

What Are Earthquakes?

BEFORE YOU READ

After you read this section, you should be able to answer these questions:

- Where do most earthquakes happen?
- What makes an earthquake happen?
- What are seismic waves?

National Science Education Standards

ES 1a, 1b

What Is an Earthquake?

Have you ever been in an earthquake? An *earthquake* is a movement or shaking of the ground. Earthquakes happen when huge pieces of Earth's crust move suddenly and give off energy. This energy travels through the ground and makes it move. **Seismology** is the study of earthquakes. Scientists who study earthquakes are called *seismologists*.



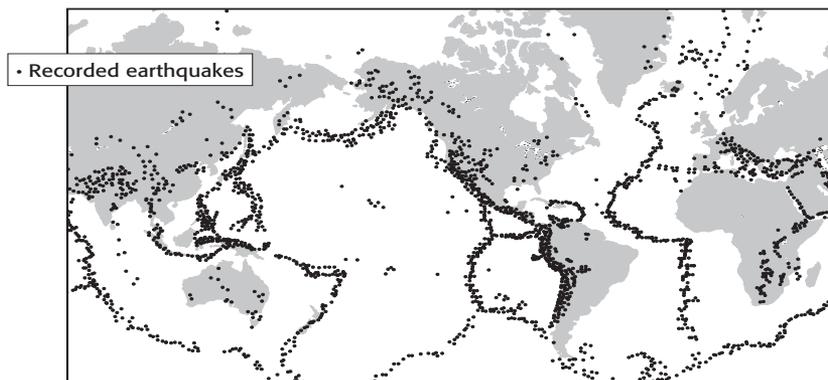
Learn New Words As you read this section, circle words that you don't understand. When you learn what they mean, write the words and their definitions in your notebook.

Where Do Most Earthquakes Happen?

Most earthquakes happen at places where two tectonic plates touch. Tectonic plates are always moving. In some places, they move away from each other. In some places, they move toward each other. And in some places, they grind past each other.

The movements of the plates cause Earth's rocky crust to break. A place where the crust is broken is called a *fault*. Earthquakes happen when rock breaks and slides along a fault. ✓

Earthquakes and Plate Boundaries



1. Define What is a fault?

TAKE A LOOK

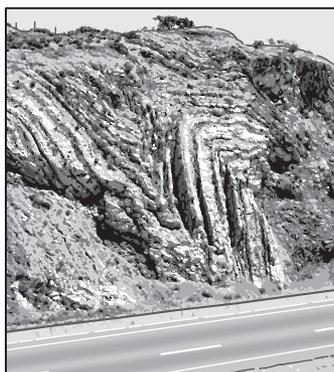
2. Infer Use the earthquake locations to help you figure out where the tectonic plate boundaries are. Use a colored pen or marker to draw plate boundaries on the map.

SECTION 1 What Are Earthquakes? *continued*

Why Do Earthquakes Happen?

When tectonic plates move, pressure builds up on the rock near the edges of the plates. When rock is put under pressure, it changes shape, or deforms. This is called **deformation**.

Some rock can bend and fold like clay. When the pressure is taken away, the rock stays folded. When rock stays folded after the pressure is gone, the change is called *plastic deformation*.



Folded Layers of Rock

TAKE A LOOK

3. Explain How do you know that the rock layers in the figure were once under a lot of pressure?

STANDARDS CHECK

ES 1b Lithospheric plates on the scales of continents and oceans constantly move at rates of centimeters per year in response to movements in the mantle. Major geological events, such as earthquakes, volcanic eruptions, and mountain building result from these plate motions.

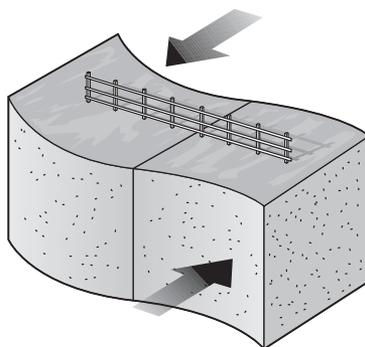
Word Help: response
an action brought on by another action; a reaction

Word Help: major
of great importance or large scale

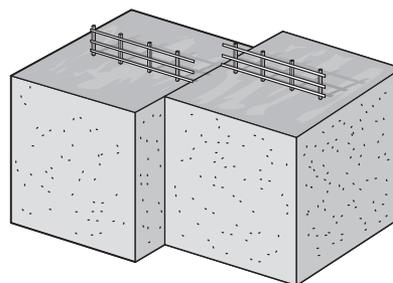
4. Explain How does the movement of tectonic plates cause earthquakes?

In some cases, rock acts more like a rubber band. It changes shape under pressure, but then it goes back to its original size and shape when the pressure goes away. This change is called *elastic deformation*.

Earthquakes happen when rock breaks under pressure. When the rock breaks, it snaps back to its original shape. This snap back is called **elastic rebound**. When the rock breaks and rebounds, it gives off energy. This energy creates faults and causes the ground to shake.



1. Forces push rock in opposite directions. The rock deforms elastically. It does not break.



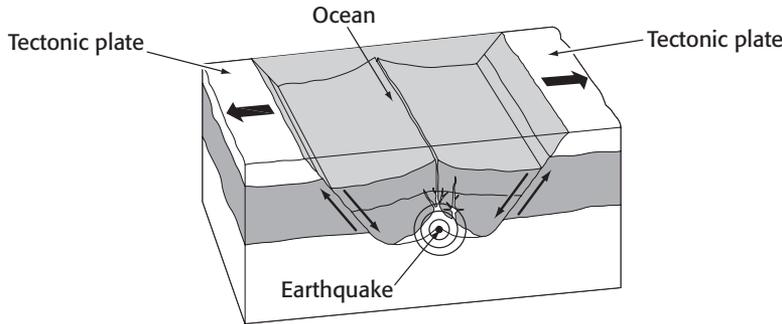
2. If enough force is placed on the rock, it breaks. The rock slips along the fault. Energy is released.

SECTION 1 What Are Earthquakes? *continued*

How Do Earthquakes Happen at Divergent Boundaries?

A *divergent boundary* is a place where two tectonic plates are moving away from each other. As the plates pull apart, the crust stretches. The crust breaks along faults. ✓

Most of the crust at divergent boundaries is thin and weak. Most earthquakes at divergent boundaries are small because only a little bit of pressure builds up before the rock breaks.

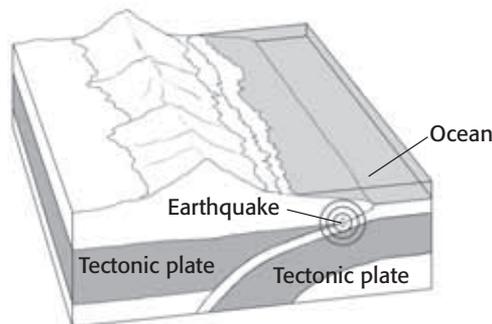


Earthquakes at Divergent Boundaries

How Do Earthquakes Happen at Convergent Boundaries?

A *convergent boundary* is a place where two tectonic plates collide. When two plates come together, the rock is put under a lot of pressure. The pressure grows and grows until the rock breaks.

The earthquakes that happen at convergent boundaries can be very strong because there is so much pressure. The strongest earthquakes ever recorded have all happened at convergent boundaries. ✓



Earthquakes at Convergent Boundaries

✓ **READING CHECK**

5. Define What is a divergent boundary?

TAKE A LOOK

6. Identify Label the faults on the figure. Put a star where an earthquake is likely to happen.

✓ **READING CHECK**

7. Explain Why are many earthquakes at convergent boundaries very strong?

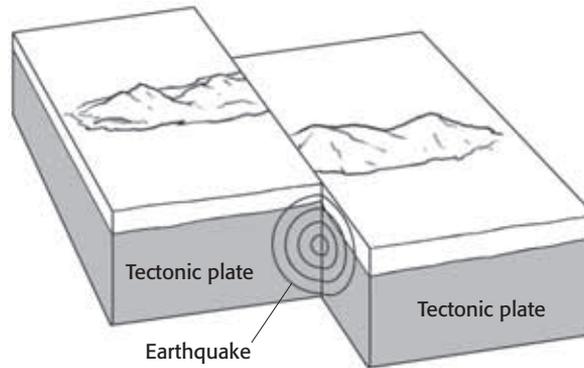
TAKE A LOOK

8. Identify Draw arrows on the figure to show the directions that the two tectonic plates are moving.

SECTION 1 What Are Earthquakes? *continued*

How Do Earthquakes Happen at Transform Boundaries?

A *transform boundary* is a place where two tectonic plates slide past each other. As the plates move, pressure builds up on the rock. Eventually, the rock breaks and the plates slide past each other along a fault.



Earthquakes at Transform Boundaries

TAKE A LOOK

9. Identify Draw arrows showing the directions that the tectonic plates in the figure are moving.

Critical Thinking

10. Apply Concepts Why are most earthquake zones near plate boundaries?

What Is an Earthquake Zone?

A place where there are a lot of faults is called an *earthquake zone*. The San Andreas Fault Zone in California is an example of an earthquake zone. Most earthquake zones are near plate boundaries, but some are in the middle of tectonic plates.

How Does Earthquake Energy Travel?

When an earthquake occurs, a lot of energy is given off. This energy travels through the Earth in the form of waves called **seismic waves**.

There are two kinds of seismic waves. *Body waves* are seismic waves that travel through the inside of Earth to the surface. *Surface waves* are seismic waves that travel through the top part of Earth's crust. ✓

READING CHECK

11. List What are the two kinds of seismic waves?

BODY WAVES

There are two kinds of body waves: P waves and S waves. **P waves** are also called pressure waves. They are the fastest kind of seismic wave.

P waves can move through solids, liquids, and gases. When a P wave travels through a rock, it squeezes and stretches the rock. P waves make the ground move back and forth.

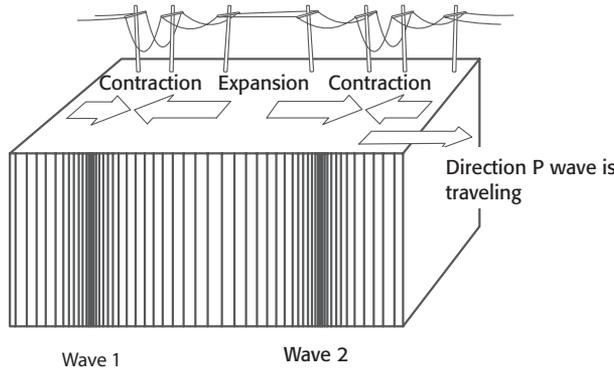
S waves are also called shear waves. S waves move rock from side to side. They can travel only through solids. S waves travel more slowly than P waves.

SECTION 1 What Are Earthquakes? *continued*

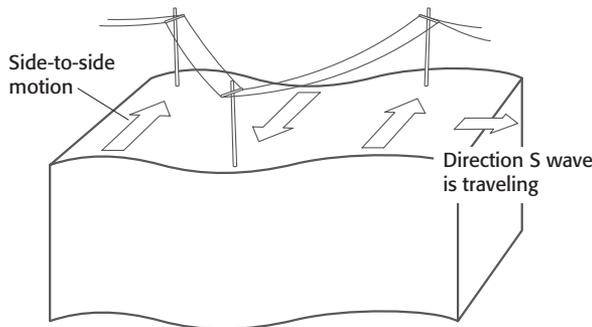
SURFACE WAVES

Surface waves travel along the top of Earth's crust. Only the very top part of the crust moves when a surface wave passes.

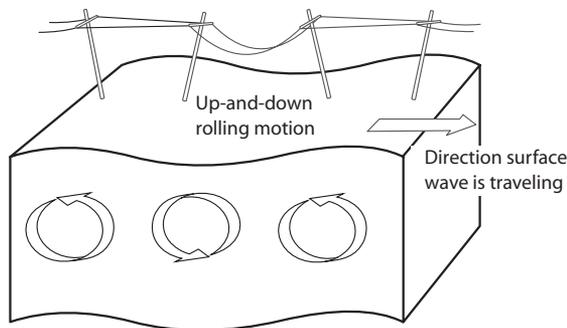
Surface waves travel much more slowly than body waves. When an earthquake happens, surface waves are the last waves to be felt. Surface waves cause a lot more damage to buildings and landforms than body waves do. ✓



P waves are body waves that squeeze and stretch rock.



S waves are body waves that can move rock from side to side.



Surface waves can move the ground up and down in a circular motion.

READING CHECK

12. Compare Which kind of seismic wave travels the most slowly?

TAKE A LOOK

13. Compare How are the motions of P waves and S waves different?

Critical Thinking

14. Infer What do you think is the reason surface waves usually cause the most damage?

Section 1 Review

NSES ES 1a, 1b

SECTION VOCABULARY

deformation the bending, tilting, and breaking of the Earth's crust; the change in the shape of rock in response to stress

elastic rebound the sudden return of elastically deformed rock to its undeformed shape

P wave a seismic wave that causes particles of rock to move in a back-and-forth direction

S wave a seismic wave that causes particles of rock to move in a side-to-side direction

seismic wave a wave of energy that travels through the Earth, away from an earthquake in all directions

seismology the study of earthquakes

1. Compare What is the difference between an earthquake and a fault?

2. Identify Where do most earthquakes happen?

3. Describe What causes earthquakes?

4. Compare What is the main difference between body waves and surface waves?

5. Apply Concepts Why are some earthquakes stronger than others?

6. Infer Why do few earthquakes happen in Earth's mantle?
