

Forces that Shape the Earth

Section 2: Earthquakes

An **earthquake** is one of the most powerful natural forces on Earth. Although scientists have learned a great deal about how earthquakes happen, they are still very difficult to predict and impossible to prevent. An earthquake is a vibration in the ground caused by movement along faults—breaks in Earth's crust where blocks of rock move past one another. Throughout history, earthquakes have caused widespread destruction. In 1906, a massive earthquake struck San Francisco, destroying nearly 30,000 buildings, many of them lost to fires that followed the shaking. Events like this showed scientists how important it was to better understand earthquakes and the forces that cause them.

To understand earthquakes, it helps to first understand plate tectonics. Earth's outer layer is broken into large pieces called tectonic plates that are constantly moving. Where these plates meet, cracks called **faults** often form. Most faults are found along plate boundaries, where powerful forces cause the crust to bend and break. One of the most famous faults is the San Andreas Fault, which runs about 600 miles through California.

There are three main types of faults, each caused by different types of stress. A **normal fault** forms when tension pulls rocks apart at a divergent boundary. In this case, the block of rock above the fault moves downward. A **reverse fault** forms when compression pushes rocks together, causing the block above the fault to move upward. The third type, a **strike-slip fault**, occurs when two blocks of rock slide past each other horizontally in opposite directions.

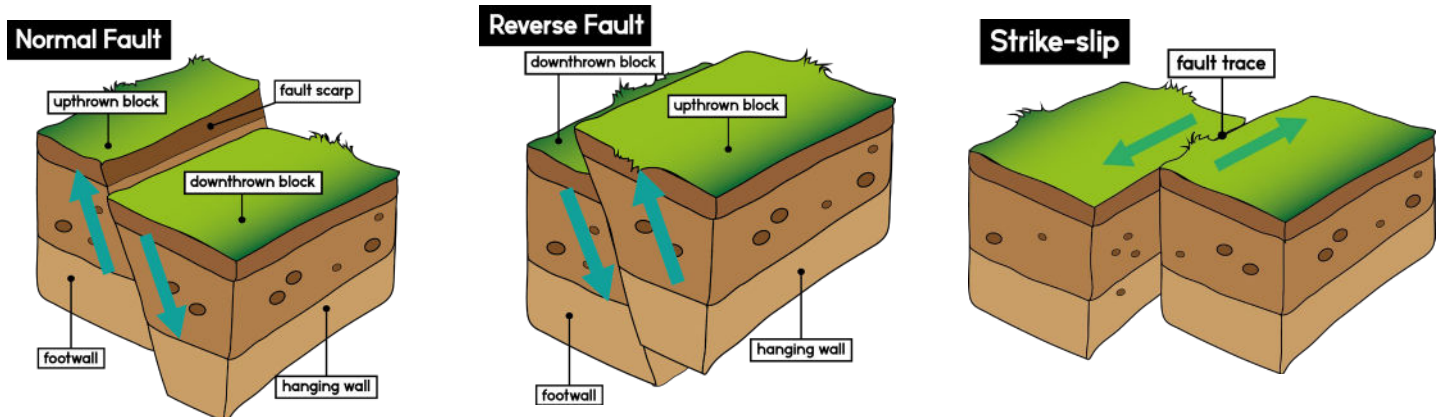


Figure 1

When rocks suddenly move along a fault, they release a tremendous amount of stored energy. This energy travels outward in all directions as seismic waves. To describe where an earthquake begins, scientists use two important terms: focus and epicenter.

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Section 2: Earthquakes Cont.

The **focus** is the point beneath Earth's surface where the rock first breaks and releases energy. If the focus is shallow, the earthquake often causes more damage because it is closer to the surface. The **epicenter** is the point on Earth's surface directly above the focus. Areas near the epicenter usually experience the strongest shaking. The energy released by an earthquake travels as seismic waves. There are three main types. **Primary waves (P waves)** are compression waves that travel through both solids and liquids. They squeeze and stretch the material they move through, temporarily changing its volume. **Secondary waves (S waves)** move more slowly and travel only through solids. They shake the ground side to side, changing its shape but not its volume. Finally, **surface waves** travel along Earth's surface. Although they move more slowly than P and S waves, they often cause the most severe ground movement and damage.

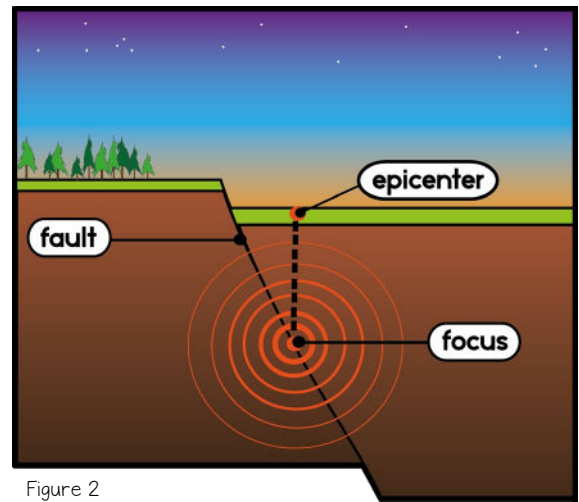


Figure 2

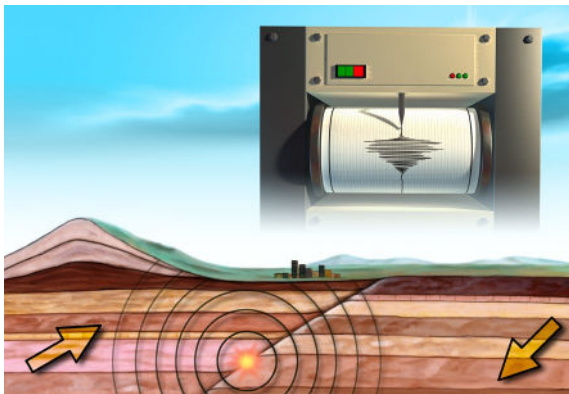


Figure 3 - An earthquake begins at the focus underground, sending seismic waves outward. A seismograph detects these waves and records them as lines on a seismogram.

Scientists use special instruments called **seismometers** to measure and record ground motion. To locate an earthquake's epicenter, they use a method called triangulation, which requires data from at least three seismometers. First, scientists calculate the difference between the arrival times of the P waves and the S waves, known as the lag time. Next, they use a lag-time graph to determine the distance from each seismometer to the epicenter. Finally, they draw a circle around each seismometer location on a map using the calculated distance as the radius.

The point where all three circles intersect marks the earthquake's epicenter. By studying faults, seismic waves, and patterns of past earthquakes, scientists continue to improve their understanding of how and where earthquakes occur—helping communities better prepare for future events.

Review:

1. How does an earthquake occur?
2. Compare a normal fault to a reverse fault.
3. Explain the difference between a P wave and an S wave.