**How Do Seismograph Stations Determine An Earthquake Epicenter?**

**I. Introduction**

 Earthquakes can be dramatic events. Although we can sometimes see an earthquakes effects, it actually occurs in Earth’s crust. Forces inside Earth keep its crust in constant motion. When the crust moves, it puts stress on rocks. The rocks break when the force is too great. Earthquakes are the vibrations that a break produces. Earthquakes produce seismic waves. Primary waves, or the first waves, move through Earth by making particles in rocks move back and forth in the direction the wave is moving. Secondary waves move through Earth by making particles in rocks move at right angles to the direction of the wave.

 Primary earthquake waves travel faster than secondary earthquake waves. Seismologists can use this difference in speed to determine the distance from a seismograph station to an earthquake’s epicenter. Because primary waves are faster, they will arrive at a seismograph station before secondary waves. The difference in arrival times of seismic waves increases with the distance between the epicenter and the seismograph station. Therefore, seismologists can tell how far away a seismograph station is from an earthquake epicenter by measuring the difference in arrival times of the two seismic waves. The epicenter location can be found using three seismograph stations.

 In this Virtual Lab you will use primary and secondary wave data from seismograph stations to determine the location of an earthquake epicenter.

**II. Procedure**

 1. Start the activity by going to the following website :

<http://www.glencoe.com/sites/common_assets/science/virtual_labs/ES09/ES09.html> .

 2. Read the news flash. Click Close to start the activity.

 3. Click a station letter on the U.S. map. Open the Table and record your selection in the

 appropriate row and column.

 4. Read the Seismograph Readout for the station. Find the difference between the arrival times

 of the primary and secondary waves by subtracting P from S. Each tick on the Seismograph

 Readout represents 15 seconds. Round off your finding to 15 seconds. Use the Calculator if

 you need to. In order to find the difference in arrival times, you will need to subtract the

 primary wave arrival time from the secondary wave arrival time. To do this, you may need to

 "borrow" a minute and add it to your seconds. For example, if the primary wave arrived at

 2:12 P.M. and thirty seconds, and the secondary wave arrived at 2:15 P.M. and fifteen

 seconds, you could re-write 2:15:15 as 2:14:75 as shown below :

 2:15:15 2:14:75

 - 2:12:30 - 2:12:30

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 2:45

 Open the Table and record your findings in the appropriate row and column. Note : The

 time is always listed in Eastern Standard Time. For example, 2:00:00 is two o’clock exactly. "P" stands for Primary Wave Arrival Time and "S" stands for Secondary Wave

 Arrival Time. The first major upswing or downswing is the beginning or arrival time of a

 primary wave.

 5. Click the Distance Graph button. Each tick on the Y axis represents a 15 second increment.

 On the Y axis find the time difference you calculated and then find the corresponding X

 value. Round off the distance to the nearest 500m increment. Click Close. Open the Table

 and record your finding in the appropriate row and column.

 6. Click the pencil in the compass. Drag it to the notch that corresponds with your distance

 finding.

 7. Click the Draw Circle button to place the circle around the station. (Some circles may not be

 completely visible because they are larger than the map.) Click the Erase Circle button if you

 want to erase the circle of the selected station.

 8. Select another station. Repeat the above steps until you have at least three circles.

 9. Click Check.

 10. If your circles are correct, the epicenter star will highlight. Click and drag the star to the

 epicenter of the intersection of the circles.

 11. Click the Reset button to explore different stations and find another earthquakes epicenter.

**III. Data**

 1. Record your data in the table.

|  |  |  |
| --- | --- | --- |
|  **Station** |  **Difference Arrival Times (min. & sec.)**  |  **Distance From Epicenter (km)** |
|  |  |  |
|  |  |  |
|  |  |  |

**IV. Analysis & Conclusions**

 **1. Which state was the earthquake's epicenter located in? Refer to a map of the United**

 **States if necessary.**

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 **2. Why does the time difference between the arrival of primary and secondary waves grow**

 **longer at Seismograph stations that are farther away from the epicenter?**

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 **3. How can the epicenter of an earthquake be accurately located?**

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