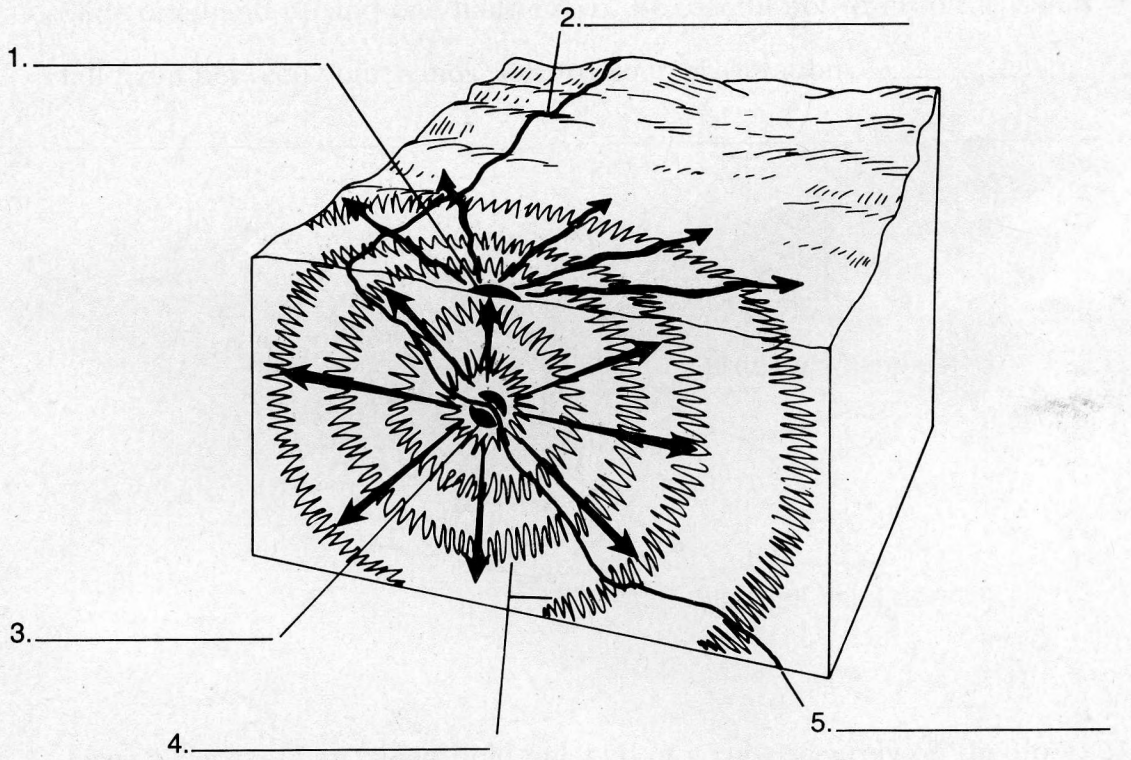
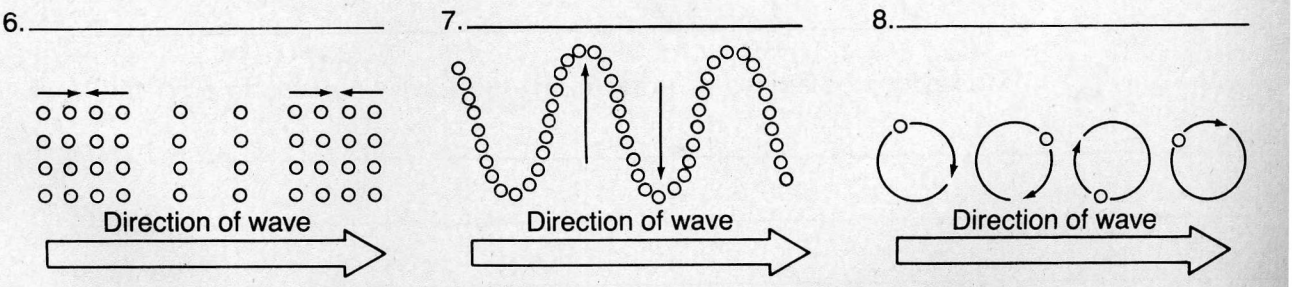
Earthquake Characteristics

Fill in the blanks associated with each diagram by choosing the correct word or words from the list below.

L wave
Seismic waves
Fault
S wave
Focus
Fault
P wave
Epicenter





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The San Andreas Fault

Background Information

The major cause of earthquakes is faulting. A fault is a break in the Earth's crust along which rocks move. An important fault that passes through the United States is the San Andreas fault. The San Andreas fault forms the boundary between the North American plate to the east and the north Pacific plate to the west. The land to the west of the fault is slowly moving northwesterly relative to the land to the east of the fault.

Materials

tracing paper

Procedure

1. The dark line on the following map represents the San Andreas fault.

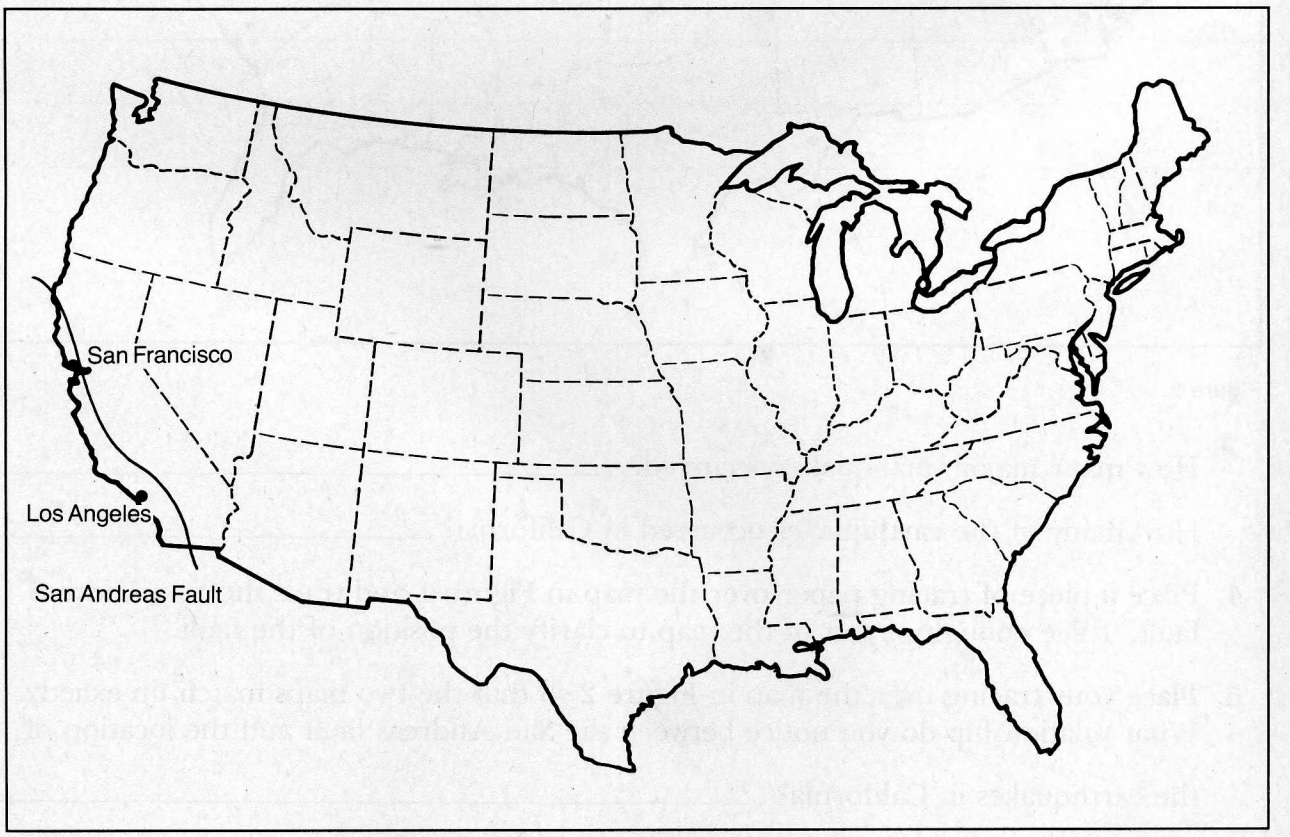

Figure 1

Describe the location of the fault. _____

_____

_____

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2. Where are San Francisco and Los Angeles relative to the fault? _____

_____

_____

3. The following map shows the major earthquakes that occurred in the contiguous, or connecting, United States during the last 250 years.

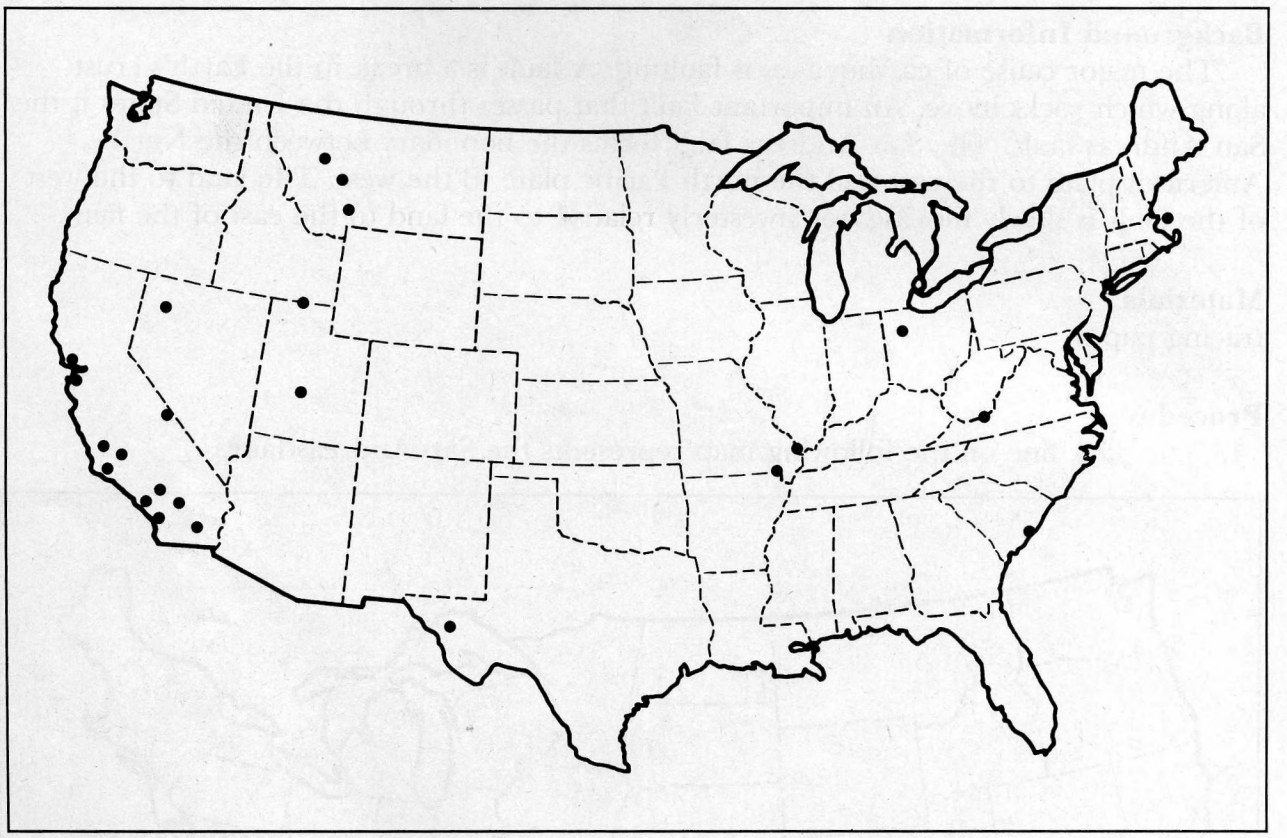

Figure 2

How many major earthquakes occurred? _____

How many of the earthquakes occurred in California? _____

4. Place a piece of tracing paper over the map in Figure 1 and trace the San Andreas fault. Trace enough of rest of the map to clarify the position of the fault.

5. Place your tracing over the map in Figure 2 so that the two maps match up exactly. What relationship do you notice between the San Andreas fault and the location of the earthquakes in California? _____

_____

_____

_____

Name _____ Class _____ Date _____

Critical Thinking

1. In which state have over one-third of the major earthquakes in the contiguous United States occurred? _____

   What can you infer about the cause of these earthquakes? _____

2. Will earthquakes continue to occur in this area? Explain your prediction. _____

3. It has been said that in 20 million years, Los Angeles will be as far north of San Francisco as it is now south. Do you agree? Why or why not? _____

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How Does the Intensity of an Earthquake Change With Distance?

When an earthquake occurs, waves of energy spread outward in all directions from the point where the earthquake originated. As the waves pass through rock material, they cause the rock to shake or vibrate. The closer a person is to the point of origin, which is called the focus, the more noticeable the shaking becomes. At the location on the Earth's surface, directly above the earthquake's focus, great damage and terrible destruction sometimes take place. This location is called the epicenter. Farther away, less damage occurs.

Earth scientists have developed "scales of intensity" that describe the kinds of experiences that people share during an earthquake, depending on their distance from the earthquake's focus. One example of such a scale of intensity is shown below. Notice that this scale, called the Rossi-Forel Scale of Earthquake Intensity, ranges from I to X. Earthquake intensities of I are the least noticeable while those labeled X are the most intense.

Rossi-Forel Scale of Earthquake Intensity

I. Recorded by instruments; felt only by experienced observers at rest.
II. Felt by small number of persons at rest.
III. Felt by several persons at rest; strong enough for the duration or direction to be appreciable.
IV. Felt by several persons in motion; disturbance of movable objects, door, windows; creaking of floors.
V. Felt generally by everyone; disturbance of furniture and beds; ringing of some bells.
VI. General awakening of those asleep; general ringing of bells; oscillation of chandeliers; stopping of clocks; visible disturbance of trees and shrubs; some startled persons leave their dwellings.
VII. Overthrow of movable objects, fall of plaster, ringing of church bells, general panic, without damage to buildings.
VIII. Fall of chimneys, cracks in the walls of buildings.
IX. Partial or total destruction of some buildings.
X. Great disaster, ruins, disturbance of strata, fissures in the Earth's crust, rock-falls from mountains.

A description of one intensity level from this scale states that an earthquake of intensity IV would be "felt by several persons in motion . . . while movable objects such as doors and windows would be disturbed. Floors of houses would creak." At a different intensity level, people located in an intensity zone of IX would experience partial or total destruction of some of their buildings. Truly a frightening experience!

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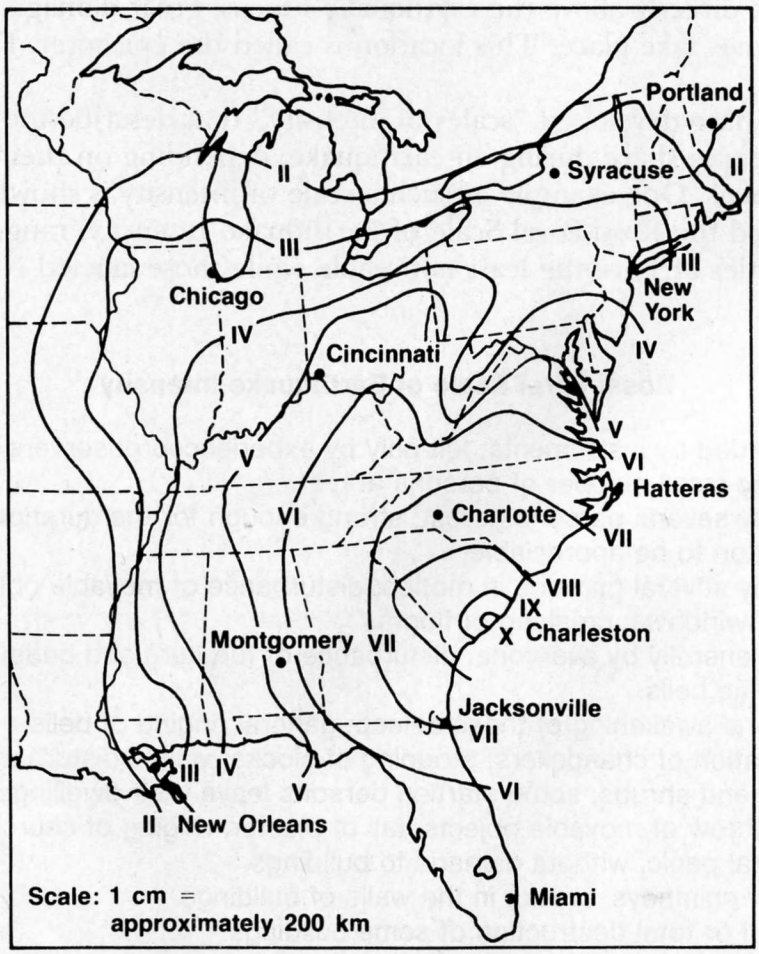
How would a severe earthquake affect people over a large region? On August 31, 1886, a devastating earthquake struck Charleston, South Carolina. The map illustrates the range of intensity of that earthquake as it was felt throughout the eastern part of the United States.

Observe the map carefully. Compare it to the Rossi-Forel scale of earthquake intensity. Answer the following questions that are based on both the map and the scale of earthquake intensity. Before you answer the questions, though, let's look at two examples that will help you to proceed. Charlotte, North Carolina, is a city about 300 km from Charleston and is inside the number VII earthquake intensity line. Therefore, people living in Charlotte at the time of the earthquake would probably have seen plaster fall, heard church bells ringing, and have experienced general panic. However, most people living in the city of New Orleans, because they were located inside the number II earthquake intensity line, and nearly 1000 km away, probably would not even have felt the Charleston earthquake.



1. Name a city shown on the map in which the earthquake of August 31, 1886, was detected mainly by instruments, rather than people._____

2. Name two cities that suffered damage similar to Charleston but less severe.

_____

_____

3. What indication of the August 31, 1886, earthquake might a person have experienced in Chicago?_____

How would their experiences have compared to those of people living in New York City?_____

4. Would people who were located 1000 km from Charleston generally have been awakened from their sleep as a result of the earthquake? Explain.

5. Describe the effect that the earthquake of August 31, 1886, had upon the city of Charleston, South Carolina._____

6. What general relationship seems to exist between earthquake intensity and distance from the earthquake center?_____

7. On the map on page 44, shade in the complete region where an earthquake would be felt by everyone, but where there would be no visible disturbance of trees and shrubs.

Name at least two cities located in this zone._____

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Earthquake Search

Wherever an earthquake occurs, two types of shock waves spread out in all directions. Each type of wave travels at a different speed. The earthquake waves that travel fastest are known as P, or primary, waves. The waves that travel more slowly are called S, or secondary, waves. After an earthquake occurs, P waves reach places sooner than S waves do.

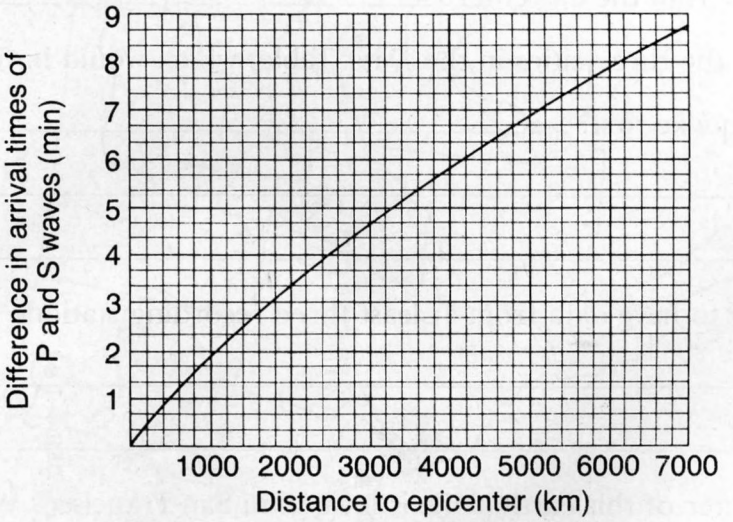
Both types of waves start out from the earthquake's focus. The focus is the underground point of origin of an earthquake. The point on the surface of the Earth directly above the focus is called the earthquake's epicenter.

To detect an earthquake, seismologists use an instrument called a seismograph. By using this instrument, scientists figure out when the first P and S waves from the earthquake arrive at the seismograph's location.

The difference between the arrival times of P and S waves is used to find the location of the earthquake's epicenter. This information must be obtained from at least three locations.

Now it is your turn to determine where an earthquake's epicenter is located. To do this, you will need a drawing compass and the map that follows.

Carefully study the graph on this page. It shows the relationship between the difference in arrival times of P and S waves and the distance to the epicenter of an earthquake. The time is in minutes. The distance is in kilometers. Use the graph to answer the questions that follow.



1. If the difference in arrival times of P and S waves at a certain location is 3 minutes, how far from that location is the earthquake's epicenter? _____

_____

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2. If a recording station is 4600 km from an earthquake's epicenter, what is the difference in arrival times of P and S waves? _____

Now suppose an earthquake has occurred somewhere in the United States. Its P and S waves are recorded by seismographs located at the three cities shown in the Data Table.

DATA TABLE

City	Difference in Arrival Times of P and S Waves
Denver	2 min 25 sec
Houston	4 min 10 sec
Miami	5 min 40 sec

3. What is the distance in kilometers from the epicenter to Denver, Colorado? _____

4. What is the distance in kilometers from the epicenter to Houston, Texas? _____

5. What is the distance in kilometers from the epicenter to Miami, Florida? _____

Place the map on page 49 on your desk. Use the scale on the map to set the compass points apart at a distance equal to 1400 km, the distance from Denver to the earthquake's epicenter. Place the sharp point of the compass in Denver. Draw a circle with the pencil point. Repeat, but this time set the compass for 2700 km, the distance from Houston to the earthquake's epicenter. Repeat, but this time set the compass for 4000 km, the distance from Miami to the earthquake's epicenter.

6. Which city on the map is closest to the earthquake's epicenter? _____

How far is this city from the epicenter? _____

7. Of the scientists at the three cities in the Data Table, which would have become aware of the earthquake first? _____

Second? _____

Third? _____

8. Why is it necessary to have data from at least three recording stations? _____

_____

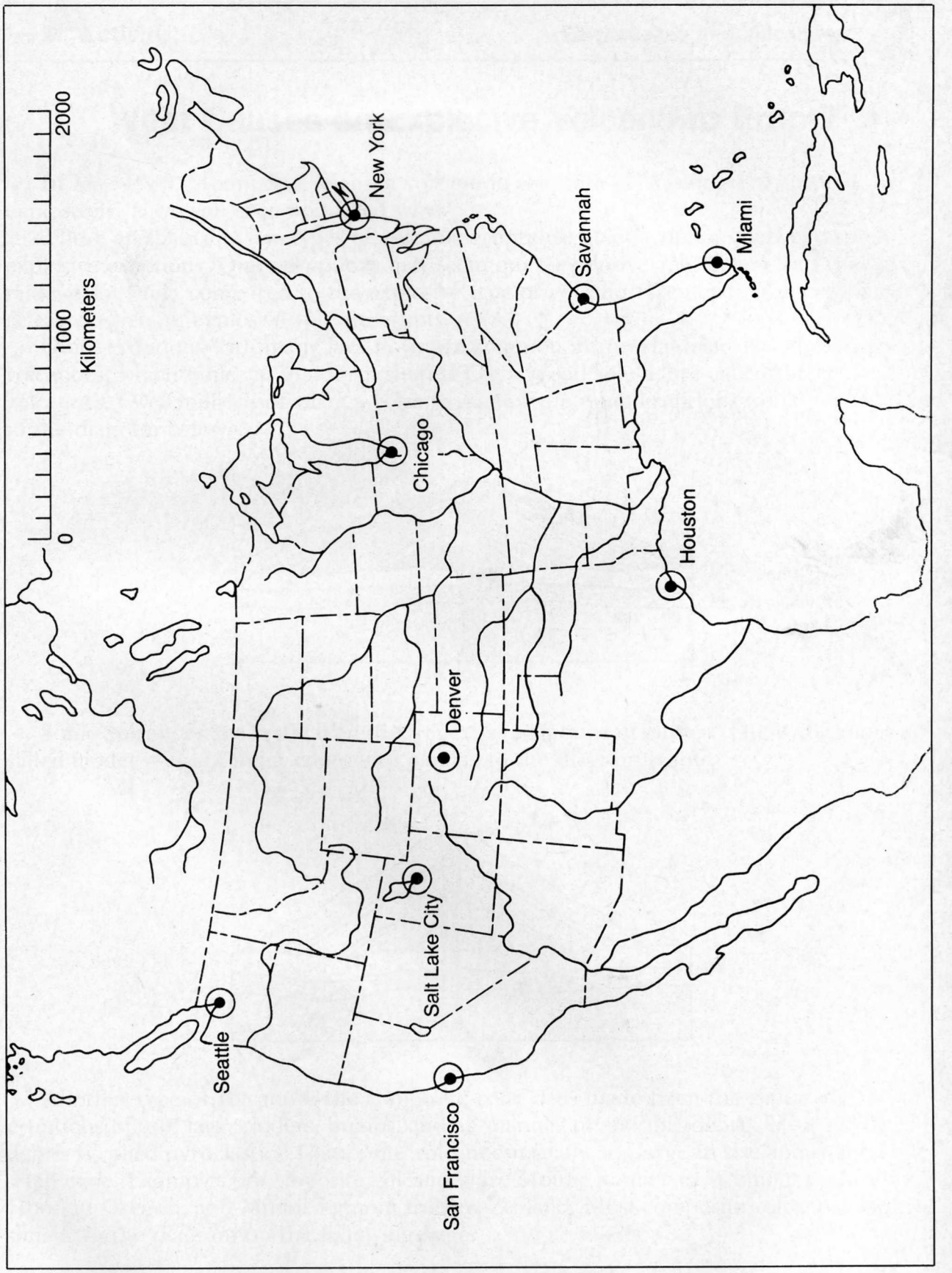
_____

9. Suppose the epicenter of this earthquake is located in San Francisco. What will be the difference in arrival times of P and S waves in New York City? _____

10. As the distance between an observer and an earthquake decreases, does the difference in arrival times of P and S waves increase, decrease, or remain the same?

_____

Name _____ Class _____ Date _____



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