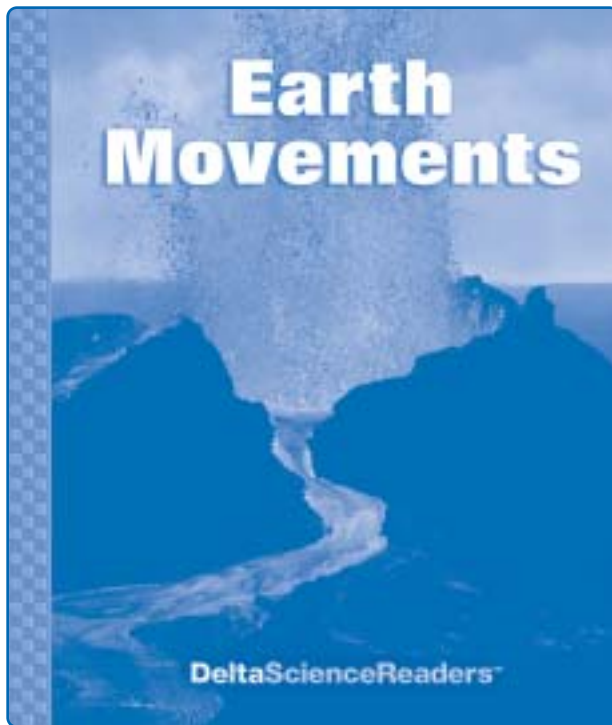


Earth Movements



Delta Science Readers are nonfiction student books that provide science background and support the experiences of hands-on activities. Every **Delta Science Reader** has three main sections: *Think About . . .*, *People in Science*, and *Did You Know?*

Be sure to preview the reader Overview Chart on page 4, the reader itself, and the teaching suggestions on the following pages. This information will help you determine how to plan your schedule for reader selections and activity sessions.

Reading for information is a key literacy skill. Use the following ideas as appropriate for your teaching style and the needs of your students. The After Reading section includes an assessment and writing links.

OVERVIEW

In the Delta Science Reader *Earth Movements*, students read about Earth's layers and landforms and the forces that shape Earth's surface. They learn how moving plates, earthquakes, volcanoes, weathering, and erosion change Earth. They also read about seismologists—scientists who study earthquakes—and about Charles Richter, the creator of the Richter scale for ranking the strength of earthquakes. Finally, students learn about the rock cycle.

Students will

- ▶ learn about Earth's three main layers
- ▶ read about Earth's many landforms
- ▶ discover how moving plates, earthquakes, volcanoes, weathering, and erosion shape Earth's surface
- ▶ examine nonfiction text elements such as table of contents, headings, and glossary
- ▶ interpret photographs and diagrams to answer questions
- ▶ complete a KWL chart

READING IN THE CONTENT AREA SKILLS

- Compare and contrast Earth's layers and landforms
- Recognize cause-effect relationships related to plate tectonics, earthquakes, and volcanoes
- Draw conclusions about the movement of continents and the Ring of Fire
- Determine the main ideas and supporting details of text sections
- Describe the sequence of events in glacier formation
- Demonstrate critical thinking
- Interpret graphic devices
- Summarize

NONFICTION TEXT ELEMENTS

Earth Movements includes a table of contents, headings, photographs, illustrations, captions, boldfaced terms, diagrams, maps, labels, a chart, and a glossary.

CONTENT VOCABULARY

The following terms are introduced in context and defined in the glossary: *barrier island, canyon, continent, continental drift, convection current, core, crust, deposition, earthquake, epicenter, erosion, erupt, fault, flood, focus, fossil, glacial till, glacier, hill, inner core, landform, lava, magma, magma chamber, mantle, mass movement, mid-ocean ridge, moraine, mountain, ocean-floor spreading, oceans, outer core, Pangaea, plain, plateau, plates, rock cycle, sediments, seismic wave, seismograph, seismologist, subduction, trench, valley, vent, vibration, volcano, weathering.*

BEFORE READING

Build Background

Access students' prior knowledge of Earth movements by displaying and discussing the cover. Ask, *What is happening in this photograph?* (A volcano is erupting.) *What happens when a volcano erupts?* (Accept reasonable responses, such as fire shoots up, lava flows out.) *How might a volcano change Earth?* (The mountain top blows off. Lava covers the land.)

Read the title aloud, and invite students to share what they know about the topic from their personal experiences and hands-on explorations in science. To stimulate discussion, ask questions such as these: *What do you think the term Earth movements means? What are some Earth movements you can think of? How do you think these Earth movements change Earth's surface?*

Begin a group KWL chart by recording facts students know about Earth movements in the K column. You may want students to copy the KWL chart so they can maintain their own charts as they read.

K What I Know	W What I Want to Know	L What I Learned	+ What I Want to Explore Further

Preview the Book

Explain that when students preview nonfiction, they should look at the title, the table of contents, headings, boldfaced words, photographs, illustrations, charts, graphics, and captions.

Then preview the book with students. Call attention to the various nonfiction text elements and explain how they can help students understand and organize what they

read. Ask questions such as these: *How do the headings help you predict what you will read about? What do you see in this picture? How do you think it will help you understand the text?* Explain that the words in boldface type are important words related to Earth movements. Point out that these words are defined in the glossary. Choose one word and have students find its definition in the glossary.

Preview the Vocabulary

You may wish to preview some of the vocabulary words before reading, rather than waiting to introduce them in the context of the book. Possibilities include creating a word wall, vocabulary cards, sentence strips, or a concept web.

For example, some of the names for landforms can be categorized according to whether they are high places or low places. Develop a two-column chart such as the one that follows:

High Places	Low Places
hill	canyon
mountain	trench
plateau	valley

Set a Purpose

Discuss with students what they might expect to find out from the book, based on their preview. Encourage them to use the questions on the KWL chart to set an overall purpose for reading.

GUIDE THE READING

Preview the book yourself to determine the amount of guidance you will need to give for each section. Depending on your schedule and the needs of your class, you may wish to consider the following options:

- **Whole Group Reading** Read the book aloud with a group or the whole class.

Encourage students to ask questions and make comments. Pause as necessary to clarify and assess understanding.

- **Shared Reading** Have students work in pairs or small groups to read the book together. Ask students to pause after each text section. Clarify as needed and discuss any questions that arise or have been answered.
- **Independent Reading** Some students may be ready to read independently. Have them rejoin the class for discussion of the book. Check understanding by asking students to explain in their own words what they have read.

Tips for Reading

- If you spread out the reading over several days, begin each session by reviewing the previous day's reading and previewing what will be read in the upcoming session.
- Begin each text section by reading or having a volunteer read aloud the heading. Have students examine any illustrations or graphics and read accompanying captions and labels. Discuss what students expect to learn, based on the heading, illustrations, and captions.
- Help students locate context clues to the meanings of words in boldface type. Remind them that these words are defined in the glossary. Provide help with words that may be difficult to pronounce.
- As appropriate, model reading strategies students may find helpful for nonfiction: adjust reading rate, ask questions, paraphrase, reread, visualize.

Think About . . . (pages 2–13)

Pages 2, 3 *What Are Earth's Layers?*

- Generate interest in the text by asking, *What do you think is inside Earth?* Explain: *Long ago, people had no way of knowing what Earth was like inside. Today, scientists have instruments that*

have given us a good idea of what lies beneath Earth's surface. Have students view the diagram of Earth's inner structure on page 2 and read the caption and labels.

- Check comprehension by asking, *What are Earth's three main layers?* (the crust, the mantle, and the core) *How many layers does the core have?* (two) *What are they?* (the outer core and the inner core) *What do you notice about the thickness of the crust compared to the rest of Earth's layers?* (The crust is very thin compared with the rest of Earth's layers.) Then have students read pages 2 and 3 to find out more about Earth's layers.
- Ask, *What is the main idea—the most important idea—about the crust on page 2?* (The crust covers Earth's entire surface.) *What details support this main idea?* (The crust is Earth's rocky outer layer; the continents are crust, and the oceans are on top of crust.)
- Guide students to compare and contrast Earth's layers. Ask, *How are the crust and the mantle alike?* (They are both made of rock.) *How are they different?* (The mantle is thicker and hotter and some of the rock flows.) *How are the mantle and the core alike?* (Both are extremely hot; the outer core flows as the mantle does.) *How are they different?* (The mantle is made of rock; the core is mostly iron and nickel.) *Which layer of Earth is the thickest?* *Which is the thinnest?* (The mantle is the thickest layer; the crust is the thinnest.)
- If necessary, provide help with the pronunciation of *Celsius* (SEL-see-us).

Pages 4, 5 **What Are Earth's Landforms?**

- Before reading the text, have students look at the photographs. Challenge them to name the different Earth features they see. Then have them read to discover some of Earth's landforms.

- Guide students to compare and contrast Earth's landforms. Ask, *How are mountains, hills, and plateaus alike?* (They are high places.) *How are they different?* (Mountains are very tall with pointed tops; plateaus are flat; hills are smaller than mountains and have rounded tops.) *How are valleys and canyons similar?* (They have rivers running through them; rivers formed them.) *How are they different?* (Valleys are low places between mountains and hills. Canyons are deep and have steep walls.)
- Invite students to tell how the photographs helped their understanding. (The text described what the landforms looked like. The photographs showed the landforms.)
- Students may be interested to know that the Great Plains of central North America include about 15 percent of the territory of the United States. The region is sometimes called America's "breadbasket" because its farms produce so much grain. In addition, its vast grasslands are a natural range for grazing cattle.

The Great Plains are both flat and relatively high—in fact, the plains are a huge plateau. Elevations reach about 1,500 m (4,900 ft) near the Rocky Mountains. The land slopes downward very gradually toward the Mississippi River, where elevations drop below 150 m (500 ft).

During the 1930s, the southern Great Plains underwent a drastic change. The sturdy plains grasses that held the soil in place during dry years had been replaced with wheat. Then in 1931 came a long period of severe drought that left the overplowed and over-grazed land vulnerable to wind erosion. Over the next 8 years, whipping winds blew away millions of tons of topsoil in massive dust storms. The region became known as the Dust Bowl. When the plains finally began to recover, new soil conservation techniques were put into practice.

- Barrier islands occur all over the world. Besides the eastern coasts of North and South America, they occur along parts of West Africa, India, Australia, and most of the North Sea coast of Europe. The longest stretch of barrier islands—4,506 km (2,800 mi)—is along the eastern seaboard and Gulf Coast of North America, from Plum Island, MA, to Padre Island, TX. Barrier islands protect the coast from storms, but they are also fragile. The same processes that build them up can break them down. Barrier islands are constantly moving, a phenomenon known as barrier island migration.
- If necessary, provide help with the pronunciation of *Himalayas* (him-uh-LAY-uhz) and *plateau* (pla-TOE).

Pages 6–13 *What Forces Shape Earth’s Surface?*

Pages 6, 7, 8 *Plates in Motion*

- Before students read, display a globe or a map of the world and point to South America and Africa. Ask, *What do you notice about the shapes of eastern South America and western Africa?* (Students should recognize that they look as if they fit together like puzzle pieces.) *What could this mean?* (Accept reasonable responses.) Have students read the first paragraph on page 6 to find the answer to this mystery.
 - Tell students that a German scientist used clues such as the shapes of the continents to come up with a theory about Earth. Have students read the next two paragraphs about Alfred Wegener’s discoveries and theory. Then have them view the maps on page 6 and read the labels and captions. To check understanding, ask, *What have you learned so far about the movement of the continents?* (The continents are not fixed in place. They were once part of a single continent named Pangaea. Pangaea broke up into the continents, and they moved to where they are today.) Invite students to predict what caused the continents to move.
- When Pangaea first began to split up, it broke into northern and southern sections. The northern part was called Laurasia; the southern part was called Gondwanaland. Laurasia split into North America, Europe, Greenland, and Asia. Gondwanaland split into South America, Africa, Australia, India, and Antarctica.
- Then have students finish reading pages 6 and 7 and study the map at the top of page 7. Assess comprehension by having students summarize the main ideas about plates. (Earth’s crust is made up of separate moving parts called plates. Heat in the mantle forms convection currents that make the plates move. The plates carry the continents with them when they move.)
 - Ask, *Are Earth’s plates still moving?* (yes) *What conclusion can you draw about Earth’s continents from this fact?* (Millions of years from now, the continents will be in different places.)
 - If appropriate, ask students to speculate about what might happen when convection currents push the plates around. Ask, *What might happen if two plates hit each other?* (Accept reasonable responses.) Then have students read page 8 to find out how moving plates change Earth’s surface.
 - After students read, ask, *In what ways do plates move with respect to each other?* (Plates move away from each other, move toward each other, and slide past each other.) *What happens when plates move away from each other? Do they leave a gap?* (No, hot magma pushes up between the plates and forms new crust.) *What two effects can happen when one plate bumps into another?* (One plate can slide up over another, forming mountain ranges. The sinking plate forms a deep ocean trench. The two plates can join together and fold upward, forming a mountain range.)

- Check comprehension by having students explain what is happening in each of the diagrams at the bottom of the page.

The first drawing shows plates moving apart at the mid-ocean ridge. Magma rises to fill the gap and forms new ocean crust. The middle drawing shows subduction. Two plates collide and the more-dense (usually oceanic) plate slides under the less-dense (usually continental) plate. A trench and mountains may form. The third drawing shows two plates carrying continental crust meeting and pushing up the land where they join. The upward fold becomes a mountain range.

- If necessary, provide help with the pronunciation of *Wegener* (VEG-ner) and *Pangaea* (pan-JEE-uh).

Pages 9, 10 Earthquakes

- Before students read, ask, *Did the previous section of text, “Plates in Motion,” tell what can happen when plates slide past each other? (no)* Explain that in the next section students will learn what effects sliding plates can have.
- Have students read the text about earthquakes on page 9 through the first paragraph on page 10. Then have them look at the photographs and the diagram and read the captions and labels. Discuss the causes and effects of earthquakes. Ask, *Where are earthquakes likely to occur?* (along faults, where plates meet, and along the mid-ocean ridge) *What can cause a fault?* (Pressure or weakness in a plate can make the plate bend or crack.) *What happens when pieces of the crust move along a fault?* (It causes an earthquake.) *What can happen when plates that are sliding past one another get stuck?* (Pressure can build up until the rocks snap.) *What effect does this have?* (It causes an earthquake.)
- Ask whether students know what a seismologist is. If necessary, explain that a seismologist is a scientist who studies earthquakes. Have students read the final two paragraphs of the text section to learn about seismologists and their work.
- You may wish to tell students that almost everything we know about Earth’s interior has come from study of seismic waves— earthquake vibrations. By studying how long waves take to reach different places, scientists can tell whether the waves went in a direct line or were bent by passing through materials of different kinds.
- If necessary, provide help with the pronunciation of *epicenter* (EP-ih-sen-ter), *seismologists* (size-MOL-uh-jists), *seismic wave* (SIZE-mik wave), and *seismographs* (SIZE-muh-grafs).

Pages 10, 11 Volcanoes

- Remind students that they discussed volcanoes when they looked at the cover of this book. Ask, *Based on what you have learned so far, where do you think volcanoes are most likely to occur?* (Some students may suggest along plate boundaries.) Have students read page 10 and through the end of the first column on page 11 to discover the causes and effects of volcanoes.
- Ask students to look at the diagram of a volcano and read the labels. Have students point to the labels one at a time. Ask questions to elicit information about each part of a volcano. *What is a magma chamber?* (a pocket of magma beneath a volcano) *What is a vent?* (the opening through which hot materials from underground reach the surface) *What is a crater?* (the opening at the top of the volcano) *What is lava?* (magma that has reached the surface)
- Discuss how moving plates can cause volcanoes. Ask, *How are volcanoes formed when one plate sinks under another plate?* (The sinking plate melts and forms magma. The magma travels up through cracks to the surface. When magma escapes through a vent, the

volcano is erupting.) *What is a hot spot?* (a very hot place deep in the mantle) *How does a hot spot cause a volcano?* (A volcano forms in a plate when the plate slides across the hot spot.)

- Point out to students that volcanoes both destroy and create Earth's surface features. Ask, *How do volcanoes destroy?* (They can blow off the tops of mountains. Lava, cinders, and ash can bury landforms.) *How do volcanoes create?* (Lava hardens and forms rock. Volcanoes build islands in the ocean.)
- Have students look at the map on the bottom of page 11 and read the caption. Ask, *What conclusion can you draw about why so many volcanoes and earthquakes happen around the Pacific Ocean?* (Students may suggest that it is related to the fact that many different plates are slipping by or sinking under other plates in this area; earthquakes and volcanoes can occur where plates meet.) Have students read the second column to find out about the Ring of Fire. Encourage them to confirm the conclusions they drew before reading.
- If necessary, provide help with the pronunciation of *Kilauea* (kil-uh-WAY-uh) and *igneous* (IG-nee-us).

Further Facts

- Crustal stretching or thinning weakens a plate. As the plate separates, magma rises through the cracks that result. Rift valley volcanoes form where two plates move apart.
- The islands at the northwest end of the Hawaiian Islands formed first. Other islands formed as the Pacific Plate continued to move northwestward over a hot spot. A new volcano, called Loihi, is growing on the ocean floor southeast of the island of Hawaii (the Big Island). It will someday become another island in the Hawaiian chain.

- Volcanologists—scientists who study volcanoes—check a variety of activities in order to predict an eruption: increase in earthquake activity, changes in gases escaping through a vent, rising ground temperature, and swelling of the ground. These signal rising magma and increasing pressure below ground.
- Efforts to predict eruptions paid off in 1991 when scientists noted signs of a major eruption of Mount Pinatubo in the Philippines. In the days before the mountain exploded, 200,000 people were evacuated from the danger zone. Although 42,000 houses and a great deal of farmland were destroyed, few lives were lost.

Pages 12, 13 *Weathering and Erosion*

- Before having students read, write the term *weathering* on the board. Ask students what they notice about the word. (It has the word *weather* in it.) Explain that *weathering* is the term used for a force that can change rocks. Invite students to speculate on what is involved in weathering. (Accept reasonable responses.)
- Have students read through the end of the first paragraph on page 13. Ask, *What is weathering?* (the breaking down of rocks into smaller pieces) *What natural forces are involved in weathering?* (water, ice, wind, temperature changes, plants)
- Assess understanding by having students explain how each natural force causes changes in rocks. (Water can freeze in cracks and split rocks apart, dissolve minerals that make up rocks, and wear away solid rock. Wind blows sand against rocks and wears away the rock. Temperature changes can weaken rock and break it apart. Plant roots can grow into cracks and break rocks apart; lichens and fungi can break down minerals in the rock.)

- Have students read the next three paragraphs on page 13 to learn about erosion. Ask, *What is the difference between weathering and erosion?* (Weathering is the breaking down of rocks by wind, water, and other natural forces. Erosion is the movement of sediments and soil by wind, water, and gravity.) Ask, *What conclusion can you draw about how long it takes for weathering and erosion to change Earth's surface?* (It takes a long time.)
- Have students finish reading the page. Draw attention to the root word *deposit* in *deposition*. Explain some common uses of the word *deposit*, such as to deposit money in the bank or to deposit a letter in a mailbox. Elicit that *deposit* means “to place or put in.” Given these examples, ask students to describe or define *deposition*. (the putting down or placing of sediments on land or in water)
- You may want to explain that there have been at least six periods in Earth's history when so much of Earth's surface was covered with ice that we call these periods ice ages. Ask, *What is a glacier?* (a river of ice) Ask students to describe the sequence of events in the formation of a glacier. (Snow is on the ground year-round. Each year, a new layer of snow is added. Because of the pressure of the weight, the snow turns into ice. When the ice gets heavy, it starts to move downhill.) Then ask, *How do glaciers change Earth's surface?* (They wear away rocks and move soil and rocks to new places.)

There have been several major ice ages during Earth's history. The last ice age, the Pleistocene, began about 2.5 million years ago. During this ice age, there have been five periods of glacial advance and retreat, interspersed with times during which the climate was relatively mild. The current mild period began about 10,000 years ago.

People in Science (page 14)

Charles Richter

- Ask whether students know how earthquakes are measured. If there has been a recent newspaper report of an earthquake that gives its magnitude, bring this to students' attention. Explain that one way in which earthquakes are ranked is by a scale called the Richter scale.
- Remind students that they learned about seismologists on page 10. Review by asking, *What is a seismologist?* (a scientist who studies seismic waves, the vibrations caused by an earthquake) Tell students that they will read about one of the world's most famous seismologists. Then have them read page 14.
- After reading, ask, *How does the Richter scale rank earthquakes?* (by how much energy they release and how much they move the land) *How does the Mercalli scale rank earthquakes?* (by how much damage they cause) *Which scale is more scientific? Why?* (The Richter scale is more scientific because it uses measurements of energy, not just damage caused. Damage caused by earthquakes of the same magnitude can vary greatly, depending on population density, local building material, types of structures, and so on.)
- If necessary, provide help with the pronunciation of *Richter* (RIK-ter).

Further Facts

- Charles Richter was born on an Ohio farm and moved with his mother to Los Angeles in 1909. He attended the University of Southern California, Stanford University, and the California Institute of Technology (Caltech), where he received his Ph.D. in 1928.
- Dr. Richter worked at the Seismological Laboratory at Caltech from 1927 until 1970.

- Although the scale bears Richter’s name, Richter developed it in association with Beno Gutenberg (1889–1960), a German-born Caltech professor.
- The Mercalli scale was subjective. It relied on visual observation of earthquake damage and interviews with survivors.

Did You Know? (page 15)

About the Rock Cycle

- Have students read the text about the rock cycle. Ask, *What is the rock cycle?* (the process by which rocks are constantly being formed, worn down, and formed again) *What can break rocks down?* (weathering by water, wind, temperature changes, and plants) *What happens to the rocks?* (They are broken down into sediments and moved to new locations by erosion.)
- Ask, *What are the three main types of rocks?* (sedimentary, metamorphic, and igneous) *How are they formed?* (Sedimentary rocks are formed from layers of sediments pressed together; examples are limestone, sandstone, and shale. Metamorphic rocks are formed from other kinds of rocks by heat and pressure; examples are slate, gneiss, and marble. Igneous rocks form from liquid rock called magma that changes into solid rock when it cools; examples are pumice, basalt, and quartz.)
- Then have students look at the diagram. Explain: *The words cycle and circle are related. Just as you can run your finger around and around a circle, a cycle repeats itself in the same order.* Ask, *How do the arrows help show that the rock cycle keeps repeating?* (They go around in a circle.)
- Trace the different stages shown in the rock cycle diagram with students. Igneous rock at Earth’s surface is broken down by

weathering. The resulting sediments are transported by erosion and settled by deposition. Then the particles are compacted or cemented into layered sedimentary rock. Great heat and pressure applied to both igneous and sedimentary rocks can alter them chemically and physically. The outcome is metamorphic rock. All three kinds of rock can be returned to Earth’s interior by Earth movements. There, the high temperatures can melt the rock back to magma. Magma that cools and hardens is igneous rock. Thus the rock cycle continues

- If necessary, provide help with the pronunciation of *sedimentary* (sed-ih-MEN-tuh-ree) and *metamorphic* (met-uh-MOR-fik).

AFTER READING

Summarize

Complete the KWL chart you began with students before reading by asking them to share the answers to their questions. Call on volunteers to retell each text section. Then have students use the information in the KWL chart to write brief summary statements.

Discuss with students how using the KWL strategy helped them understand and appreciate the book. Encourage them to share any other reading strategies that helped them understand what they read.

Direct attention to the fourth column in the chart and ask: *What questions do you still have about Earth movements? What would you like to explore further?* Record students’ responses. Then ask, *Where do you think you might be able to find this information?* (Students might mention an encyclopedia, science books, and the Internet.) Encourage students to conduct further research.

Review/Assess

Use the questions that follow as the basis for a discussion of the book or for a written or oral assessment.

1. What are the three main layers of Earth? (the crust, the mantle, and the core) What is each layer like? (The crust is Earth's outer rocky layer. The mantle is a thick layer of very hot rock that is able to flow. The core is extremely hot and is mostly the metals iron and nickel. It has two layers, the outer core and the inner core. The outer core is liquid, and the inner core is solid.)
2. What is continental drift? (It is the idea that Earth once had just a single continent, Pangaea, that broke up into different land masses. These new continents moved to where they are today.)
3. What caused the continents to move? (Earth's crust is made up of several plates. Convection currents in the mantle push the plates around the globe. The plates carry the continents as they move.)
4. What other forces shape Earth's surface? (earthquakes, volcanoes, and weathering and erosion) Which of these cause rapid changes, and which cause change to take place slowly? (Earthquakes and volcanoes cause rapid changes. Weathering and erosion take long periods of time.)

Writing Links/Critical Thinking

Present the following as writing assignments. Provide help as needed.

1. What is the connection between Earth's layers, plate movement, and changes in Earth's surface? (Earth's rocky crust is made up of different plates that can move. Heat from the mantle creates convection currents that push the plates around. Some plates move apart, some move toward each other, and some slide past each other. Where plates move apart, underwater volcanoes form new crust. Plates that hit one another can create mountain ranges and ocean trenches. Plates that slide past each other can cause earthquakes.)

2. Seismologists work in several different areas. Some work in the field, using equipment to study sites where earthquakes occur. Some work in universities, studying the findings of field research. Some try to predict when and where an earthquake might happen. Some work with engineers to plan structures that can survive earthquakes better. If you were to become a seismologist, what type of work would you choose to do? Why? (Responses will vary.)

Science Journals: You may wish to have students keep the writing activities related to the Delta Science Reader in their science journals.

References and Resources

For trade book suggestions and Internet sites, see the References and Resources section of this teacher's guide.