Earth Science & Society

Learning from the Past

At 5:15 on a Wednesday morning, most people were still sleeping when an earthquake struck California. The city of San Francisco was the hardest hit. It shook violently for an entire minute, toppling many buildings. In the days that followed, fire devastated entire neighborhoods.

The earthquake leveled the city Modern geologists calculate that the earthquake of April 18, 1906, had an approximate magnitude of 7.9. The total damage to San Francisco involved 490 city blocks—25,000 buildings were destroyed, 250,000 people were left homeless, and approximately 3000 were killed. Streets sank 1 m, bridges collapsed, and people were trapped under buildings.

Fires caused by broken gas lines spread through the city for three days. The efforts of the firefighters were futile, because the city's water supply had been destroyed. Contaminated drinking water put the survivors' health at risk. The food supply became limited, disease spread, and looting was rampant.

Scientists analyze the earthquake The 1906 San Francisco earthquake had monumental effect on human life and on the area. Before 1906, scientists knew very little about earthquakes and their effects. This earthquake is considered to be the beginning of modern seismology in the United States.

A theory is proposed At the time of the earthquake, the theory of plate tectonics was not yet understood, so the vast movements of land puzzled scientists. Geologists analyzed the displacement of the crust and the energy released in the movement. They proposed the elastic-rebound theory, which is still used today. They theorized that tensions had been gradually building up in Earth's crust north and south of San Francisco, along a line now known as the San Andreas Fault.

The San Francisco city hall was destroyed during the 1906 earthquake.

The tension accumulated until portions of the crust reached a limit. Like a rubber band that had been stretched too far, portions of the crust snapped. This sudden release of stored energy was the cause of the 1906 earthquake.

Preparing for the future Geologists know that tensions in the crust along the Hayward Fault, the part of the San Andreas Fault where the San Francisco earthquake is thought to have occurred, continue to build as they did before the 1906 earthquake. However, in the past century, scientists and society have worked to prepare for future earthquakes, to predict where they are likely to occur, and to design buildings that can withstand their impacts.

WRITING in Earth Science

Earthquake Expedition Create a presentation or Web site that compares and contrasts the 1906 San Francisco earthquake with the 1989 Loma Prieta earthquake. For more information on these earthquakes, visit glencoe.com.

GEOLAB

RELATE EPICENTERS AND PLATE TECTONICS

Background: **The separation of P-waves and S-waves on a seismogram allows you to estimate the distance between the seismic station that recorded the data and the epicenter of that earthquake. If the distance to the epicenter, called epicentral distance, from three or more seismic stations is known, then the exact location of the earthquake's epicenter can be determined. By locating the epicenter on a map of tectonic plate boundaries, you can determine the type of plate movement that caused the earthquake.**

Question: *How do seismologists locate the epicenter of an earthquake?*

Materials

U.S. map
Figure 17.16 and **Figure 19.9**
calculator
drafting compass
metric ruler

Procedure

Determine the epicenter location and the time of occurrence of an actual earthquake, using the travel times of P- and S-waves recorded at three seismic stations.

1. Read and complete the lab safety form.
2. The table gives data from three seismic stations. Use the travel-time curves in **Figure 19.9** and the P-S separation times to determine the distances from the epicenter to each seismic station. Copy the table and enter these distances in the table row *Distance from epicenter*.
3. Obtain a map of North America from your teacher. Accurately mark the three seismic station locations.
4. Use the map scale to determine the distance in centimeters represented by the *Distance from epicenter* calculated in Step 2. Enter these distances in the table row *Map distance*.
5. Use the number calculated in *Map distance* to set the compass point to a spacing that represents the distance from the first seismic station to the epicenter.

Seismic Data

Seismic station	Berkeley, CA	Boulder, CO	Knoxville, TN
P-S separation (min)	3.9	3.6	4.6
Distance from epicenter (km)			
Map distance (cm)			

6. Place the compass point on the seismic station location and draw a circle.
7. Repeat for the other two seismic stations.
8. Mark the point of intersection of the three circles. This is the epicenter of the earthquake.

Analyze and Conclude

1. **Interpret Data** Where is this epicenter located?
2. **Describe** In which major seismic belt did this earthquake occur?
3. **Interpret Data** Use **Figure 17.16** to determine which plates form the boundary associated with this earthquake.
4. **Conclude** Describe how tectonic motions caused this earthquake.

WRITING in Earth Science

Imagine You are a reporter for the newspaper based near the epicenter of this earthquake. Write an article explaining how geologic processes resulted in this earthquake. Describe whether the earthquake should have been a surprise to the residents, given its location in relation to plate boundaries.