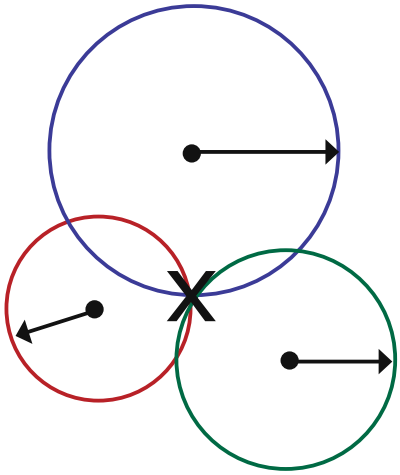
Activity—Plotting Earthquake Epicenters*

Seismic discovery

Note: *This is not an activity from the CEETEP workshop, but is a good prerequisite to the triangulation activity that follows.*



This activity is made up of two lessons:

1) ***Where in the World?*** — takes approximately 50 minutes, provides a review of latitude and longitude and use of an earthquake's magnitude and depth.

2) ***What's Shakin?*** is a long-term plotting exercise in which students regularly gather earthquake data throughout the academic year (or semester) and plot on a world wall map.

The lessons are designed for students to:

- discover unique patterns of earthquakes around the world
- identify locations of deep earthquakes and associated geologic features
- identify locations of large earthquakes and associated geologic features
- develop skills in plotting latitude and longitude points, including interpolation
- develop basic world geography knowledge

Science Standards (NGSS; pg. 287)

- Energy HS-PS3-2, MS-PS3-5
- Waves and Their Applications in Technologies for Information Transfer: MS-PS4-1, HS-PS4-1, MS-PS4-2, HS-PS4-2, MS-PS4-3, HS-PS4-5
- Earth's Systems: HS-ESS2-2

Resources on this DVD & Internet relevant to Locating Epicenter

VIDEOS—in the folder on this DVD: **3. VIDEOS_Earthquake & Tsunami**
LECTURE_Epicenter&Focus_Butler.mov, LECTURE_LocatingEpicenter_Butler.mov, LECTURE_ReadingTravelTimeCurves_Butler.mov
(or on the Internet: **http://www.iris.edu/hq/programs/education_and_outreach/videos#M**)

ANIMATIONS—are in the folder: **2. ANIMATIONS_Earthquake & Tsunami > HowAreEQLocated_WalkRunActivity.swf**
(or on the Internet: **http://www.iris.edu/hq/programs/education_and_outreach/animations/interactive**)

INTERNET LINKS

Triangulating Earthquake Locations Online **http://www.iris.edu/hq/resource/online_triangulation**
A one-page document called "*How Are Earthquakes Located*" can be downloaded from **www.iris.edu/hq/publications/brochures_and_onepagers/edu)**

* Developed by Tammy Baldwin and Anne Ortiz for Science Education Solutions

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Plotting Activity adapted from:

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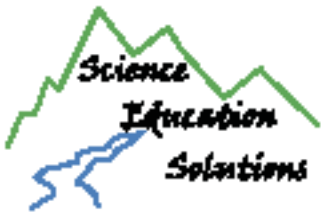


Los Alamos Research Park
Los Alamos, NM 87544

http://www.scieds.com/spinet
spinet@scieds.com

RATIONALE

In this activity students will plot worldwide earthquake epicenters to reveal the narrow zones of seismic activity on the Earth and aid in the understanding of plate tectonics. Students will use current reports of seismic events available on the internet to track global seismicity.

This activity is designed to stimulate interest in the patterns of earthquakes around the world, and the causes of these patterns. It provides a natural transition to teaching about plate tectonics. The inquiry nature of the activity will promote critical thinking and questioning by the students.

OBJECTIVES

This activity is made up of two lessons: Where in the World? which takes approximately 50 minutes, provide a review of latitude and longitude and use of earthquake magnitude and depth. What's Shakin? is a long term plotting exercise in which students regularly gather earthquake data throughout the academic year (or semester) and plot on a world wall map.

These lessons are designed for students to

- discover unique patterns of earthquakes around the world
- identify locations of deep earthquakes and associated geologic features
- identify locations of large earthquakes and associated geologic features
- develop skills in plotting latitude and longitude points, including interpolation
- develop basic world geography knowledge

What's Shakin? has students work in teams to retrieve current global seismic activity reports weekly and plot the earthquake epicenters on a world map. Plotting the events requires using latitude and longitude coordinates to locate the epicenters on the map. As students collect and plot the data they observe the patterns of earthquakes, and often begin to ask questions about interpreting the patterns.

The plotting is best done on a large classroom world map. Depending on the curriculum goals, students can plot the epicenters on the world map either by the event magnitude or the event depth. If resources permit, two world maps allow patterns in both magnitude and depth to be monitored.

VOCABULARY

Epicenter: the point on Earth's surface directly above the focus of an earthquake.

Focus: the point within the Earth that is the origin of an earthquake, where stored energy is first released as seismic waves.

Magnitude: a number that characterizes the size of an earthquake. Magnitude is calculated using the height or amplitude of waves recorded on a seismograph and correcting for the distance to the epicenter of the earthquake.

Latitude: the location of a point north or south of the equator, expressed in degrees and minutes. Latitude is shown on a map or globe as east-west trending lines parallel to the equator.

Longitude: the location of a point east or west of the Prime Meridian, expressed in degrees and minutes. Longitude is shown on a map or globe as north-south trending lines left and right of the Prime Meridian which passes through Greenwich, England.

MATERIALS

- World map with bathymetry and topography and lines of latitude and longitude, approximately 30" x 50".
- Internet connection to retrieve current seismic reports
- Colored, self adhesive dots, 1/4 inch diameter. You will need a minimum of 3 colors if plotting by earthquake depth and a minimum of 5 colors if plotting by magnitude. Students will plot approximately 20 events per week during the What's Shakin? activity.
- Crayons or color pencils to complete the Where in the World? activity
- Overhead markers

TEACHER PREPARATION

Where in the World?

- Start this activity early in the academic year, long before lessons on Earth structure, rocks or plate tectonics are covered.
- Make copies of the student answer sheet, US map, and World map (pages 5 to 7) for each student, and an overhead of each page for demonstration.
- Obtain a report of current global seismic activity from the National Earthquake Information Center website: http://wwwneic.cr.usgs.gov (choose Near Real Time Earthquake List) *** wwwneic is one word, do not separate it with a period ***
- Make an overhead of the current global seismicity report.

What's Shakin?

- Start this activity early in the academic year, long before lessons on Earth structure, rocks or plate tectonics are covered.
- Print the map keys (pages 8 to 11).
- Using the colors that are available to you, label the map key for either magnitude (page 8) or depth (page 9).
- Laminate the map keys and the world map.
- Hang the world map in an area where students will have easy access for plotting.

TEACHING TIPS

- Bathymetry and topography on the map will be a useful teaching tool when discussing topographic patterns and plate tectonics.

- A world map with latitude and longitude labeled in 10 degree increments will result in more accurate patterns than a map with 15 degree increments.

- A Map store should have a good supply of colored dots.

- Laminating the world map will allow easy removal of the dots, and the ability to repeat the activity each year.

LESSON DEVELOPMENT

Where in the World?

• Using the United States plotting map (page 6), students determine the latitude and longitude for the seven cities shown and record it on their answer sheet. Demonstrate how to determine the location for the first city for the class with the overhead map. When the students complete this section use the overhead to discuss and compare students answers.

• This activity provides students experience plotting locations on a map and is similar to what they will be doing with the wall map. Students are given earthquake locations and depths and must determine the appropriate colored symbol (based on the color scale) representing the magnitude or depth and identify the latitude and longitude on the map. Students may need a review of rounding to accurately locate the latitude and longitude points on the map.

• A key for each activity can be found on pages 12 and 13.

What's Shakin?

• After the students have mastered latitude and longitude, they are ready to plot events on the world map. The data can be obtained on a weekly basis from the National Earthquake Information Center's website at http://wwwneic.cr.usgs.gov (choose Near Real Time Earthquake List). This site provides a current list of earthquakes, and includes all the information that the students need to complete the exercise.

• Assign small groups of students responsibility for plotting the data each week. Epicenter placement can be compared with geographical location listed on the seismic activity report. Over time students will develop a map that can be used to introduce the concept of plate tectonics.

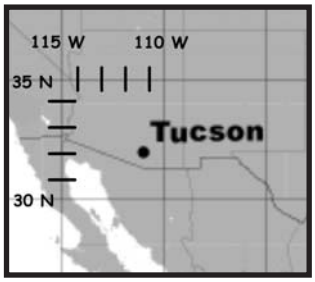
CONCLUSION

As the plotting activity progresses, a pattern of earthquakes consistent with plate tectonics will be revealed on the map. About 95% of earthquakes occur along plate boundaries.

If data are plotted by depth, the deep events will be clustered in areas where subduction is occurring. If data are plotted by magnitude the ratios of size should be evident, as well as relationships between plate processes and event size.

VOCABULARY

Interpolation: estimation of the intermediate values between labeled grid lines.



Students may be familiar with this technique for estimating values. By using a ruler to mark intermediate latitude and longitude values, students can be more accurate in estimating the location of the cities.

TEACHING TIPS

• Students benefit from reminders about the difference in East and West longitude, and North and South latitude.

• Students tend to round magnitude values when plotting. This should not be done because it changes the magnitude -frequency relationship for the earthquakes. Page 10 is included to provide a background for discussion of the magnitude scale and frequency of events.

Determining Latitude and Longitude of Major Cities

Using the United States Map record the latitude and longitude for each of the US cities.

	City Name	Latitude	Longitude
1.	Los Angeles	_____	_____
2.	Tucson	_____	_____
3.	Denver	_____	_____
4.	Chicago	_____	_____
5.	Seattle	_____	_____
6.	New York	_____	_____
7.	Miami	_____	_____

Plotting Earthquake Depths and Magnitude

Using the following depth scale, plot the following earthquakes by depth on the World Map

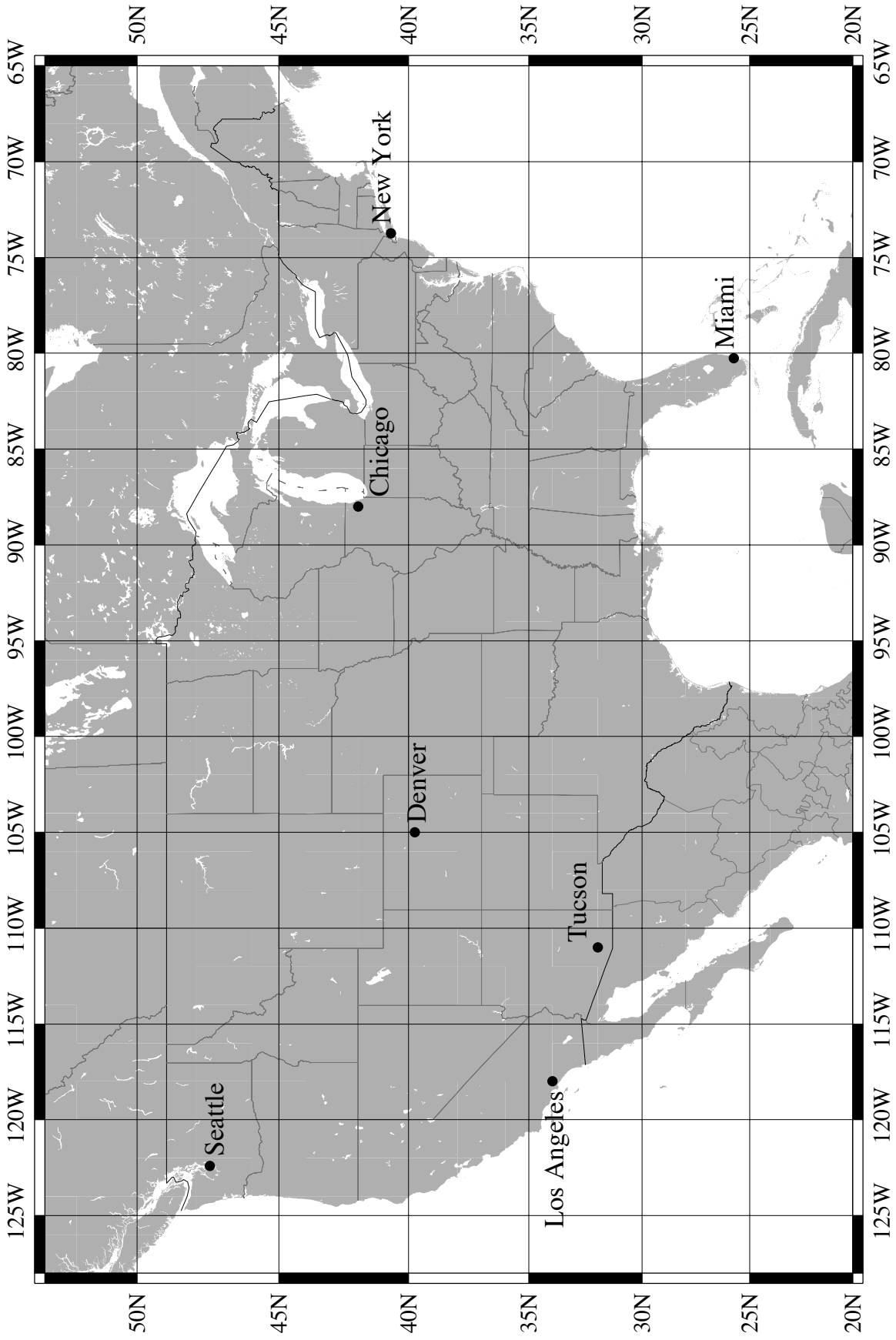
Depth (km)	Color
0-70	Blue
70-300	Red
300-700	Green

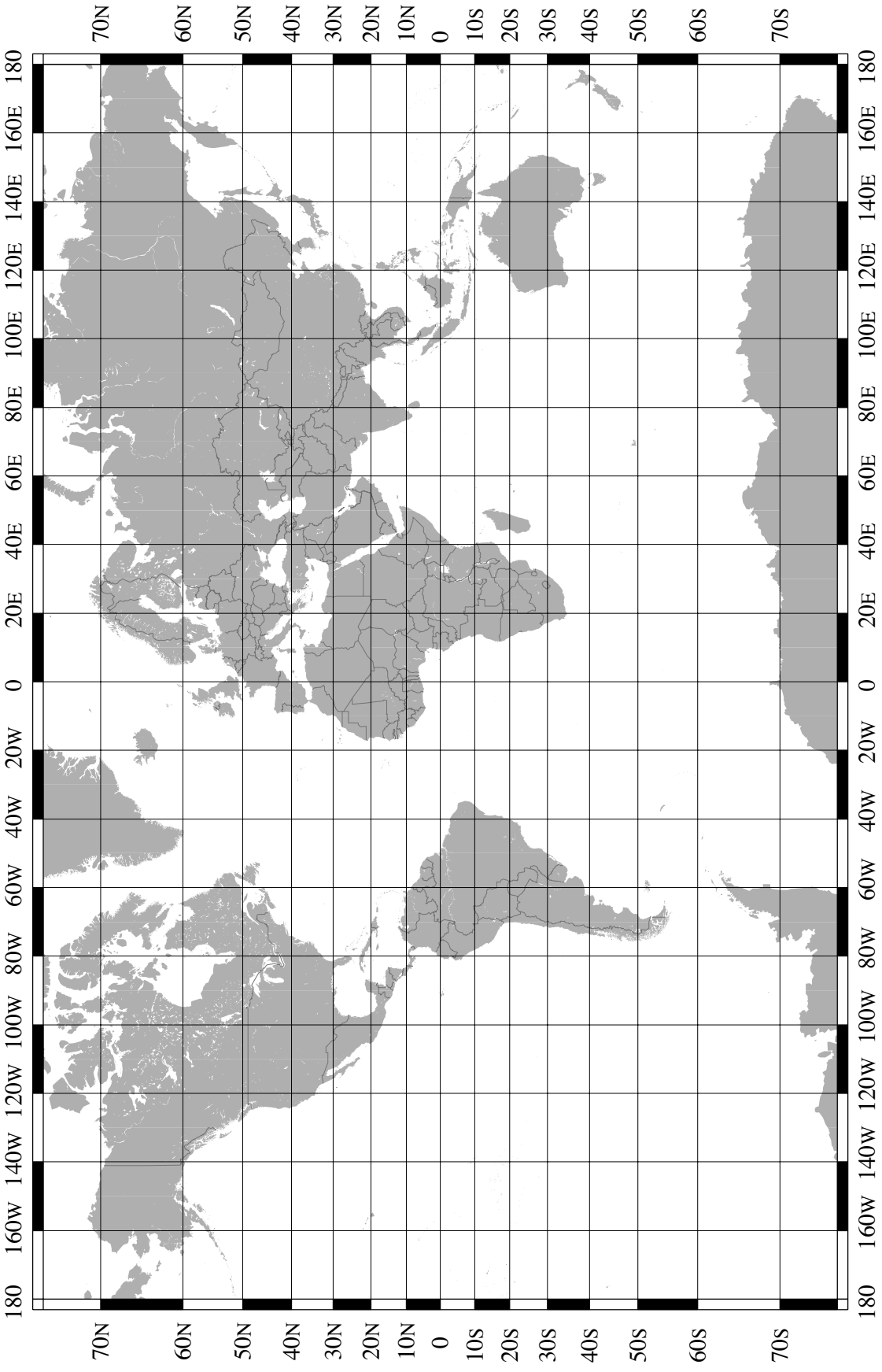
	Latitude	Longitude	Depth (km)
A)	58.22N	158.66W	33.0
B)	16.26S	174.69W	260.6
C)	26.35S	178.05E	605.6

Using the following magnitude scale, plot the following earthquakes by magnitude on the World Map

Magnitude	Color
>8	Brown
7-7.9	Orange
6-6.9	Yellow
5-5.9	Purple
<5	Black

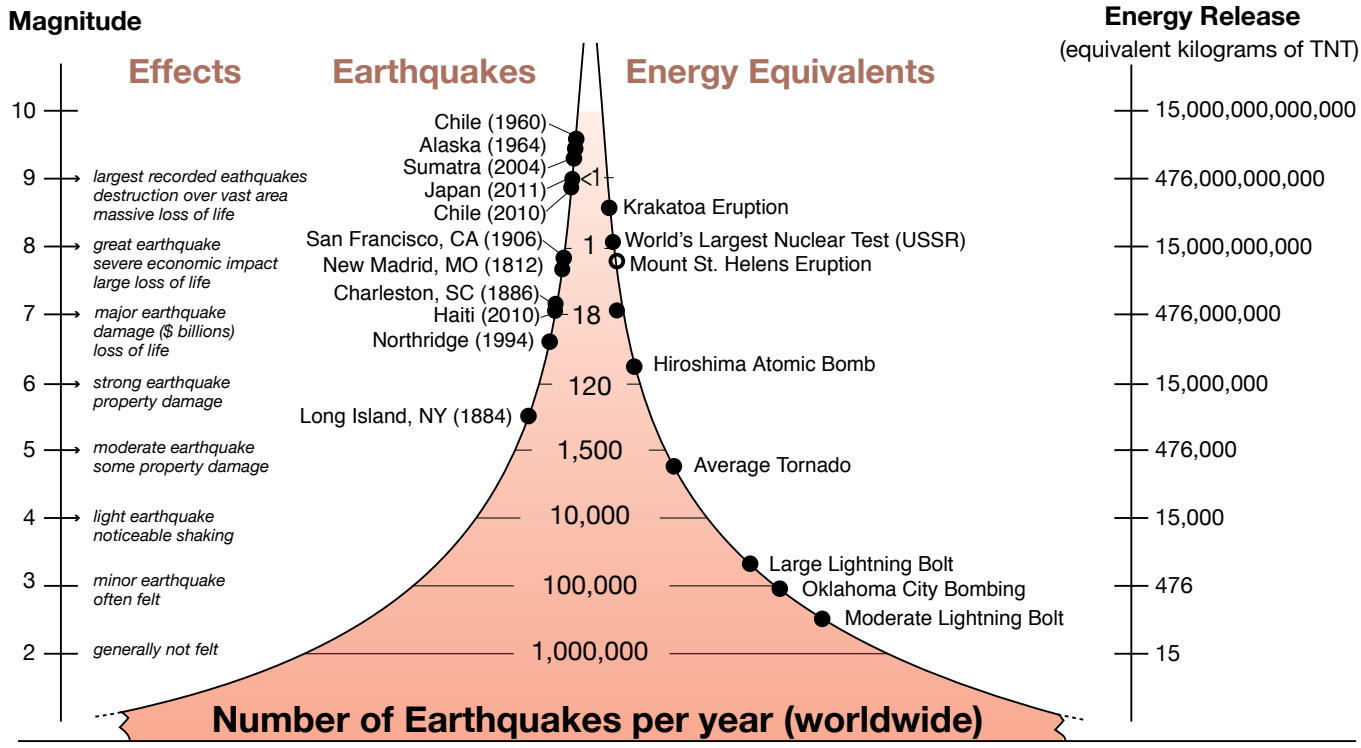
	Latitude	Longitude	Magnitude
D)	46.74N	150.65E	6.8
E)	37.28N	32.59W	5.2
F)	16.14S	73.31W	8.1





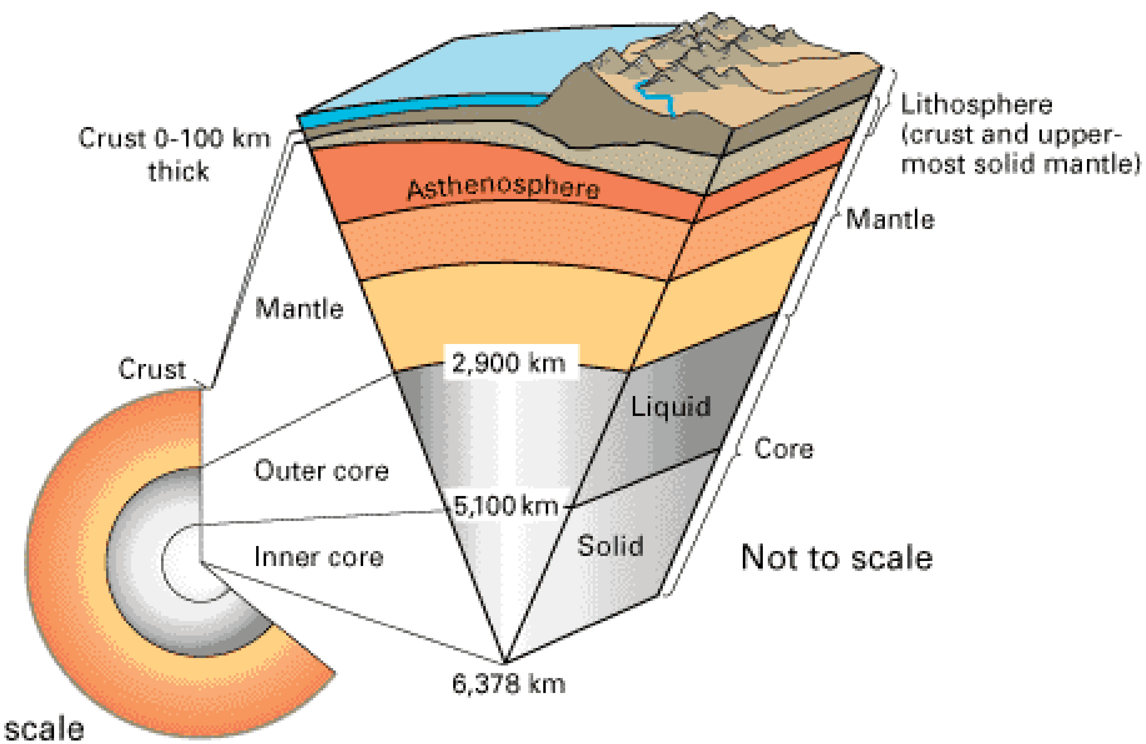
Plotting Earthquake Magnitudes

Code	Magnitudes
	> 8
	7 - 7.9
	6 - 6.9
	5 - 5.9
	< 5



Plotting Earthquake Depths

code	Earthquake Depth	
	0 - 70 km	Shallow
	70 - 300 km	Intermediate
	300 - 700 km	Deep



To scale
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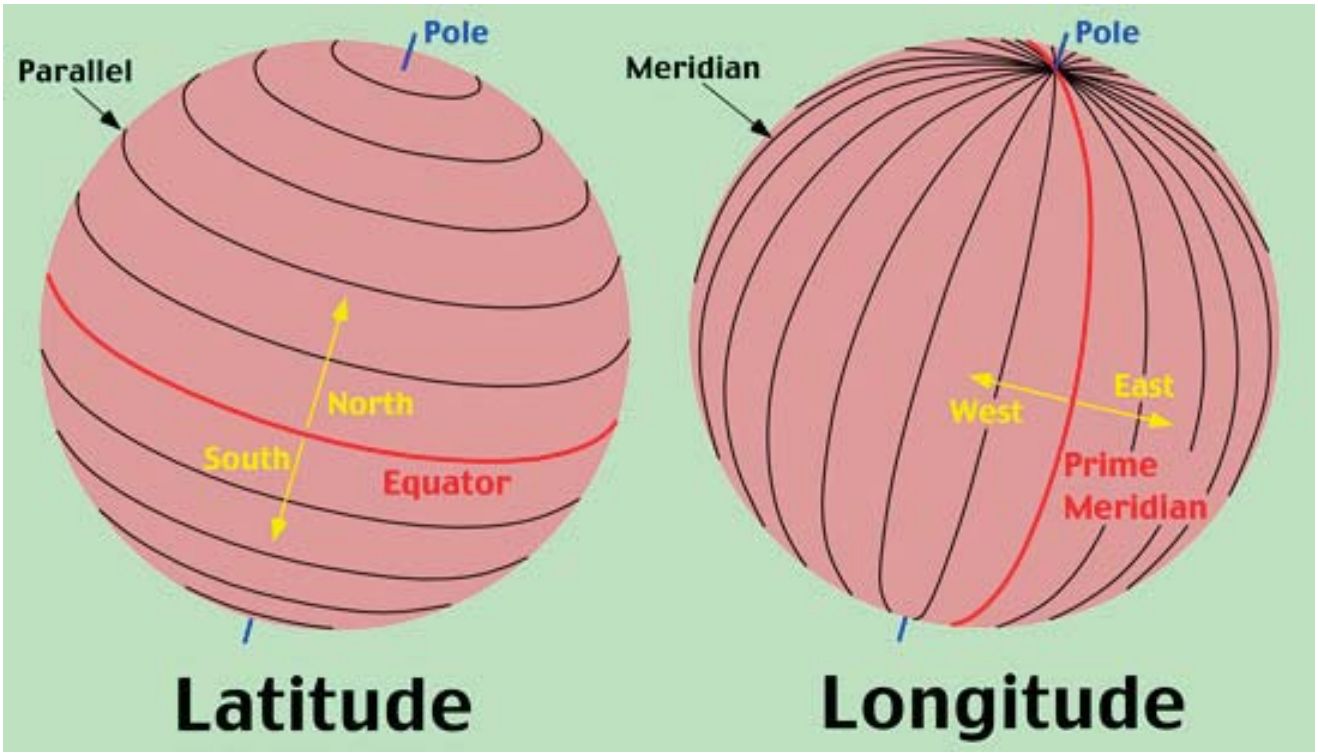
Earthquake Plotting Review



Average Annual Occurrence of Earthquakes

Descriptor	Magnitude	Annual Average
Great	8 and higher	1
Major	7 - 7.9	13
Strong	6 - 6.9	120
Moderate	5 - 5.9	800
	4 - 4.9	6,200
	3 - 3.9	49,000
Micro	2 - 3	1,000 per day
(generally not felt by humans)	1 - 2	8,000 per day

Magnitude vs Ground Motion and Energy

Change in Magnitude	Change in Ground Motion	Change in Energy
1.0	10 times	~ 32 times
0.5	3.2 times	~ 5.5 times
0.3	2.0 times	~ 3.0 times
0.1	1.3 times	~ 1.4 times

Thus, a magnitude 7.2 earthquake produces 100 times more ground motion and releases about 1000 times more energy than a magnitude 5.2 earthquake!

Reading Latitude and Longitude

Using the United States Map record the latitude and longitude for each of the US cities.

	City Name	Latitude	Longitude
1.	Los Angeles	_____34 N_____	_____119 W_____
2.	Tucson	_____33 N_____	_____111 W_____
3.	Denver	_____39 N_____	_____105 W_____
4.	Chicago	_____41 N_____	_____88 W_____
5.	Seattle	_____47 N_____	_____122 W_____
6.	New York	_____41 N_____	_____73 W_____
7.	Miami	_____26 N_____	_____80 W_____

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