How many earthquakes happen every day in the USA?

links to NGSS: “Analyze and interpret data on natural hazards”, “Analyze and interpret data from maps”

Objectives:

Students recognize common locations of earthquakes in the USA.

Students discover that over 100 earthquakes happen every day in the USA.

Students find that small earthquakes are more common than large ones.

Time: 45 minutes

This activity works best with an internet-connected computer for each student or each small group of students. For classrooms that don’t have access to such technology, I have created 7 .csv files and the screenshot maps to go with each one. These can be used in place of having the students retrieve their own data by themselves.

If you do have computers, each student can work independently or the students can work in small groups. This is a jigsaw activity, so the results from each group will be compared and merged at the end.

Start out:

Ask students who has felt an earthquake, and if they have any guesses about how many earthquakes happen every day in the USA or in the world.

If you don’t have computers you can pass out my example files, but if you do have computers then follow the directions below.

Directions:

Go to https://earthquake.usgs.gov/

Click the link “Latest Earthquakes”

Click the Settings gear icon (top right corner)

Scroll down to the menu item “Search Earthquake Catalog”

Find Basic Options: under Magnitude choose Custom and enter 0.0 in the Minimum box

Under Date & Time choose Custom and enter your most recent birthday for the start and end days. For example, my birthday is December 13. So I enter 2016-12-13 00:00:00 in the Start box and 2016-12-13 23:59:59 in the End box.

Under Geographic Region choose “Conterminous US”

Click Advanced Options

Click Event Types

Choose Earthquakes

Click Output Options. Under Format choose Map and List. Under Order By choose Magnitude - Largest First.

Click the Search button.

Now you have a map with earthquakes located on it, and a list of their locations.

[For older students to do more with this data, you’ll want to download the list:

Click “Click for more information” then click the Download button. CSV is probably best.

The file you get looks large and scary but the first 5 columns have all the information you want. Those columns are date, latitude, longitude, depth, magnitude. We chose to order the events by magnitude so the biggest earthquakes are at the top of the list.]

First order observation questions:

1. What part of the world is shown on your map? [most of N. America, Caribbean, Central America]

2. What are the red lines on your map? [plate boundaries]

3. What are the circles? [earthquake locations]

4. Why are some of the circles different sizes and colors (click the “show legend” button to get the answer to this). Colors represent how recent an earthquake is, and sizes represent different magnitudes.

5. Describe where the earthquakes are. Are they just scattered randomly or are they in certain places more than others? [Most earthquakes are in the western US and many along plate boundaries but not all of them are.]

6. How many earthquakes were there on your birthday? In my example there were 150. In my 7 example files the range is 124 - 259.

7. What is the biggest earthquake and what is the smallest in your list? In my example, the biggest is 4.5 and the smallest is 0.0

\*\*#5, #6, and #7 are good ones for comparison because students will have slightly different maps and lists since they all chose different days, yet their answers will be similar. This brings up a point about the fact that even though we can’t predict earthquakes, we know where they are most likely to be found (plate boundaries).

Extending for older students:

Seismologists have known for a long time that there are about ten times as many earthquakes every year at each lower magnitude level. For example there are about ten times as many magnitude 2’s as magnitude 3’s every year.

We don’t even have to collect a whole year’s worth of data from the whole world to prove to ourselves that this is true. We can collect some data from part of the world and see for ourselves. We can use the data we already have right now.

1. Make a table of values like this:

|  |  |
| --- | --- |
| Magnitude bin | Number of earthquakes in the bin |
| 0 <= m < 1 |  |
| 1 <= m < 2 |  |
| 2 <= m < 3 |  |
| 3 <= m < 4 |  |
| 4 <= m < 5 |  |
| 5 <= m < 6 |  |
| 6 <= m < 7 |  |

Count how many earthquakes are in each magnitude bin. Your .csv file should already have them in order of magnitude, so it is not too hard to do this counting.

2. Use a google doc the whole class has access to or else each group go write on the board their table.

3. Combine all the tables into one total table by adding up the values in each bin. (The reason to do this is that the more data we have, the more robust the statistics will be)

4. Make a plot (can be a histogram, bar graph, scatter plot) where you put magnitude on the x axis and number of earthquakes in each magnitude bin on the y axis.

5. Make the same plot but make the y axis have a logarithmic scale (or else take the log of your y values before plotting if you are not adept at making log axes.) [Notice the linear relationship of regularly fewer earthquakes as magnitude increases. The log-linear relationship between frequency of earthquakes and earthquake magnitude is a known statistical property of earthquakes on faults, at least on this planet.]

5. Extending further: Why isn’t the line perfect, especially at the very small and very large ends? [The reason is that not every small earthquake gets recorded, so fewer magnitude 0 show up than there actually are. Also, since there are fewer mag 5+, it is statistically unlikely to find one if we only look at a few days of data. How to solve this problem: If you want to extend the line, you can collect more days of data and you will increase the chance of finding some big events. But the only way to extend the line further towards small events is to install more seismometers closer together to find all the teeny earthquakes.]