

Features of Plate Tectonics

Textbook pages 518–537

Before You Read

Earthquakes frequently occur in British Columbia. State what you already know about earthquakes in the lines below.

What lies below Earth's surface?

Earth is made of four layers with distinct characteristics. The **crust** is Earth's outermost layer. It is made from solid, brittle rock and is 5–70 km thick. The **mantle** is Earth's thickest layer. The upper mantle (660 km thick) is composed of partly molten rock that flows like thick toothpaste. A transition zone separates it from the lower mantle (about 2300 km thick), which is made of solid, dense material including magnesium and iron. Below the mantle lies the liquid **outer core** (about 2300 km thick and mostly nickel and iron). The **inner core** with a radius of 1200 km lies at Earth's centre. The incredible pressure at Earth's centre keeps the iron and nickel in the inner core solid. Scientists believe that the inner and outer cores rotate at different speeds, producing Earth's magnetic field. ✓

What are tectonic plates?

Tectonic plates are large, rigid, but mobile plates of rock. There are about 12 major tectonic plates and many smaller ones. Made up of the crust and the uppermost mantle, they form the **lithosphere**. Oceanic plates contain dense basalt rock. Continental plates contain large amounts of granite. Below the lithosphere lies the **asthenosphere**, a partly molten layer in the upper mantle. Radioactive decay in some parts of the asthenosphere heats the mantle in these regions. Convection currents result as these hotter, and therefore less dense, regions of the mantle rise, cool, and sink again, only to be reheated. This **mantle convection** is one of the driving forces behind plate movement. ✓

 **Mark the Text**

Identify Definitions

As you read this section, highlight the definitions of the words that appear in bold print.

 **Reading Check**

List the four layers that make up Earth.

 **Reading Check**

Name the process in the asthenosphere that pushes magma to Earth's surface, causing tectonic plates to move.

How do tectonic plates interact?

A region where two tectonic plates are in contact is known as a **plate boundary**. The way in which tectonic plates interact depends on the type of plates and the direction the plates are moving relative to one another.

There are three main types of plate interactions:

1. Divergence \longleftarrow : **Divergent plate boundaries** mark the areas where tectonic plates are spreading apart. Such plates, for example, the East African Rift, are known as **diverging plates**. Rising currents of magma cool as they reach the surface and become “new” rock, resulting in spreading centres. A spreading centre in the ocean is called a spreading ridge or oceanic ridge. On land, it is called a **rift valley**. As new material at a ridge or rift pushes older material aside, the tectonic plates move away from the ridge. This process is called **ridge push**. **Rift eruptions** may occur when magma erupts at divergent plate boundaries. The Juan de Fuca ridge is an example.

2. Convergence \longrightarrow : A **convergent plate boundary** occurs where tectonic plates collide. Such plates are known as **converging plates**. If a dense oceanic plate collides with a continental plate, the heavy oceanic plate will dive under the lighter continental plate in an event known as **subduction**. A deep underwater valley, called a **trench**, forms where the plates make contact. As the edge of a tectonic plate subducts, it pulls the rest of the plate with it. This process is called **slab pull**. Along with convection currents and ridge push, slab pull helps keep tectonic plates in motion. As subduction occurs, magma can break through to the surface, forming volcanoes. A long chain of volcanoes, called a **volcanic belt**, may form as a result. The force of the collision between oceanic and continental plates also creates mountain ranges as the continental rock crumples and bends. British Columbia’s Coast Mountains and Cascade Mountain Range were produced by such collisions.

Most volcanoes in volcanic belts are **composite volcanoes**, such as Mount Garibaldi, in British Columbia. Their cone shape results from repeated eruptions of ash and lava. **Shield volcanoes** are the world's largest, and their shape resembles a shield. They are not formed when plates collide, but when weaker areas of the lithosphere move over a "hot spot". The Anahim Belt is a chain of shield volcanoes in British Columbia. **Rift volcanoes**, like the Krafla volcano in Iceland, are formed when magma erupts through long cracks in the lithosphere.

Subduction also occurs where two oceanic plates converge. Cooling causes one plate to become denser. The denser plate slides deep into the mantle. Such convergence may produce a long chain of volcanic islands known as a **volcanic island arc**. The Aleutian islands and the islands of Japan are examples of a volcanic island arc. Subduction does not occur when two continental plates collide since the plates have similar densities. As continental plates collide, their edges fold, forming large mountain ranges, such as the Himalayas.

3. Transform \rightleftharpoons : Convection currents in the mantle often cause tectonic plates to slide past each other. Such regions are known as **transform plate boundaries**. Earthquakes and **faults** (breaks in rock layers due to movement on either side) may result. A fault that occurs at a transform plate boundary is known as a **transform fault**. The San Andreas Fault is an example of a transform plate boundary.

How are tectonic plates linked to earthquakes?

Friction between moving tectonic plates often works against convection currents, producing stress (the build-up of pressure). When the plates can no longer resist the stress, there is an earthquake—a massive release of energy that shakes the crust. The **focus** is the location inside Earth where an earthquake starts. The **epicentre** is the point on Earth's surface directly above the focus. An earthquake with a shallow focus (0–70 km) typically creates more damage than one with an intermediate focus (70–300 km), or a deep focus (greater than 300 km), as energy release occurs closer to the surface.

continued

· Energy released by an earthquake produces vibrations known
· as **seismic waves**. **Seismology** is the study of earthquakes
· and seismic waves. There are three types of waves: **primary**
· **waves (P-waves)** and **secondary waves (S-waves)**, both of
· which travel underground, and **surface waves (L-waves)**,
· which roll along Earth’s surface.

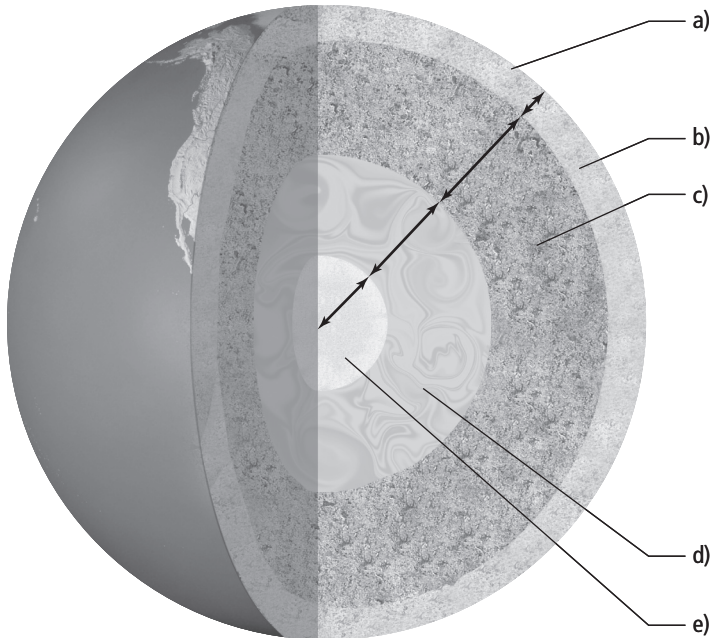
· Scientists use a seismometer to measure seismic waves.
· With each 1-step increase on the magnitude scale, the
· seismic waves are 10 times larger. Earthquakes can be felt if
· they are over magnitude 2.0. Over magnitude 6.0, they can
· damage building. P-waves are the fastest and stretch in the
· direction of the wave, like a spring. They can travel through
· solids, liquids, and gases. S-waves are slower, and move
· perpendicularly to the direction of the wave. They travel
· through solids but not liquids. L-waves are the slowest and
· cause a rolling motion like ripples on the ground.

Use with textbook pages 520--522.

Layers of the Earth

Earth is made up of layers with distinct characteristics.

1. Label the layers of the Earth on the following diagram.



Layers of the Earth

2. Each layer of the earth has a varying thickness, state (solid, liquid, gas) and composition. Fill in the following table beginning with the innermost layer in the order that you would find the layers from the inside to the outside of earth.

Layer	Thickness	State	General composition
(a)			
(b)			
(c)			
(d)			
(e)			

3. What is the difference between the lithosphere and the asthenosphere?

Use with textbook pages 522-- 528

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1. What do geologists believe heats the upper mantle portion of the asthenosphere?

2. What is one of the driving forces behind plate movement?

3. What is the difference between a rift valley and a spreading ridge?

4. What occurs when dense oceanic plates collide with a continental plate?

5. What events commonly occur at subduction zones?

6. When geologists record plate boundaries on a map, symbols are used to represent the three main types of plate interactions. Draw and label the three main symbols representing plate interactions.

(a) _____

(b) _____

(c) _____

7. Describe the type of plate interactions that have occurred at the following geographic locations.

Geographic location	Plate interaction
1. East African Rift	
2. Juan de Fuca plate	
3. Islands of Japan	
4. Himalayan mountains	
5. San Andreas Fault	

8. When continental plates collide, does subduction occur? Explain your answer.

Use with textbook pages 528–536.

Seismic waves, earthquakes, and volcanoes

Seismic waves can be either body waves that travel underground or surface waves that travel along the surface of the Earth.

1. Fill in the table below, summarizing the different types of seismic waves.

Seismic wave	Abbreviation	General diagram of wave	Description of action	Type of material it travels through	Speed it travels at
primary wave					
secondary wave					
surface wave					

Measurement of Earthquakes

2. What is a seismometer?

3. How does the term magnitude relate to how earthquake activity is recorded?

4. What scale is often used to measure the magnitude of an earthquake?

5. What is the difference between the focus of an earthquake and the epicentre?

6. Explain the classification scale used to describe the depth of origin of earthquakes.

7. For the three geographic locations listed below, classify the type of volcano found there and describe what type of events led to its formation.

Geographic location	Type of volcano	Description of events
Mount Garibaldi volcano		_____ _____ _____
Anahim Volcanic Belt		_____ _____ _____
Kraflia volcano		_____ _____ _____

Use with textbook pages 518–534.

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Matching

Match each Term on the left with the best Descriptor on the right. Each Descriptor may be used only once.	
Term	Definition
1. _____ asthenosphere	A. the point on Earth's surface directly above the focus where an earthquake starts
2. _____ epicentre	B. a recurring current in the mantle that occurs when hotter, less dense material rises, cools, and then sinks again
3. _____ lithosphere	C. the process in which new material at a ridge or rift pushes older material aside, moving the tectonic plates away from the ridge
4. _____ mantle convection	D. a steep-sided valley formed on land when magma rises to Earth's surface at a spreading centre on land
5. _____ plate boundary	E. a partly molten layer in Earth's upper mantle just below the lithosphere
6. _____ ridge push	F. areas of subduction, which typically experience large earthquakes and volcanic eruptions
7. _____ rift valley	G. a long chain of volcanoes
8. _____ slab pull	H. the region where two tectonic plates are in contact
9. _____ subduction zone	
10. _____ volcanic belt	

- I.** the pulling of a tectonic plate as its edge subducts deep into the mantle
- J.** the layer made up of the crust and upper most mantle

Multiple Choice

Circle the letter of the best answer.

11. Which layer of the Earth has the highest temperature?
- A.** inner core **C.** lower mantle
B. outer core **D.** upper mantle
12. What causes the asthenosphere to be molten?
- A.** gravity **C.** hot spot
B. volcanoes **D.** radioactive decay
13. Where do transform plate boundaries usually occur?
- A.** near mountains
B. near continents
C. near ocean ridges
D. near subduction zones
14. Which layers of the earth can S-waves travel through?
- A.** mantle only
B. mantle and outer core
C. mantle and inner core
D. mantle, outer core, and inner core
15. Where are composite volcanoes usually found?
- A.** near subduction zones
B. in ocean basins
C. on mountain ranges
D. by ridge pushes