TOPIC
4.3

How does the theory of plate tectonics explain Earth's geological processes?

Key Concepts

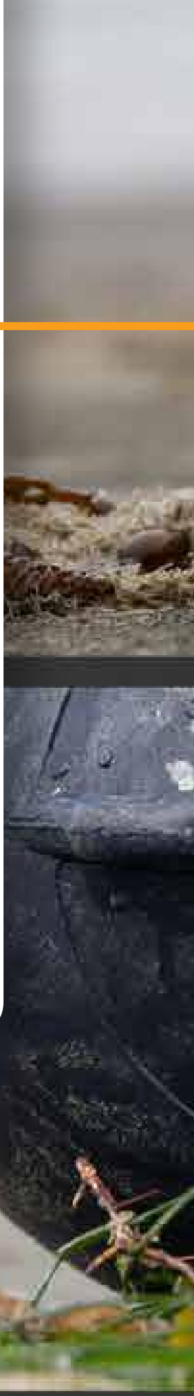
- Most earthquakes occur near tectonic plate boundaries.
- Movement along faults produces seismic waves.
- Most volcanoes occur where oceanic crust collides with another plate.
- Mountain ranges can also form when continental crust collides.

Curricular Competencies

- Reflect on your investigation methods.
- Co-operatively design projects.
- Contribute to care for community.
- Express and reflect on a variety of experiences and perspectives of place.
- Transfer and apply learning to new situations.

Earth is changing all the time. Sometimes the changes can be immediately visible, such as when an earthquake or tsunami strikes. The photos on these pages show objects that washed up on the shoreline of British Columbia as a result of the earthquake and tsunami that occurred in Japan in 2011. Most of the time, Earth's surface is changing in slow, almost unnoticeable ways. The slow, steady movement of tectonic plates, the violent eruption of a volcano, the rumbling of the ground, and the gradual formation of mountain ranges are all caused by the movement of Earth's plates.

The theory of plate tectonics explains how earthquakes, volcanoes, and mountain ranges are linked together. It also allows scientists to explain how, where, and sometimes when these geologic processes occur.



Starting Points

Choose one, some, or all of the following to start your exploration of this Topic.

1. **Identifying Preconceptions** Suppose your friend tells you that she is scared of earthquakes because they are all highly destructive and cause lots of damage. Would you agree with her statement? Why or why not? Share your response with your classmates. What do they think about the power of earthquakes? Are all earthquakes disastrous? How could you find out the answer?
2. **Testing Ideas** You have learned that the theory of plate tectonics relates many geologic processes.
   - **a)** How are earthquakes, volcanoes, and mountains related? Make a list of ideas that you have. Which ones could you test or investigate to see if they are valid? How would you test them?
   - **b)** Earthquakes, volcanoes, and mountains are very different, but all result from plate tectonics. How might the theory explain their differences? Make a list of your ideas.
3. **Investigating History** Many First Peoples have oral histories or mythologies about volcanoes. For example, Hawaiians believed that the Fire Goddess Pele lived inside a volcano. They believed the volcano erupted when she became angry. Find an oral history or myth about volcanoes. Tell it in your own words.

Key Terms

There are eight key terms that are highlighted in bold type in this Topic:

- earthquake
- fault
- focus
- seismic waves
- epicentre
- seismographs
- magnitude
- volcano

Flip through the pages of this Topic to find these terms. Add them to your class Word Wall along with their meaning. Add other terms that you think are important and want to remember.

CONCEPT 1

Most earthquakes occur near tectonic plate boundaries.

Activity

Modelling a Geologic Fault

Use the information in Table 4.2 to build models of the three types of faults. In what ways does your model accurately represent a fault? What features are not represented by your model? Compare your model with models built by your classmates. Make a list of the advantages of the models and describe the challenges with using models to represent faults.

If you read or listen to the news, you know that earthquakes can happen all over the world. However, exactly where they occur is not random. Almost all earthquakes occur along plate boundaries. Figure 4.13 shows locations of major earthquakes that have happened worldwide in recent history. Notice the pattern of earthquake activity.

Tectonic plate boundaries are where there is greatest stress on the rock in Earth's crust. Movements in Earth's crust can squeeze, stretch, or twist the rock. This applies pressure to the rock. Imagine bending a stick with your hands. At some point, the stick will not bend anymore and it breaks. When the pressure on the rock is applied too quickly or is larger than the strength of the rock, the rock breaks and the stored energy in the rock is released in the form of an earthquake.

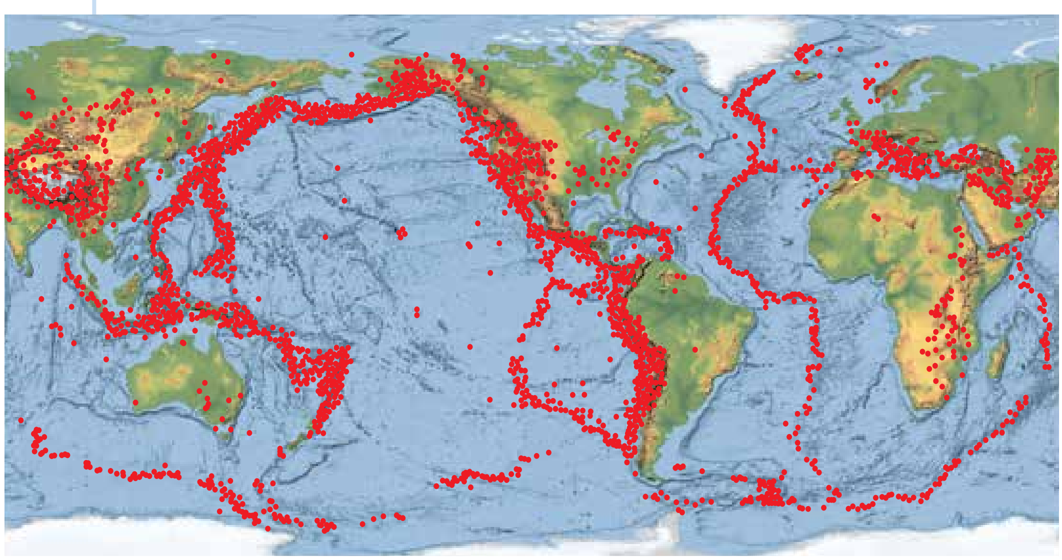


Figure 4.13 Almost 80% of all major earthquakes occur in the Circum-Pacific seismic belt.

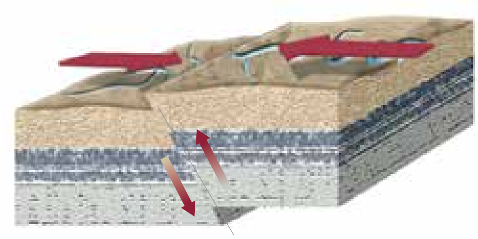
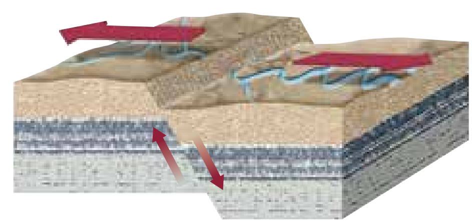
Earthquakes Happen at Faults

An **earthquake** is the natural movement or vibration of the ground that happens when part of Earth's crust shifts. Earthquakes usually occur when rocks suddenly shift along a break in the rock, releasing built-up pressure. The break where movement happens is called a **fault**. During an earthquake, one block of rock slides against or alongside another block of rock at a fault. Three types of faults can form: a reverse fault, a normal fault, and a strike-slip fault. Table 4.2 shows what happens at each type of fault. A *fault line* is the line along the surface of the ground where the break in the rock happens.

earthquake ground-shaking release of energy when a break in the crust occurs

fault large break in rock

Table 4.2 Types of Faults

Reverse	When rock is squeezed together and one block rides up to overlap the other block, a reverse fault forms. The crust is shortened, horizontally.	
Normal	When rock is pulled apart and one block slips downward, a normal fault forms. The crust is lengthened.	
Strike-slip	When blocks of rock move past each other horizontally, a strike-slip fault forms.	

Before you leave this page . . .

1. Describe the relationship between the locations of tectonic plates and the locations of major earthquakes.
2. What happens at a fault?
3. You find out that a friend's parents are considering buying a house near a fault line. Make a list of three questions they should find answers to before buying the house.

CONCEPT 2

Movement along faults produces seismic waves.

Activity

Seismic Slinky™ Waves

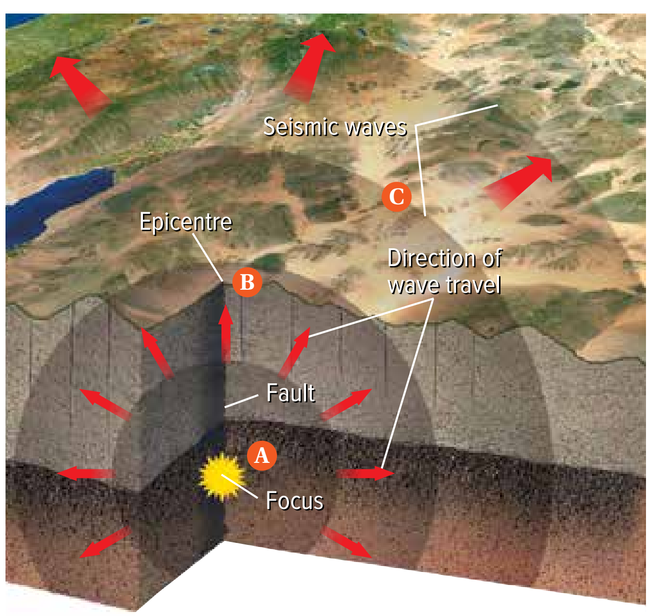
Working with a partner, use the information in Table 4.3 to model the three types of seismic waves using a Slinky™. What did you need to do with the Slinky to generate P waves? S waves? L waves? Describe the movement of each type of wave that you generated using the Slinky™.

focus location in Earth where an earthquake starts

seismic waves vibrations caused by release of energy during an earthquake

epicentre point on Earth's surface above where an earthquake starts

Study Figure 4.14. It shows what happens in Earth's interior when an earthquake occurs. An earthquake starts at a location called the **focus**. The focus is the point where breakage of rock first happens. The focus is usually at least several kilometres below the surface of Earth. As an earthquake occurs, rocks along a fault move into a new position and the ground feels like it is vibrating. The vibrations are **seismic waves**. An earthquake's **epicentre** is the point on the surface of Earth that is directly above the focus. When people describe where an earthquake has occurred, they usually refer to the epicentre of the earthquake.



A The focus is the point where breakage of rock inside Earth first happens.

B As an earthquake occurs, seismic waves leave the focus in all directions.

C An earthquake's epicentre is the point on the surface of Earth that is directly above the focus.

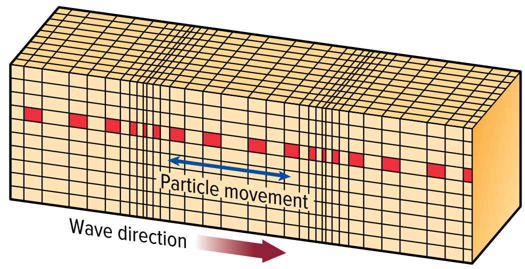
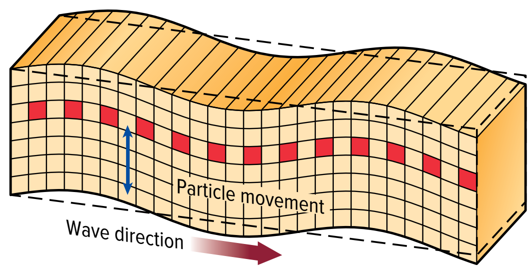
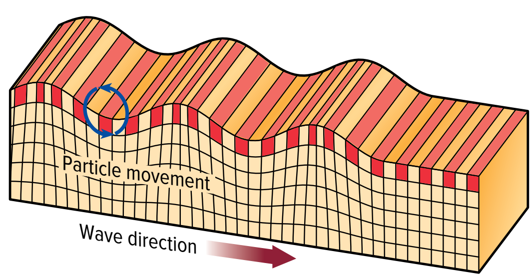
Figure 4.14 When an earthquake happens, seismic waves travel out from the focus.

Types of Seismic Waves

Table 4.3, on the next page, describes the three types of waves and the rock movements they cause when an earthquake happens.

Connect to Investigation 4-E on pages 314–315

Table 4.3 **Types of Seismic Waves**

Wave Type	Characteristics	Effect on Rock Particles	Where They Travel
Primary Waves (P waves)	• move the fastest • are the first ones detected in an earthquake	• cause rock particles to move forward and backward 	• can travel through both solids and liquids
Secondary Waves (S waves)	• move slower than P waves	• cause rock particles to move up and down 	• can only travel through solids
Surface Waves (L waves)	• are the slowest of the three waves • are on the surface and often cause the greatest damage	• cause rock particles to move both up and down and side to side 	• can travel along the surface of Earth and not through Earth's interior

Extending the Connections

Seismic Waves Provide Information About Earth's Interior

Scientists have identified and divided Earth's interior into layers based on the composition and properties of the materials in each layer. Recall that these layers are the crust, mantle, inner core, and outer core. Find out how scientists use S and P seismic waves from earthquakes to learn about Earth's interior.

How Earthquakes Are Measured

Seismic waves are detected and recorded by scientific instruments called **seismographs**. A seismograph includes a seismometer, which detects ground motion, and a device that amplifies and records the signal. Study **Figure 4.15** to find out how a seismograph works. When an earthquake occurs, seismic data from many instruments at different stations are uploaded to computers that process the information and determine the strength and location of the earthquake.

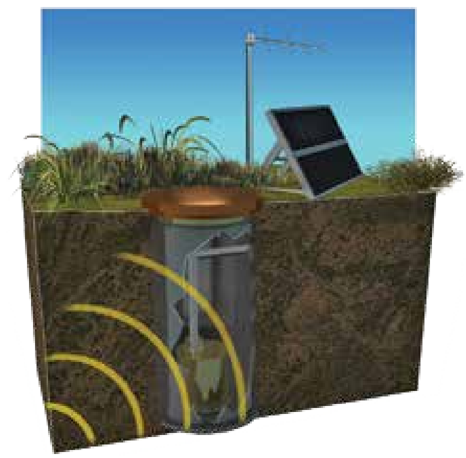
seismograph instrument that measures and records ground vibration

Figure 4.15 A Early models of seismographs used a seismometer made of a suspended mass in a frame. B Modern seismographs contain three electronic seismometers to record three components of motion. **What non-earthquake events could interfere with seismograph recordings?**

A Historic Seismograph

This device only records ground movement parallel to the red arrows. So, it only records a single direction.

B Modern Seismograph



This device records north-south, east-west, and up-down motion using three seismometers.

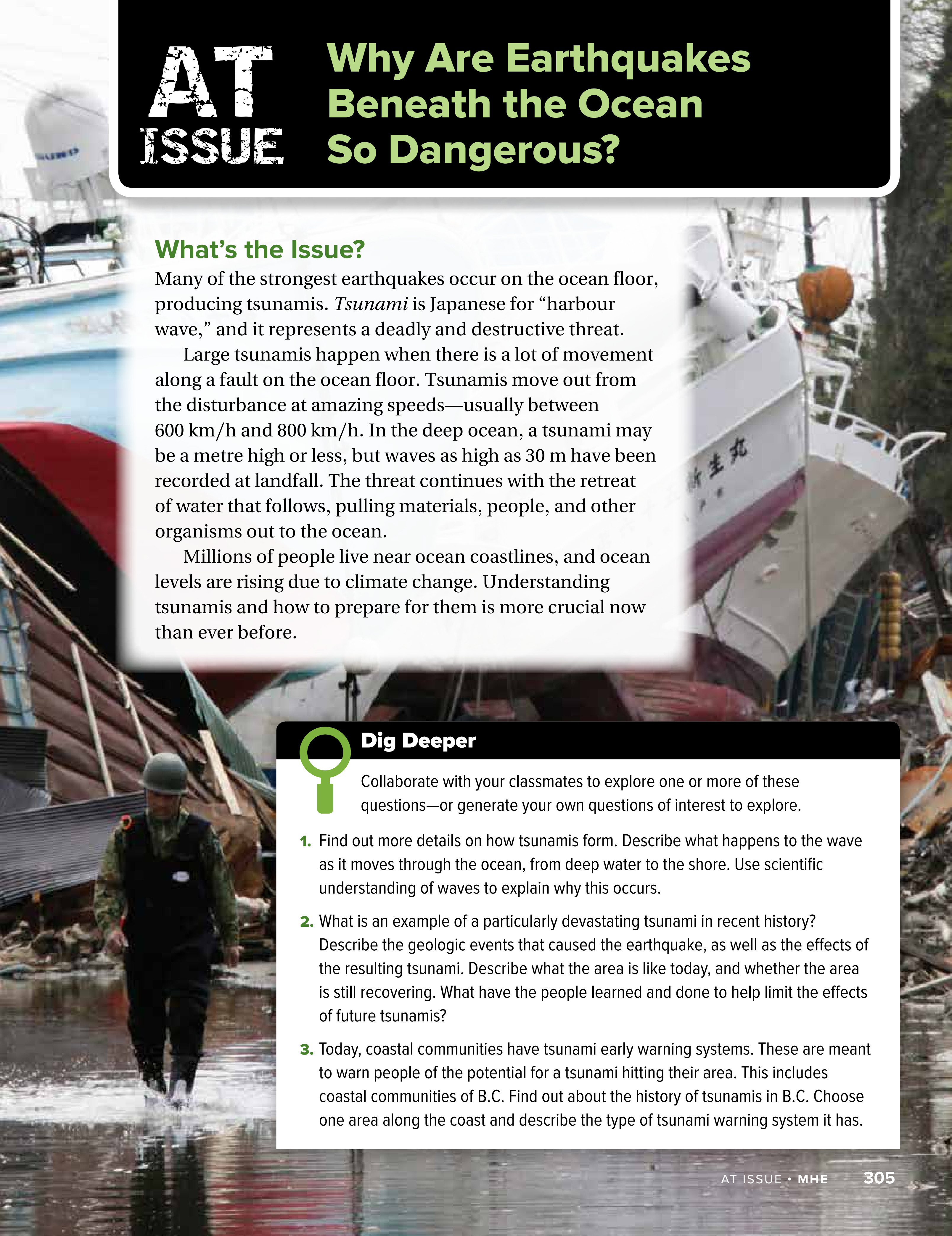
The **magnitude** of an earthquake refers to how strong the earthquake is. News reports of earthquakes usually refer to the magnitude of an earthquake using the Richter scale. The *Richter scale* is based on the size of the largest seismic waves that are formed. The higher the number, the greater the strength of the earthquake. Each number on the scale represents a 10-fold difference. For example, a magnitude-8 earthquake is 10 times larger than a magnitude-7 earthquake and a hundred times larger than a magnitude-6 earthquake. In general, earthquakes that are magnitude-4 or less do not cause damage. The world's strongest recorded earthquake was a magnitude-9.5, in Chile in 1960.

magnitude for earthquakes, a number that represents strength

Connect to Investigation 4-F on page 316

Before you leave this page . . .

1. Where is the epicentre of an earthquake?
2. Why do you think seismographs are buried and placed far from highly populated areas?



AT ISSUE Why Are Earthquakes Beneath the Ocean So Dangerous?

What's the Issue?

Many of the strongest earthquakes occur on the ocean floor, producing tsunamis. *Tsunami* is Japanese for "harbour wave," and it represents a deadly and destructive threat.

Large tsunamis happen when there is a lot of movement along a fault on the ocean floor. Tsunamis move out from the disturbance at amazing speeds—usually between 600 km/h and 800 km/h. In the deep ocean, a tsunami may be a metre high or less, but waves as high as 30 m have been recorded at landfall. The threat continues with the retreat of water that follows, pulling materials, people, and other organisms out to the ocean.

Millions of people live near ocean coastlines, and ocean levels are rising due to climate change. Understanding tsunamis and how to prepare for them is more crucial now than ever before.

Dig Deeper

Collaborate with your classmates to explore one or more of these questions—or generate your own questions of interest to explore.

1. Find out more details on how tsunamis form. Describe what happens to the wave as it moves through the ocean, from deep water to the shore. Use scientific understanding of waves to explain why this occurs.
2. What is an example of a particularly devastating tsunami in recent history? Describe the geologic events that caused the earthquake, as well as the effects of the resulting tsunami. Describe what the area is like today, and whether the area is still recovering. What have the people learned and done to help limit the effects of future tsunamis?
3. Today, coastal communities have tsunami early warning systems. These are meant to warn people of the potential for a tsunami hitting their area. This includes coastal communities of B.C. Find out about the history of tsunamis in B.C. Choose one area along the coast and describe the type of tsunami warning system it has.

CONCEPT 3

Most volcanoes occur where oceanic crust collides with another plate.

Activity

British Columbia and the Pacific Ring of Fire

The majority of Earth's earthquakes and volcanoes occur in an area called the Ring of Fire. There is constant earthquake and volcanic activity in this area—and British Columbia is a part of it. Find out the following. Describe how plate tectonic activity has resulted in the Ring of Fire. Which countries are often affected by plate movement in this area? Give two or three examples of populations that have been badly affected by the geologic activity in this region. Now answer any of your own questions about this area of the world.

volcano opening in Earth's surface where magma and other materials are released

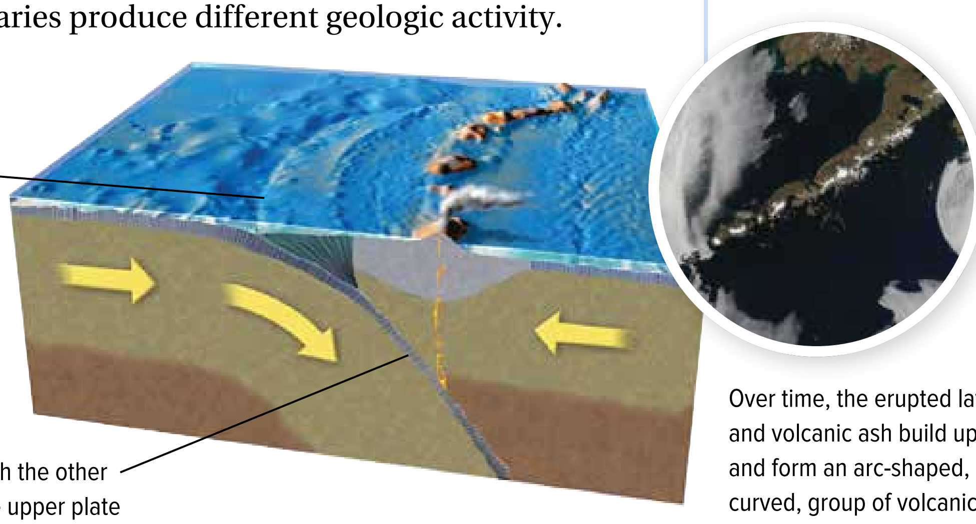
Anywhere that magma from the mantle reaches Earth's surface can be called a **volcano**. Magma that has been released onto Earth's surface is called *lava*. Volcanic eruptions, such as the one shown in Figure 4.16, can send hot gases and volcanic ash flying high into the air. An eruption can also cause dangerous landslides that produce massive paths of destruction.

Figure 4.16 Mount St. Helens in Washington State erupted in 1980. This was the last major eruption near British Columbia.

Connect to Investigation 4-G on page 317

How Volcanoes Form at Plate Boundaries

Many volcanoes occur at convergent boundaries. **Figure 4.17** shows two ways scientists think volcanoes can form. Part A shows what happens when crust from an oceanic plate collides with crust from another oceanic plate. This is often called an oceanic-oceanic convergent boundary. Part B shows what happens when oceanic crust collides with continental crust, at an oceanic-continental convergent boundary. Notice how these two types of convergent boundaries produce different geologic activity.



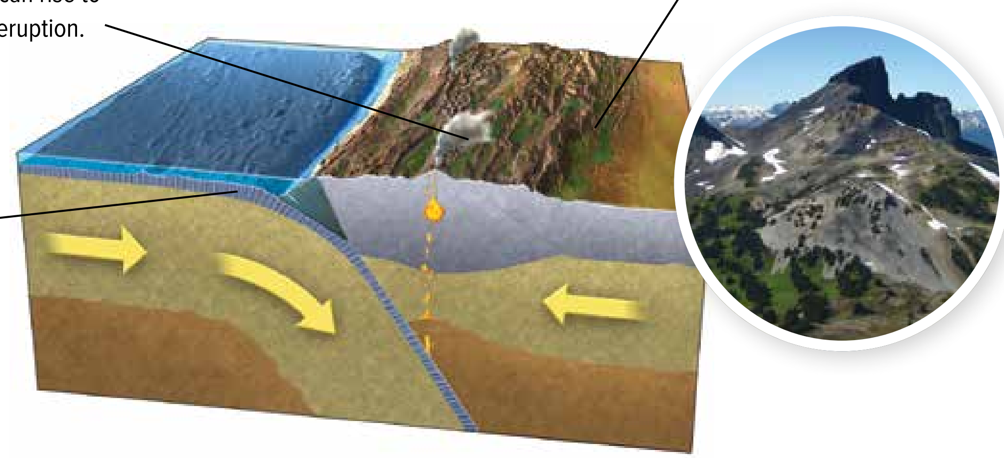
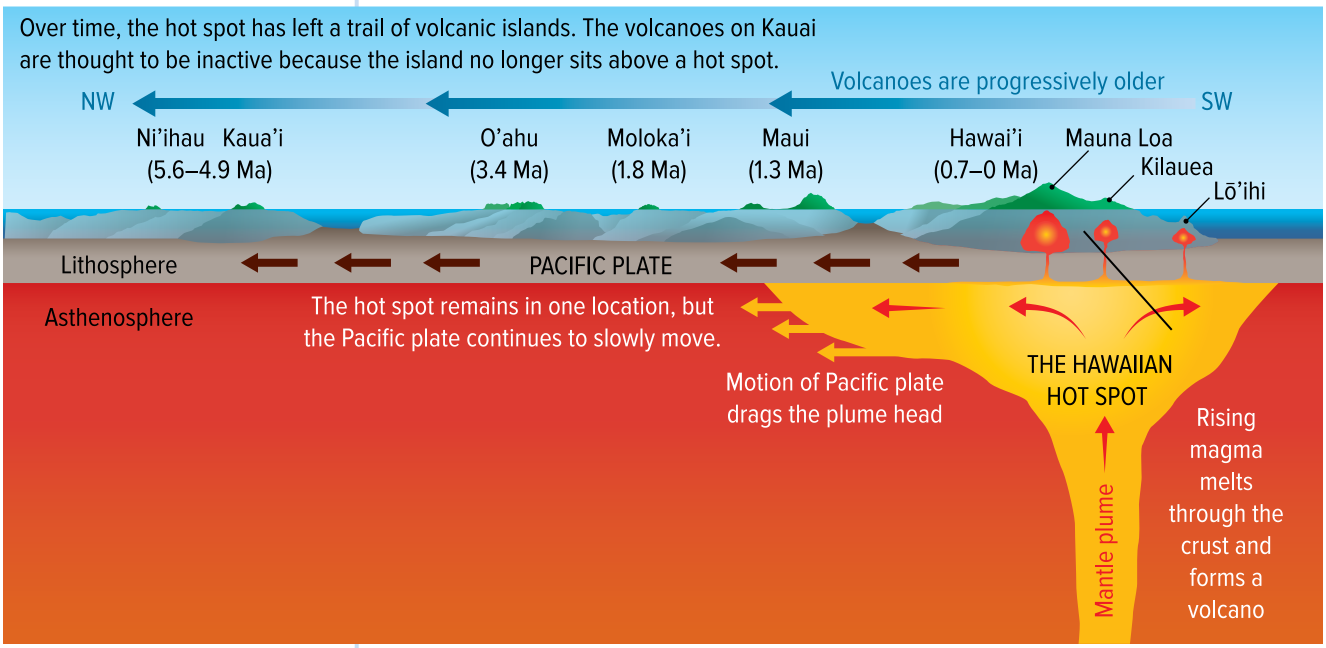


Figure 4.17 (A) Oceanic-oceanic convergent plate boundaries form a pattern of islands called volcanic island arcs. The Aleutian Islands of Alaska are an island arc of volcanoes. Evidence indicates they have formed from the collision between the Pacific plate and the North American plate. (B) Oceanic-continental convergent plate boundaries form large continental volcanoes. The Coast Mountain Range includes a series of dormant volcanoes. It is thought that they formed from the collision between the Juan de Fuca plate and the North American plate.

Hot Spot Volcanoes

In the early 1960s, many scientists did not support the theory of plate tectonics because it could not explain volcanic activity that was not near plate boundaries. In 1963, Canadian scientist John Tuzo Wilson proposed an idea to explain this. He suggested that tectonic plates could move over fixed areas called hot spots. *Hot spots* are defined as unusually hot regions of Earth's mantle where magma rises to the surface by breaking through weak parts of the lithosphere. **Figure 4.18** shows how the Hawaiian Islands are thought to have formed from a hot spot under the ocean.

Figure 4.18 The volcanic islands of Hawaii are thought to have formed from a hot spot.
Analyzing Which island has volcanic activity? How do you know?



Extending the Connections

Investigate Types of Volcanoes

Volcanoes have different sizes and shapes. They can also contain different types of rocks. Learn how scientists have classified different types of volcanoes. What are the characteristics of a composite volcano? What are the similarities and differences between cinder cone volcanoes and shield volcanoes?

Before you leave this page . . .

1. What is a volcano?
2. According to the theory of plate tectonics, describe two ways that volcanoes can form at plate boundaries.
3. What is a hot spot?
4. How do hot spots support the theory of plate tectonics?

CONCEPT 4

Mountain ranges can also form when continental crust collides.

Activity

Investigating B.C.'s Mountain Ranges

Obtain a copy of a topographic map that shows the mountain ranges of B.C. Use your own knowledge as well as research sources to answer these questions.

- How many mountain ranges are there, and where are they located?
- Which ones include volcanoes?
- What are the names and elevations of the tallest peaks in each range?
- What patterns do you notice about the directions that mountain ranges run? Use your understanding of plate tectonics to account for this.

The Rocky Mountains, shown in **Figure 4.19**, are 4800 km long and run from British Columbia to New Mexico in the United States. Mountain ranges contain many peaks grouped together in a continuous line that can be hundreds or even thousands of kilometres long. Also, their locations on Earth are not random. Scientists have carefully studied Earth's mountain ranges to learn how they might have formed millions of years ago. These spectacular structures hold detailed information about Earth's history and the role that plate tectonics may have played in their formation.

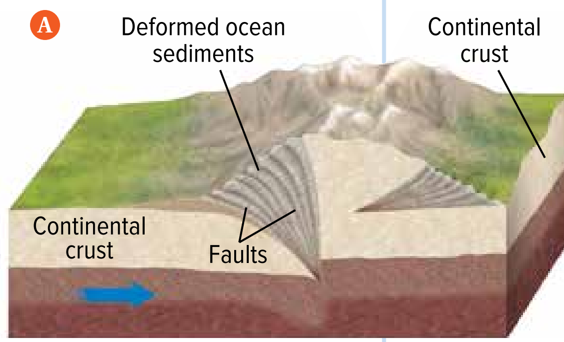
You have learned about how tectonic plate movements involving oceanic crust collisions can result in formation of volcanic mountains. There are also plate movements that produce mountains that are not volcanoes. Some of these collisions have produced the highest mountain peaks on Earth.

Figure 4.19 Mountain-building processes involving tectonic plate collisions resulted in the Rocky Mountains.

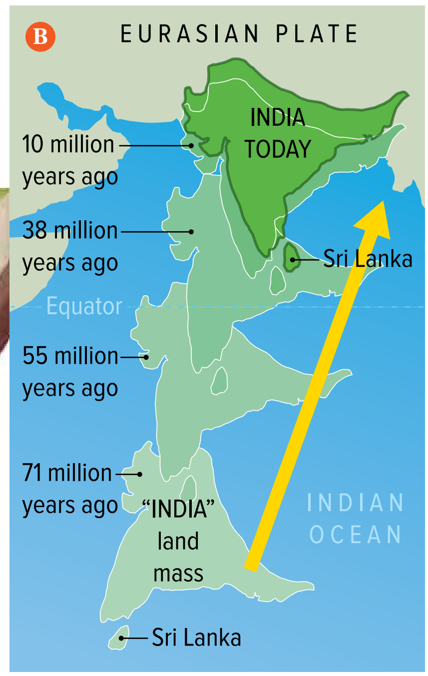
Continental Crust Collisions

Earth's tallest mountain ranges have been formed by collisions between plates of continental crust. Unlike when oceanic crust collides, continental crust is not easily subducted beneath the other plate. Instead, one plate is shoved beneath the edge of the other plate. This impact causes a large area to be pushed up, forming mountains, as shown in **Figure 4.20**. The collision also places large pressures on the plates. This produces features in the surrounding rock, such as faults, and causes the crust to become deformed.

Figure 4.20 (A) When two plates of continental crust collide, massive mountain ranges are formed. (B) The Himalayan Mountain Range in southern Asia is thought to have formed from a collision between the Eurasian plate and Indian plate.



Thick pieces of the crust can be piled onto each other. This can increase the thickness of the deformed crust for hundreds of kilometres into the continents.



The fast movement of the Indian plate would have caused a violent collision. Scientists think this contributed to making the Himalayas the tallest mountain range on Earth.

Extending the Connections

How the Rocky Mountains Formed

The way that the Rocky Mountains are thought to have formed is complex and happened over many millions of years in certain phases. Find out how scientists think plate tectonics resulted in formation of the Rocky Mountains. How is the angle of the subducting plate related to the formation of this mountain range?

Before you leave this page . . .

1. Draw and label a sketch of a convergent plate boundary involving two plates of continental crust.
2. Why does the collision between plates of continental crust differ from what happens when oceanic crust collides with continental crust?

Focus on Earth Science

What kinds of jobs are there for people who study geological processes?

- Communications Officer
- Ethnographer
- Volcanologist
- Oceanographer
- Pilot

Geological Technician

If you enjoy engaging with people as much as with machines and are as at home outdoors as indoors, then a geological technician might interest you. (Oh, and flying in helicopters!)

Seismologist

Can't decide between your passions for physics and geology? Have an interest in exploring fossil fuels or civil engineering? Seismology may be the right fit for you.

Surveyor

A knack for making exacting measurements, a keen eye, and a desire to determine precise boundaries may help to set surveyors apart.

Questions

1. What other jobs and careers do you know or can you think of that involve the study of Earth's plates and how they move?
2. Research a job or career related to Unit 4 that interests you. What attracts you to it? What kinds of things do you have to know, do, and understand for this job or career?

AT ISSUE

What's in a Name?

What's the Issue?

Within the Columbia Mountains of southeastern British Columbia lie the Selkirk Mountains, within which is the Valhalla range of mountains. And nestled amongst the Valhallas is a small yet distinctive peak whose official name is Mount Wilton. But ask the people of Winlaw, Vallican, Slocan Park, and others who can see this mountain from their homes in the Slocan Valley, and you are more likely to hear it called by another name—Frog Peak, in honour of the spirit animal sacred to the Sinixt Nation.

During the 19th and 20th centuries, many First Peoples traditional place names in British Columbia were replaced with colonial European names. Recently, some places have been renamed or co-named using their traditional names.

Dig Deeper

Collaborate with your classmates to explore one or more of these questions—or generate your own questions of interest to explore.

1. Choose a landform, body of water, settlement area, or other place near where you live that has more than one name by which it is known. Trace the history of these names and why one may be used in preference to others.
2. How do the names of places become "official" to begin with? What is the process of changing an official place name, and under what circumstances can this process occur?

Check Your Understanding of Topic 4.3

QP Questioning and Predicting PC Planning and Conducting PA Processing and Analyzing E Evaluating
AI Applying and Innovating C Communicating

Understanding Key Ideas

1. Describe the relationship between tectonic plate boundaries and each of the following:
   a) earthquake activity
   b) volcanic activity
   c) mountain formation PA

2. According to the theory of plate tectonics, describe what happens when two plates of oceanic crust collide. Use diagrams to support your answer. PA C

3. In a format of your choice, describe the relationship between the terms "fault," "epicentre," and "focus." C

4. Using a table, summarize three types of convergent boundaries and the geologic features that are formed at each.
   In your answer, include diagrams that represent each process. C

5. The San Andreas Fault in California is where the Pacific plate slides past the North American plate. What type of plate boundary exists there? What do you know about the geologic activity in this area? PA AI

Connecting Ideas

6. Millions of people all over the world live near volcanoes. Why do you think so many people would live in these regions? PA

7. In the early 1960s, the Canadian geologist John Tuzo Wilson developed a concept that is now considered a crucial milestone to the plate tectonics theory. It was important because it provided an explanation for a geologic feature that was not near any plate boundaries.
   a) Describe what this contribution was and an example that supports it.
   b) At the time, his idea was considered very radical. He could only get his paper published in a little-known journal at the time called the *Canadian Journal of Physics*. Why do you think he had such a difficult time getting his work published? PA

Making New Connections

8. Mountains have been the inspiration for many writers. Often their works include extensive knowledge of the mountain, with very descriptive passages about the mountain and its special features. The mountain can also be an important part of the plot, outcome, or character development.
   a) Write a short fictional story or poem that includes a mountain in B.C. Identify the mountain and have it be a central part of your story or poem. Be sure to include important features of the mountain.
   b) Explain why you chose that mountain to be part of your story. AI C

INVESTIGATION

4-E

STRUCTURED INQUIRY

Skills and Strategies

- Processing and Analyzing Data
- Evaluating
- Applying and Innovating

What You Need

- access to online, print, and living sources of information

British Columbia's Earthquakes: Past and Present

Today, state-of-the-art technologies help scientists monitor and record earthquake activity as it happens. However, long before this technology was invented, First Peoples recorded major events through the use of oral histories and narratives. One example in shown in the box on the next page.

In this investigation, you will reflect on how the ways of knowing of First Peoples and the ways of knowing of western science and technology can help us understand earthquake activity in British Columbia.

Question

How do different ways of knowing complement our understanding of earthquake activity?

Procedure

1. Read through the entire procedure to determine the information you need to research. Then do the following.
   - Decide what resources you will use. Have your teacher approve the resources.
   - Decide how your group will work together to find, combine, and present the information.
2. Research technologies used to monitor earthquake activity. Make a list of questions that you want to find answers to. As part of your research, include:
   - a description of a technology and how it works
   - how data are collected and analyzed
   - how often earthquakes happen in B.C. and what the magnitudes typically are.
3. News reports about earthquake activity in B.C. often refer to "The Big One", which is predicted to happen. Find out what this is and the evidence for it.

Earthquake Foot
by Tim Paul, Nuu-chah-nulth

In speaking about this work, Tim Paul relates:

The Earthquake is our eleventh relative. We as a people must prepare ourselves each day and give thanks for all good things. We converse with the Maker when the moon is growing at the time of the new moon. Sometimes we take more than we need and do not put enough back. Our earthquake relative quickly reminds us of who we are and what we are entitled to. He will get angry and step out of his home in the mountain.

The earthquake is four dwarf-like people figures who live inside the mountain. When they see a passer-by they begin to sing and dance and try to entice the visitor into joining them in the celebration. If lured into the dance, the visitor will be forced to dance until tired and eventually to stumble into the large central drum. When the foot makes contact with the drum, it becomes infected with what is called Earthquake Foot and with each step the earth begins to tremble until it causes an earthquake.

Tim Paul

Source: Spirit Wrestler Gallery

4. Research the 1700 Cascadia earthquake and the role of First Peoples oral histories in reconstructing this event. (This earthquake is the one that created the Ghost Forest featured in the opening to this unit.)

Process and Analyze

1. Describe how important First Nations' history has been in providing knowledge of the 1700 Cascadia Earthquake.

Evaluate, Apply, and Communicate

2. Reflect on and respond to the Question posed to start this Investigation. Support your opinions with evidence.

INVESTIGATION

4-F

GUIDED INQUIRY

Skills and Strategies

- Planning and Conducting
- Processing and Analyzing
- Evaluating
- Applying and Innovating
- Communicating

What You Need

Possible materials:

- small pieces of wood
- box
- string
- roll of paper
- pen
- soup can

Make Your Own Seismograph

A seismograph is an instrument used by scientists to measure the strength of the seismic waves produced from an earthquake. In this investigation, you will design and build your own seismograph.

Question

How can a seismograph be made using simple materials?

Procedure

1. Work with your group to decide how you will design, build, and operate your seismograph. A good design should
   - require inexpensive materials that can be easily found,
   - be able to show the strength of each vibration it measures, and
   - be able to measure continuously for at least a minute and be sensitive enough to detect small vibrations.
2. Draw and label your design.
3. Make a list of materials you will need and develop a plan for how to build your model. Make sure your teacher approves your plan and materials.
4. Build your model.
5. Demonstrate your seismograph for other students.

Analyze and Interpret

1. How sensitive was your seismograph? Overall, how well did it work?
2. Describe any challenges you had building your model or demonstrating how it works.

Conclude and Communicate

3. Compare your model with those of your classmates. How are they the same? How are they different? Did one model work better than others? If so, in what way was it better?
4. What improvements could you make to your seismograph based on other groups' designs?

INVESTIGATION

4-G

GUIDED INQUIRY

Skills and Strategies

- Questioning and Predicting
- Planning and Conducting
- Processing and Analyzing
- Evaluating
- Applying and Innovating
- Communicating

British Columbia's Volcanoes and Their Oral Histories

The Nass Valley in northwestern B.C. is the last place where a volcano erupted here. It happened more than 250 years ago, killing more than 2000 people. Two of the four villages of the Nisga'a First Nation were buried. There is a traditional Nisga'a oral history to explain the eruption, and it provides lessons from the Elders.

Procedure

1. Find an example of a volcanic eruption that has occurred in or near your region. If there isn't one, use the Nass Valley or another example from B.C.
2. Write out any questions you have about the eruption.
3. Decide which questions you will investigate, and plan how you will answer them. As part of your plan, find traditional oral histories associated with the eruption. How do or can they contribute to the process of scientific inquiry undertaken by geologists and other scientists?
4. Carry out your plan.

Analyze and Interpret

1. What effect did the eruption have on the people in the area? What lasting effect, on the landscape or people, has the eruption had?

Conclude and Communicate

2. How does considering different ways of knowing, including First Peoples and Western scientific ways of knowing, benefit the study of geological processes such as volcanoes?
3. Develop a creative way of sharing what you learned about the volcanic eruption you researched. This can include a recording, a dramatization, or a song.