Teacher Directions

If I say, "earthquake" what state do you think of?

Answers will vary, but California is a likely answer.

What if I asked you, "Where could you live in the U.S. and not be at risk of experiencing an earthquake?"

List all states on chart paper, board, or overhead.

Break students into groups and distribute the ***Seismicity Map***. Ask students what they think the map is designed to show. Explain that each dot represents an earthquake that occurred during the 20 year time period from 1977 to 1999.

Have students locate their state. Have them do the following activities:

1. Check your list from the beginning of the lesson. Cross off any states students said were earthquake free.
2. Did our state have an earthquake during that twenty-year period?
3. Can you tell how many earthquakes occurred?
4. Estimate how many earthquakes occurred.
5. Which state appears to have had the most earthquakes?
6. Which state appears to have had the least amount of earthquakes?
7. Are there areas or regions that seem to have more earthquakes than other regions? Which ones?
8. How can you tell from the map which areas have more earthquakes than others?
9. Is there anything on the map that you expected to see? If so, what?
10. Is there anything on the map that surprised you? If so, what?

Hand out the *Earthquakes in Ohio?* ***Earthquake Risk in the U.S.*** map. Ask the students to study the map for a moment and talk to their group about what they think the map is describing. Then ask the students to share their impressions with the whole class. Keep the conversation brief. Students should discover/discuss that the map describes "danger zones" or "rating of danger."

Explain to the students that the information for the maps comes from the U.S Geological Survey. The maps show how high each state's risk is that an earthquake will occur in that area.

Points to stress:

- ✓ These are not guarantees that earthquakes will occur in these places; they are educated guesses or predictions.
- ✓ These predictions are based on data from past earthquakes.
- ✓ USGS gathers information about the size, intensity, duration, and destructiveness of past earthquakes to estimate earthquake risk for the future.

Distribute the Lab sheet and have the students answer the questions in their groups.

Name_____

Lab Sheet

1. Compare the two maps. What do you notice?

2. A good key on a graph or table will help you make sense of your graph. The risk map has a key that includes seven levels of risk, from "A" to "G". What is the key trying to tell you? What does each letter describe? Can you think of labels that might be more helpful than just using letters? Create your own labels for these categories. Make sure you label all seven levels.

3. Below you will find a chart. Put your labels in the first column. List the fraction of risk for each section, then go back and write the percentage of risk. You can use the table below to organize your figures.

Risk Level Label	Fraction of the U.S.	Percent of the U.S.

4. If a percent represents the whole thing, do your columns add up to 100%? If not, why not?

5. Look at your chart. Can you make some general statements about earthquakes in the United States?

Lab Sheet – *Answer Key*

1. Compare the two maps. What do you notice?

Examples:

- *We now have data about Hawaii and Alaska.*
- *The risk ratings match up with the earthquake activity. The more severe the rating the more earthquakes occur in that place.*
- *You cannot determine a place where there have been no earthquakes on the risk map. You get trends of occurrence.*
- *The seismic map shows place and not trend. (Caution: the students may infer that there are places that have not had earthquakes, remind them this is a 20 year snapshot.)*
- *More earthquakes occur on the coastlines.*
- *Fewer earthquakes occur in the central states.*

2. The hazard ranking has seven levels of risk, from "A" to "G". Do they help you understand the graph? Create your own labels for these categories. Make sure the labels you choose describe all seven levels. Put your labels in the first column of the table that is shown below.
If the students struggle with this pose the following question: If your best friend was moving to "X" (i.e., California), how would you describe the earthquake activity in "X"? Can you find one of two words, a picture, or a symbol that might work just as well?

3. Complete the table below. Choose the number of states you think fit the label. Write the fraction to represent what portion of the United States it describes. *It might be helpful to tell the students that they are counting states, and that their fraction will be out of fifty. This number can be easily doubled to give them an "out of 100" number.* Next you will write the percentage of risk. You can use the table below to organize your figures. *The answers in this area will vary depending on how the child chooses to organize the data. They may choose to include a state in multiple categories because the state may contain more than one level of risk, or they may choose to count it once by choosing to assign a value they think represents the majority of the danger for that state. Either is acceptable.*

*The following table is an **example** of the types of answers you may receive. Student responses for fractions and percentages may vary from those found in the chart, yet be valid based on their risk groupings*

Risk Level Label	Fraction of the U.S.	Percent of the U.S.
Extreme 7	*9/50*	*18% or about 20%*
Very High 6	*4/50*	*8% or about 10%*

High 5	*16/50*	*32%*
Moderate 4	*24/50*	*48% or about 50%*
Low 3	*36/50*	*72% or about 50%*
Very Low 2	*29/50*	*58% or about 60%*
Extremely Low 1	*21/50*	*42% or about 40%*

4. If a percent represents the whole thing, do your columns add up to 100%? If not, why not?
Because some states are assigned multiple risk ratings. A single state may be counted in several categories.

5. Look at your chart. Can you make some general statements about earthquakes in the United States? *Following are sample responses:*

- *Most of the United States has a moderate chance of an earthquake occurring.*
- *Not very many states have earthquakes that are in the two most volatile ranges.*
- *About 50% of the states might have an earthquake.*
- *About 75% of the states have a low chance of having an earthquake.*

Rubric for Grading Lab Sheet

1. Compare the two maps. What do you notice?

0 points – No response

1 point – Simple comparisons that do not show a relationship between the data on the maps. For example: They are both a map of the U.S., or one has the continental U.S. and the other shows all the states.

2 points –- Comparisons that clearly show a relationship or reflection of the data on the maps in addition to other features.

2. A good key on a graph or table will help you make sense of your graph. The risk map has a key that includes seven levels of risk, from "A" to "G". What is the key trying to tell you? What does each letter describe? Can you think of labels that might be more helpful than just using letters? Create your own labels for these categories. Make sure you label all seven levels.

0 points - no answer

1 point – answers do not address the question or are vague

2 points – labels that clearly explain a hierarchical danger level

3. Complete the table below. Choose the number of states you think fit the label. Write the fraction to represent what portion of the United States it describes. Next you will write the percentage of risk. You can use the table below to organize your figures.

Risk Labels

0 points – Not completed.

1 point – Partially completed table or more than half of the responses incomplete.

2 points - Table completed more than half of the responses correct.

4. If a percent represents the whole thing, do your columns add up to 100%? If not, why not?

0 points – No response.

1 point – Unclear or incomplete responses that attempts to explain that these are discrete categories.

2 points - Responses do not explain that these are discrete categories.

3 points - Responses explain that these are discrete categories. They do not add up to 100% because one state may be included in multiple categories. The categories are not based on whether the state has an earthquake, but how many earthquakes the state has had and the probability that it will experience another earthquake

5. Look at your chart. Can you make some general statements about earthquakes in the United States?

0 points – No response

1 point – Few responses or responses that do not reflect findings from the student's table.

2 points – Responses that reflect findings from the student's table.

Earthquake Facts

The San Andreas Fault moves an average of 2 inches a year. That's about how fast your fingernails grow.

California is not going to "fall of into the ocean." Two land masses (plates) are moving against each other in different directions. This is called strike-slip fault. Someday, Los Angles will be side by side with San Francisco.

There are earthquakes on the moon (moonquakes?).

Some people believe animals act differently before an earthquake, becoming "earthquake predictors." However, animal behavior can be affected by many things, so this would not be a reliable method of predicting earthquakes.

Scientists estimate that in one year there are about 500,000 earthquakes around the world. Approximately 100,000 of those earthquakes are large enough to be felt by people. On average, 100 earthquakes a year cause damage.

Scientists cannot predict earthquakes. They can look for trends and make conjectures for mathematical data and maps, like we have done.

Large earthquakes can have aftershocks that occur months after the earthquake itself.

Scientists have caused earthquakes by injecting water into a known earthquake activity area. This process is known as, "lubricating a fault."

Most earthquakes occur less than 50 miles beneath the earth's surface.

The largest recorded earthquake to occur in the United States measured 9.2 on the Richter scale. It occurred in Alaska in 1964. (This is also the second largest earthquake on record behind Chile's 9.5 earthquake.)

The largest recorded earthquake to occur in the continental United States happened in California. It measured 7.9. But believe it or not it was a tie for number one; Missouri also had a 7.9 earthquake.

A tsunami is a sea wave caused by an underwater earthquake.

Each year the southern California area has about 10,000 earthquakes. However, most of them are so small no one feels them.

The swimming pool at the University of Arizona in Tucson lost some of its water from sloshing back and forth. An earthquake in Mexico caused the water to slosh. The earthquake was an 8.1 magnitude earthquake that was located 1240 miles away.

The San Andreas Fault in California is not one fault, but a series or group of fault lines that make up a fault zone. The San Andreas Fault Zone is about 800 miles long.