

## **EARTHQUAKE ANALYSIS**

### **GLOBAL DISTRIBUTION OF EARTHQUAKES IN SPACE AND TIME: AN EXERCISE ON THE INTERNET**

This exercise will ask you to use contemporaneous earthquake occurrences to draw conclusions about the global distribution, character, and frequency of earthquakes. The internet has become an increasingly useful tool for earthquake study, as cooperative networks of seismic stations share their data in real-time. We will be using the United States Geological Survey's (a branch of the Department of the Interior) "Earthquake Hazards Program" website. This can be reached via the Geology 11 Blackboard webpage (where you should select "External Links"), at the Geology 11 CMS webpage (where you should scroll down the main page to see the link labeled "Earthquake website link") or directly at: [http://earthquake.usgs.gov/eqcenter/recenteqsww/Quakes/quakes\\_all.html](http://earthquake.usgs.gov/eqcenter/recenteqsww/Quakes/quakes_all.html).

The United States Geological Survey (USGS) uses the records of seismograms from an extensive network to locate earthquakes and determine their magnitude in near real time, posting a bulletin of global earthquake occurrences that is updated almost continuously. (Note that the site only lists earthquakes that are larger than 4.0 in magnitude outside the U.S. and larger than 2.5 in magnitude within the U.S. There are many small earthquakes each day that go unrecorded.) Because this is a real-time list, you can expect it to be different each time you access it. This means (1) your answers to the following questions will differ from those of others in the class, depending on when you did the exercise, and (2) it is well worth visiting this site from time to time over the rest of the semester to see how frequent earthquakes are (or are not) on a human scale, and how they distribute themselves globally.

You will want to have your textbook with you as you do this exercise so that you can refer to several important figures.

### **GO TO THE USGS EARTHQUAKE ACTIVITY WEB PAGE.**

1) Check the most recent earthquake listed. What was its location? How long ago did it occur? (Time is given in "UTC" time, which is a universal geophysical clock. Simply check the current UTC time in red at the top of the page and subtract!)

2) How many earthquakes are listed in the past 24 hours?  
(Note: Many more earthquakes may have occurred, this web site shows only those of magnitude greater than 4.0 worldwide or 2.5 within the US.)

3) Find the largest and the deepest earthquakes listed in the past three days. (This may or may not be the same earthquake.) List the location (place name), depth, and magnitude of each of these two earthquakes.

a) Largest earthquake:

b) Deepest earthquake:

Click on the link for the earthquake you identified as largest by clicking on the date/time data for that earthquake (but not the “MAP” link). Do this again for the deepest earthquake in a second window. This will bring up additional information about the earthquake and more links. Select the “Maps” tab in this window, and from there select the “Historical Seismicity” map. (In some cases, the earthquake will not have a “Historical Seismicity” map. If this happens to you, pick the next biggest or the next deepest earthquake and work with that one.) The “Historical Seismicity” window will show a map of the area of the earthquake, and all the earthquakes in that area since 1990. On this map, the depth of an earthquake is shown with a color code; the diameter of the colored dot is proportional to the magnitude of the earthquake according to the scale reproduced below the map. Also note that plate boundaries are indicated by colored lines. Subduction zones are located at purple lines, spreading centers at red lines, and transform faults along green lines.

The following questions can be answered by considering the Historic Seismicity map for the largest and deepest earthquakes.

4) Are earthquakes a common feature of the regions of these two earthquakes? If so, are large earthquakes (magnitude 6 or greater) more common or are small earthquakes (magnitude 5 or smaller) more common?

a) Largest earthquake:

b) Deepest earthquake:

5) Did the earthquake occur near or at a plate boundary? If so, what kind of boundary is it (convergent, divergent, or transform)? Describe the depth distribution of earthquakes in the area and consider how that relates to the type of plate boundary present. (An area with only orange dots indicates all the earthquakes are shallow and could be occurring along either a divergent or a transform boundary. Quakes at depths > 35 km [colors other than orange] must be from a subduction zone, and parallel bands of successively deeper earthquakes shown by yellow, green, purple, blue and red dots in that order, show the Wadati-Benioff zone distribution.)

Note that there may be more than one plate boundary coming together in the area of the earthquake.

a) Largest earthquake:

b) Deepest earthquake:

6) Consider the deepest earthquake. Use the map view and the color code of earthquake depths to visualize the subducting plate as it descends into the asthenosphere.

a) What is the direction of dip of the subducting plate? How could you tell?

b) Are there any orange dots in the same area as the blue, purple, or red dots? If so, these represent shallow earthquakes that must lie in the over-riding plate on the surface above the earthquakes in the subducting plate at depth.

c) Now use the grid below to draw a vertical cross-section perpendicular to the convergent plate boundary in the map by using the locations of the earthquakes as an indicator of where rigid lithosphere lies. Just hold this page up to the computer monitor, adjacent to the map. Draw in a representative sample of earthquakes at their proper depth below where they appear on the map. Use simple dots or x's to represent an earthquake focus on your cross-section. Space your earthquake foci across the cross-section as the corresponding epicenters are spaced across the map. Remember that lithosphere is approximately 100 km thick and be sure to draw in both an upper and lower boundary for all plates. Check out Figure 10.21 (page 324) in your text (Figure 10.21, page 296 in the Second Edition) for an example of what this kind of cross section might look like.



Finally, go back to the Latest Earthquakes in the World List to answer the remaining questions.

7) Scroll down below the earthquake list to the bottom of the page and select the link “Back to world earthquake map”. Compare this map to Figures 4.4 and 4.5 in your text (page 90; Figures 4.3 and 4.5 on pages 80-81 in the Second Edition) to locate the earth’s plate boundaries.

a) Have any of the earthquakes on the list occurred at a location that is *not* on or near a plate boundary? Where did those earthquakes occur?

b) Is there one or more earthquake from a mountain range such as the Himalayas, Alps, or Rockies?

c) Is there one or more from near the Hawaiian, Yellowstone, or Iceland hotspots?

d) Is there one or more from the middle of a continent? If so, which continent?

8) Use your web browser's "reload" function to make a fresh connection to the site. Check the most recent earthquake on the Latest Earthquakes in the World List and compare it to your answer to Question 1 above. Has an earthquake occurred while you have been on the internet?