

Earthquake Triangulation

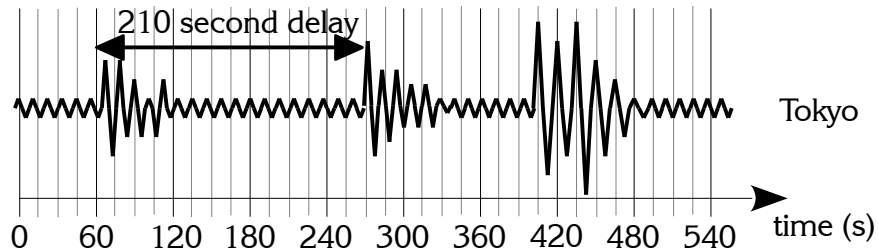
Because P-waves and S-waves travel at different speeds through the Earth, it's possible to estimate the distance to an earthquake's epicenter. Measure the delay between the arrival of the two waves on your seismogram, and then calculate the distance with this formula:

$$(\text{delay in seconds}) \cdot (5 \text{ miles/second}) = (\text{distance in miles})$$

For a given earthquake, you only need three seismograms (from different monitoring stations) to locate the epicenter. Since there are three measurements involved, this is called **triangulation**.

For each seismogram, once you know the distance from the monitoring station to the epicenter, use the scale on the map to set your compass. Draw a circle with that radius around the station. Once you have three circles drawn for the same earthquake, they should all cross at a single location. That's your epicenter!

Example



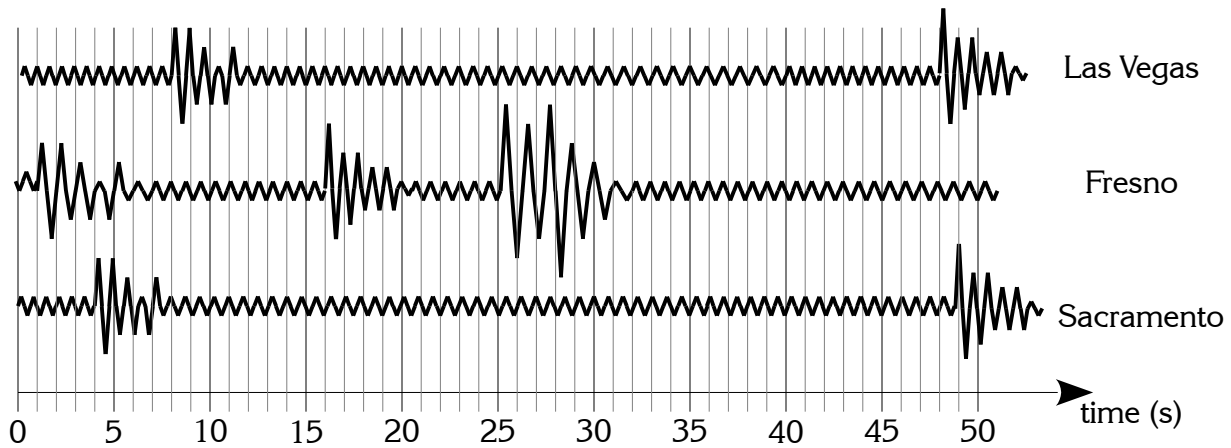
This seismogram was recorded in Tokyo. The P-waves arrived at a time of 60 s and the S-waves arrived at around 270s. This means a delay of 210 seconds between them. (If you see a third bunch of waves, they're the surface waves. You don't need to measure them for this activity.)

Each second of delay represents 5 miles, so the distance to the epicenter is $5 \cdot 210 = 1,050$ miles.

If you had a map of Japan, you could then use the scale on the map to set your compass to a distance that represents 1,050 miles and draw a circle centered on the city of Tokyo. The epicenter of the quake must be somewhere on that circle.

With data from two more stations you could draw two more circles. The spot where all three circles intersect would be the epicenter of your earthquake.

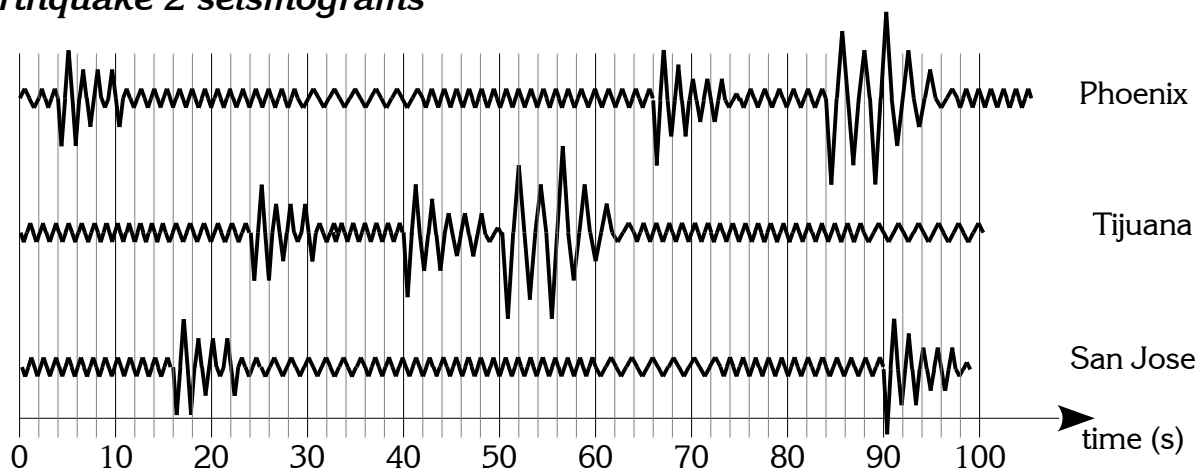
Earthquake 1 seismograms



Do your work here before flipping to the map:

Station	P-Wave Arrival Time	S-Wave Arrival Time	Delay Time (S - P)	Miles to epicenter
Las Vegas				
Fresno				
Sacramento				

Earthquake 2 seismograms



Do your work here before flipping to the map:

Station	P-Wave Arrival Time	S-Wave Arrival Time	Delay Time (S - P)	Miles to epicenter
Phoenix				
Tijuana				
San Jose				

California and the Southwest US

Use this map to locate the earthquakes from your seismograms. Note the scale in the bottom-left corner of the map! When you determine the number of miles from a station to the epicenter, you'll need to use that scale to figure out what size of a circle to draw.

Draw the circles for your two earthquakes in different colors to make the map less confusing!



Questions

1. What information about an earthquake can you learn from a single monitoring station's data?
2. How many stations do you need to pin down the exact location of an earthquake?
3. Compare your earthquake locations with a map of known faults in California. Does it seem like your locations are plausible?
4. Your three circles for an earthquake might not have crossed perfectly at a single point. Name TWO possible reasons for this.