Plate Tectonics

A Reading A–Z Level Y Leveled Book
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LEVELED BOOK • Y

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Illustrated by Signe Nordin

www.readinga-z.com

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Correlation

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Introduction

When you look at a globe, do you ever wonder why Earth looks the way it does? Why are there big areas of land separated by oceans? Why isn't there just one large land mass? Why are there separate continents?

In this book, you will look for answers to these questions. You will learn about Earth's structure and how it has changed. You also will learn a little about how it may look in the future.

One thing you will certainly learn is that Earth is always changing. In fact, it's changing right now.

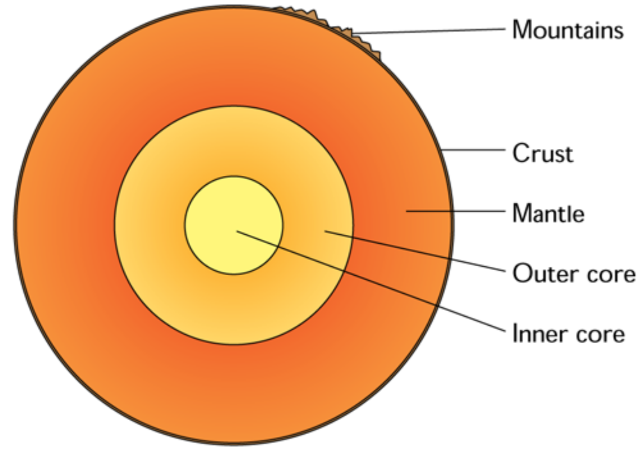
Before you learn about why Earth looks the way it does and how it changes, you will learn a little about how it is put together. If you can understand the way Earth is made, you will better understand how it changes.

Do You Know?
There is an earthquake every 11 seconds. There are more than 600 active volcanoes in the world. Each earthquake and volcanic eruption is part of Earth's way of changing.

Earth's Structure

The size of Earth—about 12,249 kilometers (7,650 mi) in diameter—has been known since the time of the ancient Greeks. But it wasn't until the early 1900s that scientists knew Earth was made up of three main layers: the crust, the mantle, and the core.

Internal Structure of Earth



This picture shows the internal structure of Earth. The picture is drawn to scale (relative size of each layer, just much smaller). The **crust**, or outer layer, is very rigid and thin compared to the other two layers. Its thickness changes in different areas of the Earth. Under the oceans, the crust is very thin, around 4.8 kilometers (3 mi) thick. But under a mountain range, like the Swiss Alps or the Cascades in the northwestern United States, the crust can be as much as 100 kilometers (62 mi) thick. Earth's crust is brittle and can break when under great pressure.

Below the crust is the **mantle**. The mantle is a dense, hot layer of semi-solid rock that is about 2,800 kilometers (1,750 mi) thick. It is semi-solid because the mantle is much hotter than the crust.

The pressure at the depths of the Earth is much greater than at the surface. The pressure causes the mantle to be both hotter and denser at its deepest part.

Beneath the mantle and at the center of the Earth is the **core**. The core is almost twice as dense as the mantle because the pressure is even greater in the core. The core is mostly metal, rather than rock like the mantle. Earth's center has two layers. The liquid outer core is about 2,080 kilometers (1,300 mi) thick. There is also a solid inner core, the true center of the Earth. The inner core is made almost entirely of iron. As Earth rotates, the liquid outer core spins. This spinning action creates Earth's magnetic field.

So, there is the thin outer crust, which is kind of stiff and can break. There is the middle layer, the mantle, which is much hotter and not quite solid. And in the middle is the core, which has a solid center and a liquid-like outer layer. Some people like to compare Earth to a hard-boiled egg. The crust is the shell, the mantle is the white, and the core is the yolk. You might want to use this comparison to help you remember the layers of the Earth. But remember—unlike an egg yolk, Earth's core has two layers.

Earth's Fragile Crust

When you think about the mantle, remember that it is very hot. When rock or metal is heated to high temperatures, it begins to get softer and turn to liquid. For example, when a blacksmith makes a horseshoe, he heats the metal until it turns red. When it gets that hot it becomes soft, and he can hammer it to fit the horse's hoof. Well, the mantle is always at a very hot temperature, so it is not quite solid. It's like Silly Putty® or Play-Doh®. It may feel solid, but if you push on it, it will change shape. This is how the mantle works.

The mantle is kind of solid, but not quite. It is stuck between the rigid crust of Earth's surface and the spinning, liquid outer core. Being caught in the middle causes stress to build up. The mantle is continually caught between two powerful forces. As a result, the mantle stays in constant motion.

Riding on top of the moving mantle is the crust. Most of the time, the crust is solid and stays in one piece. However, stress and pressure, which cause the mantle to move, can cause large slabs of Earth's crust to move, too. The pressure and motion can cause the crust to crack. The cracks, called **fault** lines, are where earthquakes are known to occur.

Fault lines are commonly found where large slabs of Earth's crust meet. You will learn about this movement in the next section.

If the pressure is great enough, enough heat is created to turn the mantle into a liquid called **magma**. The hot magma expands and places pressure on the crust above. The magma is pushed through cracks in the crust. In time it can get very close to Earth's surface. If the pressure is great enough, the magma will break through the surface and form a **volcano**. Sometimes the pressure is so great that the magma explodes through the crust, shooting dust, ash, steam, and liquid rock called **lava** into the air. Like earthquakes, volcanoes are usually found in areas where two or more slabs of Earth's crust meet.

Exploding lava

Tectonic Plates

Earth's crust is made of about fifteen enormous slabs, or **plates**. Some of the plates are moving apart. Others are moving together. Still others are sliding past each other. The plates are located under both land masses and oceans. Those under land are called **continental plates**. Those under the oceans are called **oceanic plates**. Over time, one plate may disappear and another one may appear, so the number of plates can change. But the number won't change during your lifetime. It takes millions of years for these changes to happen.

The process of plates forming and moving is called **plate tectonics**. The word *tectonic* comes from a Greek word that means "to build." The phrase *plate tectonics* means that Earth is built from plates of rock. These plates probably formed very early in Earth's five-billion-year history.

A very long time ago, all the continental plates were joined as one large plate. There was only one continent at that time. We call that continent **Pangaea**, meaning "all lands" in Greek.

Pangaea

The illustrations on the next page show how the seven continents were one giant mass of land long ago. Over many hundreds of millions of years, forces within the Earth have caused the continental plates to move and spread apart. The spreading plates have moved the continents to the locations we know today. As you move from one picture to the next, notice how the continents look like puzzle pieces. You can see how South America once fit right into the coast of Africa. Who knows how the continents might look hundreds of millions of years from now?

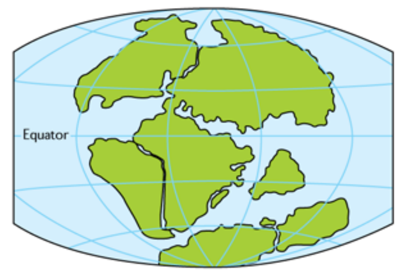
It has taken 225 million years for the continents to separate and move to their current locations. Some scientists believe most of the continents will someday be a single mass again. This movement of the continents over time is called **continental drift.**

What forces in Earth could be powerful enough to cause huge plates of the crust to move?

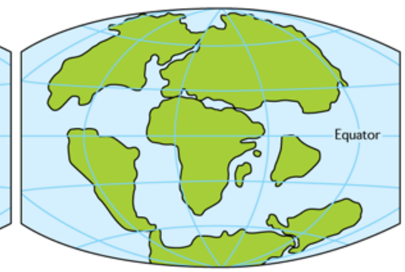
Movement of Continental Plates

PERMIAN
225 million years ago

TRIASSIC
200 million years ago



JURASSIC
135 million years ago



CRETACEOUS
65 million years ago

PRESENT DAY

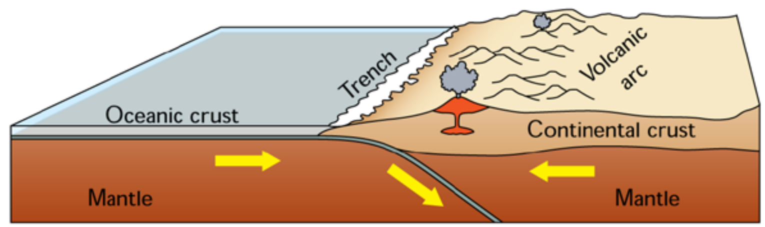
Ocean Ridges and Trenches

In the middle of the Atlantic Ocean, scientists found a strange chain of mountains. Over the years, they found that this mountain chain exists between all the continents, winding its way around the Earth. This mountain chain is called the **global mid-ocean ridge**. Along this ridge, hot magma seeps to the surface through fault lines in the crust. The magma spreads out along the ocean floor and cools. This buildup of magma causes the oceanic plates to change and grow. These plates push out toward the other plates. In some places along the ridge, underwater volcanic eruptions occur. Some of these eruptions have brought enough magma to the surface to form islands in the ocean. The island of Iceland formed in this way.

Around the Pacific Ocean is a series of deep **trenches**. Some of the older crust is pushed into these trenches as new crust is created. These trenches are places where one plate is pushed under another plate. Wherever this happens, there are lots of earthquakes and volcanoes. For this reason, the rim of land that surrounds the Pacific Ocean is called the **Ring of Fire**. The mountain ranges along the western shores of North and South America and the eastern shores of Asia were created when oceanic plates pushed beneath

continental plates. These mountain ranges, which contain many volcanoes, were formed when the colliding plates pushed the crust upward.

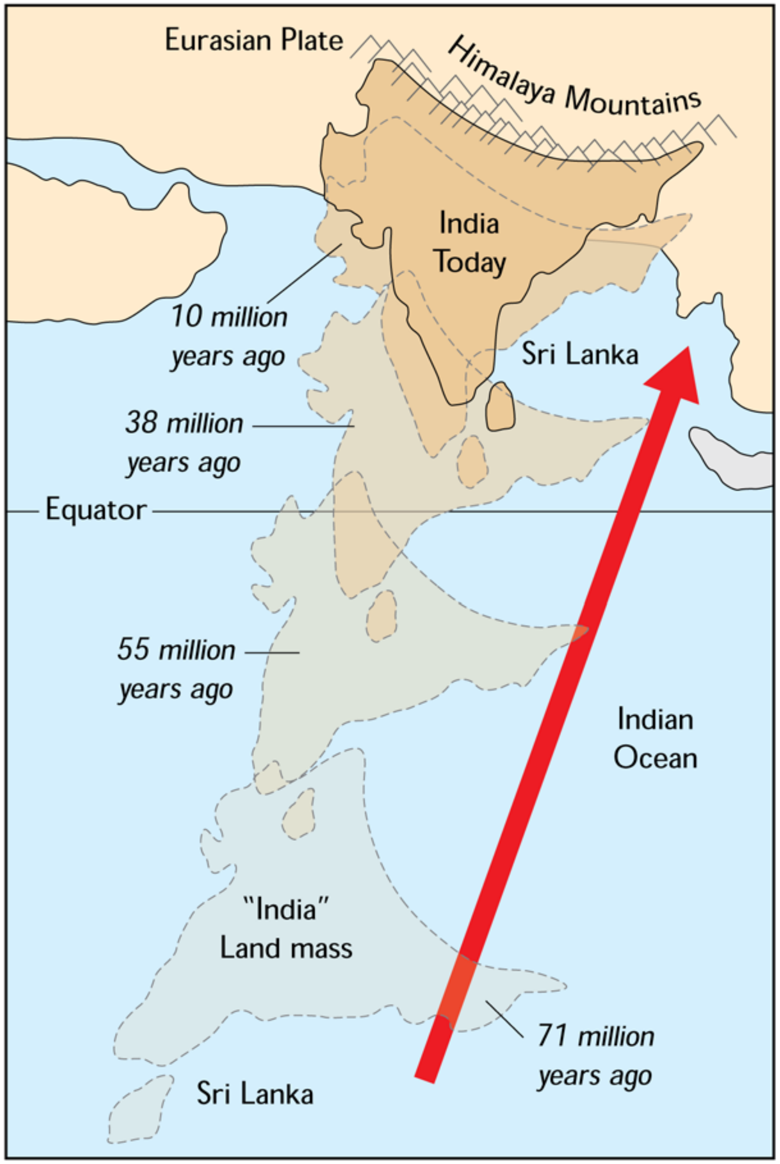
Plate Movement



An oceanic plate moves under a continental plate.

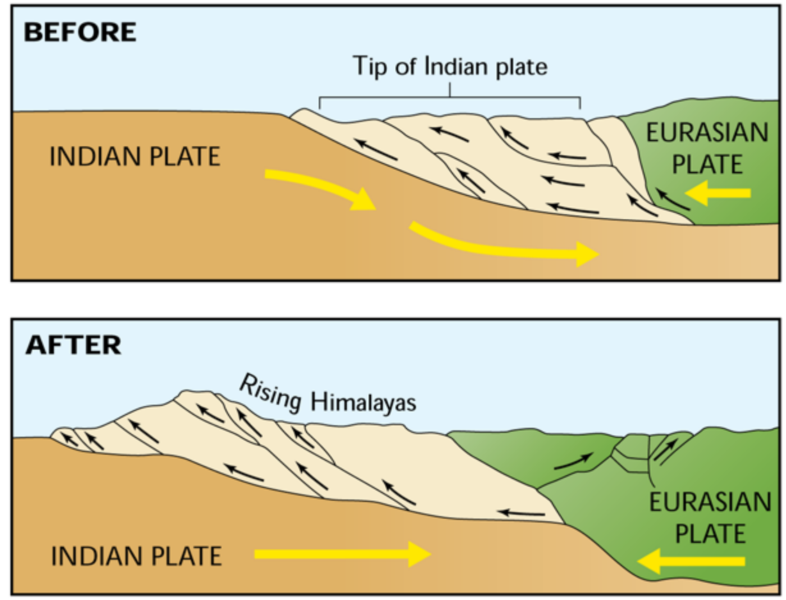
A similar process pushed India into the Asian continent millions of years ago. India was an island off the Australian coast when Pangaea broke up. Over a long period of time, India moved northward at a rate of about 9.1 meters (30 ft) per century. When it finally hit the Asian coast, it moved much more slowly but continued to move north. The northern movement of India pushed its coastal edge upward against the unmoving Eurasian continent. The coastal edge of India grew to become the Himalaya Mountains, the largest and tallest mountain range in the world. Some of the mountains are nearly 9.6 kilometers (6 mi) tall and are still growing. Sandstone and other rocks found in the Himalayas contain fossils of water creatures, proving that the land was once under salt water.

This illustration shows how India has moved north over the last 80 million years.



These illustrations show how the tip of the Indian plate has been pushed upward to form the Himalayas by the pressures of the colliding plates. The Indian plate is still moving, causing the Himalayas to continue to grow.

Himalayan Mountain Formation



Do You Know?

The Himalaya Mountains continue to grow at a rate of 1 centimeter (.39 in) a year. In a million years, that is 9.66 kilometers (6 mi) of growth!

Conclusion

The study of plate tectonics tells us a lot about how Earth has changed over the years and how it will continue to change. Plate tectonics is still a new science. Over time it will offer many more insights into how the Earth is made.

Throughout your lifetime, several major earthquakes and a few serious volcanic eruptions will occur. Each of these events will reveal information about how Earth is put together. It is now possible to track these changes on a daily basis. At the end of this book is a list of some books where you can learn more about how Earth changes. You will also find instructions for searching the Web for more information. Some Web sites keep track of earthquakes and volcanic eruptions around the world.

The study of plate tectonics teaches us a lot about Earth's past. It also can suggest Earth's possible future. For example, many scientists believe that Los Angeles will eventually be right next to San Francisco. Los Angeles is on an oceanic plate that is moving northward. San Francisco is safely on a continental plate and isn't moving. One day in the far future, Los Angeles may be in the area where Alaska is now.

Sliding Motion of Two Plates

This is an illustration of the movement of the Pacific Plate and the North American Plate. One day, Los Angeles will be next to San Francisco.

Wouldn't it be fun to live long enough to see this happen? Well, okay, that is a long time. But for Earth, it's just the blink of an eye.

Glossary

continental drift	the slow process of the Earth's continents moving as the Earth's plates shift (p. 11)
continental plates	plates in the Earth's crust that hold the continents (p. 10)
core	the innermost layer of the Earth, made up of a liquid outer core and a solid inner core (p. 7)
crust	the solid outer surface of the Earth (p. 6)
fault	a crack in Earth's crust along which movement occurs (p. 8)
global mid-ocean ridge	an underwater mountain range that zigzags between all the continents (p. 13)
lava	liquid rock that reaches the surface (p. 9)
magma	melted rock that rises from the mantle and lies beneath the surface (p. 9)

mantle	the semi-solid layer of the Earth between the outer crust and the outer core (p. 6)
oceanic plates	the crustal plates located beneath the oceans (p. 10)
Pangaea	a single continent made up of all of the Earth's land mass long ago (p. 10)
plate tectonics	the process of crustal plate movement (p. 10)
plates	the large slabs of rock that make up the Earth's crust (p. 10)
Ring of Fire	the ring of volcanoes along the edges of the continents that border the Pacific Ocean (p. 13)
trenches	extremely deep areas where two plates meet and one slides under the other (p. 13)
volcano	a vent in a planet's crust from which molten or hot rock and steam come out; also, a hill or mountain made up of the material that comes out of the vent (p. 9)