ShakeAlert™
Version of activity from:
IRIS
www.iris.edu/earthquake

Mapping Worldwide Earthquake Epicenters

An Activity for Seismic Discovery

www.iris.edu/hq/inclass/lesson/467

Version 2.1

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OVERVIEW

Learners plot earthquake epicenters on a map of the world using current reports of seismicity available on the Internet. These plots reveal narrow zones of seismic activity globally that will aid in understanding plate tectonics.

This activity is designed to stimulate interest in global earthquake patterns and their causes, and provides a natural transition to teaching plate tectonics. The inquiry nature of the activity promotes critical thinking and questioning.

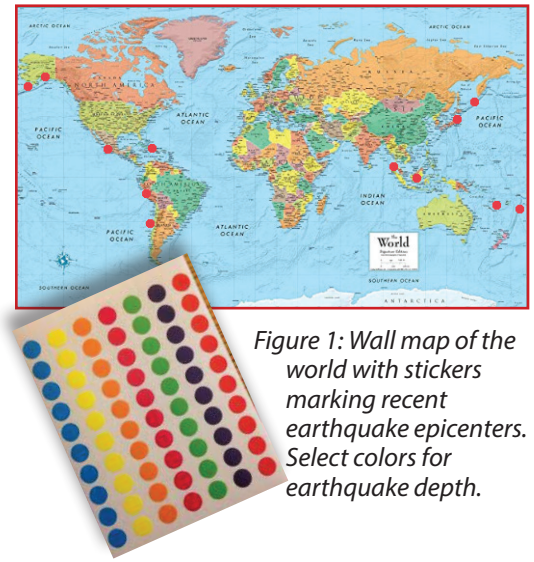
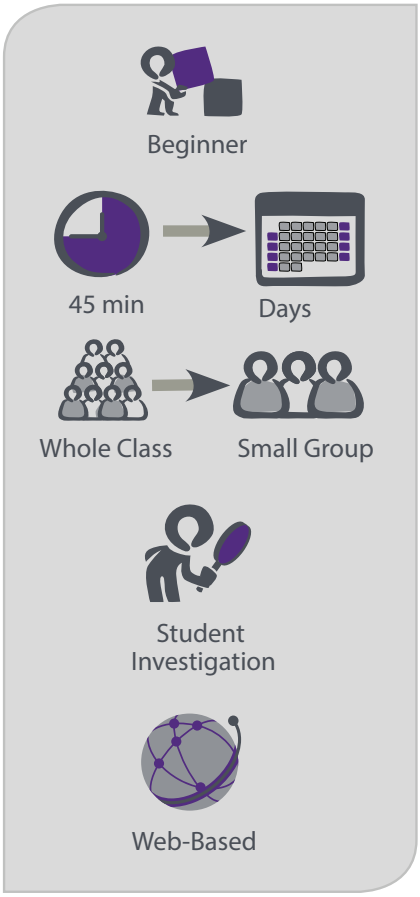


Figure 1: Wall map of the world with stickers marking recent earthquake epicenters. Select colors for earthquake depth.

This lesson includes 2 activities. One short term and one optional long term:

1) W 2) What's Shaking? is a long-term mapping exercise in which learners gather earthquake data weekly throughout the academic year (or semester) and plot them on a wall map of the world.



OBJECTIVES

These lessons are designed for learners 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 knowledge of world geography

TABLE OF CONTENTS

MATERIALS

- Wall map of the world, ~30" x 50" with bathymetry, Crayons or color pencils to complete ***Where in the World?***
- Learner worksheets (Pages SW-1, -2, -3; end of this document)
- Colored, self adhesive dots, 1/4 inch diameter. You will need a minimum of three colors if plotting by earthquake depth and a minimum of five colors if plotting by magnitude. *NOTE*: For ***What's Shaking?*** learners will plot approximately 20 events per week during the course of the activity.
- Internet connection to retrieve current seismic reports for
  Lesson 2: ***What's Shaking?***.

TEACHER PREPARATION

Lesson 1: Where in the World?

- Review the Vocabulary words in the gray box..
- To help learners get a sense of the logarithmic earthquake magnitude scale, consider doing the simple "Pasta Quake" demonstration: www.iris.edu/hq/inclass/lesson/411
- Start this activity early in the academic year, before lessons on Earth structure, rocks, or plate tectonics are covered.
- Print copies of Learner Worksheets (pages SW-1, -2, -3) for each learner.
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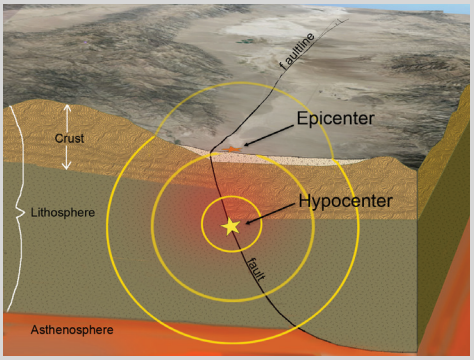
Lesson 2: What's Shaking?

- Mount the map of the world on the wall.
- Choose whether to have learners plot by magnitude or depth, and print the appropriate map legends from Appendix A.
- Using the sticker colors available to you, label and color the map legend for either "Magnitude" or "Depth".
- Mount the map legends next to the large wall map.
- Obtain a report of current seismic activity from the IRIS Internet website (Figure 2). For this activity, click: http://ds.iris.edu/ieb/. This link has preselected to include 5,000 earthquakes greater than magnitude 4 since January 1, 2000, with "Show Plates" turned on. To change your settings, click the settings on the right side of the window.
- Touch individual circles on the interactive map to get magnitude, depth, date, and lat/long adata.

VOCABULARY

Epicenter: The point on Earth's surface directly above the hypocenter of an earthquake. (*See figure below.*)

Hypocenter: The point within Earth that is the origin of an earthquake, where stored energy is first released as seismic waves. Called the "focus" in some textbooks.



Epicenter is directly above the hypocenter.

Interpolation: Estimation of the intermediate values between labeled grid lines. Learners may be familiar with this technique for estimating values. By using a ruler to mark intermediate latitude and longitude values, learners can be more accurate in estimating the location of the cities.

Intensity: A number (written as a Roman numeral) describing the severity of an earthquake in terms of its effects on the earth's surface and on humans and their structures. Watch this animation to see how it differs from *Magnitude* www.iris.edu/hq/inclass/animation/517.

Magnitude: A number that characterizes the size of an earthquake. Magnitude is calculated using the height or amplitude of seismic waves recorded on a seismograph and correcting for the distance to the epicenter of the earthquake. (See "Intensity" above.) Animation that explains magnitude: www.iris.edu/hq/inclass/animation/205.

LESSON DEVELOPMENT

Lesson 1: Where in the World?

- Project the image of the map of the United States from Page 2 of the learner worksheet (SW–2) to demonstrate to the class how to determine the geographical coordinates for the first city on their list. (Use Instructor Key on Page AK-1 to check your numbers.) Learners record the numbers on Page SW-1. Next, learners will individually determine the latitude and longitude for the other six cities shown and record them on their answer sheet.
- In the second part of the activity, learners plot locations of earthquakes on a world map using longitude and latitude coordinates similar to what they will be doing with the wall map. NOTE: Learners may need a review of rounding to accurately locate the latitude and longitude points on the map; but see "TIPS" about not rounding up magnitudes.
- Next, learners determine the appropriate colored symbol (based on the color scale) representing earthquake magnitude or depth using references provided on (SW-1)
- When the learners complete this section, use the the projected map to discuss and compare learners' answers.

Lesson 2: What's Shaking?

- After the learners 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 IRIS Earthquake Browser website at www.iris.edu/ieb which provides a current list of earthquakes, and includes all the information that the learners need to complete the exercise. The link in Figure 2 was preselected to show 20 years of all earthquake greater than Magnitude 4.0. Experiment with the Options on the right to get the most recent earthquakes of specific size or depth in any given Region.

TIPS

- Learners benefit from reminders about the difference in east and west longitude, and north and south latitude.
- Learners tend to round magnitude values when plotting. This should not be done because it changes the magnitude-frequency relationship for the earthquakes.
- 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.
- If you do not have a non-tearable map, laminating the world map will allow easy removal of the dots, and the ability to repeat the activity each year.

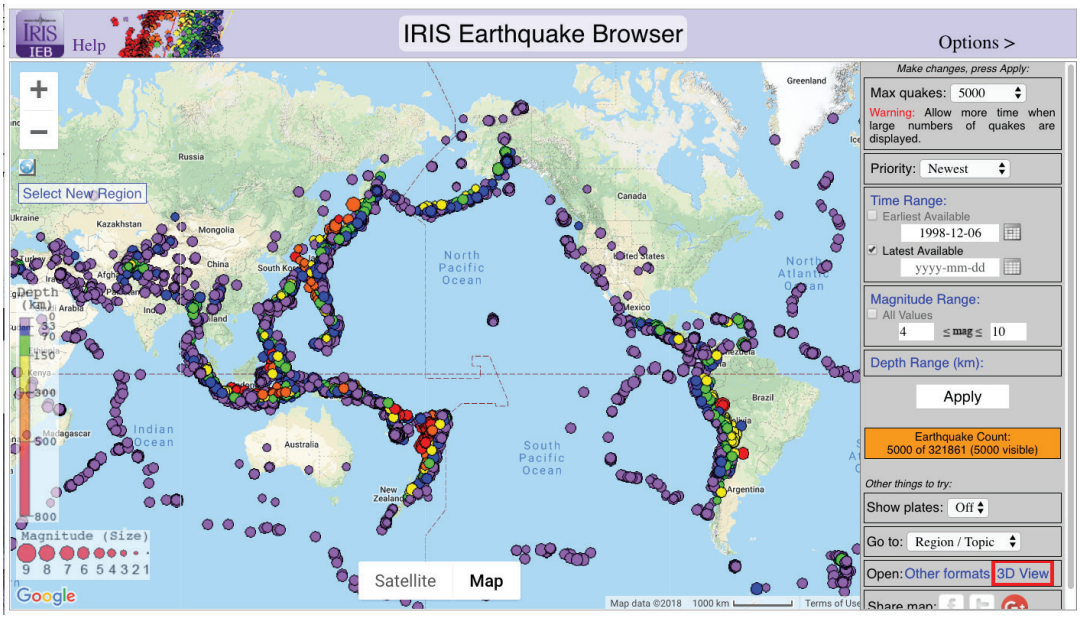


***Figure 2**: The user selects earthquakes to display on the map using filtering options like **date**, **magnitude**, and **depth** ranges, along with choosing a priority for either most recent or largest magnitude quakes. Regions of interest can be selected by drawing a selection box on the map.*

Select your preferences from the blue menus. Selected here are 5,000 earthquakes greater than magnitude 4.0 since January 1, 2001 in this selected region.

Choose your setting and then "Bookmark" the page to share the url with others.

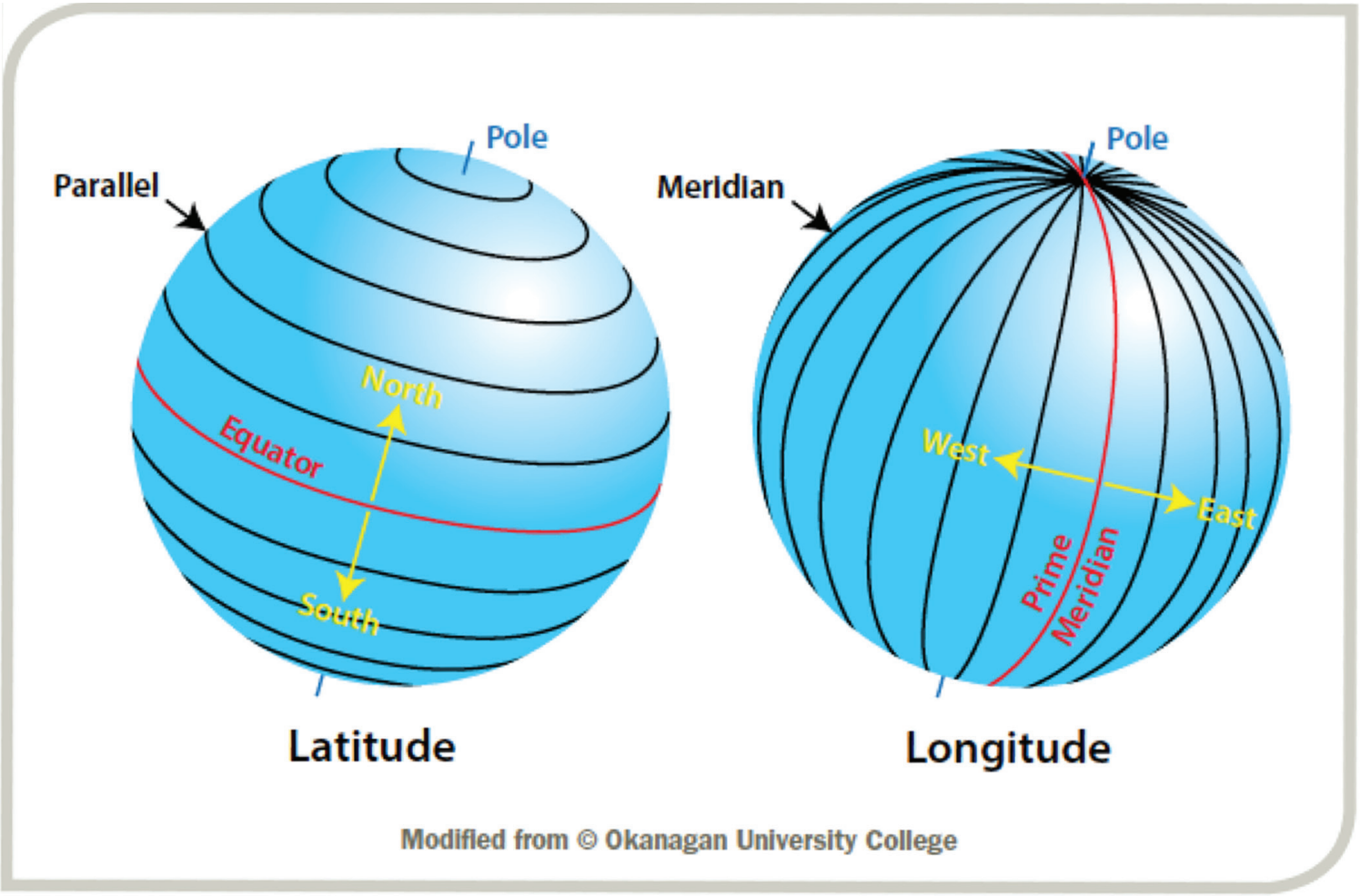
This setup is bookmarked here.

- The plotting is best done on a large wall map of the world. Depending on the curriculum goals, learners can plot the epicenters on the world map *either* by the event magnitude *or* by the event depth. If resources permit, two world maps allow patterns in both magnitude and depth to be monitored.
- Assign small groups of learners the responsibility for plotting the data each week. Epicenter placement can be compared with geographical location listed on the seismic activity report. As learners collect and plot the data, they observe the patterns of earthquakes, and often begin to ask questions about interpreting the patterns (Figure 3). Over time, learners will develop a map that can be used to introduce the concept of plate tectonics.
- 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.

Figure 3: Middle-school learners recognize a pattern of earthquakes along the Japan subduction zone.

APPENDIX A
PRINTOUTS TO ACCOMPANY WALL MAP

Spherical coordinates
A review of latitude and longitude



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

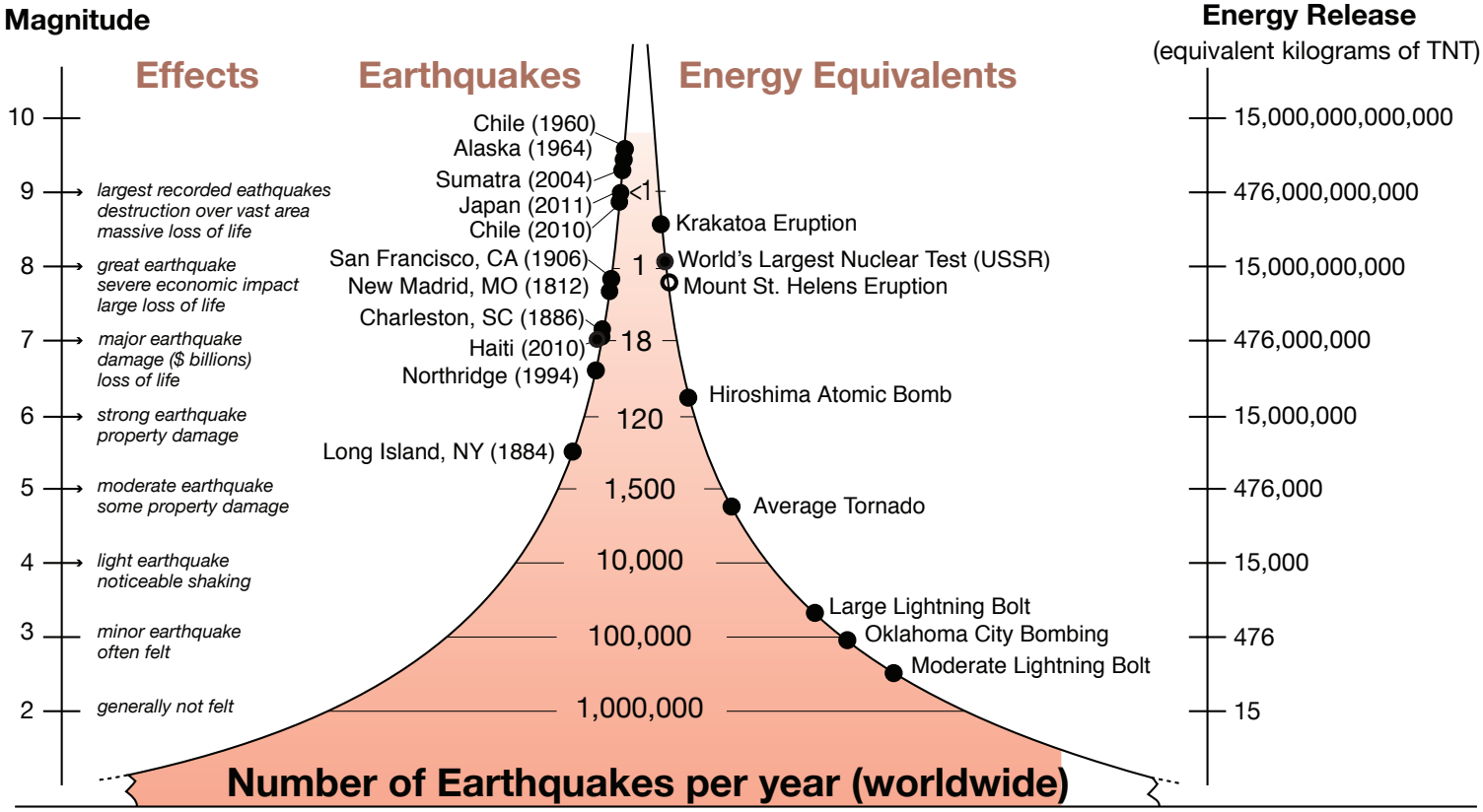
Longitude: The location of a map position east or west of the Prime Meridian expressed in degrees and minutes. Longitude, as shown on a map or globe, are north-south trending lines east and west of the Prime Meridian.

Prime Meridian: North-south line of 0° longitude line that passes through Greenwich, England. With the antimeridian (180°) they form a great circle that divides the globe into two hemispheres.

WHAT'S SHAKING?

Key to **MAGNITUDES** on the large world map

Code	Magnitudes
☐	>8
☐	7–7.9
☐	6–6.9
☐	5–5.9
☐	<5



THINGS TO THINK ABOUT:

What is the biggest earthquake ever recorded? How big was it? Where was it?

How many **M 8** (magnitude 8) earthquakes occur every year?

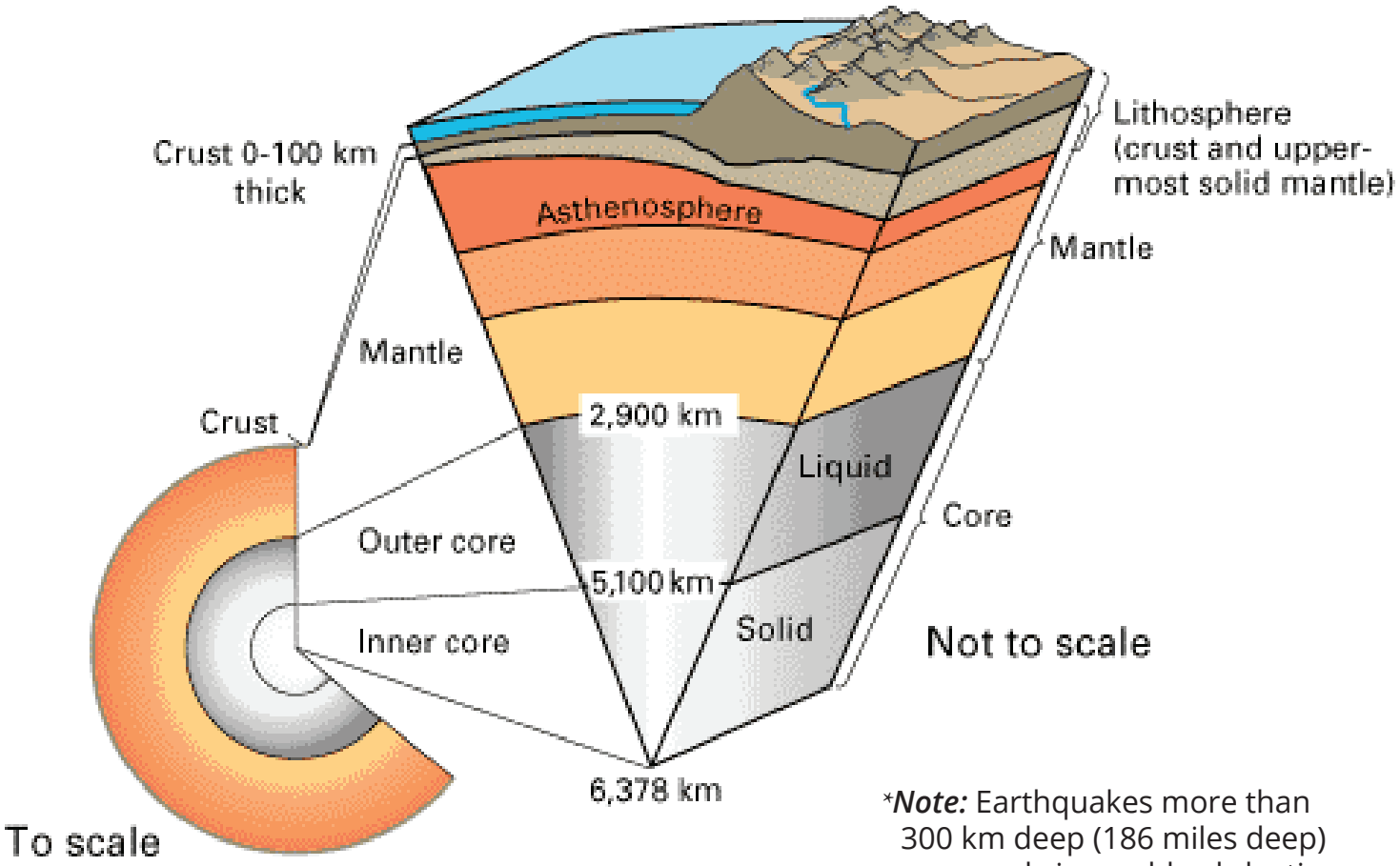
People near a **M 3** earthquake can feel it; how many occur every year?

Did you know that a **M 8** earthquake is 100,000 times bigger than a **M 3** earthquake? And it releases 31,622,776 times more energy!

WHAT'S SHAKING?

Key to **DEPTHS** on the large world map

Code	Earthquake depths
☐	0–70 km
☐	70–300 km
☐	300–700 km



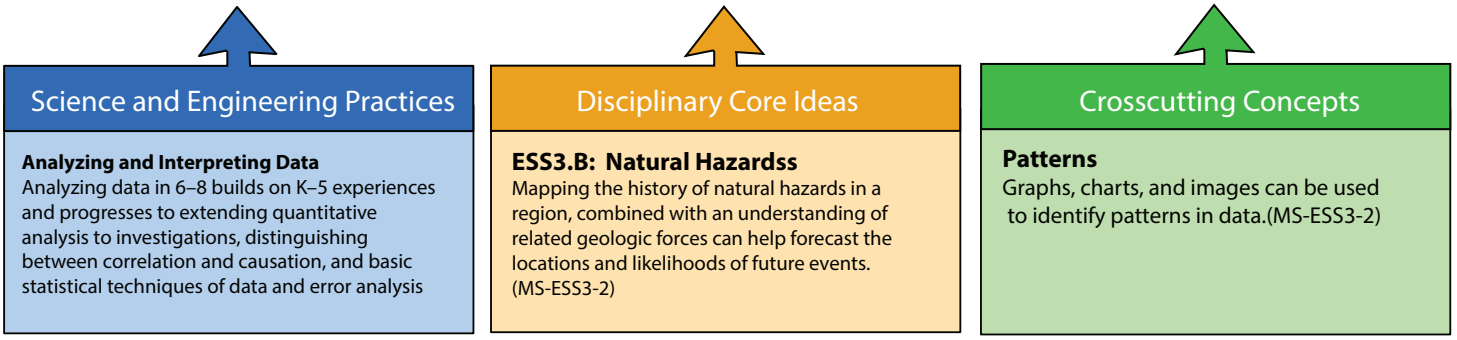
*__Note:__ Earthquakes more than 300 km deep (186 miles deep) occur only in a cold subducting plate, not in the asthenosphere.

APPENDIX C— NGSS SCIENCE STANDARDS & 3 DIMENSIONAL LEARNING

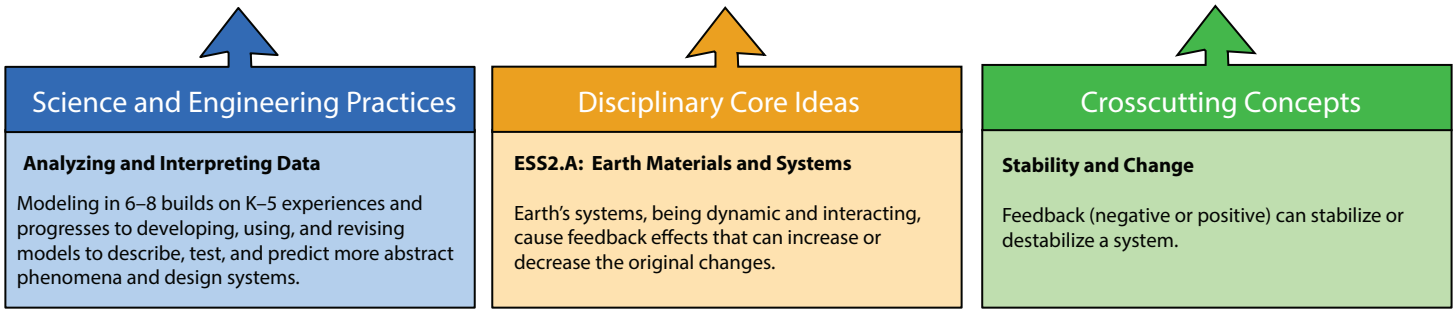
Touch the url links to get more information

Earth's Systems

- **MS-ESS3-2** Analyze and interpret data on natural hazards to forecast future catastrophic events and inform the development of technologies to mitigate their effects. http://ngss.nsta.org/DisplayStandard.aspx?view=pe&id=213

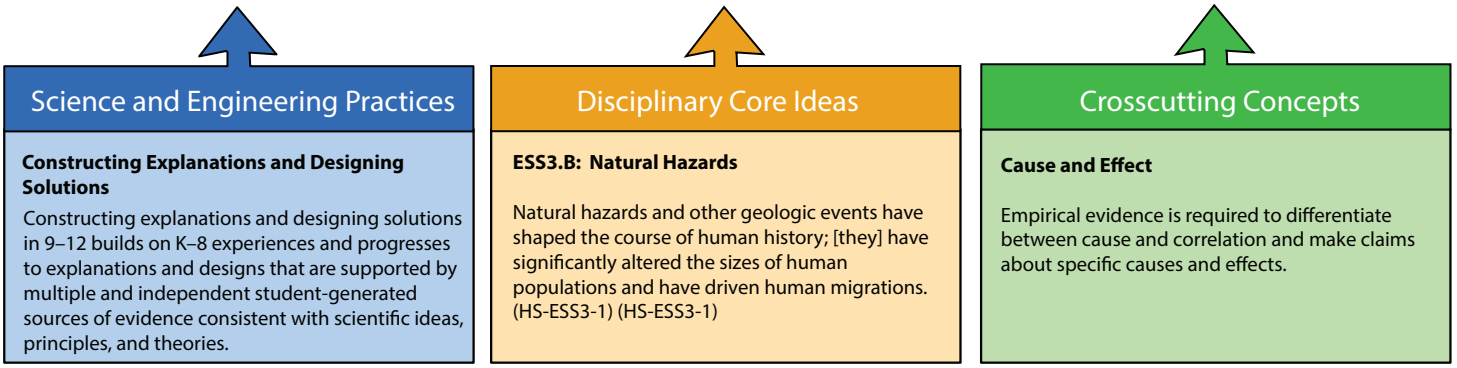


- **HS-ESS2-2** Analyze geoscience data to make the claim that one change to Earth's surface can create feedbacks that cause changes to other Earth systems. http://ngss.nsta.org/DisplayStandard.aspx?view=pe&id=185



Earth and Human Activity

- **HS-ESS3-1** Construct an explanation based on evidence for how the availability of natural resources, occurrence of natural hazards, and changes in climate have influenced human activity. http://ngss.nsta.org/DisplayStandard.aspx?view=pe&id=191



NAME: _____

DATE: _____

IRIS
www.iris.edu/earthquake

WHERE IN THE WORLD?

Determining Latitude and Longitude of Major Cities

Using the U.S. map, record the latitude and longitude for each of the U.S. 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 scale to the right, plot the following earthquakes by depth on the World Map:

	Latitude	Longitude	Depth
A)	58.22N	158.66W	33.0
B)	16.26S	174.169W	260.6
C)	26.35S	178.05E	605.6

DEPTH SCALE		
Depth (km)		Color
0–70	Shallow	Blue
70–300	Intermediate	Red
300–700	Deep	Green

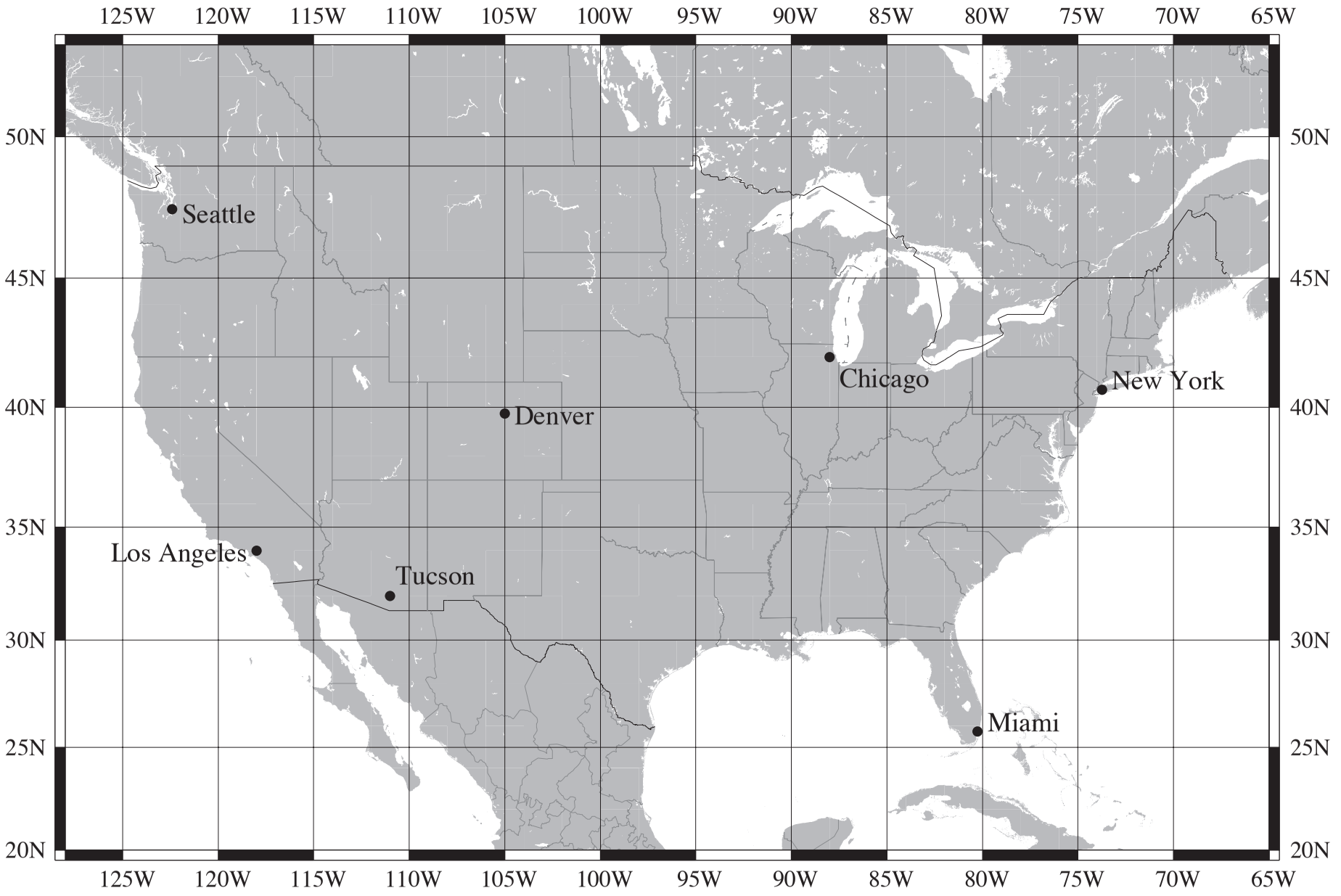
Using the magnitude scale to the right, plot the following earthquakes by magnitude on the World Map

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

MAGNITUDE SCALE	
Magnitude	Color
> 8.0	Brown
7.0–7.9	Orange
6.0–6.9	Yellow
5.0–5.9	Purple
< 5.0	Black

U.S. Plotting Map

Name _____

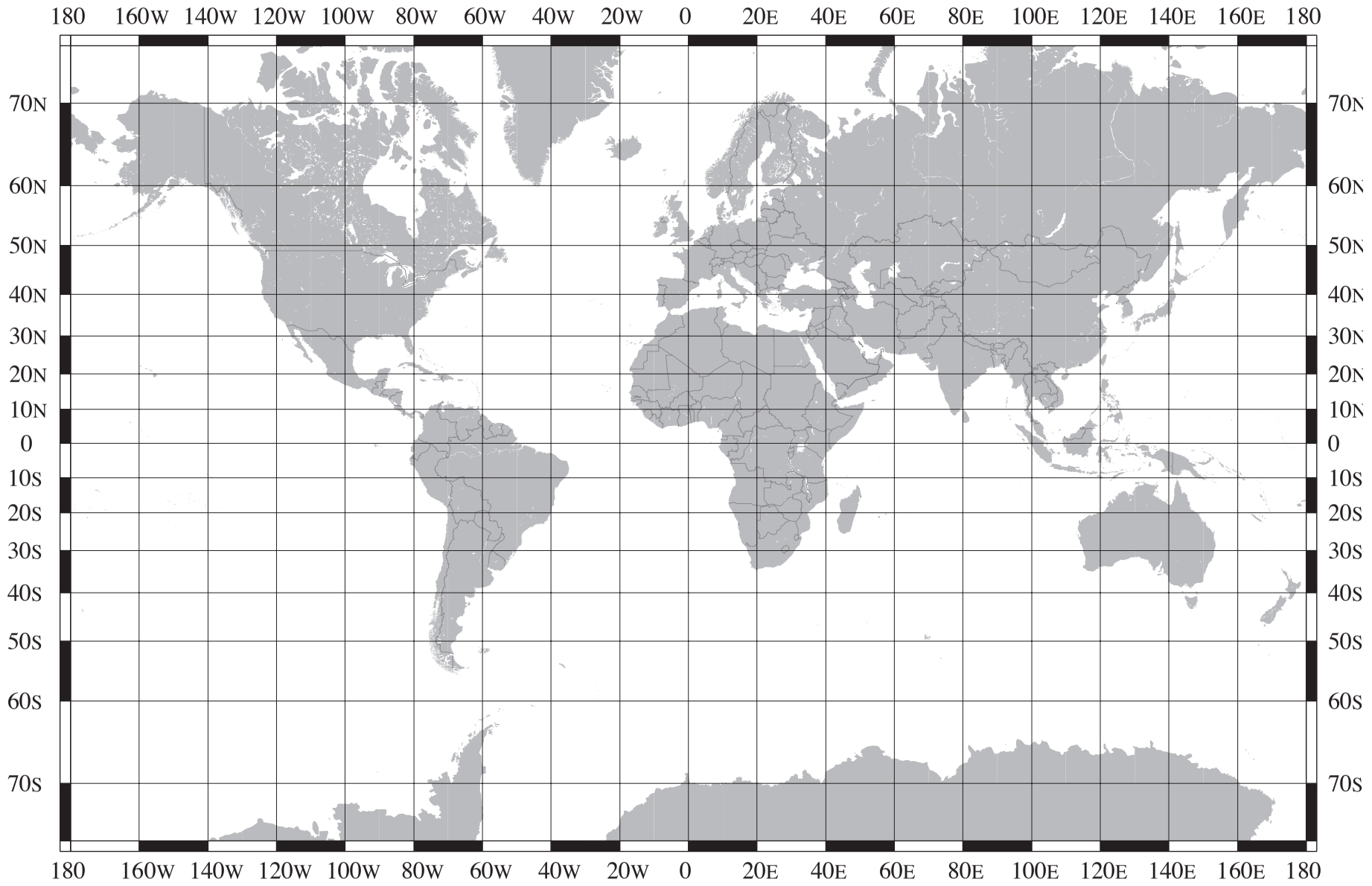


SW–2

STUDENT WORKSHEET

World Plotting Map

Name _____



SW-3

STUDENT WORKSHEET

NAME: _____

INSTRUCTOR KEY

DATE: _____

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WHERE IN THE WORLD?

Determining Latitude and Longitude of Major Cities

Using the U.S. map, record the latitude and longitude for each of the U.S. 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

Plotting Earthquake Depths and Magnitude [Answers plotted on map next page]

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

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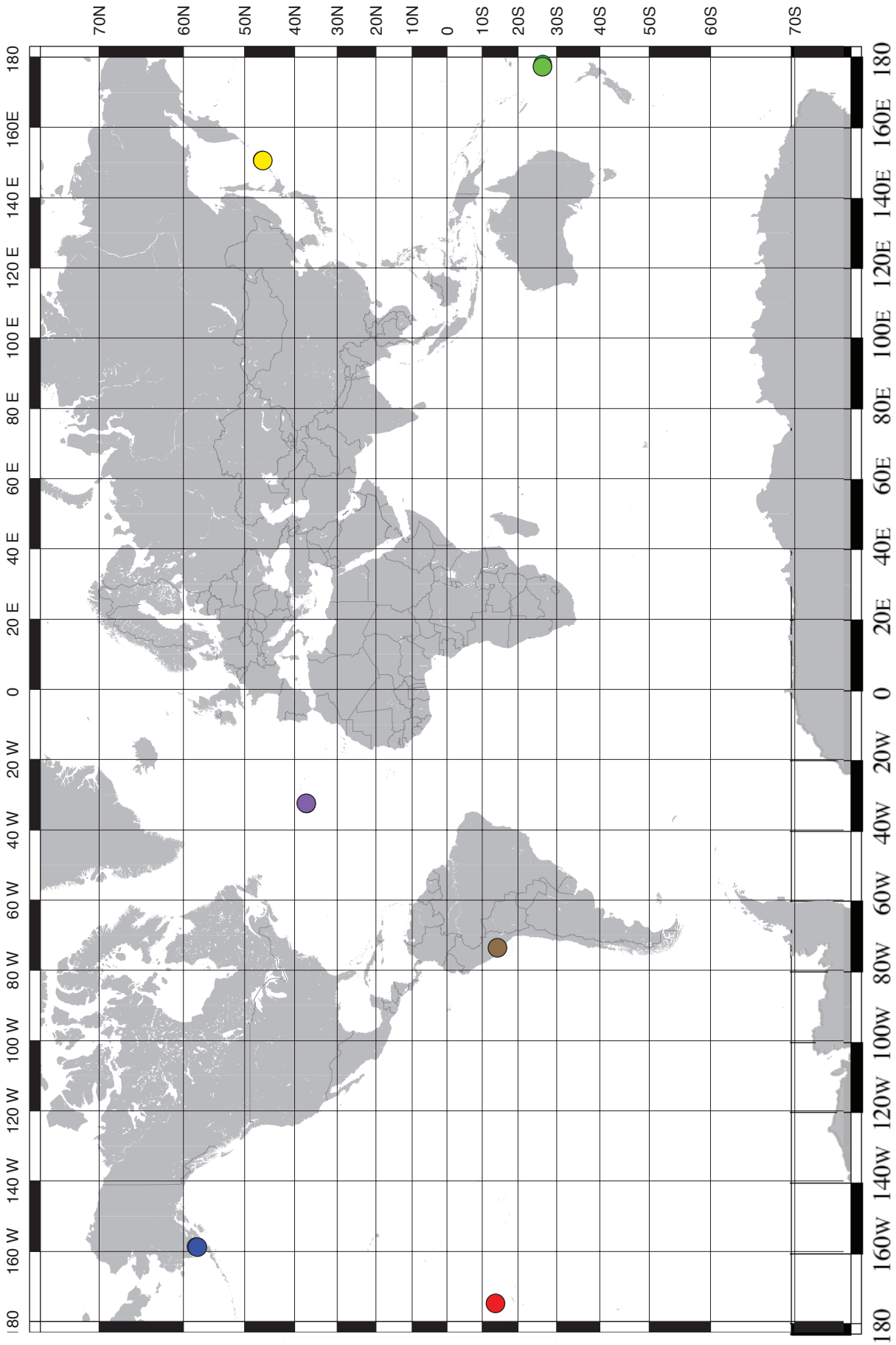
INSTRUCTOR KEY

World Plotting Map



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