Earth Science Regents
Locating an Epicenter

Name______________________

Period ______

Introduction:

As you have learned in class, earthquakes are vibrations caused by large releases of energy. These energy releases can occur as a result of fault movements, asteroid impacts, volcanic eruptions, and movements of magma, as well as by explosions. As a result, vibrations can begin both in and on the Earth's crust. The energy released radiates away from the point of origin, the **focus**. Commonly, when describing the *location* of an earthquake, scientists and the media often talk about the earthquake's **epicenter,** the point on the Earth's surface directly above the focus.

Earthquake energy can be recorded on a **seismograph**, producing a **seismogram**. Seismographs can "pick up" several types of energy **waves**, which travel through the Earth, and radiate in all directions from the focus. Two of these waves are used to locate earthquake epicenters:

- **"P"-waves** or **longitudinal waves:** "P" stands for primary. These waves travel fastest and arrive at seismographs first. They are compressional ("push-pull") waves.
- **"S"-waves** or **transverse waves:** "S" stands for secondary. These waves travel more slowly and arrive at seismographs after P-waves. They are perpendicular ("side-to-side") waves.

As you may recall, we use travel time graphs (Page 11 ESRT's) to show how long it takes each type of seismic wave to travel a distance, measured on Earth's surface. The difference between the *S-wave* arrival time and the *P-wave* arrival time corresponds to the distance of the seismograph from the focus of the earthquake. However, these waves can arrive at a seismograph from ***any direction!*** Thus, one seismograph is not enough to determine the epicenter of an earthquake. A second seismogram, recorded in a different location, can narrow down the possible location to some degree, but at least three seismograms are required in order to accurately plot the epicenter.

In this lab, you will use seismograms from three locations to determine the epicenter of an earthquake. You will use the *P-* and *S-wave* arrival time difference to determine distance to epicenter, then use a compass to record the distance radius measured by each station. Remember, accuracy is important- take care to make accurate measurements!

Materials:

- ❑ 3 seismograms from the same earthquake
- ❑ Safe drawing compass
- ❑ *P-* and *S-wave* travel time curve
- ❑ Map for plotting the earthquake epicenter
- ❑ Straight edge

Procedure:

1. Examine Figure 1, which shows seismograms of an earthquake recorded at three different locations. Note that the first set of zigzags at each city indicate the arrival of P-waves, and the second set of zigzags indicate the arrival of S-waves. In order to determine the time of arrival for each P- and S-wave, move your finger in a straight line down to the **time axis** beneath the wave.

2. Estimate to the nearest ten seconds, the times of the first arrival of the P-waves and S-waves at each station in Figure 1. Then, subtract the S minus P:

	First P arrival	**First S arrival**	**S-P**
San Jose, Costa Rica			
New York, NY			
San Francisco, CA			

4. Next, find the earthquake's epicenter, using the distances just obtained and the procedure below.

- Use the **scale** in Figure 2 to set the appropriate radius on your compass. You can do this by opening your compass to a length equal to the ***Distance to Epicenter*** determined for **San Jose, Costa Rica**, as recorded in the chart above.
    - **NOTE:** You may notice that the distance is LONGER than the scale. Open the compass to the entire length of the scale (3,000 km). Then, move the compass to the LEFT until the point that WAS on 3,000 touches 0. Then, continue opening it the REMAINING length.
- Place your compass point on the circle labeled **San Jose** on your map. Scribe a complete circle around the seismic station.
- Repeat this procedure for **New York** and **San Francisco**.
- The circles you should draw should intersect near one point. **This point is the epicenter!**

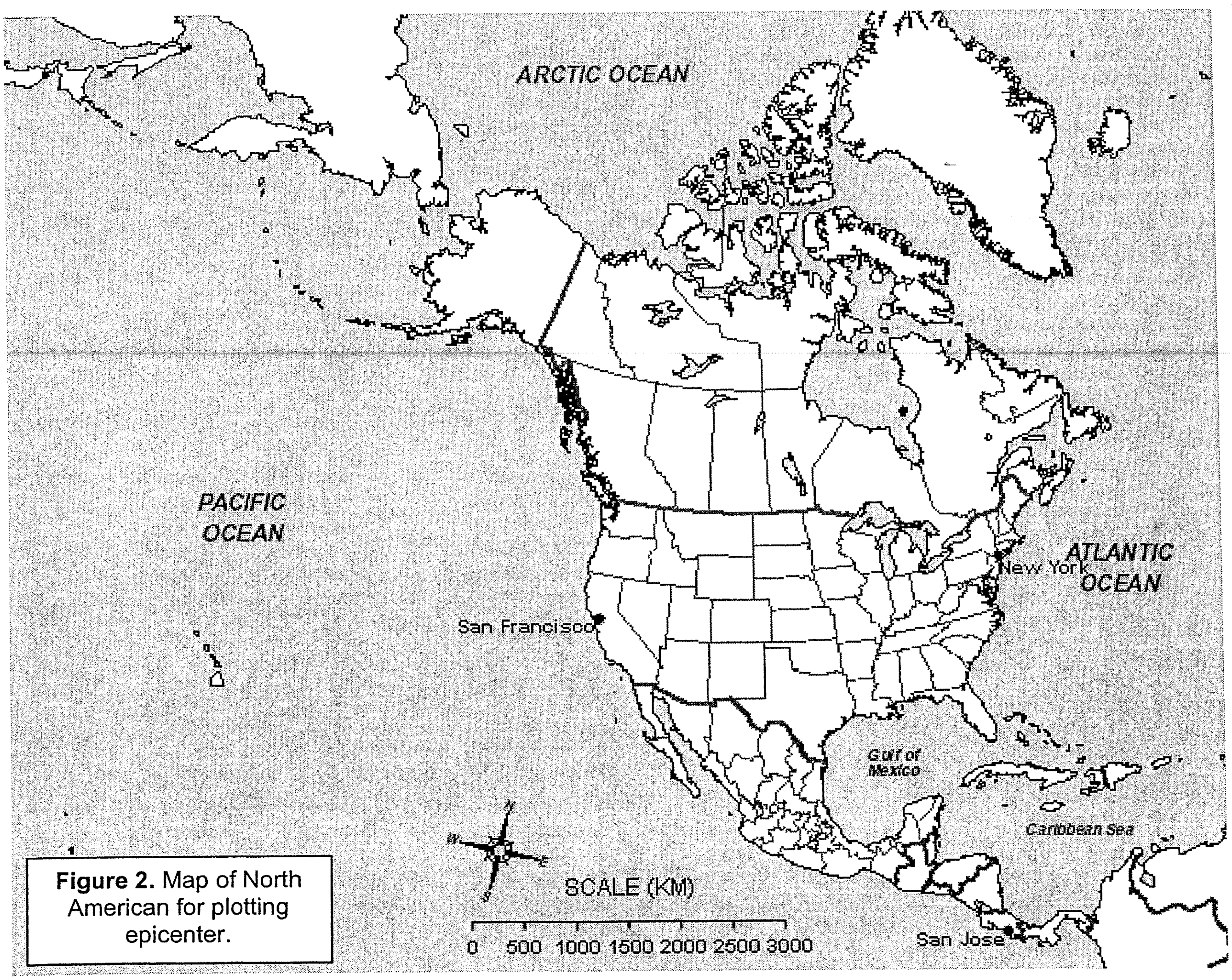

Figure 2. Map of North American for plotting epicenter.