



Earth Science

Interactions of Air, Water, and Land

Advanced Level

Fast Earth- Changing Processes

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Fast Earth-Changing Processes

How do natural events affect our world?

CORE CURRICULUM STATEMENTS

Many of the phenomena that we observe on Earth involve interactions among components of air, water, and land.

Extreme natural events (floods, fires, earthquakes, volcanic eruptions, hurricanes, tornadoes, and other severe storms) may have positive or negative impacts on living things.

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Fast Earth-Changing Processes ^{AL}

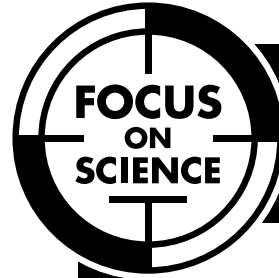
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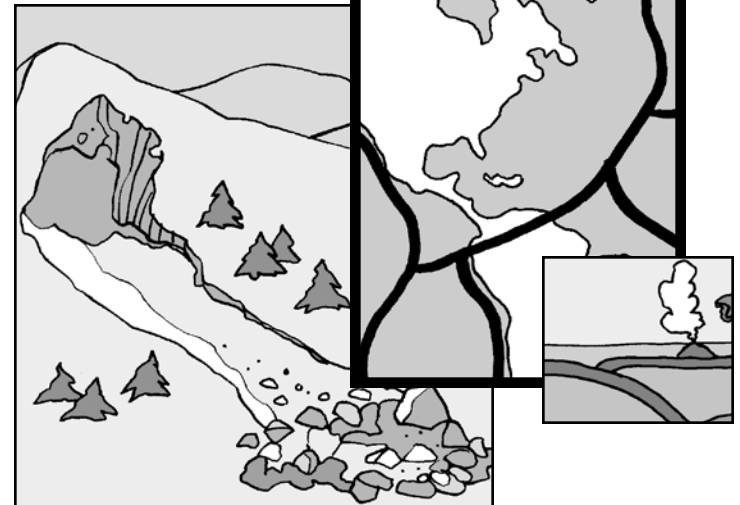


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Fast Earth-Changing Processes

by
Caitlin Scott





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Curriculum materials for **your** content standards

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*– Predict –
What do you think you will
learn from reading this book?*

INTRODUCTION

Earth Is Changing

The surface of Earth is constantly changing. Most of these changes happen gradually. For example, on sandy beaches everywhere on Earth, the wind is blowing sand into large piles called sand dunes. All the rivers of Earth are slowly washing dirt and small rocks downstream to the ocean. These slow changes are gentle and do not disrupt plant and animal life.

However, Earth is changing rapidly, too. These fast changes can be extremely **dramatic**. They can kill plants and animals. Sometimes, they even bring down buildings and put people in danger. Fast Earth-changing processes include:

- earthquakes
- volcanoes
- tsunamis
- landslides
- avalanches
- forest fires

dramatic: very noticeable

Why do these rapid changes occur? Can we predict when they will occur? What can we do to protect ourselves and the land?

These are all questions that scientists can answer by studying the planet Earth. Often, by noticing small changes, scientists can predict large changes such as earthquakes, volcanoes, or tsunamis. These scientists, called geologists, do important work that helps people understand our planet and stay safe during these events.

There are about 28,000 geologists in the United States. Would you be interested in a **career** studying changes on Earth? If you would, you should study science and mathematics in school. You will also need to get a college **degree**. Later, you might even get a more advanced graduate degree.

– Conclude –
*Why are geologists important?
Talk about it with a friend.*

career: the work or a series of jobs a person has
degree: a rank given to a student for completing a course of study

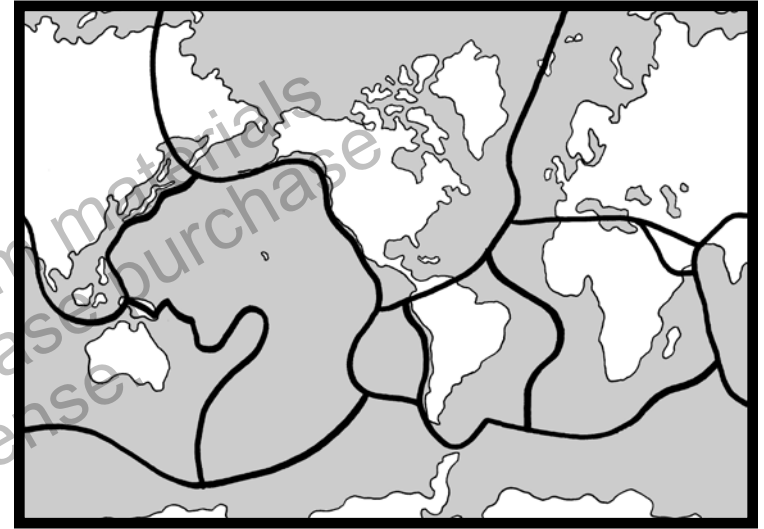
Shifting Plates

When you look at a map of Earth, you might notice that the land could be fitted together like a puzzle. For example, South America and Africa look as if they could be puzzle pieces that fit together. That's because long ago, these continents were once side by side.

Earth is composed of layers. The crust, which is the layer we walk on as well as the layer right under the oceans, breaks easily. Below the crust, the mantle is much softer, like a thick liquid. The crust floats on the mantle in big pieces called plates. Approximately 300 million years ago, heat inside Earth began pushing the continents on the plates apart. That is why South America and Africa are now apart.

Most of the time, the plates move extremely slowly, but sometimes two plates moving past each other get stuck together. The pressure builds up; then, suddenly the plates move. This causes an earthquake.

Earth's Major Plates



The dark lines on this map show the edges of Earth's major plates. Plates are large pieces of Earth's crust that are always moving.

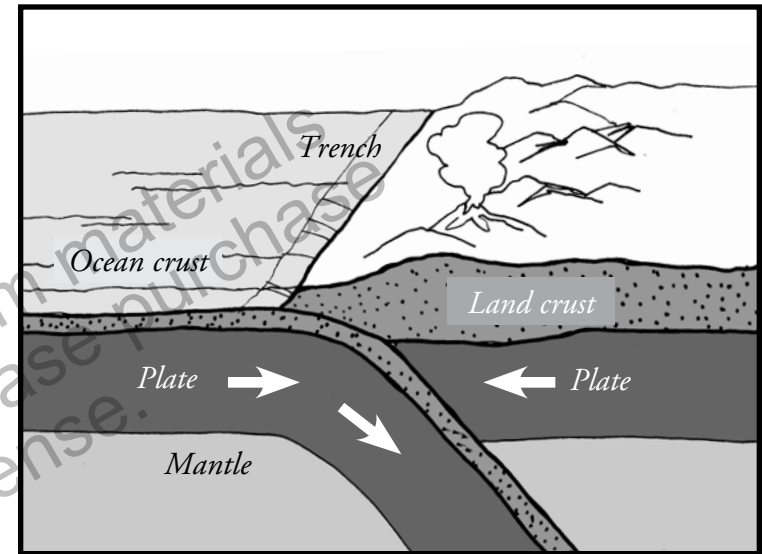
Earthquakes

When two of Earth's plates get stuck and then move suddenly, they can cause an earthquake on land. This earthquake shakes the land, buildings, and roads along the line where the plates were stuck together. Sometimes, earthquakes cause gentle shaking that you might not even notice or that might be strong enough to knock a book off a table. Other times, earthquakes bring down entire buildings and rip roads in half.

Places where earthquakes occur frequently are called fault lines. On the map on page 7, you can see a dark fault line running down the west coast of North America. This is why the state of California gets a lot of earthquakes.

Where do the world's most damaging earthquakes occur? The strongest earthquakes occur along subduction zones, where one of Earth's plates is moving under another.

Subduction Zones



Along fault lines, one plate moves under another. This causes earthquakes. It can also form a volcano.

People who live in subduction zones should make a special effort to learn what to do in an earthquake. They should also make sure the buildings they live and work in can withstand earthquakes. In recent years, scientists have found ways to build buildings that will sway in an earthquake rather than fall down.

Volcanoes

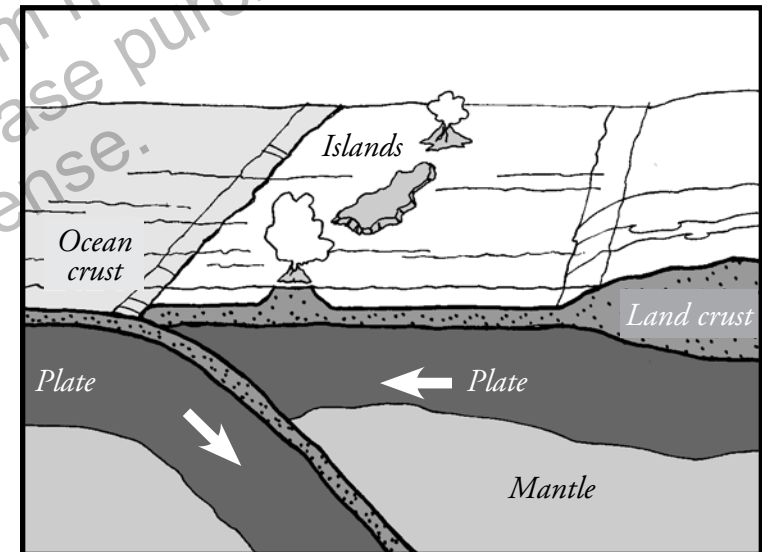
Volcanoes also happen along subduction zones, where one plate moves under another. Look at the diagram on the next page. One plate is moving under another. When this happens, heat is generated. This heat melts some of the rock. If the melted rock is pushed toward the crust, a volcano forms.

Volcanoes are very dangerous. The ground shakes when they **erupt**. Hot rocks, **lava**, ash, and mud fly up from the top of the mountain. The trees and buildings for miles around can be knocked down.

Fortunately, scientists are learning how to predict when a volcano will erupt. People usually have time to evacuate. If you live near a volcano and hear that it might erupt, listen to the news. Scientists will tell people when the volcano is likely to erupt and how to get away.

erupt: to explode with great force
lava: molten rock that flows or bursts from a volcano

Some subduction zones are underneath the ocean. The movement of the plates causes volcanoes to erupt under water. Eventually, the dirt, lava, mud, and rocks from the eruption break through to the surface, forming islands. This is how the Hawaiian Islands were formed. The volcanoes on the big island of Hawaii are still active.



Heat from the two plates rubbing against each other causes rock to melt. The lava is pushed up, forming a volcano. This is how undersea volcanoes form islands.

Tsunamis

You have learned that there are fault lines all around the crust of Earth. Many of these fault lines are under the ocean. You have also read about what happens when a volcano erupts underwater. But what happens when there is an earthquake underwater? It can be devastating!

When you throw a rock in water, ripples move out in all directions. The same thing happens in an underwater earthquake, but the ripples from earthquakes are huge waves. As these waves move toward land, they can be 100 feet tall and travel at more than 400 miles per hour.

In the United States, Hawaii is the place at the greatest risk for tsunamis. It gets about one big wave each year. California, Oregon, and Washington State get big waves about once every 28 years.

Tsunamis cause a lot of damage, because the big waves can tip over boats and knock down buildings. The flood waters left behind by tsunamis cause problems in towns and cities, too.

Fortunately, there are tsunami warning centers in both Hawaii and Alaska, so scientists usually know when a tsunami is coming. People can do some simple things to stay safe in a tsunami.

First, if you are near the ocean and feel an earthquake, listen to the news. It will tell you if there is a tsunami coming. Next, if you are told to evacuate, leave the area as soon as possible and get to higher ground. If you live near the ocean, you should make a plan for escape ahead of time. Finally, do not go back to the ocean after the first big wave, because a tsunami usually has several large waves.

Gravity

Most of the time, gravity causes slow changes on Earth's surface. For example, gravity can make broken rocks fall from a mountain top and send sand rolling downhill.

However, gravity also causes sudden changes. These changes are less common and can be extremely dangerous. Both landslides and avalanches are caused, in part, by gravity.

Landslides

In a landslide, gravity makes mud and rocks suddenly slide downhill, burying buildings and destroying roads. These landslides can occur in any one of the 50 states. In the United States, landslides cause about \$2 to \$3 billion worth of damage a year.

Landslides often happen at the same time as other disasters. For example, when earthquakes or floods loosen dirt and rocks, gravity can cause a landslide. Human activities can also cause landslides. For example, sometimes digging on a steep hill causes a slide.

What can people do to protect themselves from landslides? The first thing to do is avoid building houses or other buildings on steep hills. This is especially important if the hills are along a fault line or if the hills flood frequently.

Second, people should be aware of shifts in the land. If trees or fence posts appear to be leaning over, there might be a landslide soon. If you are in a landslide, try to get away. If you can't get away, get under something heavy like a table and wait to be rescued.

Finally, after the landslide, you still need to be careful. Do not go into the landslide area, because the land may still be shifting.

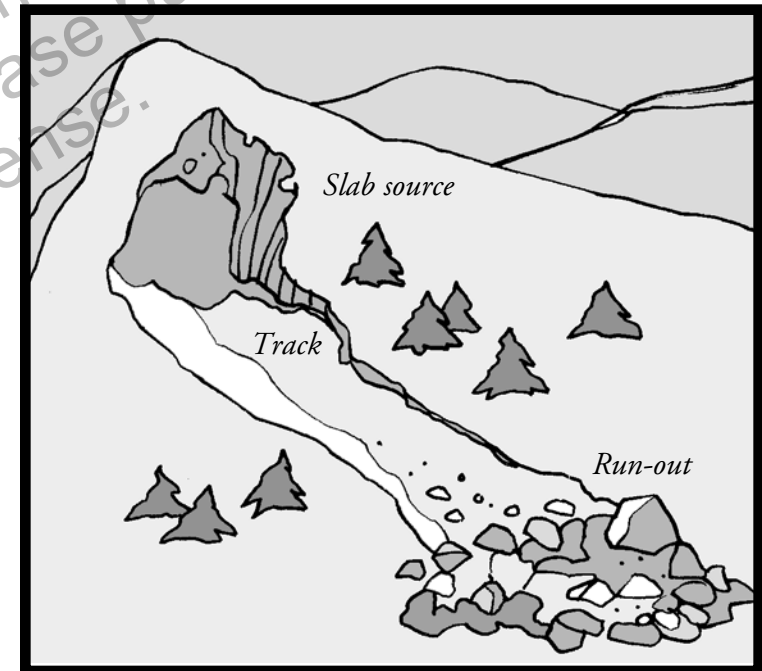
Avalanches

Avalanches are similar to landslides in that both are caused, in part, by gravity. However, landslides are slides of mud and rock, while avalanches are slides of snow, ice, and rock.

What causes avalanches? On mountains, snow piles up in layers. There might be ice or even pockets of air between the layers, due to melting and freezing snow. The larger the spaces between the layers, the more likely gravity will make the layers slide away from each other, causing an avalanche. Some avalanches are just loose snow and are not dangerous, but others are huge slabs of snow and ice that can bury people.

Most avalanches happen very high in snowy mountains. Skiers and mountain climbers are in the most danger of being caught in an avalanche.

Most ski resorts have avalanche warning systems. If there is avalanche danger, don't go out to ski or hike. If you do get caught in an avalanche, try to stay above the snow. If you get buried, put one hand in front of your face to keep a pocket of air in front of you, so you can breathe. If you can't dig your way out, don't exhaust yourself, just wait for rescue.



This slab avalanche will cause the entire slab of snow and ice to race downhill. This is the most dangerous type of avalanche.

Fire

Shifting plates and gravity can cause both fast and slow changes on Earth. Fire causes only one type of change—a fast change.

Forest Fires

You might think that forest fires are bad for the environment. However, some forest fires are natural and good for forests because bigger plants and trees need fire to clear out smaller plants and make room for new growth. Some fires are also useful, because certain types of plants need fire to make their seeds grow. These good fires start because of lightning or extreme heat on dry leaves and twigs.

Other fires are unnatural and can be damaging. Some fires occur in the wrong places, while others burn too hot. These fires can be dangerous to both land and people. Sometimes these fires are started by people, like a camper who does not put out a campfire. Lightning may also cause these fires.

Firefighters and park rangers have to work hard to contain a forest fire. One strategy is to dig long **trenches**. Because the dirt in these trenches will not burn, they help keep the fire from spreading. Another strategy firefighters use is dumping dirt, sand, water, or special chemicals on the fire from airplanes flying over the site of the fire. Finally, some firefighters still have to fight the fire on the ground, which is a very dangerous job.

If you find yourself in the path of a forest fire, you need to get to safety quickly. You should listen to the news to learn the best way to escape. This is not something you can plan ahead, because you never know which way the fire will turn.

trench: a long, narrow ditch

Let It Burn?

Hikers report smoke billowing up from a heavily wooded hillside in southern California. A park ranger flies over the site to check it out. Sure enough, the ranger sees the flames—the beginning of a forest fire. Should people put out the blaze, try to contain it, or let it burn? The question is not so easy to answer. Scientists need to think about questions such as:

- What kinds of plants are in the forest?
- How rapidly will the forest burn?
- Has there been a fire in the area recently?
- Do some plants need this fire to survive?
- What is the weather likely to be in the coming days? How quickly will the fire spread?
- How close will the fire come to people and buildings? Can these people get to safety?

– Analyze –

What data would you collect to answer these questions? What other questions would you ask? How would you go about designing an investigation to answer the questions?

Scientists who study forest fires spend years gathering **data** about forests and fires, so that they can make good decisions when a fire starts.

If you were a biologist, what data would you look at to answer the questions on page 20? What other questions would you ask about the situation? How would you go about answering these questions?

If scientists decide to let this fire burn, some people will disagree and be angry. These people may think all forest fires are bad and should be stopped. They may also be afraid that the fire will reach their homes and burn them down. What could scientists tell these people to convince them that this burn is a good thing for the land?

– Summarize –

Describe how we know that the surface of Earth undergoes fast changes.

data: information; facts

Glossary

career—the work or a series of jobs a person has

data—information; facts

degree—a rank given to a student for completing a course of study

dramatic—very noticeable

erupt—to explode with great force

lava—molten rock that flows or bursts from a volcano

trench—a long, narrow ditch

To Find Out More . . .

Want to learn more about fast Earth-changing processes?

Try these books

Volcanoes and Earthquakes by Andres Llamas Ruiz. Sterling Publishing Company, Inc., 1997.

Forest Fires by Luke Thompson. Children's Press, 2000.

Access these Web sites

U.S. Department of Labor Occupational Outlook Handbook: Geoscientists
<http://www.bls.gov/oco/ocos288.htm>

FEMA for Kids: Federal Emergency Management Agency
<http://www.fema.gov/kids/>

USDA Forest Service
<http://www.fs.fed.us/>

Write for more information

USDA Forest Service
1400 Independence Ave., SW
Washington, D.C. 20250-0003

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Assessments

Fast Earth-Changing Processes

Print pages 20–22 of this PDF for the assessments.

Check Understanding

Shade the circle next to the correct answer or write your answer on the lines provided.

1. A class listens to the news of a fire that is spreading through a forest in New York. The wind is causing the fire to spread quickly, and people who live near the forest are evacuating their homes. How are forest fires good for the environment?
 - Ⓐ They create new homes for animals.
 - Ⓑ They allow new plants and trees to grow.
 - Ⓒ They make room for new buildings to go up.
 - Ⓓ They are caused by lightning or extreme heat.
2. Which of the following fast Earth-changing processes results when an earthquake occurs underwater?
 - Ⓐ volcano
 - Ⓑ tsunami
 - Ⓒ landslide
 - Ⓓ avalanche

3. Students are studying how gravity can cause changes to Earth. Identify one fast Earth-changing process that is caused, in part, by gravity.

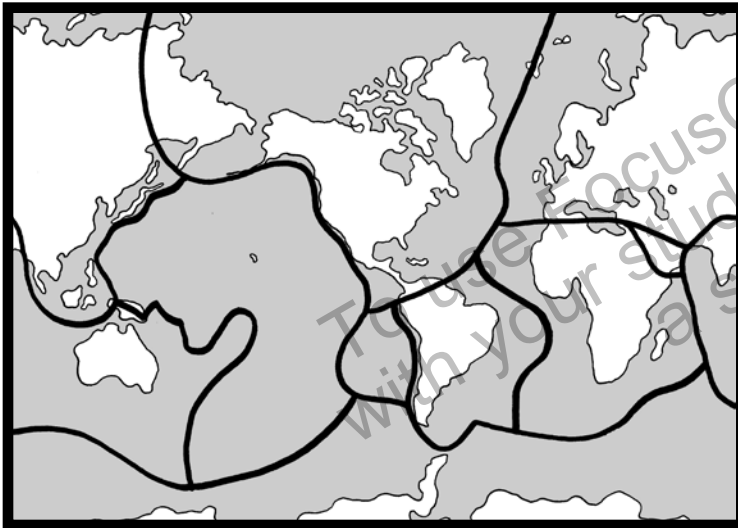
Explain how gravity plays a role in this process.

Check Understanding

Write your answer on the lines provided.

4. The map below shows Earth's major plates.

Earth's Major Plates



Identify two fast Earth-changing processes that occur along subduction zones.

- 1) _____
- 2) _____

Explain how each process occurs.

Assessment Scoring Guidelines

1. Answer B is correct.

2. Answer B is correct.

3. Avalanche

Gravity causes the layers of snow and ice on a mountain to slide away from each other.

Landslide

Gravity causes loosened rocks or mud to slide downhill.

4. Earthquakes

Earthquakes occur when two plates get stuck and then move quickly.

Volcanoes

Volcanoes occur when one plate moves under another, creating heat, which melts some of the rock.

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English Language Arts Activities

Fast Earth-Changing Processes

Print pages 24–28 of this PDF for the reading activities.

Main Idea and Supporting Details

TRY THE SKILL

The main idea is the writer's main point. Supporting details give more information about this main idea.

Here is a paragraph from *Fast Earth-Changing Processes*. The graphic organizer shows the main idea and supporting details.

Volcanoes are very dangerous. The ground shakes. Hot rocks, lava, ash, and mud fly up from the top of the mountain. The trees and buildings for miles around can be knocked down.

Main Idea

Volcanoes are very dangerous.

Supporting Details

- The whole ground shakes.
- Hot rocks, lava, ash, and mud fly up from the top of the mountain.
- The trees and buildings for miles around can be knocked down.

Read this paragraph from *Fast Earth-Changing Processes*.

Landslides often happen at the same time as other disasters. For example, when earthquakes or floods loosen dirt and rocks, gravity can cause a landslide. Human activities can also cause landslides. For example, sometimes digging on a steep hill causes a slide.

Now complete this graphic.

Main Idea

Supporting Details

Question and Answer

TRY THE SKILL

You can monitor your understanding of what you read by asking questions about the topic and then reading to find the answer. Sometimes authors will even write a question in the text and then answer it.

Read the paragraph from *Fast Earth-Changing Processes*.

Some subduction zones are underneath the ocean. The movement of the plates causes volcanoes to erupt under water. Eventually, the dirt, mud, and rocks from the eruption break through to the surface, forming islands. This is how the Hawaiian Islands were formed. The volcanoes on the big island of Hawaii are still active.

What question could you ask?

What happens when there are volcanoes on a subduction zone under the ocean?

What is the answer?

The dirt, mud, and rocks from volcanic eruptions break through to the surface, forming islands such as Hawaii.

Read the question from *Fast Earth-Changing Processes*. Write an answer in your own words.

1. Where do the world's most damaging earthquakes occur?

2. Now think of another question you could ask based on *Fast Earth-Changing Processes*. Write the question. Then, write an answer in your own words.

Question: _____

Answer: _____

Purpose for Reading

TRY THE SKILL

Authors have different reasons, or purposes for writing, and readers have different purposes for reading. Sometimes people read to understand something better. Sometimes they read to learn something new. Sometimes they read to solve problems.

Read this passage from *Fast Earth-Changing Processes* and try to determine the author's purpose.

People can do some simple things to stay safe in a tsunami. First, if you are near the ocean and feel an earthquake, listen to the news. It will tell you if there is a tsunami coming. Next, if you are told to evacuate, leave the area as soon as possible and get to higher ground. If you live near the ocean, you should make a plan for escape ahead of time. Finally, do not go back to the ocean after the first big wave, because a tsunami usually has several large waves.

Why might the author write this?

To help people solve a problem—to stay safe in a tsunami.

Who might read this and why might they read this?

Someone who lives near the ocean might read this to learn about what to do in a tsunami.

Read the passage from *Fast Earth-Changing Processes* and answer the questions.

Earth is composed of layers. The crust, which is the layer we walk on as well as the layer right under the oceans, breaks easily. Below the crust, the mantle is much softer and very hot. The crust floats on the mantle in big pieces called plates. Approximately 300 million years ago, heat inside the Earth began pushing the continents apart.

1. Why might the author have written this?
 - A To help people understand Earth better.
 - B To help people learn something new about the mantle.
 - C To help people solve the problem of the plates moving.

2. Who might want to read this?

Nonfiction Text Features

TRY THE SKILL

Chapter headings in a table of contents tell what a chapter is going to be about. Subheadings tell more about the information within a chapter.

Read the beginning of the table of contents from *Fast Earth-Changing Processes*.

Introduction:

Earth Is Changing 4

Chapter 1:

Shifting Plates 6

 Earthquakes 8

 Volcanoes 10

 Tsunamis 12

Chapter 2:

Gravity 14

 Landslides 14

 Avalanches 16

What page and chapter would give you information about Earth’s plates?

The table of contents says this information is on page 6 in Chapter 1.

What might be another good title for Chapter 1?

Instead of “Shifting Plates” this chapter could be called “Plate Movement” because this has the same meaning.

Read the table of contents from *Fast Earth-Changing Processes* again. Answer the questions.

1. What page and chapter would give information about gravity?

2. What page and chapter would give information about volcanoes?

3. What page and chapter would give information about huge waves?

4. What would be another good title for Chapter 2?

- Ⓐ Natural Disasters
- Ⓑ Downhill Slides
- Ⓒ Geology

Answer Key

Main Idea and Supporting Details

Main Idea

Landslides often happen at the same time as other disasters.

Supporting Details

- When earthquakes or floods loosen dirt and rocks, gravity can cause a landslide.
- Human activities can also cause landslides.
- Sometimes digging on a steep hill causes a slide.

Question and Answer

1. The strongest earthquakes occur along subduction zones, where one of Earth's plates is moving under another.
2. Answers will vary.

Purpose for Reading

1. A
2. Answers will vary but may include: Someone who likes science.

Nonfiction Text Features

1. Page 14, Chapter 2
2. Page 10, Chapter 1
3. Page 12, Chapter 1
4. B