

UNIT OVERVIEW

Landforms are constantly forming and changing. The Changing Landforms unit helps students understand what landforms are, how they form, and how different forces shape them over time. It introduces students to Earth's structure, including the crust, mantle, and core. Hotspots and earthquake patterns are also addressed, as well as how weathering, erosion, and people shape the land. The unit addresses the three major categories of rocks—igneous, sedimentary, and metamorphic—and explains how one rock type may change into another.

Certain reading resources are provided at three reading levels within the unit to support differentiated instruction. Other resources are provided as a set, with different titles offered at each reading level. Dots on student resources indicate the reading level as follows:

- low reading level
- : middle reading level
- : high reading level

THE BIG IDEA

Earth changes every day. 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. Over the course of this unit, students will learn about how landforms change and, in the process, they may consider the effects of changing landforms on Earth's environment and its living creatures. Students may also consider the role they play in shaping Earth's surface.

Other topics

This unit also addresses topics such as: new land formation in the Hawaiian Islands, open pit mining, different types of landforms caused by erosion, and the deepest point on Earth's crust—the Mariana Trench.

SPARK

The spark is designed to get students thinking about the unit's topics and to generate curiosity and discussion.

Materials

- lightweight area rugs or bathroom rugs (without nonslip backing)
- thin wooden boards of similar length to rugs



Activity

This activity is meant to illustrate how landforms change as Earth's plates move. Explain to students that during this unit, they will learn that Earth is covered with plates. The wooden board will represent the plates under the ocean, which are heavy and strong. The rug will represent the plates under the continents, which are lighter and weaker.

Set a rug and a board down flat on a smooth tiled floor or on top of a large table. A longer edge of the rug should be touching a longer edge of the board. Ask several students to go to the far end of the rug and spread out along its length. Ask several other students to go to the far end of the board and also spread out. When cued, each group should start *slowly* pushing the rug and board toward each other. The groups should stop pushing once they observe changes occurring.

The stronger board may cause the weaker rug to buckle, fold over, and change shape. The board may slip beneath the rug. All these changes model realistic possibilities when Earth's plates collide. Students might also observe shapes in the rug that could symbolize landforms found on continents, such as mountains and valleys.

Try this activity again with variations, such as making two rugs or two boards collide or making two rugs slide past each other to represent fault lines. Invite students to share their observations with the class.

Below are questions to spark discussion.

How do you think rugs and boards are like Earth's surface?

What kinds of landforms were modeled when the rug and board collided?

What might have happened if the rug and board had actually been huge pieces of Earth's surface?

Do you think Earth's plates actually move faster or slower than the rug and board were moved in this activity?

Use this activity to begin an introductory discussion about changing landforms. Explain that landforms change as huge pieces of Earth's crust move on top of the semi-solid mantle. Some of Earth's crust is softer and some is harder. As different types of crust collide, landforms are created, altered, or destroyed. These collisions can also result in dramatic events such as earthquakes and volcanic eruptions. Unlike this activity, changes in landforms usually happen very slowly—over many thousands or millions of years. Throughout the unit, students will learn more about changing landforms.

Many of the unit's vocabulary terms are related to the spark activity and can be introduced during the spark. For vocabulary work, see the Vocabulary section in this *Unit Guide*.

PRIOR KNOWLEDGE

Invite students to explain their understanding of what a landform is, and ask them to name landforms they know. Discuss how landforms might change over time and why.

Probing Questions to Think About

Use the following questions to have students begin thinking of what they know about changing landforms.

- What is our planet like under the surface?
- What are some examples of different landforms?
- Do these landforms change over time? How?
- How do mountains form?
- Do mountains ever change or disappear over time?
- What causes a volcano to form? What happens when a volcano erupts?
- Why do earthquakes happen?
- How are islands made?
- How have glaciers affected Earth's surface?
- What might occur if two landmasses collided?
- Has the map of Earth always been the same?
- Do any of the continents on a world map look as though they once fit together?
- How are different types of rocks created?
- Do rocks change over time? How?
- Why are there different layers in some areas of Earth's surface?

Tell students they will learn more about these topics soon.

UNIT MATERIALS

Each unit provides a wide variety of resources related to the unit topic. Students may read books and other passages, work in groups to complete hands-on experiments and investigations, discuss science ideas as a class, watch videos, complete writing tasks, and take assessments.

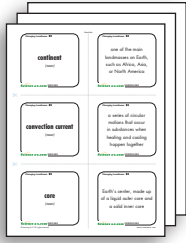
Resources are available for printing or projecting, and many student resources are also available for students to access digitally on **Kids A-Z**.

Selected unit resources are available in more than one language.

For a complete list of materials provided with the unit, see the Changing Landforms unit page on the Science A-Z website.

VOCABULARY

Use the terms below for vocabulary development throughout the unit. They can be found in boldface in the *Nonfiction Book*, the *Quick Reads*, and/or other unit resources. These terms and definitions are available on *Vocabulary Cards* for student practice. Additional vocabulary lists are provided in the teaching tips for *Investigation Packs* and *FOCUS Books*.



Core Science Terms

These terms are crucial to understanding the unit.

continent	one of the main landmasses on Earth, such as Africa, Asia, or North America
core	Earth's center, made up of a liquid outer core and a solid inner core
crust	the thin outer layer of Earth's surface
erosion	the process of transporting and wearing away rocks or soil as loose particles are moved by water, wind, ice, or gravity
igneous rock	rock formed by the hardening of hot, molten magma
landform	a natural formation on Earth's surface, such as a valley, plateau, mountain, plain, hill, or glacier
magma	melted, liquid rock beneath Earth's surface
mantle	the semisolid layer of Earth that lies between the crust and the core
metamorphic rock	rock formed by exposing igneous or sedimentary rock to extreme heat and pressure
plate	a large sheet of rock that makes up part of Earth's crust
plate tectonics	the theory that the plates of Earth's crust move due to the movement of magma in Earth's mantle
rock cycle	the series of changes that rock undergoes as it shifts between different forms
sedimentary rock	rock formed when sediment is compacted
volcano	a place in Earth's crust where gases, ash, and lava spew onto the surface
weathering	the process of wearing away or otherwise changing Earth's surface from exposure to natural forces

Other Key Science Terms

The following vocabulary is not essential for comprehending the unit but may enrich students' vocabulary.

convection current	a series of circular motions that occur in substances when heating and cooling happen together
delta	a triangle-shaped area of land formed by sediment at the mouth of a river

deposition	the act or process by which wind or water sets down sediment
dune	a mound of sand formed by the action of wind or water
earthquake	a sudden shaking of the ground due to plate movement
fossil	the remains or traces of a plant or animal that turned to stone over time
glacier	a large body of accumulated ice and compacted snow that is found year round and that slowly moves downhill
island	an area of land, smaller than a continent, that is surrounded by water
landmass	a large area of land, such as a continent
levee	a ridge or raised area of land that prevents a river from overflowing
moraine	a pile of soil and rocks scraped up and deposited by a glacier as it recedes
sediment	particles of dirt and rock that are carried by water, wind, or ice and deposited elsewhere

Vocabulary Activities

You may choose to introduce all the terms that will be encountered in the unit before assigning any of the reading components. *Vocabulary Cards* with the key science terms and definitions are provided. Dots on the cards indicate the reading levels of the *Nonfiction Book* or the *Quick Reads* in which each term can be found. If all level dots appear, the term may come from another resource in the unit. Students can use these cards to review and practice the terms in small groups or pairs. The cards can also be used for center activity games such as Concentration.

The *Word Work* activity sheets offer fun puzzles and practice with key vocabulary terms from the unit. For further vocabulary practice and reinforcement, you can choose from the vocabulary *Graphic Organizers*. To build customized vocabulary lessons with terms related to the topic, see *Vocabulary A-Z*.

Students can use the *Word Smart* vocabulary *Graphic Organizer* to organize information on the science terms. You may want to assign each student one to three words to share his or her *Word Smart* knowledge with classmates. Students who have the same word should first compare their *Word Smart* sheets with each other and then report to the larger group.

The science terms can be used in oral practice. Have students use each term in a spoken sentence.



As students read, encourage them to create a science dictionary by recording new vocabulary terms and definitions in their *SAZ Journal*.

BACKGROUND AND MISCONCEPTIONS

Use this section as a resource for more background knowledge on unit content and to clarify the content for students if misconceptions arise. Refer to Using the Internet below for more ways to extend the learning.



Q: *What is inside Earth?*

A: Earth has three primary layers: the core, the mantle, and the crust. The core is in the center of Earth. The other layers of Earth are squeezing it tightly, so it is under extreme pressure. It is also intensely hot—as hot as the surface of the Sun! The inner core has so much pressure that it cannot melt, even with temperatures as great as 5000° Celsius (more than 9000°F)! The outer core, which is liquid, spins around the inner core, creating Earth's magnetic field. Moving outward, the next layer is the mantle. The mantle is the thickest layer of Earth. It is 2,900 kilometers (1,800 mi.) thick and makes up almost 80 percent of Earth's volume. The mantle is made of weak rock that is kept hot by the heat of Earth's core and that has the texture of playdough. On top of the mantle lies the thin, outermost layer of Earth—the crust. The crust is Earth's hard outer shell. It is where landforms are found. There are two types of crust: continental and oceanic. Continental crust is thick—up to 100 kilometers (62 mi.) under huge mountain ranges—compared to oceanic crust, which is about 5 kilometers (3 mi.) thick. Continental crust is also softer than oceanic crust.

Q: *Can people really travel to the center of Earth, as they do in books and movies?*

A: No. The deepest hole that anyone has ever drilled into Earth's crust is the Kola Superdeep Borehole, which is located in northwest Russia. After drilling slightly more than 12 kilometers (7.5 mi.) into the crust, it became impossible to go any deeper due to extreme temperature. At this depth, the crust registered a temperature of 180° Celsius (356°F). At this temperature, the rocks were so hot that they actually acted like liquid wax, filling in parts of the hole once the drill was removed! (Remember, water boils at just 100° Celsius.) So, not only could people not travel to Earth's center, they would not even be able to get far into the thin shell of Earth's crust! Below the crust, it only gets much hotter with much more pressure from the weight above.

Q: *How do scientists know about Earth's layers if we can't see or go inside the planet?*

A: Scientists have gathered information about Earth's density, seismic activity, and magnetic field. The crust and the upper mantle are known to not be very dense in comparison with Earth's total bulk density. Therefore, the middle of Earth must be extremely dense. This suggests that Earth has a solid core. Seismic activity offers more clues. When an earthquake occurs in one area, a tool called a *seismograph* can measure seismic waves, even on

the other side of the planet. Depending on the composition and density of what they travel through, seismic wave vibrations can go faster, go slower, stop, or be deflected. By recording which seismic waves reach different locations, scientists have been able to determine that Earth has a semi-solid mantle and a solid core. Finally, Earth's magnetic field helps decipher its structure. A high concentration of metallic elements is needed in order to generate the magnetic field. These elements do not appear in high concentrations in Earth's crust or upper mantle, so scientists know that they must be present in the core. Because of the intense pressure generated by Earth's gravity, these metallic elements (mostly iron) are pushed into a solid state in the very center of Earth.

Q: *What did the landforms in my area look like long ago, and what will they look like in the future?*

A: This depends on where you live. Most landforms change very slowly over many, many years. New mountains have formed as the plates of Earth's crust slowly collided, and others have been worn away by weathering and erosion. Glaciers may have gradually scraped ice over the land, eventually leaving behind lakes or valleys once the ice receded. Students may be able to conduct research to learn about the geologic history of their local area. While scientists can predict what certain areas will look like in the future, only time will tell.

Q: *Can I see landforms changing?*

A: Most changes to Earth's landforms happen very gradually over millions of years. However, some changes are abrupt and drastic. Floods and landslides can change landforms in a matter of seconds. Volcanic eruptions can also change landforms quickly. On the largest island of Hawaii, visitors can watch the island grow as molten lava reaches the ocean and solidifies into new land. In the state of Washington, Mount St. Helens blew its top when it erupted on May 18, 1980, and lost two thousand feet of elevation in a matter of seconds. An example of new oceanic crust formation is found at the Mid-Atlantic Ridge, where magma rises and cools as tectonic plates pull away from each other. At the same time, other parts of the crust are destroyed as they are subducted under moving plates. Earthquakes, weathering, and people change landforms much more quickly than plate movements, and these changes can often be observed.

Q: *How do scientists know that Earth's continents are moving?*

A: When Alfred Wegener proposed the idea of a supercontinent called Pangaea in the early 1900s, he had to piece together continents using maps of the world. Today, we can use satellite technology to monitor plate movement. Three of the most common systems are satellite laser ranging (SLR), very long baseline interferometry (VLBI), and the global positioning system (GPS).

The information gained from these satellites tells us that the continents are moving between 1 and 10 centimeters (0.4 and 4 in.) each year. This is about as fast as your fingernails grow. There is also geological and biological evidence to suggest that certain continents' coastlines were once connected.

Q: I live very far from the ocean, so why are seashells and fossils of water creatures found in the soil here?

A: Over millions of years, geologic and climatic changes can cause bodies of water to recede or dry up, and the land underneath, which contains signs of past aquatic life, may now be exposed. Scientists often use shells and fossils as indicators of the age of soil layers. In North America, some inland seashells can be explained by the Western Interior Seaway, a huge body of water that once split the continent and connected what we now know as the Pacific and Atlantic Oceans.

Q: Should I be concerned because I live near a volcano?

A: It would be better to be prepared for a volcanic eruption than to be scared. Living near a volcano is much like living in other areas, such as earthquake zones, that have a higher chance of natural disasters. It is important to have an emergency plan, just in case. However, scientists alert communities when they think a volcano is highly likely to erupt. These scientists are called *volcanologists*. They measure volcanic gases, seismic activity (earthquakes and tremors that occur before a volcano erupts), steam vents, and new cracks or other changes in Earth's surface. Volcanologists can often alert people of a possible eruption in time for evacuation. Bear in mind, however, that many volcanoes are dormant, and others are considered extinct or dead.

Q: If people know that their area gets earthquakes, can they do anything to prevent them?

A: While there have been some proposed ideas to prevent catastrophic earthquakes—such as intentionally triggering smaller ones to prevent a big one—people have not developed a way to control when an earthquake will occur. Instead, scientists (seismologists) help the public by monitoring geologic activity and by trying to forewarn people as early as possible. Communities can increase their chances of being safe during an earthquake by constructing buildings to withstand strong tremors and by regularly practicing earthquake drills.

Q: Rocks are so strong that I find it hard to believe they can be broken by ice or wind. Is this true?

A: Definitely. Ice is a very powerful agent of weathering. When water freezes, it undergoes thermal expansion. Have students ever put a plastic water bottle or soda can in the freezer? The plastic bottle or metal probably stretched to contain the ice, or it may have even broken or exploded! The

same thing happens with water as it flows around and into rocks. Small cracks may form after many years of thermal expansion. When water gets into these cracks and freezes, the expanding ice pushes the cracks farther apart until the rock eventually breaks. Wind is another agent of weathering. Over many years, an exposed rock can be worn away as wind blows small particles of rock and soil against it. Over time, cracks may form, and the rock may change shape or break apart.

Q: *If the Grand Canyon formed because of a river running through it, why aren't similar canyons found everywhere that large rivers exist?*

A: The Grand Canyon formed due to a combination of factors. Yes, the Colorado River runs through it. But it was the great uplifting of the land (the Colorado Plateau), the steep angle of the river as it descends from the Rocky Mountains to the Sea of Cortez, and the many distinctive layers of earth cut by the river, that together made this amazing landform develop the way it did. Millions of years of erosion have given it its distinctive side canyons, mesas, plateaus, cliffs, and colors.

EXTENSION ACTIVITIES



Using the Internet

Most search engines will yield many results when the phrase *changing landforms* is entered. You can also search for information on *plate tectonics* or *geology*. Be aware that some sites may not be educational or intended for the elementary classroom. More specific inquiries are recommended, such as:

- landform diagrams
- Earth's structure
- weathering and erosion
- seafloor maps
- rock types
- glacial valleys
- subduction
- Pangaea
- Pacific Ring of Fire
- volcano and earthquake patterns



Projects and Activities

- **Arts:** After studying diagrams of divergent and convergent plate movement, volcanoes, earthquakes, and glaciation, allow students to choose one or more of these topics and create a technical illustration complete with accurate labels.
- **Project:** Have students create a pop-up book demonstrating different kinds of landforms.
- **ELL/ESL:** Have students create a word wall using vocabulary from the Changing Landforms unit.
- **Field Trip:** Bring students to a mineral museum to observe many different kinds of rocks from all over the world. They can keep a journal of the most interesting rocks and minerals they observed.

- **Guest:** Invite a seismologist, volcanologist, or paleontologist to class to share his or her knowledge.
- **Inquiry Science:** Allow students to research and investigate how the landforms in their local area actually formed. Then have groups present their findings in a written, oral, and/or multimedia presentation.
- **Math:** Have students research the depth of each of Earth's layers and calculate what percentage of Earth's total volume is taken up by each layer.
- **Research:** Help students track and map global earthquakes over a one-week period. Compare the location of the earthquakes to known fault lines.
-  **Technology:** Using a slideshow application, allow students to create their own dictionary of vocabulary terms from the unit—complete with images—and present it to the class.
- **Project/Home Connection:** Invite students to bring a variety of rocks to school, and have groups investigate whether each rock is primarily igneous, metamorphic, or sedimentary.
- **Research/Home Connection:** Students can conduct research as a family/home project or in the library/media center to extend the learning about a topic in one of the *Quick Reads* or other unit resources.

