Be a Scientist!

Be an Engineer!

Model how liquefaction during an earthquake changes Earth's surface and affects buildings. Put sand in a large plastic container. Mix enough water into the sand to make the ground feel firm. Stack several wooden blocks on top of the sand to represent buildings, then gently shake the container. Observe what happens. Experiment to find out what happens when you stack the blocks higher, add more water, or shake the container harder.

How can you help keep the blocks from falling over? Sketch a design to make the buildings more earthquake-resistant. Discuss your plans with peers and then try your methods. Adjust your design as needed. Then report on the results.

Beyond the Book

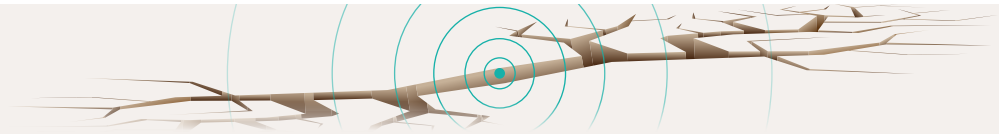
Conduct research to learn how to stay safe during an earthquake.

FOCUS Book

Earthquakes

Science A–Z

Notes



Earthquakes

FOCUS Question

How do earthquakes change Earth's surface?

Stability and Change

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Earthquakes

Written by Janette Schuster

www.sciencea-z.com

Shaking Things Up

It was the third game of the 1989 World Series. More than sixty thousand baseball fans packed Candlestick Park in San Francisco, California. But the fans got more action than they bargained for when the entire stadium shook for fifteen seconds. It was an *earthquake!* The game was called off. Luckily, the fans were unharmed. People in other parts of the city were not so fortunate.

Although you may not feel the ground shaking, an earthquake is probably happening someplace on Earth right now. An earthquake is the shaking that occurs when enormous rocks in Earth's crust suddenly move and energy is released.

Players and fans evacuated Candlestick Park after the Loma Prieta earthquake shook the stadium during the 1989 World Series.

Notes

Read-Think-Write

Write your answers on separate paper. Use details from the text as evidence.

1. What is an *earthquake?*
2. Look at the map on page 3. Is the west coast of the United States more or less likely to have an earthquake than the east coast of the United States? What causes this difference?
3. How can shaking during an earthquake change Earth's surface?
4. Look at the chart on page 6. What would be the effects of a magnitude 5 earthquake?
5. Which features of a building make it resistant to earthquake damage?

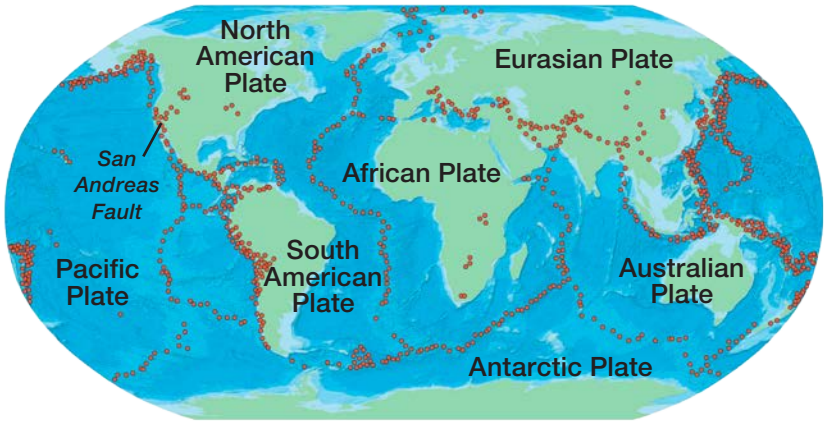
FOCUS Question

How do earthquakes change Earth's surface? Write a news report describing how an imaginary earthquake changed Earth's surface in your area. Describe the earthquake's magnitude and any damage it caused. Also identify the focus and epicenter of the earthquake.

Fault Formation

Earth's crust—its outermost layer—is made up of many distinct pieces called *tectonic* (tek-TAH-nik) *plates.* These plates sit on top of a layer called the *mantle,* which is not as rigid and can flow. Currents in the mantle cause the plates to move slowly and continuously. This movement of Earth's plates is known as *plate tectonics.*

Tectonic plates meet at plate boundaries, where they can separate, collide, or slide past one another. At plate boundaries, huge slabs of rock push and pull, and pressure builds up within them. If enough pressure builds up in the rocks, they break and form a *fault*—a crack in Earth's crust. Most faults occur along plate boundaries, but they can also form in the middle of plates. Where there are faults, there are often earthquakes.



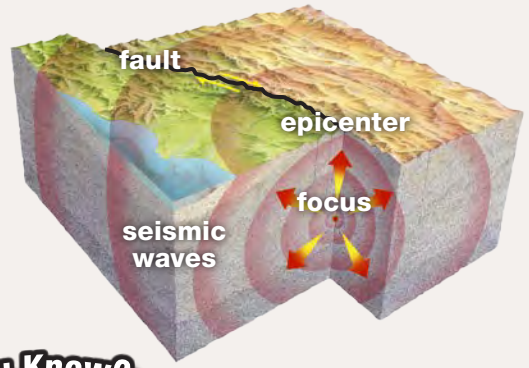
Most earthquakes (shown in red dots) happen at faults along plate boundaries. The pressure buildup along the San Andreas Fault caused the 1989 Loma Prieta earthquake.

Earthquake Alert

An earthquake begins when the land along a fault suddenly moves. The *focus* of the earthquake is the underground location where the land first moves. Waves of energy, called *seismic* (SIZE-mik) waves, radiate outward from the focus like ripples of water on a lake. This release of energy causes the ground to shake. The *epicenter* of the quake is the point on Earth's surface directly above the focus. It's where the strongest shaking occurs.

During an earthquake, rocks on either side of a fault move in opposite directions—upward, downward, or sideways. This motion can abruptly change Earth's surface.

FOCUS AND EPICENTER OF AN EARTHQUAKE



Do You Know?

Earthquakes can change Earth's rotation. A massive earthquake near Indonesia in 2004 made Earth spin a bit faster and slightly shortened the length of one day.

Standing Up to Earthquakes

Earthquakes have destroyed cities. But scientists and engineers have come up with ways to make structures that can stand up to the shaking.

Strong frameworks, or *trusses*, around the outside of buildings support the walls and make them stronger. Vertical frames built within the structure are called *shear panels*. These special walls stiffen buildings. They help the buildings stay standing even when they are swaying back and forth. *Base isolators* are plates that separate a building from the ground below. They act like shock absorbers, adjusting when the ground shakes so the building stays still.

The hope is that stronger structures can keep people safe during future earthquakes.


trusses


cross-bracing framework

Shaking Alaska

The most powerful earthquake ever recorded in the United States was in Alaska. The quake happened on March 27, 1964. This 9.2 magnitude earthquake struck when the Pacific Plate suddenly slid under the North American Plate. Parts of the surface shifted upward, while other areas sank.

Strong shaking lasted more than four minutes. In the city of Anchorage, huge landslides broke up and moved the land. During the earthquake, the ocean floor around Montague Island was lifted up more than 8 meters (26 ft.). The quake also triggered a tsunami that crashed on the shore. High waves swallowed coastal areas and damaged shorelines as far away as California.

Strong shaking during a 1964 earthquake caused land and buildings to slide downhill in Anchorage, Alaska.

Changing Earth's Surface

Earthquakes change the surface and put people and structures at risk. During an earthquake, the *displacement* of rock can be small, moving Earth's surface less than a meter. But rock can also move several kilometers. A cliff, called a *scarp,* can form when an earthquake causes one side of a fault to push upward. Landforms such as valleys and ridges become *offset* (not lined up) where one side slides past the other.

A fault scarp exposes limestone after one side of Earth's surface pushes upward.

Liquefaction during the 1989 earthquake in San Francisco caused buildings to sink and collapse.

Normally, soil acts like a solid and can support the heavy weight of landforms and structures. But shaking makes some soil behave like a liquid. This process is called *liquefaction.* Liquefied soil can trigger landslides and mudslides. Bridges, buildings, and roads built on the loosened soil can collapse.

Measuring Up

More than a million earthquakes happen around the world each year. Most are so minor that you wouldn't even feel them, while others are massive. One way to measure and compare the strength, or *magnitude,* of earthquakes is to use the *Richter scale.* On this scale, larger numbers indicate more powerful earthquakes. Each higher number on the scale represents an increase of about thirty-one times more energy.

Scientists also use the *moment magnitude scale* (below). This scale is based on the total energy recorded for an earthquake. As with the Richter scale, the higher the number, the larger the earthquake and the more energy it has.

EFFECTS OF EARTHQUAKES	
Moment Magnitude	**Typical Effects**
2 and lower	Generally not felt
3	Minor earthquake usually felt
4	Light earthquake with shaking felt
5	Moderate earthquake with some damage to property
6	Strong earthquake with damage to property
7	Major earthquake with damage to property and some loss of life
8	Great earthquake with costly damage and large loss of life
9 and higher	Largest earthquake with massive destruction and widespread loss of life

Data source: http://www.iris.edu/hq/files/publications/brochures_onepagers/doc/EN_OnePager3.pdf

Rocking Japan

The country of Japan is an island chain in the Pacific Ocean. It is located on or near four tectonic plates. On March 11, 2011, movement along the Japan Trench, an underwater fault off the coast, caused a 9.1 magnitude earthquake (measured on the moment magnitude scale).

When the earthquake pushed the seafloor upward, it triggered a *tsunami* (su-NOM-ee). This series of huge, fast-moving waves flooded the land. In some areas, the waves reached heights of 38.9 meters (127.6 ft.). Movement along the fault also caused Japan's largest island to move 2.4 meters (8 ft.) to the east. In some areas, the earthquake caused the land to *subside,* or sink down. The movement of the land, along with the tsunami, caused massive destruction and loss of life.

In 2011, tsunami waves hit the coast of Japan, causing massive destruction and loss of life.