Activity 4 Earthquake History of Your Community

Goals

In this activity you will:

- Recognize patterns in the global distribution of earthquakes.
- Interpret maps and research written information to determine the earthquake history of the community and region.
- Examine correlations between faults and earthquakes on a regional and community scale.
- Assess the likelihood of future earthquakes in the community.
- Interpret graphical data to examine long-term trends in the number of earthquakes in the United States.

Think about It

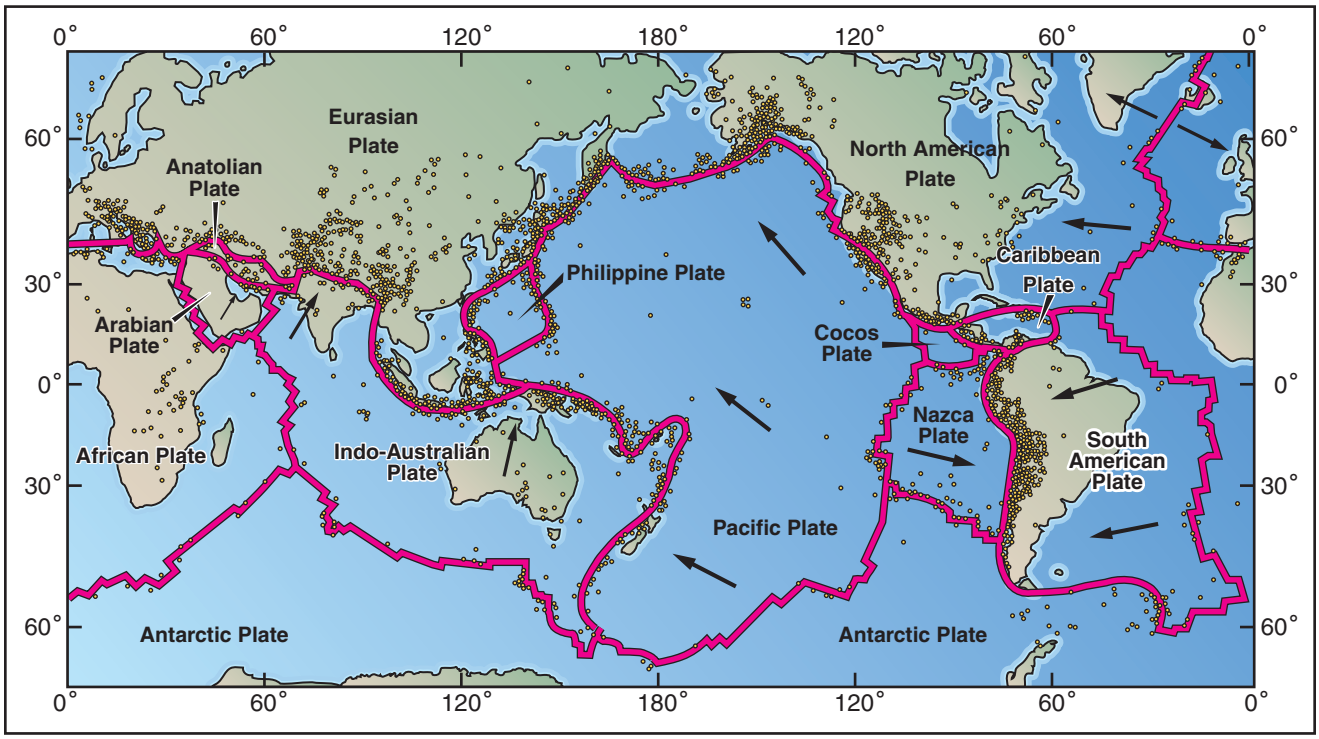
Earthquakes occur all over the world, every day, but not many are strong enough for people to feel them.

- Is there a general pattern to where earthquakes occur on Earth?
- Has an earthquake occurred in your community? Could it occur in your community?

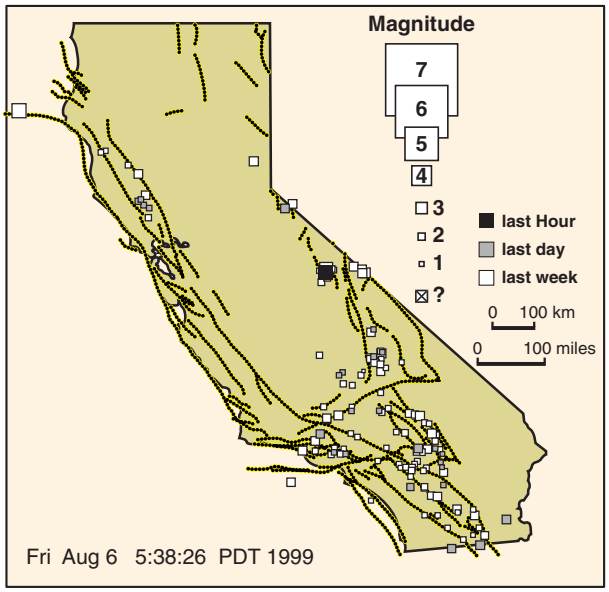
What do you think? Record your ideas about these questions in your *EarthComm* notebook. Be prepared to discuss your responses with your small group and the class.

Investigate

1. In your group, take a close look at the USGS map *This Dynamic Planet*. You may wish to use the map below instead. Discuss the following questions within your group and record your ideas.
   a) How would you describe the pattern of earthquakes around the Earth?
   b) Are earthquakes concentrated in any particular areas on the Earth's surface? If so, what other phenomena and features correspond to these areas?
   c) Are patterns different for ocean and continental areas?



2. The next figure shows two maps of California. One map shows the San Andreas Fault system and other large faults. The other map shows recent earthquakes for a period of a week.
   a) Describe the distribution and arrangement of earthquakes in California.
   b) Do earthquakes correlate with identified large faults?
   c) Do earthquakes occur in areas without identified large faults?
   d) In your small group, discuss what a fault is and what causes one to occur. Record your ideas.



3. Obtain a map of the world and a geologic map of your state (with latitude and longitude marked). If possible, obtain a geologic map of your region (with latitude and longitude marked). Use electronic and print resources to answer the following questions. Visit the *EarthComm* web site for suggested Internet sites to visit and explore.
   a) Plot notable earthquakes of the world on the world map.
   b) Plot important earthquakes of the United States and Canada on the world map (or a map of North America).
   c) Write down the criteria you used to determine if an earthquake was notable or important.

d) Plot earthquakes that have occurred within 200–500 km of your community on your state and/or regional map.

e) Find out about, list, and mark on your maps the locations, sizes, dates, and any other information you can get about past earthquakes in your state, region, or community.

f) Share with other groups so that each has information about worldwide, continental, regional, and state earthquake distributions.

4. Look at the geologic map of your community or state. Locate faults on the map.

   a) Describe the relationship between the location of faults and the locations of earthquakes in your community or state.

Reflecting on the Activity and the Challenge

You found that most earthquakes occur along linear belts in oceans. You also found scattered or broad bands of earthquakes on most continents. You looked at maps of fault zones and earthquakes in California. This showed that most earthquakes happen near faults. Your work with local maps helped you to look for local patterns and relationships. Compiling information on past earthquakes helped you to think about the potential risk of earthquakes in your state, region, and community. This will help you explain to the public the risk of an earthquake in your area, as well as the magnitude of this risk.

Geo Words

transform fault: a vertical surface of slippage between two lithospheric plates along an offset between two segments of a spreading ridge.

Digging Deeper

THE GLOBAL DISTRIBUTION OF EARTHQUAKES

Earthquake Patterns and Plate Tectonics

Earth's plates move relative to one another at their boundaries. In some places, two plates slide past one another along **transform faults**. Earthquakes are common along transform faults, like the

San Andreas Fault in California. In other places, plates move away from each other or toward each other. These motions also cause forces in the rocks near the plate boundaries. When the forces build up to be greater than the strength of the rocks, the rocks break, causing an earthquake. Thus, you should expect to see many earthquakes near plate boundaries. The concentration of earthquakes along plate boundaries is very high.

The depths of earthquake foci also match the types of boundaries. Shallow-focus earthquakes occur at mid-ocean ridges and transform faults. At **subduction zones**, where one plate dives beneath another to great depths in the Earth's mantle, earthquakes range from shallow-focus ones to very deep-focus ones.

Areas of Risk in the United States

Risk is the impact of natural **hazards** on people. The size of the natural hazard, how often they occur, how close they are to people, and population density affect risk. Certain locations in the United States have had large earthquakes in recorded history. This puts them at higher risk from earthquakes again than at other places.

The map in *Figure 1* shows earthquake risks for the United States. The map is based mainly on earthquake history. The areas at highest risk are near plate boundaries. Southern Alaska is near a subduction zone. California has a very long transform fault (the San Andreas Fault), which extends from north of San Francisco all the way to the Gulf of California, in Mexico. Large earthquakes have also happened far from plate

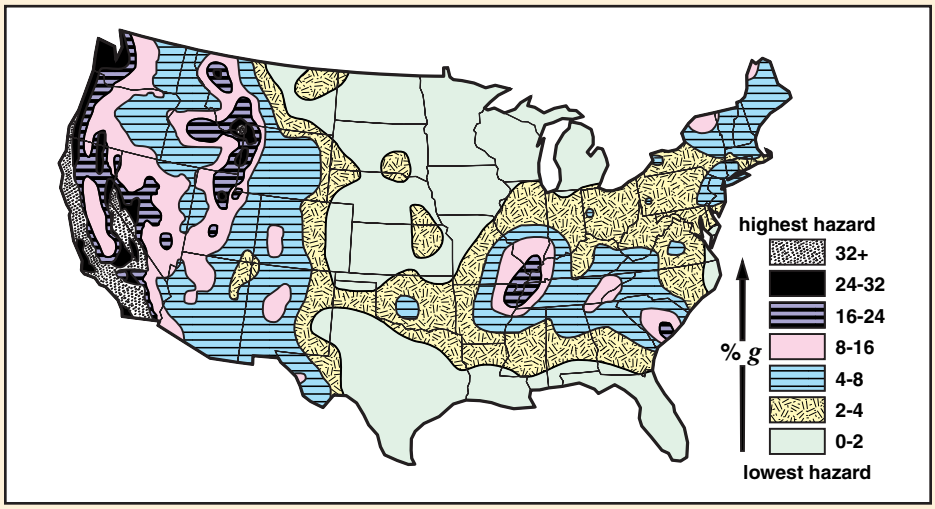


Figure 1 Earthquake risk for the United States.

Geo Words

subduction zone: a long, narrow belt in which one plate descends beneath another.

risk: the potential impact of a natural hazard on people or property.

hazard: a natural event, like an earthquake, that has the potential to do damage or harm.

boundaries. This suggests a zone of weakness and/or high stress in the crust. These earthquakes are not as easy to understand as the ones that happen at plate boundaries. Keep in mind that the forces produced by plate motions are transmitted all the way across the plates. Here's an example of that from everyday life: when you squeeze a brick from its ends or try to pull it apart, the forces you apply act throughout the brick, not just at its ends. Some areas within plates have unusually weak rocks, for a number of geologic reasons. In these areas, the forces that build up within the plates cause the rocks to break, causing an earthquake. Here are some examples: New Madrid, Missouri; Charleston, South Carolina; and parts of southern Quebec.

The legend of the map is in units of percentage of one *g*, the acceleration due to gravity, which is how fast an object gains speed when it is dropped. You have felt "*g* forces" yourself, when an airplane makes a sharp turn or when an elevator or an automobile stops suddenly. You would feel them if you were caught in an earthquake, too! Shaking during an earthquake causes an object that's attached to the ground, like a building, to move back and forth. How fast its velocity changes as it moves back and forth can be described in units of *g*.

Check Your Understanding

1. Why do scientists use the distribution of earthquakes as evidence to support the theory of plate tectonics?
2. In general, where is the highest risk of earthquakes?

Understanding and Applying What You Have Learned

1. The table on the following page shows major earthquakes in the United States. Use the data to address the following questions:
   a) When was the last major earthquake in the eastern United States?
   b) How might the time interval between major earthquakes influence your thoughts about the danger from earthquakes?
   c) What is the likelihood of major earthquakes in western states compared to the eastern states?
   d) Has the frequency of earthquakes in the western states been increasing over time? Explain.
   e) Note the low number of deaths from the New Madrid earthquake in Missouri. Would you expect the same number of deaths if an earthquake of that size took place today? Explain your answer.
   f) How can you explain that there was only one major earthquake in the 1700s but there were 15 major earthquakes during the 1900s?

Major Earthquakes in the United States			
Year	**Nearest City/ Epicenter**	**Richter Magnitude**	**Number of Deaths– Comments**
1755	Boston/Cape Ann, MA	6	Buildings damaged
1811 1812	Memphis, TN/New Madrid, MO	7.8	8 in 3 separate earthquakes
1812	San Juan Capistrano mission San Gabriel, CA	7	40 – roof of church caved in
1857	Los Angeles/Ft. Tejon, CA	8.0	1 – San Andreas Fault
1868	San Jose, CA	7.0	30 – Hayward Fault
1872	Bishop, CA/Lone Pine, CA	8.0	27 – Sierra Nevada Fault
1886	Charleston, SC	6.8	100 – Liquefaction of soil
1925	Santa Barbara, CA	6.3	13 – Unnamed offshore fault
1933	Long Beach, CA	6.3	120 – inspired codes of construction of schools
1934	Salt Lake City/Kosmo, UT	6.6	0 – Wasatch Fault System
1949	Seattle/Puget Sound, WA	7.1	8 – Area of occasional earthquakes
1952	Bakersfield/Kern County, CA	7.7	12 – White Wolf Fault
1954	Reno/Dixie Valle, NV	7.1	0 – Epicenter in rural area
1959	Bozeman/Hebgen Lake, MT	7.3	28 – In landslide caused by earthquake
1964	Anchorage/ Prince William Sound, AK	9.2	131 by tsunami and landslides; tsunami kills 11 in CA
1971	Los Angeles/San Fernando Valley, CA	6.4	65 – buildings and highway bridges collapse
1975	Kalapana, Hawaii	7.2	2 – tsunami damage
1983	Coalinga, CA	6.5	1 – older buildings destroyed
1987	Whittier, CA	5.9	8 – $358 million damage
1989	San Francisco – Oakland/Loma Prieta, CA	7.1	62 – Most in overpass collapse; over $6 billion damage
1991	Arcadia/Sierra Madre, CA	6	2 – $18 million damage
1992	Yucca Valley and Big Bear Lake, CA	7.4 and 6.5	2 – over 170 injured; Extensive ground cracking in remote area

2. Refer to the *This Dynamic Planet* map to answer these questions:
   a) Are all linear belts of earthquakes found with volcanoes?
   b) Do patterns depend on whether or not the earthquakes happen on continents or under oceans?
   c) Do you think this map is complete? Explain.
   d) How does seismic risk correlate with the edges of the continents?
3. The distribution of major earthquakes in the eastern states appears to be random. Unlike the western states, there are no linear belts. How might this make preparing the public for future earthquakes more difficult?

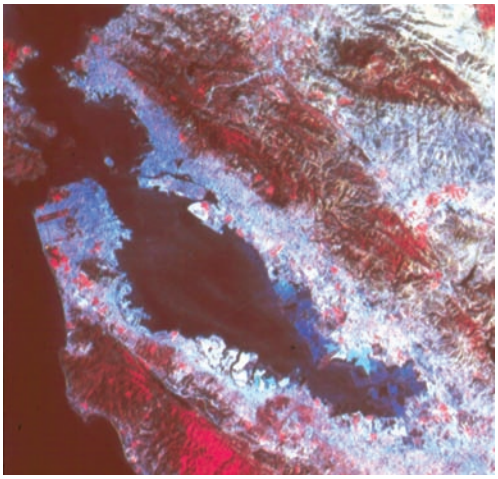
Preparing for the Chapter Challenge

Write a background summary for the brochure for your **Chapter Challenge**. Discuss the earthquake history of your state and community. Note any major earthquakes. Also, note the frequency of earthquakes that have been felt, and the maximum magnitude the public should prepare for. Make your summary concise, easy to understand, and accurate. It should fit on one page. Include maps and diagrams as needed.

Inquiring Further

1. **Earthquakes of magnitude 7 or greater**

   Use electronic or print resources to answer the following questions. Visit the *EarthComm* web site for suggested electronic resources.
   a) What is the maximum number of earthquakes with magnitude 7 or greater that occurred in one year from 1900 to 1989?
   b) On average, how many earthquakes of this size happen in a given year?
   c) Describe any patterns that you see in the data.
   d) Can you suggest any natural forces that might cause the observed variation in the number of earthquakes over time? Explain.



Can you find the San Andreas (transform) fault in this Landsat image of the San Francisco Bay Area?