3.6 Investigate

How Can One Year of Earthquake Data Help You Better Identify Plate Boundaries?

You noticed that using one week of earthquake data left you with some gaps in your plate boundary inferences. If you had more data, you might be able to make better decisions about the locations of the plate boundaries.

You and your partner will use a tool called the Big Data Map to improve your plate boundary predictions. The Big Data Map is a large map of the world, very much like the Big World Map, but with earthquake data marked on it. You will be examining the Big Data Map to identify where earthquakes occurred in your region during a one-year period. You will use that data to make inferences about the location of the plate boundaries in or near your region. You and your partner will be sharing a Big Data Map with others whose regions are geographically close to yours.

When you have completed analyzing the map, you will use My World to fill in even more detail. With a year of data, you may have a better idea of where the plate boundaries are located in and near your region.
Learning Set 3 • What Happens at Plate Boundaries?

Procedure

1. With your partner, examine the Big Data Map to understand what it represents. After reading each question below, find the data on the map that helps support your answer, and then, discuss the answers with the other students who are working with you on the Big Data Map.

- Over what period of time did earthquakes recorded on the Big Data Map take place?
- What earthquakes does this map show? Does it show all the earthquakes that took place over a year?
- What would the map look like if all the earthquakes for the year were plotted?
- What information does this map give you about each earthquake?

Materials
- Big Data Map
- blank transparencies
- transparent tape
- transparency markers in black, red, and green
- masking tape or paper clips

Earthquakes from the year 2002, mag. 4.5 and above. Collected from the Advanced National Seismic System (http://www.anss.org), and the NGDC Natural Hazards Database (http:ngdc.noaa.gov/seg/hazard/vol_srch.shtml).

The Big Data Map
2. Do not write or draw on the Big Data Map. You will use transparencies to record data and draw plate boundary predictions. Place transparencies over the part of the map where your region is located and tape them together. Secure your transparencies to the map using clips or masking tape. Trace enough latitude and longitude coordinates (intersections and numbers) from the Big Data Map onto your transparencies so you can place them back in the same spot on the Big Data Map each time you use it.

3. Observe the earthquake activity in your region. Look for bands and clusters of earthquakes. The bands and clusters you find will help you identify the plate boundaries in your region.

4. Discuss with your partner where you think there are plate boundaries in your region. To identify these boundaries accurately, you need to see a band of earthquake activity. There may be places on the map with so many dots that their pattern is hard to distinguish. There may also be places where there are not enough dots to be certain about a plate boundary. To help you identify where the plate boundaries are within your region, read Identifying Plate Boundaries from Earthquake Data on the next page.

5. Share the plate boundary you are identifying with the other students working with you at the Big Data Map. Take turns pointing to the bands and clusters you have identified, and together, sort them into three categories:
   - bands that seem to have the right amount of data for you to identify plate boundaries
   - bands or clusters where you think there is a boundary but have so much data that you are not sure where the boundary is
   - bands or clusters where you think there might be a boundary but where there is too little data for you to be sure

Mark each band or cluster with a different color marker.
Identifying Plate Boundaries from Earthquake Data

Look at the Aleutian Islands, Alaska, on the data maps on the next page. Think about what each map tells you about the location of the plate boundary. The map with too much data shows you a wide band of earthquakes on the left and a huge cluster of earthquakes on the right. You can guess that the boundary zone on the left is between the red lines, but you cannot tell anything about the cluster toward the right. That cluster is not in a line. The boundary zone probably extends into that area, but you cannot tell which earthquakes are at the boundary and which are not. You need to narrow down the data in some way to identify the full plate boundary.

Identifying the location of the plate boundary on the map with too little data is difficult because there are so few earthquakes shown. There is no clear line of earthquakes to guide your inference. Within the red lines, you can see a band of earthquakes, but you cannot tell exactly where the boundary might be. The cluster on the right of that map gives you even less information. There might be a band extending diagonally from the red lines, but with so few earthquakes, you cannot know how to draw the line. You need to see more earthquake activity to identify the plate boundaries on this map.

The map with just the right amount of data shows a clear line of earthquakes in the lower left side of the map that extends into the middle right side of the map. The plate boundary is much easier to see on this map than on the other two.

The amount of data you will see on any earthquake map depends on two things: the amount of time the map covers (how many years or months) and the magnitude of the earthquakes plotted. The Big Data Map you are using shows one year of earthquakes with magnitudes greater than 4.0. It does not include earthquakes with magnitudes less than 4.0. There are some places in the world with enough earthquakes with magnitudes of 4.0 occurring within a year to see easily where a plate boundary is. In other places, one year of data provides too little or too much data for you to be sure about where a plate boundary is.
How Much Data Is Enough?
Look at the data maps of the Aleutian Islands, Alaska. One has too little data and the other has too much.

Too little data

Too much data

The data map below represents just the right amount of data. You will need to decide what data you need to support a plate boundary inference for your region.

Just right data

Where would you draw a plate boundary for the data represented here?
Analyze Your Data

1. Where is your region in relation to the plate boundaries you sketched? Is your region in the middle of a plate, or is it on or very near to a plate boundary?

2. In what ways did your plate boundary predictions change after using a whole year of data? Why did they change?

3. What earthquake data do you need to feel more confident about your plate boundary predictions?
Refine Your Data to Improve Your Plate Boundary Inferences

To better identify where the plate boundaries are in your region, you will now use maps from My World. Using My World, you will be able to examine three years of data for earthquakes with magnitudes larger than 4.0. You will be able to select only the data you want. For example, if some part of your region has so many earthquakes that three years of data is too much, you can choose to look at only one or two years of data. If a year of data is too much in some part of your region, you can choose to look at less data. You can also change the way the world map appears. That is, you can change what you see to show the part of the globe you want to see and view the earthquake data more easily. For reminders about using My World, turn to the back of the book.

Procedure

1. Working with your partner, review the earthquakes and plate boundaries sketched on your transparencies. Identify regions where you need more data to support your plate boundary predictions. Mark those areas on a Three-page Map. You will refer to the Three-page Map as you work on the computer.

2. Prepare a My World earthquake map by following these steps.

   a) Open My World by double-clicking on the My World icon on your computer screen.

   b) From the Data Library drop-down menu, select Earth Structures & Processes.

   c) Open the ESInquiry file. This map has information about your regions, including latitude and longitude, elevation and depth, earthquakes and volcanoes.

Materials

- transparencies with your plate boundary sketches
- blank Three-page Map
- markers: blue and yellow
d) **Click on Earth Structure boxes.** Make sure the Show/Hide layer button is on (the eye icon is visible).

e) **Show the Earthquake data on your map.** In the Layer List, click Earthquakes big. This layer reveals all earthquakes with a magnitude of 6.0 or higher. If this layer is currently inactive, select the Show/Hide layer button on the right to reveal an eye. You now have the opportunity to choose how many years of data you wish to view. If there is not enough data when looking at only the big earthquakes, you can turn on the Earthquakes medium layer, which will reveal all earthquakes between the magnitudes of 4.0 and 5.9. If there is too much data, you can change the number of years of data shown.

f) **Zoom in and reposition the map to view the earthquakes in your region.**

3. Look at your Three-page Map to decide on which part of the plate boundary you need to focus.

4. Use My World to examine earthquake data in your region that will help you identify the locations of the plate boundaries.

5. As you identify plate boundaries, draw them on your Three-page Map. Annotate the map with earthquake data from My World that supports the inferences you make about your plate boundaries.

6. When you are finished gathering data, use the information you gathered from My World to revise the plate boundaries on your transparencies. Use a different colored marker than you used last time. Use a blue marker to mark plate boundary lines you are now sure of and yellow to highlight places where you still do not think you have enough data. You will be using the map to show the class your old and new plate boundary inferences.
Update Your Region Project Board

You have looked at earthquake data in several ways to determine the plate boundaries for your region. Working with your partner, record what you have learned about earthquakes in your region in the What are we learning column? of the Region Project Board. In the What do we think we know? column, record what you can now infer about plate boundaries in your region. Include any questions you still have. Record these in the What do we need to investigate? column.

Reflect

You have made two iterations of plate boundary inferences. Think back to each one as you answer the following questions.

1. How have your inferences changed as you collected more data?
2. Why have your inferences changed?
3. How confident do you feel now about your plate boundary inferences? What has affected your level of confidence?
Update the *Project Board*

You have been working with earthquake data to refine your plate boundary inferences. In the process, you have learned a lot about earthquakes and where they occur. You have also gathered evidence to justify the plate boundaries you have located. Now add what you have learned, along with the evidence to support it, to the *Project Board*.

As you worked on each iteration of your plate boundary map, you may have thought of more questions. For example, you know that the plates making up Earth’s crust move, but you may not fully understand how they move. These questions should be added to the *What do we need to investigate?* column.

**What’s the Point?**

Earthquake data can provide clues to the locations of the plate boundaries. These clues can be found in different amounts of earthquake data. Sometimes there is too much data, and it is difficult to see a pattern. With too little data, a pattern is also hard to find. It is important to identify the correct amount of data needed for answering different questions.