SCRAPBOOK Wave Watch

San Francisco, April 18, 1906

This is one of the most exciting days in the life of G.K. Gilbert, a geologist working for the U.S. Geological Survey. He explains why: *It is the natural and legitimate ambition of a properly constituted geologist to see a glacier, witness an eruption, and feel an earthquake. When therefore, I was awakened in Berkeley on the 18th of April... by a tumult of motions and noises, it was with unalloyed pleasure that I became aware that a rigorous earthquake was in progress.*

Gilbert witnessed the results of one of the most famous quakes in the United States—the San Francisco quake of 1906. From his home in Berkeley, 15 miles (24 km) east of the epicenter, he wrote the following in his diary of observations on the quake.

Wednesday, April 18,1906

An earthquake shock at 5:11 followed by others at intervals. I note [them at] 6:11 and 7:47, also 6:53 p.m. Motion in my room North-South, in other rooms East-West. Water spilled from pitcher. Duration estimated at 1 minute. No apparent damage in laboratory.

Thursday, April 19,1906

Unsuccessful attempts to go to San Francisco. A faint [after]shock at 10:15 p.m.

Friday, April 20,1906

[travels to San Francisco]

The made ground about lower Market Street shows much settling .. [perhaps as much as] 3 to 4 feet. The buildings on this ground suffered more from earthquake than those on firm ground.

On Shaky Ground

The amount of damage waves can do often depends on what kind of ground they are shaking. Note Gilbert's comment about the "made" ground allowing for more damage to the structures above it. Loose soil shakes more than solid bedrock. This is why San Francisco residents should be concerned about their marina district: It was built over a landfill made by the rubble from the 1906 quake!

RIDING THE WAVES

Earthquakes happen when underground rock breaks, causing vibrations and releasing huge amounts of energy. The waves ripple through the earth, radiating out from the place where the rock broke, moving the earth up and down, forward and backward, and side to side.

Different kinds of waves travel in distinct ways and at dissimilar speeds. Body waves travel through the body of the earth. Surface waves move over the earth's surface.

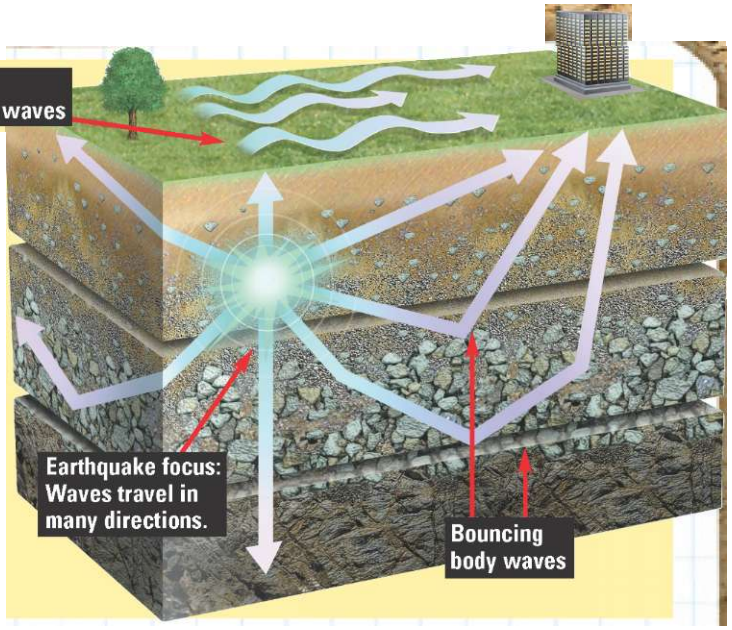
There are two kinds of body waves: primary and secondary. Primary waves, called P waves, are the fastest, so they are the first ones we feel. Many people can hear P waves before they feel the rumbling and rattling. P waves move the rock forward and backward, squeezing and extending the rock.

The next waves we feel are secondary, or S waves. These waves shake the rocks up and down and from side to side. They often cause the most damage.

The Force Isn't With You

The motions you feel in an earthquake are caused by surface waves coming directly from the focus of the earthquake and body waves that have been bounced around under the earth.

Whether seismic waves cause a quick jerking motion or a slow rolling motion depends on how long each wave is and how fast it moves. P and S waves create jerks and jolts because they are short and fast. Surface waves are rolling because each wave is long and slow. Even though surface waves are slower, they travel farther. Body waves die out more quickly.

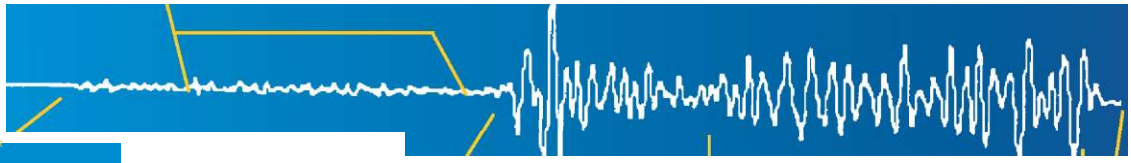


READING RIGHT

Seismic waves can be felt around the globe. Below is a seismogram from the 1906 San Francisco earthquake. The moment it hit, this seismogram was recorded 6,100 miles (9,817 km) away in Gottingen, Germany. The captions explain each part of the seismogram.

P waves that bounced off Earth's core

In Gottingen, the largest S waves moved the ground .04 inches (1 mm) back and forth.



First P waves arrive in Gottingen.

10 minutes later, first S waves arrive in Gottingen.

S waves that have bounced off Earth's core

Surface waves arrive, and they are so large they go off scale.

Activity

MAKING WAVES Imagine that you are an earthquake creating P and S waves. You can re-create the waves, using yourself and a friend as "the quake," and a metal Slinky™ as a substitute for the wave that passes through rock. To begin, you'll need a non-carpeted floor. Sitting across from each other, you and your friend should each take an end of the Slinky. Make sure you are sitting close enough so that the Slinky isn't completely extended.

Rest the Slinky on the floor. Create a P wave: Give one end of the Slinky a quick push forward. Can you see the compressed part running down to your friend and then bouncing back? Behind the compressed part near your hand is an extended section. Notice that it is the energy wave, not the Slinky itself, that moves from you to your friend. How can you now create an S wave? Try doing so and watch the wave run down the Slinky and bounce back.

What happens when you put a piece of cardboard or wood through the middle of the Slinky and then try to make waves? What real-life earthquake experience is this similar to? When the wave gets to your end of the Slinky, you can feel it in your hand. What happens to the wave energy when it hits your hand? What does this represent?