smaller quakes in the same area called **aftershocks**.

- Bigger earthquakes often have *more and larger* aftershocks and the sequences can last for years.
- **Earthquake swarms** are sequences of earthquakes striking in a specific area within a short period of time in which no single earthquake has notably higher magnitudes than the other.

# What Real Data Looks Like

