

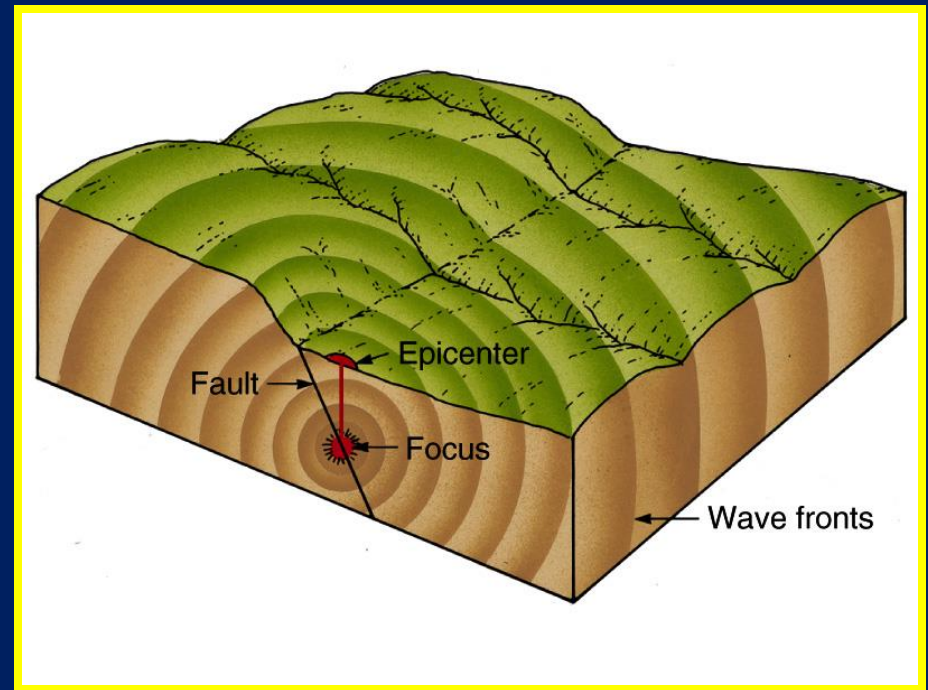
# Using Seismology to Locate the Epicenter of an Earthquake



# Anatomy of an Earthquake

Recall that most earthquakes occur deep within the crust, along fractures in the rock called faults.

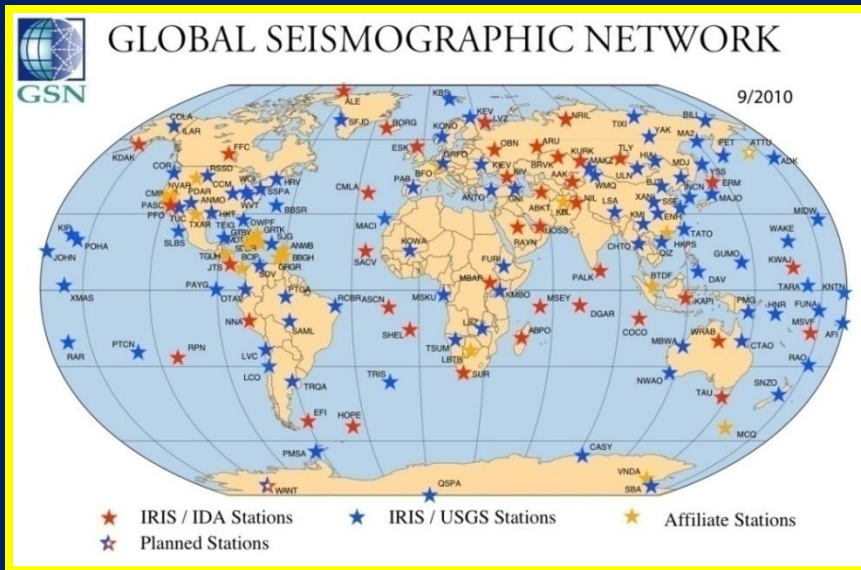
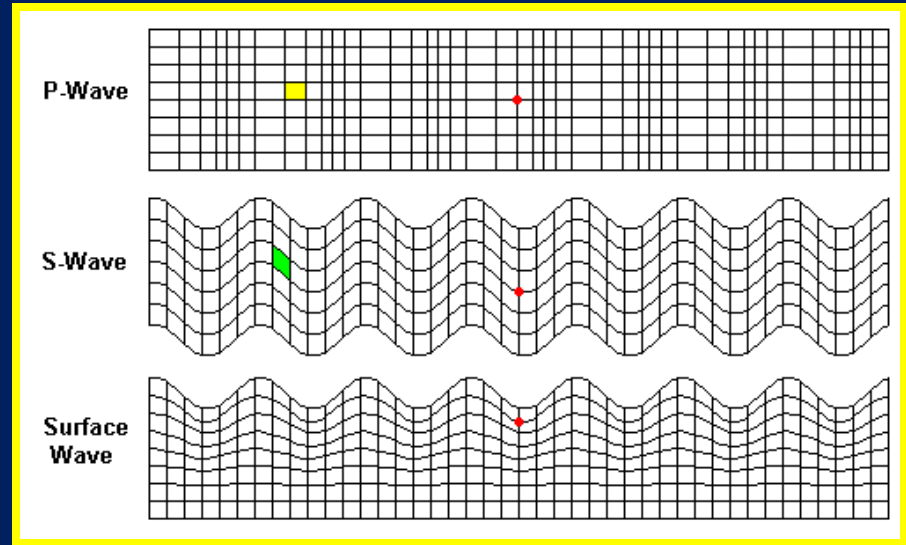
The location at which the actual earthquake occurs is called the focus.



The location, on Earth's surface, directly above the focus is called the epicenter.

# Seismic Waves

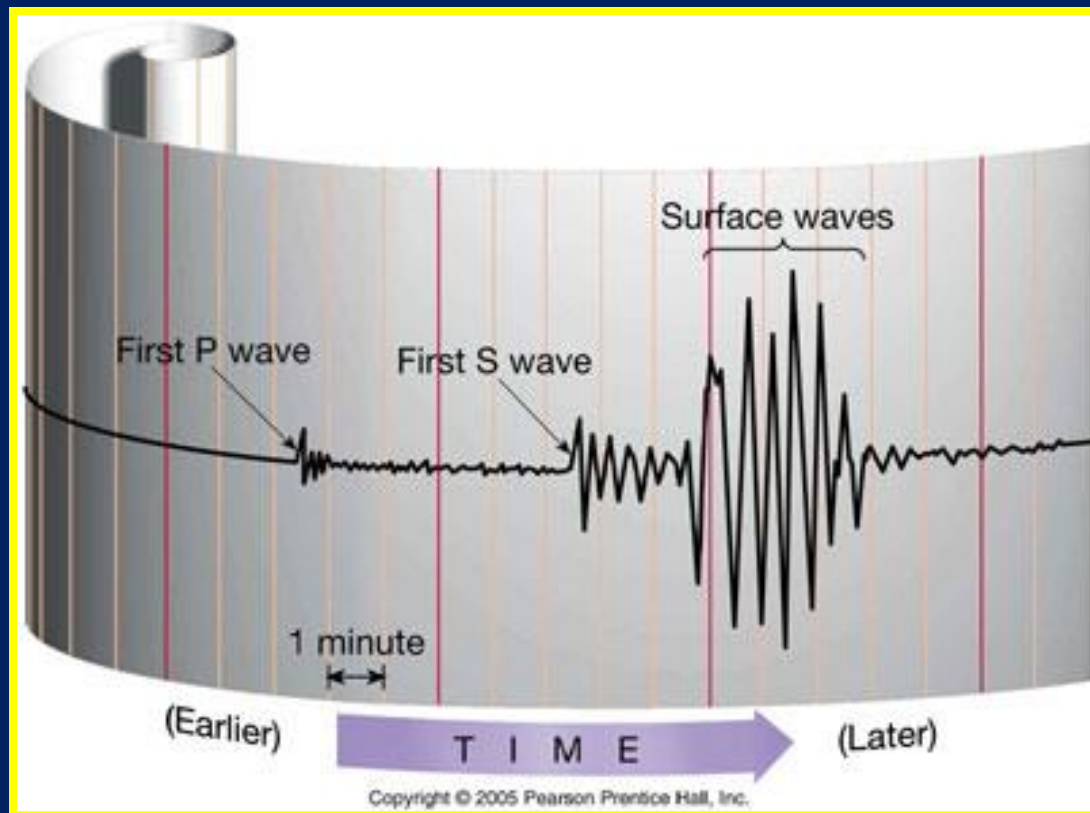
Also recall that there are three different types of seismic waves: primary waves, secondary waves, and surface waves.



Seismic waves from earthquakes are measured and recorded at seismic stations located around the world.

# Seismic Waves

At seismic stations, primary waves arrive first; secondary waves arrive second; and surface waves arrive last.



# Time Vs. Distance

The farther away the epicenter is from where the waves are recorded, the more time separation there is between the primary and secondary waves.

## Seismic Travel-time Curve

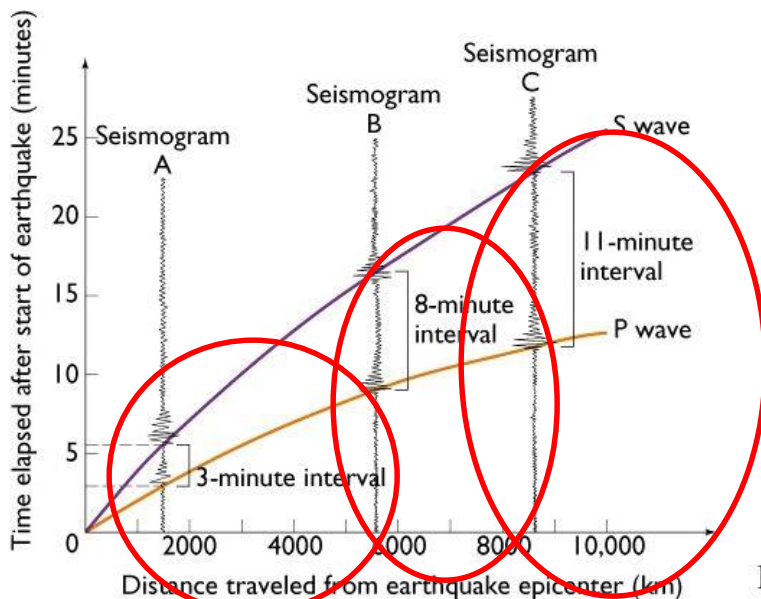


Fig. 18.9b

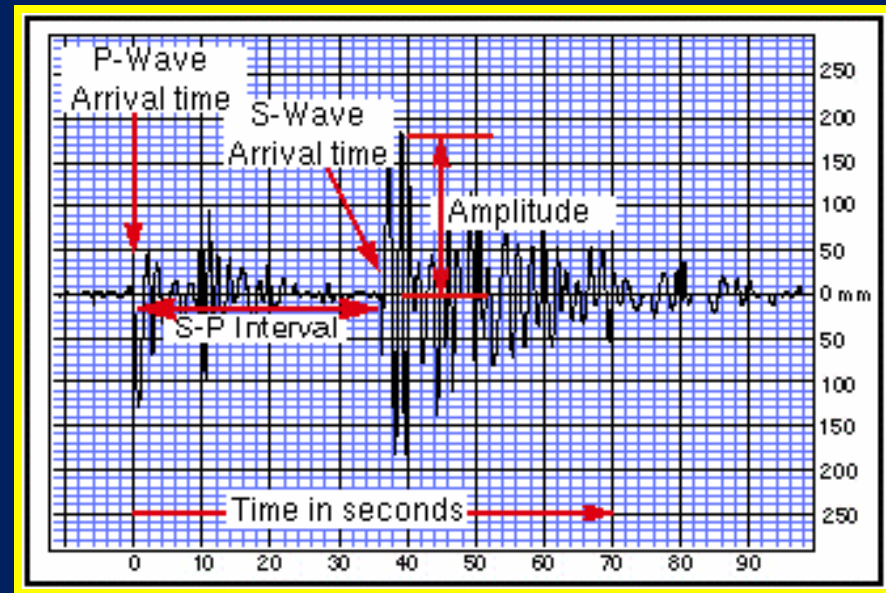
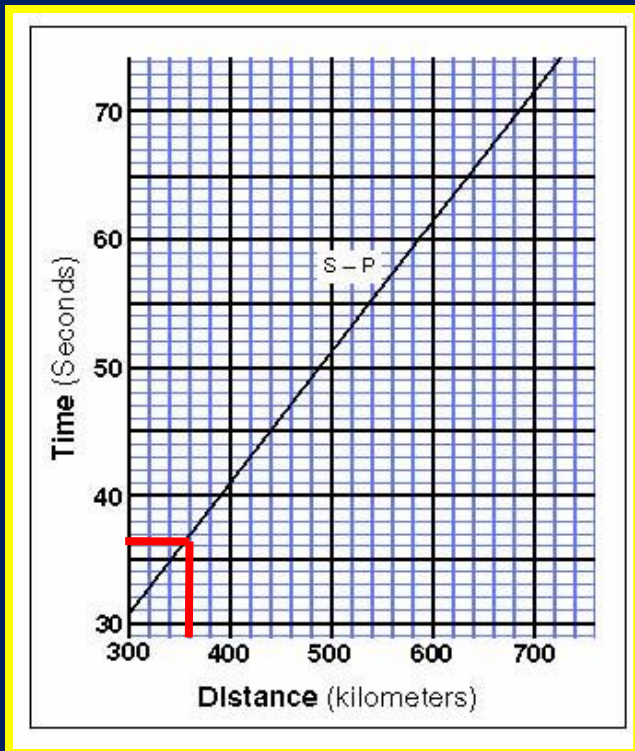
2,000 km - 3 minute interval

6,000 km - 8 minute interval

8,500 km - 11 minute interval

# Distance to Epicenters

Overtime, seismologists have developed a Time-Travel Curve graph that can be used to predict the distance from a seismic center to the epicenter of any earthquake.

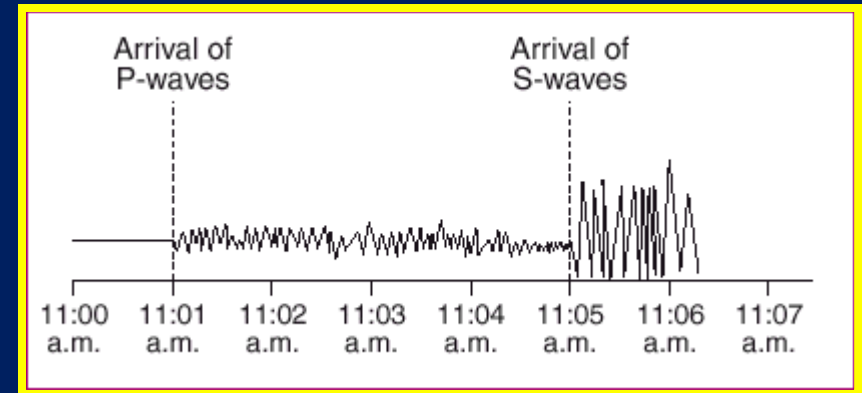
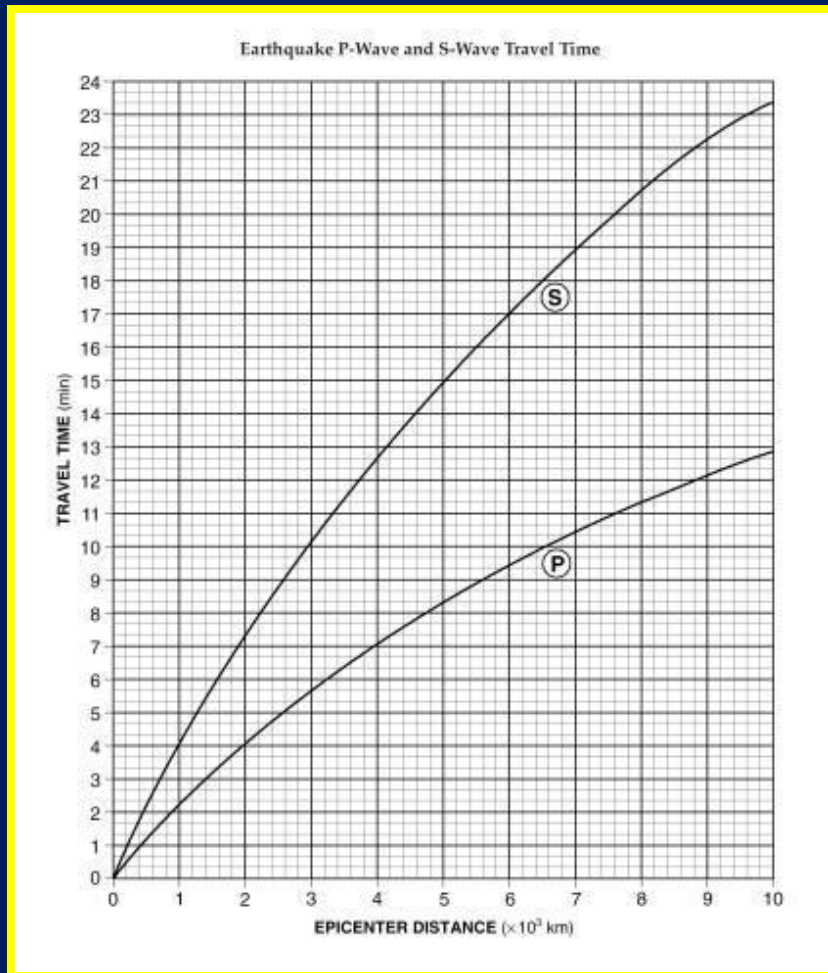


Time = 36 seconds

Distance = 360 km

# Distance to Epicenters

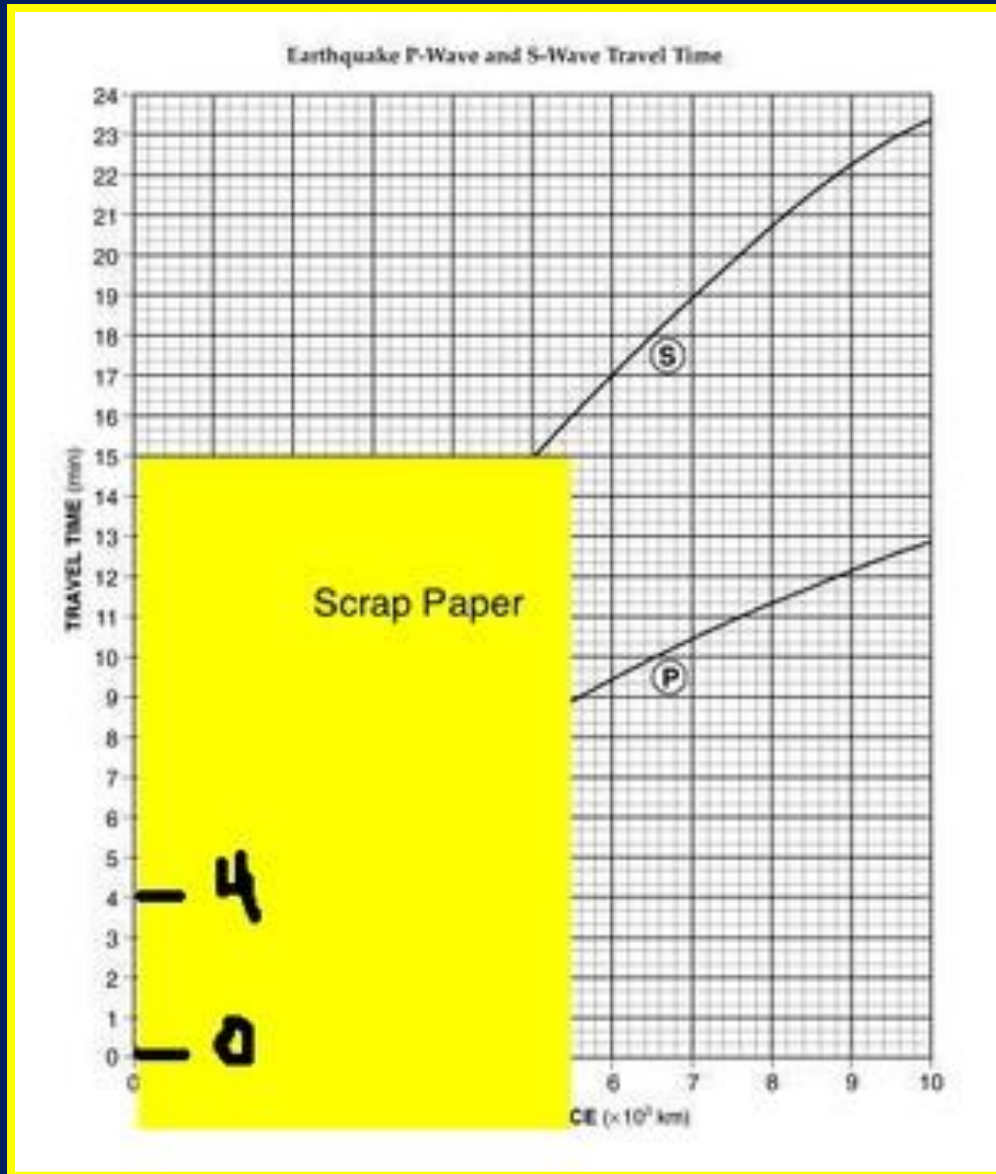
Most Time-Travel curves include both P-waves and S-waves.



1. Subtract the difference in arrival times

$$11:05 - 11:01 = 4 \text{ minutes}$$

# Distance to Epicenters

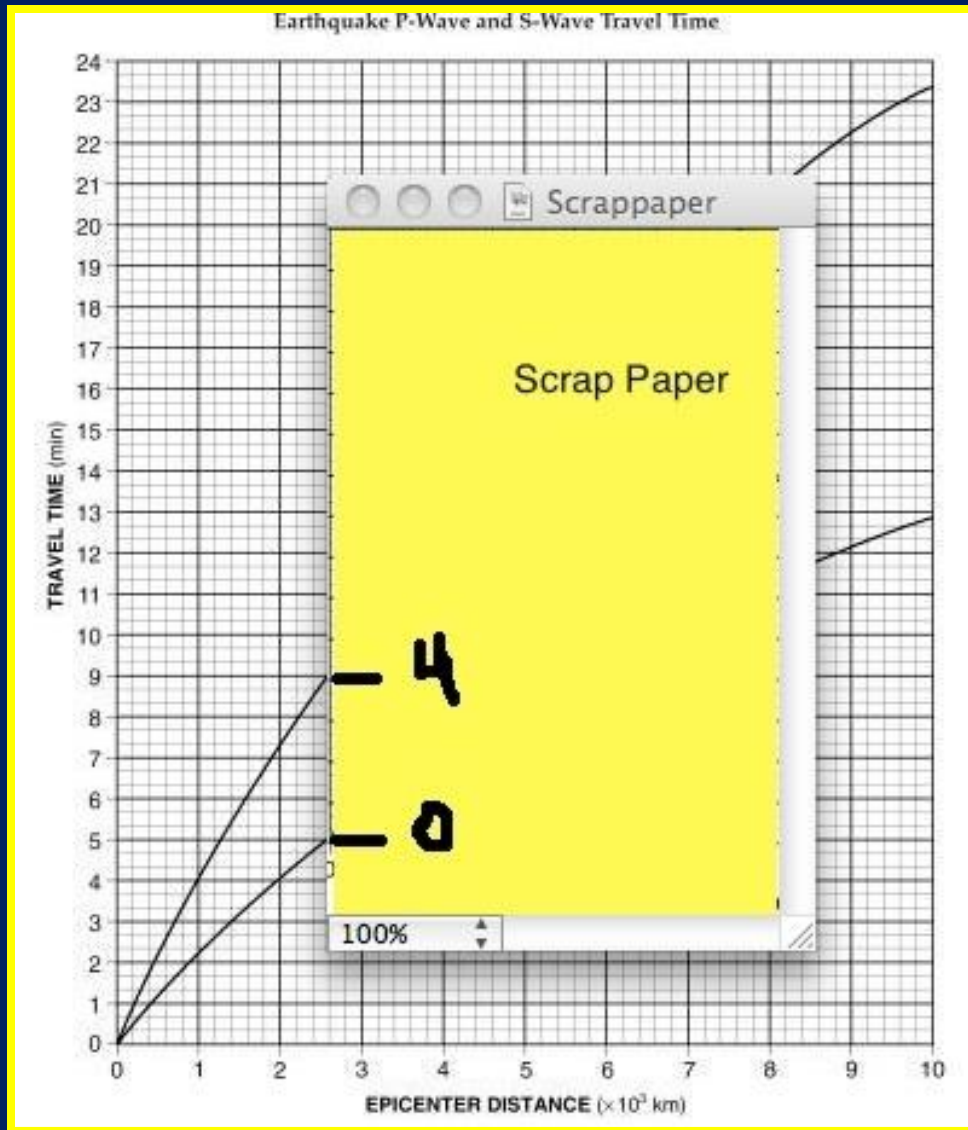


2. Line up a piece of scrap paper with the axis

3. On the scrap paper, mark O and the time difference, in this case, 4 minutes.

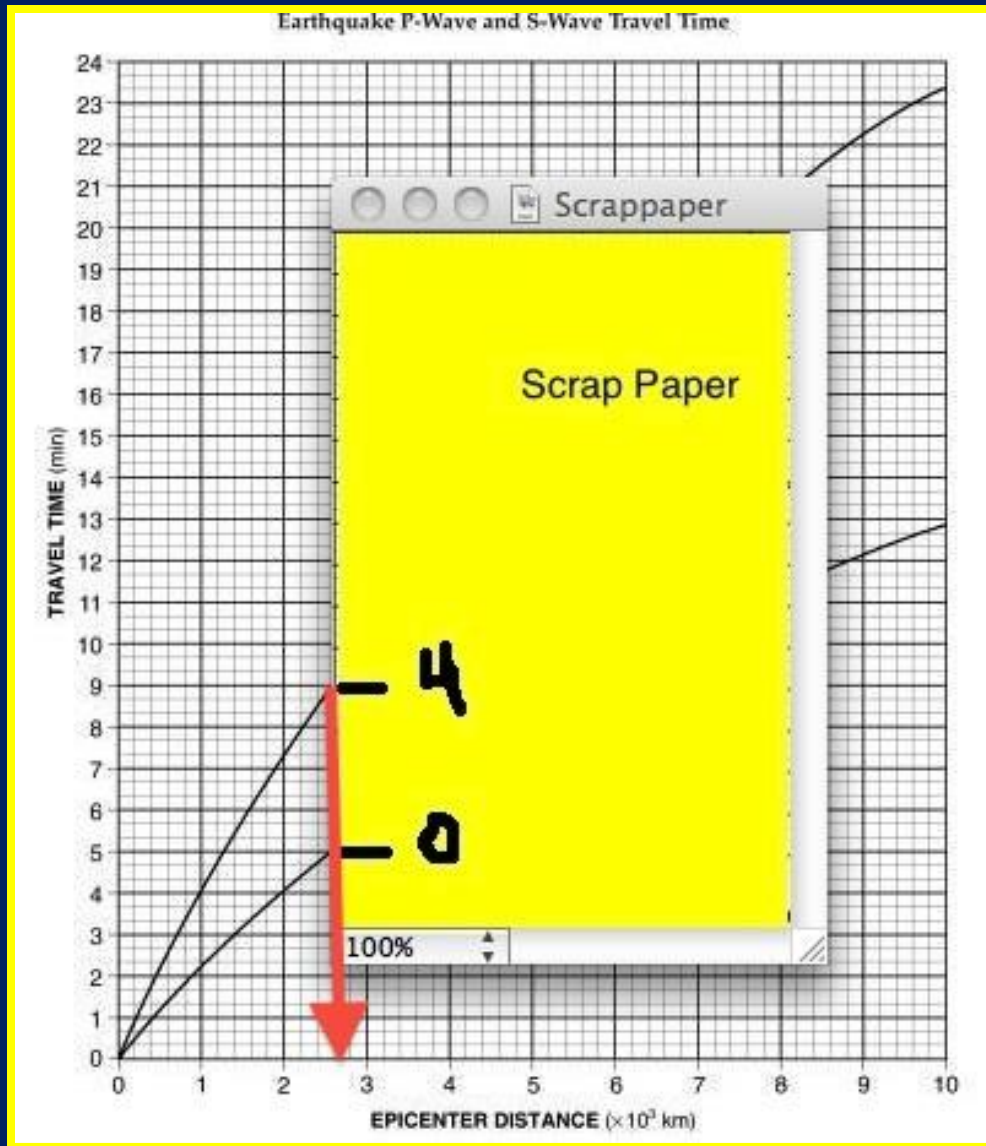


# Distance to Epicenters



4. Slide the scrap paper across the graph until the two marks match the P and S curves

# Distance to Epicenters

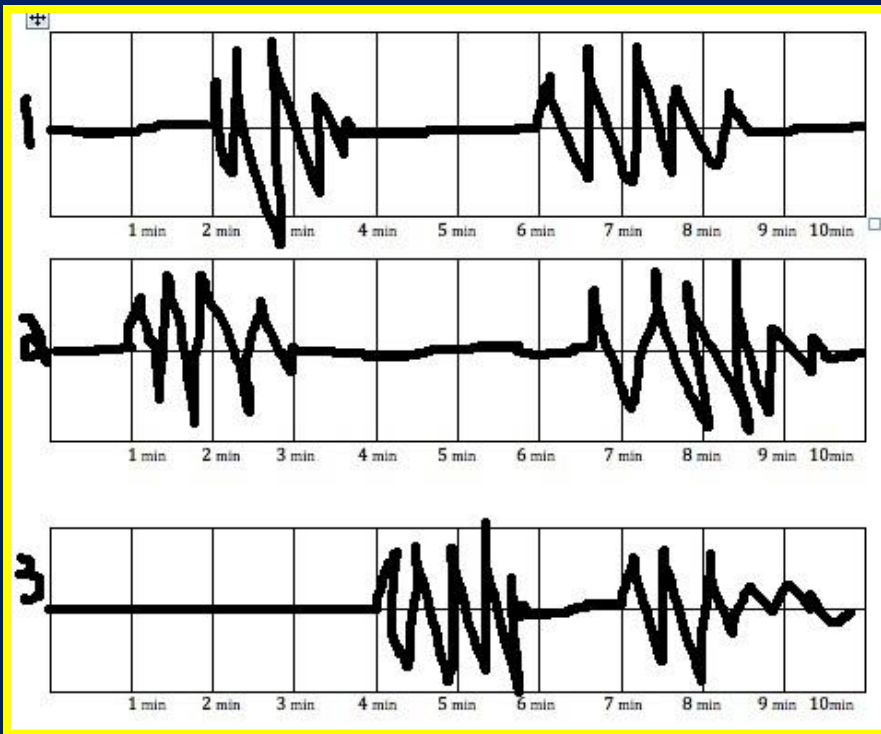


5. Follow the edge of the paper downward, to find the distance to the epicenter.

2,600 km

# Locating Epicenters

In order to find the exact location of an epicenter, you need to use seismographs from three different stations.



**Station 1**

Time Difference = 4 min.

**Station 2**

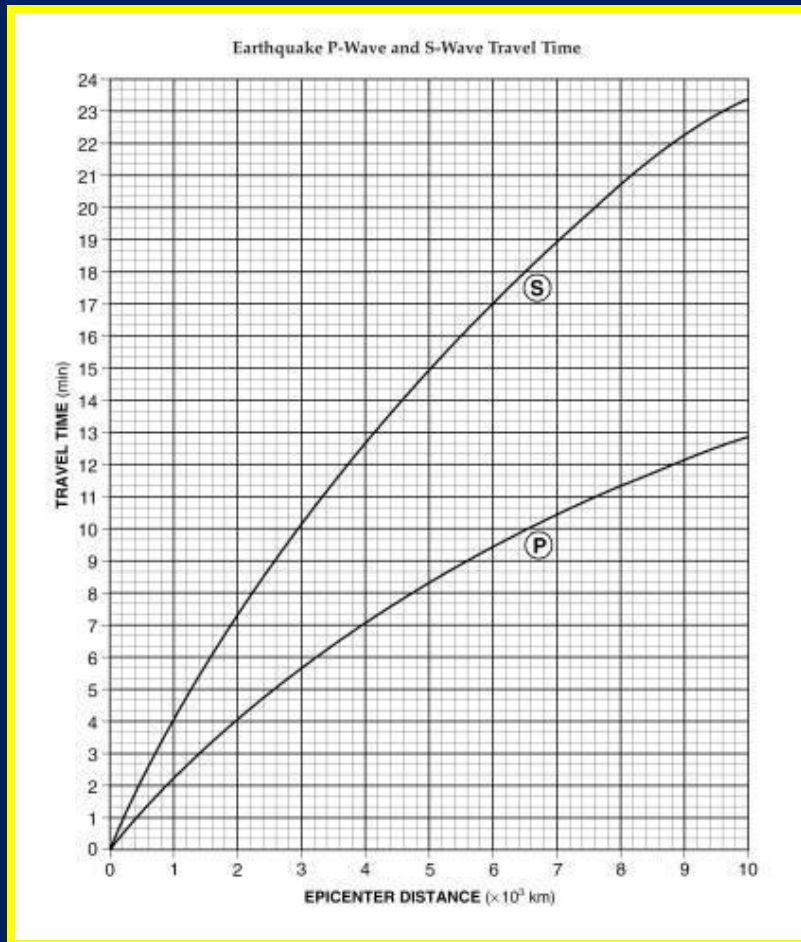
Time Difference = 5.6 min.

**Station 3**

Time Difference = 3 min.

# Locating Epicenters

Next, use the Time-Distance curve to find the distance from each station to the epicenter.



**Station 1 (Time = 4 min)**

Distance = 2,600 km

**Station 2 (Time = 5.6 min)**

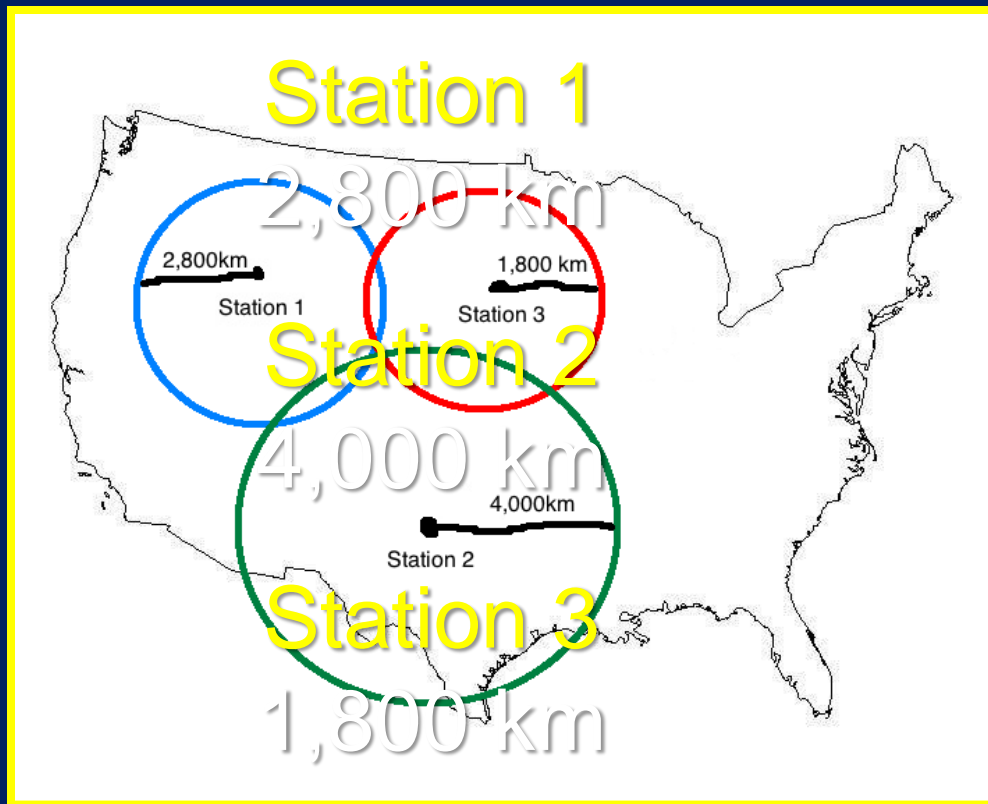
Distance = 4,000 km

**Station 3 (Time = 3 min)**

Distance = 1,800 km

# Locating Epicenters

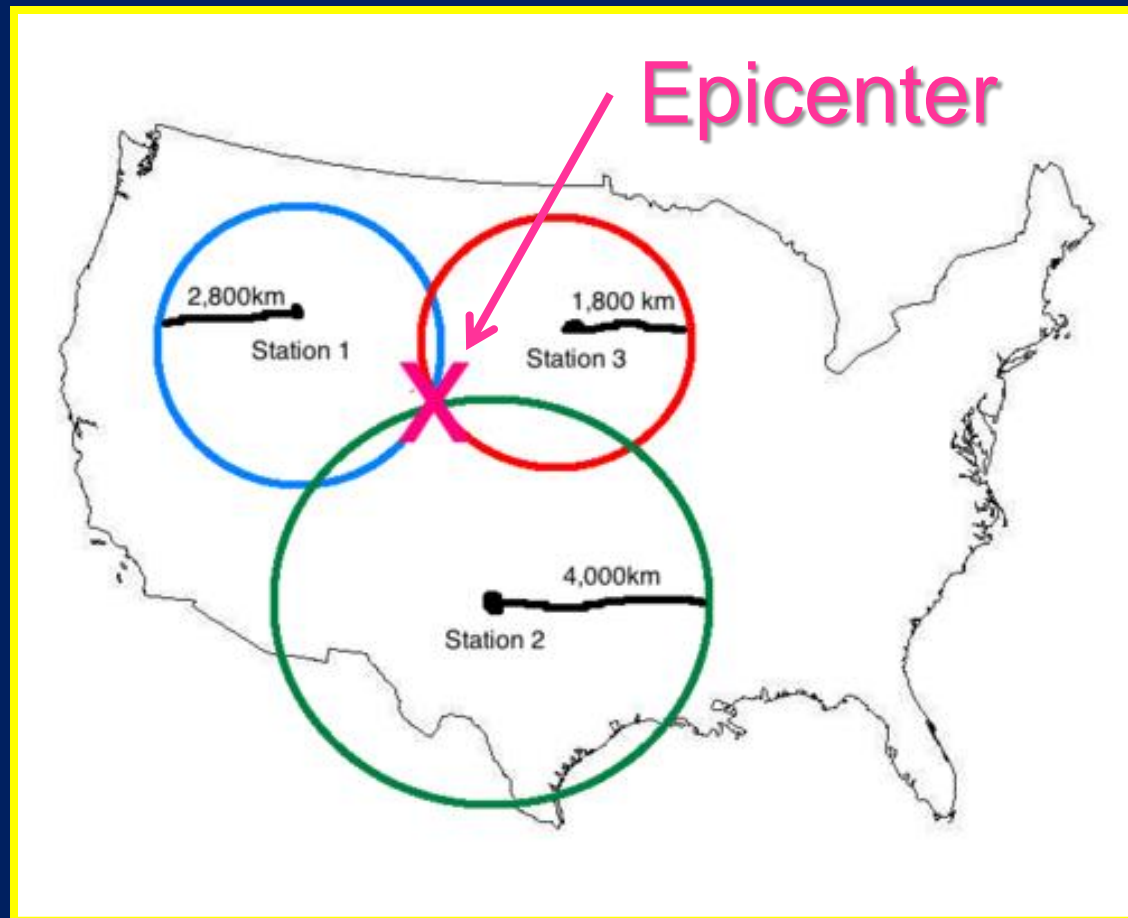
While we now know the distances to the epicenter, for each station, we still don't know the direction.



Therefore, we have to draw circles around each station, with the radius being equal to the distances.

# Locating Epicenters

The epicenter is located where the three circles intersect.



# The End

