The earth moves under our feet

from the Esri GeoInquiries™ collection for Earth Science

Target audience – Earth Science learners **Time required – 15 minutes**

Activity	Investigate where current quakes are today from ground-sensed motion.
Science Standards	**NGSS:MS-ESS2-3** – Analyze and interpret data to provide evidence for phenomena. **NGSS:MS-ESS2-4** – Develop a model to describe unobservable mechanisms.
Learning Outcomes	• Students will describe how the energy from breaking rocks at an earthquake epicenter travels away in waves. • Students will determine where earthquakes occur using the difference in speed of waves from the seismograph.

Map URL: http://esriurl.com/earthgeoinquiry7

Engage

How can you tell how far away lightning strikes?

→ Click the URL above to launch the map.
? Describe what happens to an ice pop stick or a pencil when you apply continual pressure to bend it. *[Eventually, it breaks, releasing the energy as a loud snap.]*
? At a track meet, in which order do these events happen: runners start running; smoke rises from the gun; you hear the starter pistol?
? Why do these events at a track meet happen in this order? *[Light waves travel quickest, so you see the smoke first. The sound typically reaches you next because it is fairly fast. The runners take time to respond and are last .]*

Explore

How do you measure an earthquake?

→ Click the link in the upper-right, Modify Map.
→ With the Details button underlined, click the button, Show Contents of Map (Content).
– The Global Seismographic Network is displayed on the map.
? What are seismograph machines listening for? *[A seismograph measures earthquakes by an independent mass hanging from a spring and a writing device attached to a string. When the seismograph moves, the mass tends to stay still because of inertia, and the pen marks the disturbance on a moving plot of paper attached to the floor.]*
→ Click several of the seismograph locations on the map, and then click More Info when the pop-up box opens.
? From the information on the pop-ups, where are seismographs housed? *[They are frequently stationed in basements or small shelters underground to firmly feel when earthquakes happen.]*
→ Scroll down to the tabs below the map on the More Info seismograph page for one seismograph you clicked on.
→ Click the Heliplot tab.
? Looking at the heliplot drawing, what does a typical earthquake look like? *[Earthquakes display as bigger squiggly lines along where the pen makes the mark on the heliplot - at least two "packets" of squiggly lines (P waves and S waves).]*

Explain

Do all waves travel the same?

– The time between the P and the S waves tells you how far away you are from a quake. The heliplot is marked off in 10-minute intervals.
– Use a ruler or note card to measure the distance between the start of the P and the S waves (x) and also the distance from the 0 to 10 minute mark (y). x/y = z the fraction of the 10 minutes between P and S waves.
– In this example, .6/2.3 = .26 of 10 minutes, or 2.6 minutes. Using this number, you can calculate approximately how far the wave travels in a 2.6-minute time period. Example wave traveled 1,300 km to the seismometer.
– Click any seismograph point, and enlarge the graph in the pop-up to compare the computed time to the chart.

more ▶

Elaborate

What is used to calculate quake distances?

- Click the Caribbean Quake bookmark to zoom to the three practice seismometers to determine where a quake occurs.
- Turn on the layer, Finding Epicenter Tools. Click each pin to measure the time between P and S waves.
- Use this time to calculate the quake distance from each instrument with the formula in the Explain section.
- Use the Measure tool to mark some landmark at the quake distance that is easily recognizable.
- Click the Edit button, and choose the Quake Distance From Seismograph circle to stretch a circle from your seismograph to the feature you just determined. The quake should have occurred somewhere on this circle.
- Draw circles around the remaining two seismographs, and find the location of the quake where the circles overlap.

Evaluate

Are you ready to be an earthquake hunter?

? Search the seismograph link heliplots to determine a quake's location from three different seismographs.
– For ease, after you find a medium-sized or large earthquake, look for sensors within a similar region whose P and S waves are less than 10 minutes apart.

MEASURE

- At the top of the map, click the Measure button.
- Hover and click the Distance button.
- Click and drag the mouse to the km from wave to seismometer computed in the Explain section.

BOOKMARK

- At the top of the map, click the Bookmarks button.
- Choose your bookmark; the map will take you there.

Next Steps

DID YOU KNOW? ArcGIS Online is a mapping platform freely available to public, private, and home schools. A school subscription provides additional security, privacy, and content features. Learn more about ArcGIS Online and how to get a school subscription at http://www.esri.com/schools.

THEN TRY THIS...

•Log in to your ArcGIS organization account and perform analysis on World Mountain Ranges.

•Select a seismograph of interest, and calculate a buffer of the appropriate distance from the seismograph.

TEXT REFERENCES

This GIS map has been cross-referenced to material in the earthquakes sections of chapters from middle-school texts.

- *Earth Science by Glencoe McGraw Hill – Chapter 11*
- *Earth Science by Holt – Chapter 7*
- *Earth Science by McDougal Littell – Chapter 7*
- *Earth Science by Prentice Hall – Chapter 6*

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