Earth's Changing Face

A Science A–Z Earth Series

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KEY ELEMENTS USED IN THIS BOOK
The Big Idea: Earth changes every day. Landforms are constantly forming and being shaped. Sometimes these transformations are quite small, and at other times they are extraordinary. While many of the changes to Earth's landforms are brought about by natural forces, others are caused by people. Earth's changing landforms have an effect on Earth's environment and its living creatures.
Key words: arch, billion, butte, canyon, change, cliff, continent, convection current, core, create, crust, delta, deposition, dune, Earth, earthquake, erosion, erupt, fault, flood, force, glacier, heat, igneous rock, island, landform, landmass, lava, layer, magma, mantle, metamorphic rock, million, molten, moraine, mountain, ocean, peninsula, plate, plate tectonics, ridge, rock cycle, sediment, sedimentary rock, shape, surface, trench, valley, volcano, weathering **Key comprehension skills:** Main idea and details *Other suitable comprehension skills:* Compare and contrast; classify information; cause and effect; identify facts; elements of a genre; interpret graphs, charts, and diagrams **Key reading strategy:** Connect to prior knowledge *Other suitable reading strategies:* Ask and answer questions; summarize; visualize; using a table of contents and headings; using a glossary and boldfaced terms

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Notes

plate tectonics	the theory that the large sections of plates of Earth's crust are carried by moving magma in Earth's mantle (p. 9)
rock cycle	the series of changes that rock undergoes as it shifts between different forms (p. 19)
sedimentary rock	rock formed when sediment is compacted (p. 20)
volcano	a place in Earth's crust where gases, ash, and lava spew onto the surface (p. 4)
weathering	the process of wearing away or otherwise changing Earth's surface from exposure to natural forces (p. 13)

Index

Table of Contents

Mount Redoubt has erupted five times since 1900—the last time in March 2009.

Introduction

"Mount Redoubt had recently erupted. When I arrived in Anchorage, Alaska, three days later, it was raining. I wiped the rain from my face and noticed that my fingers were black. *What is that?* I wondered. I looked around. A black film covered everything. I realized it was raining volcanic ash!"

That story was told by a teacher. Mount Redoubt is a **volcano**. Volcanoes are places where gases, ash, and lava can spew out from beneath Earth's surface.

Volcanoes are forces that create new features on Earth. Other forces, like water and wind, change existing features. Some changes happen quickly. Others take place very slowly. In this book, you will read about Earth's changing "face."

Glossary

continents	the main landmasses on Earth, such as Africa, North America, and Asia (p. 5)
core	Earth's center, made up of a liquid outer core and a solid inner core (p. 7)
crust	the thin outer layer of Earth (p. 5)
erosion	the process of transporting and wearing away rocks or soil as loose particles are moved by water, wind, ice, or gravity (p. 14)
igneous rock	rock formed by the hardening of hot, molten magma (p. 19)
landforms	natural formations on Earth's surface, such as valleys, plateaus, mountains, plains, hills and glaciers (p. 6)
magma	melted, liquid rock beneath Earth's surface (p. 9)
mantle	the semisolid layer of Earth that lies between the crust and the core (p. 7)
metamorphic rock	rock formed by exposing igneous or sedimentary rock to extreme heat and pressure (p. 21)
plates	large sheets of rock that make up Earth's crust (p. 8)

Conclusion

Earth's surface is constantly changing. It has been changing for millions of years and will continue to change.

All the landforms on Earth were created by forces that build them up and tear them down. Magma in the mantle moves the plates above it. As the plates move, mountains are thrust upward. Rivers and glaciers flow down mountains, carving valleys and canyons. Sediment carried by rivers is deposited at low elevations. This process creates deltas and low, flat plains with fertile soil that is used by farmers.

One thing is certain. Earth will keep changing due to both the forces of nature and the people who come in contact with it.

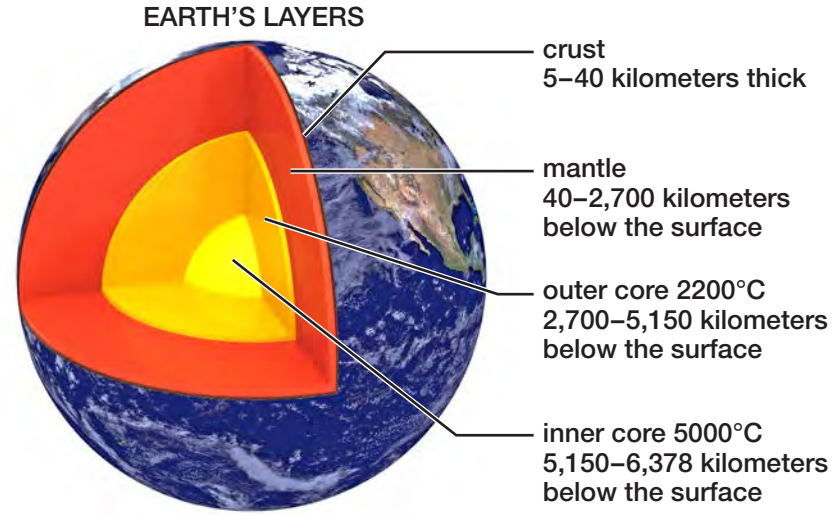
What forces do you think created these landforms?

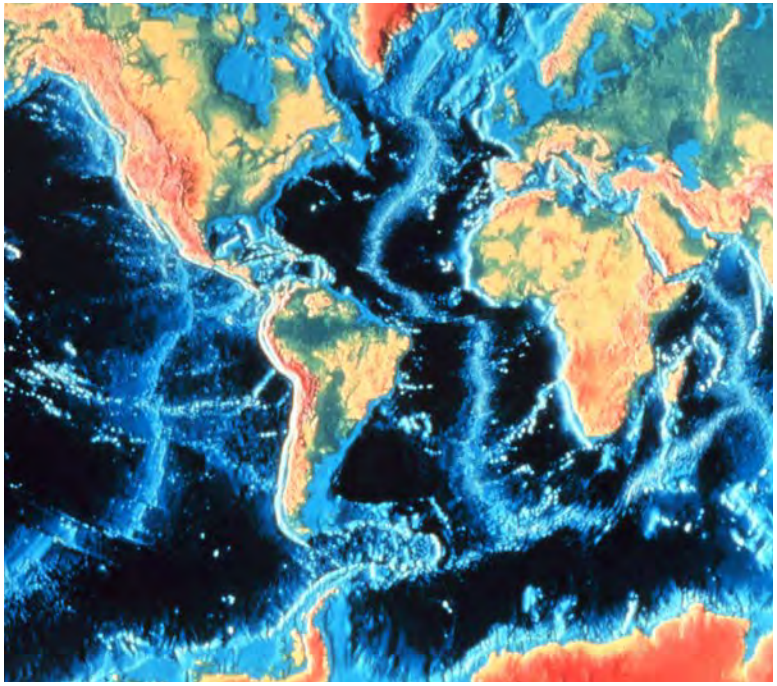
Earth's Structure

To understand Earth's surface, you have to look deep inside it. Imagine a hard-boiled egg. It has three layers: the eggshell, the white, and the yellow yolk inside. Earth has layers, too. Its layers differ in thickness, temperature, and weight.

The Crust

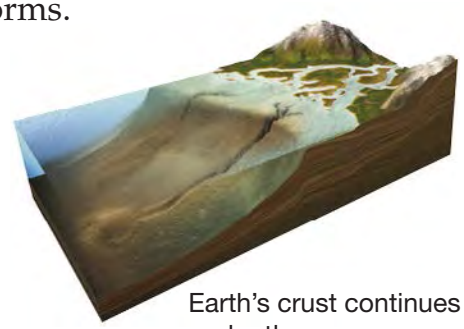
Earth's outer layer is called the **crust**. Unlike an eggshell, its thickness varies. It ranges from about 5 to 40 kilometers (3–30 mi.). The thickest crust is simply land that is higher in elevation. These are the landmasses where people live. We call the largest of these landmasses **continents** and the smaller ones *islands*. The thinnest part of the crust is land that is lower in elevation. It forms the floor of all the oceans.





This image shows Earth's largest mountain range—the mid-ocean ridges (the blue lines in the middle of the ocean), where ocean plates meet.

The crust is not smooth like an eggshell but instead is uneven. The different shapes of land are called **landforms**. Look at the collection of pictures on pages 22 and 23 to see some of Earth's many landforms. We will learn about the forces that created and shaped these landforms in the next section.



Earth's crust continues under the ocean.

A SAMPLE OF EARTH'S LANDFORMS

A **peninsula** is a piece of land on its way to becoming an island. The land sticks out into a body of water and is connected to the mainland by a small strip of land.

A **glacial moraine** is a large pile of rocks created when a glacier melts and leaves behind the rocks it once carried.

A **delta** is land formed by a river depositing sediments as it meets a large body of water, such as an ocean.

An **island** is a piece of land, smaller than a continent, that is entirely surrounded by water.

A SAMPLE OF EARTH'S LANDFORMS

A **canyon** is a cut through the top of Earth's crust that can be formed by water, wind, or the uplifting of a continental plate.

Many **mountains** are created by pressure between two plates that pushes the land up high.

A **butte** is a narrow, flat-topped hill made of hard rock around which softer rock has eroded away. It usually has steep sides.

Arches are natural bridges formed when wind or water wears away the sedimentary rock underneath them.

WOWSER!

Because lava can be so hot—up to 1250°C (2000°F)—there's nothing people can do to stop it!

The Mantle

Deeper inside Earth, temperatures get hotter. This layer is called the **mantle**. The rock there is in a semi-liquid, rubbery state. The mantle is very thick, making up about 80 percent of the planet.

The Core

Deeper still, at the very center of Earth, is the **core**. It consists of two layers—the outer core and the inner core. Although both layers are made of iron and nickel, they are very different. The metals in the outer core are in liquid form, with a temperature of about 2200 degrees Celsius (4000°F). That's nearly as hot as the Sun's surface! The inner core is even hotter—about 5000 degrees Celsius (9000°F). With the rest of Earth's weight pressing down on it, the inner core is squeezed very tightly. It is a ball of solid metal.

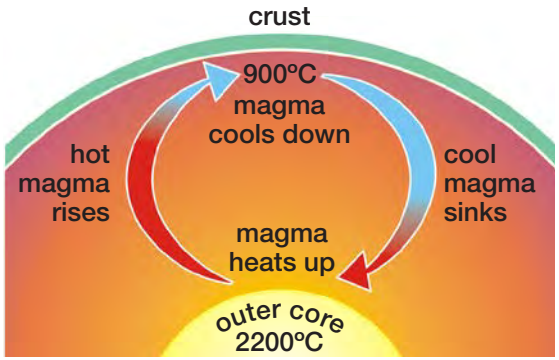
Forces That Create Landforms

Landforms such as mountains are constantly being created, inch by inch, over millions of years. To understand how and why, we need to understand more about Earth's interior.

Moving Magma, Moving Crust

Like a cracked eggshell, Earth's crust is cracked. The pieces of crust are called **plates**. The plates move about as fast as your fingernails grow—two to three inches a year! To understand why, picture a pot of thick soup.

The hottest soup is at the bottom of the pot, nearest the heat source. The coolest soup is at the surface, farthest from the heat source. If you have ever watched soup boil, you know that it moves. Hot substances rise. Cool substances sink. These temperature changes cause the soup to move in circular motions called *convection currents*.



Magma heats up near the core, rises toward the crust, then cools and sinks again.

Metamorphic Rock

When plates crash together, some of the rock is pushed into Earth's mantle. As it goes deeper into the mantle, it is subjected to greater pressure and hotter temperatures. When this happens, rock changes in texture, color, and mineral makeup, becoming **metamorphic rock**. A *metamorphosis* means a change in form. Marble, a metamorphic rock, is often used as a building material. It was once limestone, a sedimentary rock.

Limestone, a sedimentary rock, forms many caves.

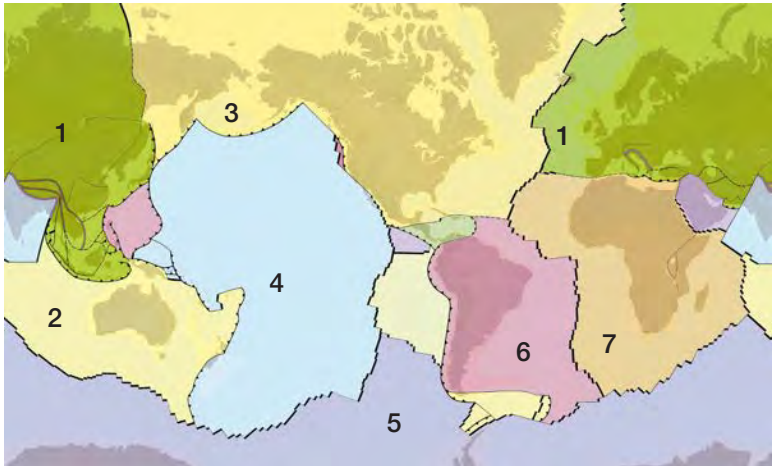
Marble, a metamorphic rock that was once limestone, is used as a building material.

Sedimentary Rock

Have you noticed that water in a lake sometimes looks cloudy? What you are seeing is water mixed with sediment—tiny particles of soil and sand. Sediment settles to the bottom of bodies of water. As more and more sediment is deposited, it presses down on the lower layers. Over millions of years, the sediments get so squeezed together that they become **sedimentary rock**.

Sedimentary rock sometimes contains fossils—the remains of living things that became trapped in the sediment long ago. By examining these ancient plants and animals, scientists have learned much about Earth's history.

Sedimentary rock shows layers of sediments as bands of color.



1–Eurasian Plate, 2–Australian Plate, 3–North American Plate, 4–Pacific Plate, 5–Antarctic Plate, 6–South American Plate, 7–African Plate

The same thing happens to **magma**, the molten rock in the mantle. The magma nearest the core is the hottest, so it rises. When it hits the underside of the crust, it cools, which causes it to sink. Together, rising and sinking magma forms convection currents. The plates move as the currents of magma move underneath them. The movement of Earth's plates is called **plate tectonics**.

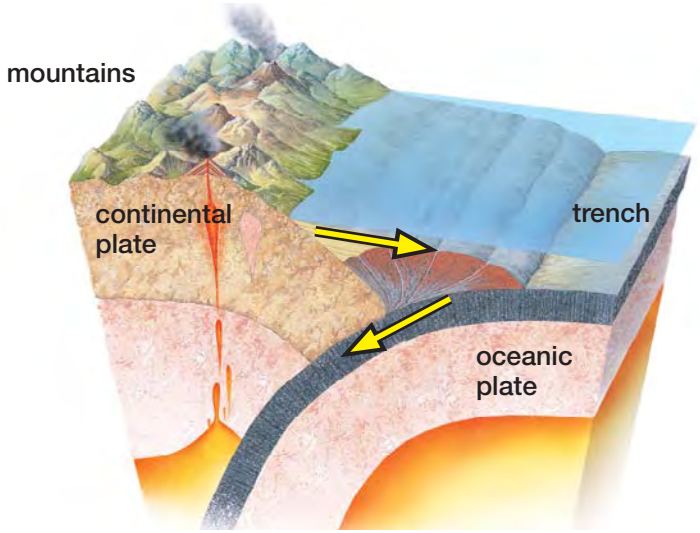
We now know that Earth's plates have been moving for billions of years—all because of moving magma in the mantle. Some plates collide. Others separate. These movements are responsible for creating many of Earth's landforms.

Forming Landforms

Earth's crust is made of two types of plates—continental and oceanic. Continental plates are lighter in weight than oceanic plates. When two continental plates collide, both are forced upward. This kind of collision has created many of Earth's tallest mountain ranges, such as the Himalayas in Asia and the Alps in Europe.

However, when a heavier oceanic plate rams into a lighter continental plate, the heavier plate sinks beneath the other one. It dives into the mantle, where it melts and becomes magma. This kind of collision forms mountains, such as the Andes in South America. It also creates volcanoes and deep ocean trenches.

HOW THE ANDES MOUNTAINS FORMED



The Rock Cycle

The next time you walk outdoors, pick up a pebble. It has a story to tell. It may be millions of years old. It may have undergone many changes.

All the forces that change Earth's surface are part of the **rock cycle**. Over time, rocks are melted, cooled, broken, and squeezed. The story of a single pebble is part of a cycle that goes on and on.

Igneous Rock

When red-hot lava erupts from a volcano, it hardens into **igneous rock**. To remember the term, think of the word *ignite*—to start a fire. Igneous rocks can have different textures, depending on how fast or slowly they cooled. If they cooled quickly, they tend to be smooth. If they cooled slowly, they are often lumpy, with large crystals.

Obsidian is igneous rock that cools very quickly.

Granite is igneous rock that cools slowly.

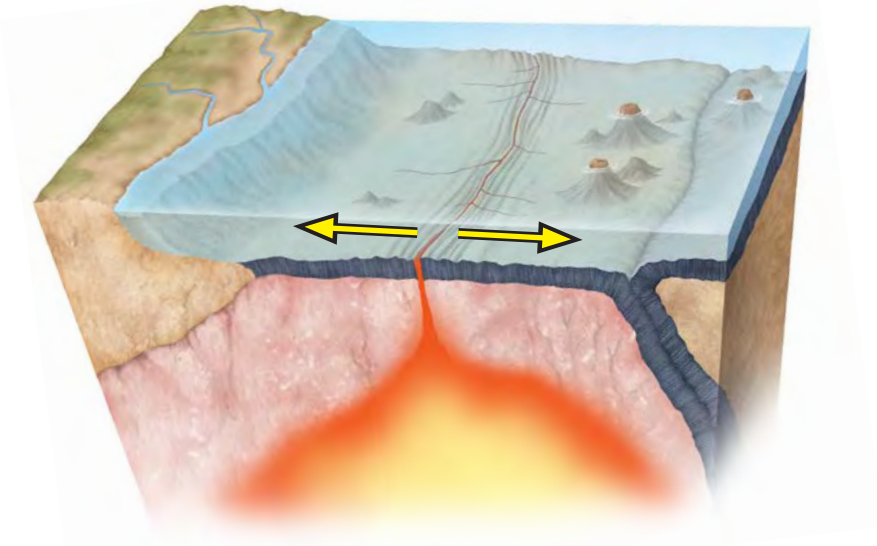
Wherever you're sitting, look around. Your chair might be made of wood. Your books are made of paper. Your telephone and pens are made of metals. All these materials are resources that come from Earth. People have often been careless about how they have used Earth's resources. People have cut down whole forests to use wood for building and making paper. This activity increased erosion on hillsides. We have dug mines in order to extract minerals, such as copper or silver. In some places, the mining has left scars on the land that have filled with polluted water. But today in some places, forests are being replanted. Mining areas are being restored to a more natural look.

Do You Know?

Many mines are being returned to a more natural look after they close.

Open-pit mining scrapes away Earth's surface and changes the landscape.

THE ATLANTIC OCEAN FLOOR



The Mid-Atlantic Ridge is where two plates are pulling apart from each other.

Sometimes plates move away from each other. Then lava oozes out of the crack between them. (Magma is called lava when it reaches Earth's surface.) When the lava hits cold water, it hardens into new crust. The new crust pushes apart the old pieces of crust. This process has created a line of ridges on the Atlantic Ocean floor.

Look at the image on page 6. Over millions of years, colliding and separating plates have formed mountains, volcanoes, and deep ocean trenches along cracks in Earth's crust. This process is still happening, and it will continue as long as magma in the mantle continues to move.

Causing Earthquakes

Earthquakes occur along plate boundaries, too. Sometimes plates slowly pass by each other in opposite directions. As this happens, pressure builds up. If the pressure gets big enough, the plates can suddenly jolt. This jolt releases energy, causing the ground to shake. Earthquakes can be minor or major. Large ones can destroy lives and property.

Earthquakes happen regularly along the San Andreas fault in California, as the Pacific Plate and the North American Plate slide past each other in opposite directions.

Sand dunes are created when wind blows sand.

In some places, wind changes Earth's surface. Dunes—large hills of sand—form when winds carrying sand slow down. Particles of sand are then deposited.

People as Change Agents

In order to meet their needs, people shape the land, too. People need a constant supply of fresh water. In some places, we build dams across rivers. Water collects behind the dams, creating large lakes. People tap the water and pipe it to cities.

Sometimes too much water is a problem. When rivers flood, they can damage farms and property. So people build levees—long hills along riverbanks. The levees prevent water from spreading out to low-lying areas.

Ice is also a player in the sculpting drama. Mountain glaciers are frozen rivers that travel slowly down mountain slopes. If you have ever touched an ice cube right out of the freezer, you know that ice has a sticky quality. The same is true of ice in glaciers. Rocks stick to the bottoms and sides of glacial ice. As a glacier moves down a mountain, it carries rocks to lower elevations while scraping away the land beneath it.

During past ice ages, glaciers changed the landscape. We can see the evidence today. They scraped out low areas of land. When the ice melted, these areas filled with meltwater. The five Great Lakes in the United States and many smaller lakes formed in this way. Melting glaciers also left behind rocks they had been carrying. These piles of rock are called *moraines*. Many hills are actually moraines formed by melting glaciers.

When glaciers move over the land, they scrape out valleys in the way that you might scrape ice cream from a container.


Water, ice, and wind sculpt landforms.

Forces That Shape Landforms

You have just read that moving plates are slowly creating new landforms. At the same time, other forces are at work constantly changing Earth's surface.

Weathering

Imagine you are holding a handful of sand. Look closely. Each grain is a different color, size, or shape. The grains are actually tiny rocks that broke off much larger rocks.

The process of wearing down rock is called **weathering**. Wind and water pound rock surfaces, breaking off small pieces. Temperature changes cause rocks to expand and contract, which cracks them. Ice can form, making cracks grow wider. Eventually, the cracks can break rocks apart.

Plants can play a role in the process, too. If a seed lands on a cliff, it may send roots down into

cracks in rock. As plant roots grow, they break the rock apart.

Other types of weathering cause rocks to dissolve or break down. Rocks can change because of chemical reactions between water or acids and the minerals in the rock.

Plants can break rocks with their roots.

Erosion and the Shaping Process

The grains of sand you held in your hand may have traveled thousands of miles. This sand is an example of **erosion**. It is the process of transporting rocks, rock particles, and soil over long distances.

The Grand Canyon was carved by running water over millions of years. It is over 1.6 kilometers (1 mi.) deep.

Fast-moving streams and rivers are major agents of erosion. Rushing water carries sand and pebbles, which batter the rock in riverbeds. In the process, they change the shape of landforms such as canyons and cliffs. Look at the photo of Arizona's Grand Canyon. Over millions of years, the Colorado River cut through rock that forms the canyon walls. That process made the canyon wider and deeper.

As a river reaches flatter surfaces, it slows down. As it does, it drops some of its cargo along the banks. Over time, these tiny particles of rock and soil build up, forming low, flat plains. This process is called *deposition* because the river deposits, or leaves, particles in new places. Another landform that results from deposition is a delta. A delta forms where a river slows down as it enters a larger body of water. There, it drops its sand and soil, which build up and form new land.

Do You Know?

The first landform called a delta was the Nile River Delta in Egypt.