

BIG Idea Volcanoes develop from magma moving upward from deep within Earth.

Vocabulary

Key Concepts

Section 18.1 Volcanoes

- caldera (p. 505) ^A
- cinder cone (p. 507) ^B
- composite volcano (p. 507) ^C
- conduit (p. 505) ^D
- crater (p. 505) ^E
- fissure (p. 504) ^A
- flood basalt (p. 504) ^D
- hot spot (p. 502) ⁻
- shield volcano (p. 507) ^D
- vent (p. 505) ^E
- volcanism (p. 500) ^A

MAIN Idea The locations of volcanoes are mostly determined by plate tectonics.

- Volcanism includes all the processes in which magma and gases rise to Earth's surface.
- Most volcanoes on land are part of two major volcanic chains: the Circum-Pacific Belt and the Mediterranean Belt.
- Parts of a volcano include a vent, magma chamber, crater, and caldera.
- Flood basalts form when lava flows from fissures to form flat plains or plateaus.
- There are three major types of volcanoes: shield, composite, and cinder cone.

Section 18.2 Eruptions

- pyroclastic flow (p. 513) ^B
- tephra (p. 512) ⁻
- viscosity (p. 509) ^P

MAIN Idea The composition of magma determines the characteristics of a volcanic eruption.

- There are three major types of magma: basaltic, andesitic, and rhyolitic.
- Because of their relative silica contents, basaltic magma is the least explosive magma and rhyolitic magma is the most explosive.
- Temperature, pressure, and the presence of water are factors that affect the formation of magma.
- Rock fragments ejected during eruptions are called tephra.

Section 18.3 Intrusive Activity

- batholith (p. 515) ^E
- dike (p. 516) ^A
- laccolith (p. 515) ^B
- pluton (p. 514) ^C
- sill (p. 515) ^D
- stock (p. 515) ^E

MAIN Idea Magma that solidifies below ground forms geologic features different from those formed by magma that cools at the surface.

- Intrusive igneous rocks are classified according to their size, shape, and relationship to the surrounding rocks.
- Most of Earth's volcanism happens below Earth's surface.
- Magma can intrude into rock in different ways, taking different forms when it cools.
- Batholiths form the core of many mountain ranges.

Vocabulary Review

Make each of the following sentences true by replacing the italicized words with terms from the Study Guide.

- In the most explosive types of eruptions, lava accumulates to form a *shield volcano*.
- Lava travels through a conduit to erupt through a *fissure* at the top of a volcano.
- Hot spots* refer to all processes associated with the discharge of magma, hot water, and steam.
- Ash is the smallest type of *lava flow*.

Complete the sentences below using vocabulary terms from the Study Guide.

- A(n) _____ is a bowl-shaped depression that surrounds the vent at a volcano's summit.
- A(n) _____ forms in the depression left when an empty magma chamber collapses.
- The type of volcano that is the smallest and has the steepest slopes is called a(n) _____.

Match each description below with the correct vocabulary term from the Study Guide.

- any rock body that has formed at great depths underground
- plutons having an area of more than 100 km²; often forms the core of mountains
- flowing cloud of tephra and lava mixed with hot, suffocating gases
- formed when magma intrudes vertically across existing rock

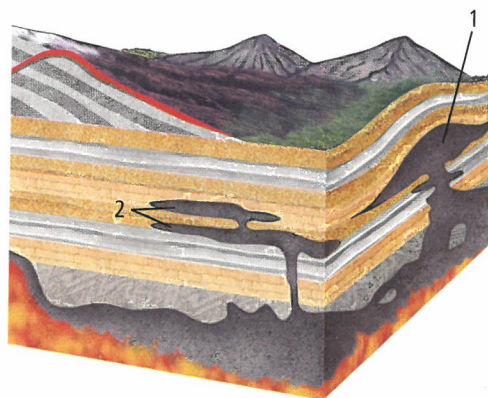
Use what you know about the vocabulary terms to describe what the terms in each pair have in common.

- laccolith, sill
- shield volcano, flood basalt
- fissure, conduit
- sill, dike

Understand Key Concepts

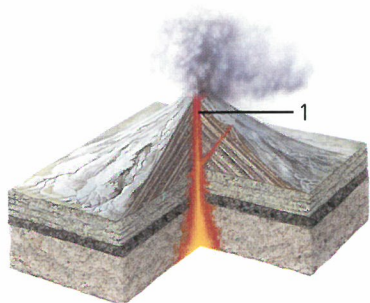
- Which area is surrounded by the Ring of Fire?
 - the Atlantic Ocean
 - the United States
 - the Mediterranean Sea
 - the Pacific Ocean

Use the diagram below to answer Questions 17 and 18.



- In the diagram, what is the structure labeled 1?
 - batholith
 - laccolith
 - dike
 - sill
- In the diagram, what is the structure labeled 2?
 - batholith
 - laccolith
 - dike
 - sill
- Which is not true?
 - An increase in silica increases the viscosity of a magma.
 - Andesitic magma has both an intermediate gas content and explosiveness.
 - An increase in temperature increases a magma's viscosity.
 - Basaltic magma has a low viscosity and retains little gas.

Use the figure below to answer Questions 20 and 21.



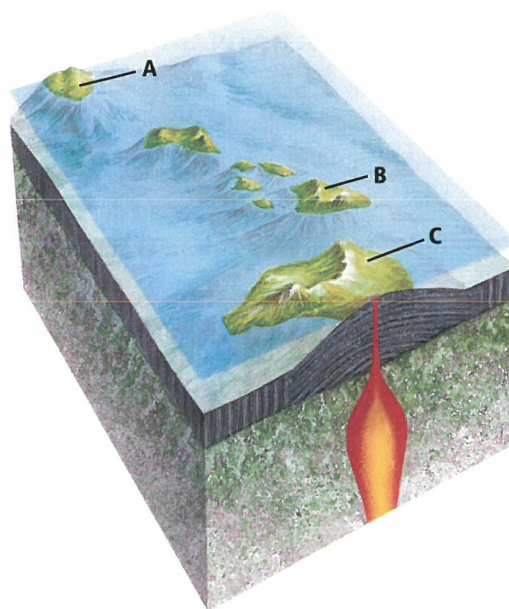
20. Which type of volcano is shown?
 - A. shield volcano
 - B. composite volcano
 - C. flood basalt volcano
 - D. cinder cone
21. What is the feature labeled 1?
 - A. crater
 - B. cinder cone
 - C. vent
 - D. magma chamber
22. What causes the magma to rise upward in a mantle plume?
 - A. The magma is less dense than the surrounding material.
 - B. The magma is denser than the surrounding material.
 - C. The magma is pulled upward by the air pressure.
 - D. The magma is pushed upward by the surrounding rock.
23. Which type of volcanism produces the most lava annually?
 - A. convergent
 - B. divergent
 - C. hot spot
 - D. cinder cones

Constructed Response

24. **Differentiate** among batholiths, stocks, and laccoliths according to their relative sizes and shapes.
25. **Infer** A particular outcrop has a narrow ribbon of basalt that runs almost perpendicular to several layers of sandstone. What is this feature called?

26. **Describe** hot spots.
27. **Identify** one specific example of the three types of volcanoes.
28. **Compare and contrast** Kilauea and the Columbia River flood basalt in terms of the processes related to their development.
29. **Analyze** why volcanic blocks are uncommon on shield volcanoes.

Use the diagram below to answer Question 30.



30. **Distinguish** which island is the oldest and in which direction the plate is moving. Explain your reasoning.
31. **Decide** Is the Pacific Ring of Fire an accurate name? Explain.
32. **Explain** the relationship between the viscosity of a magma and its temperature.
33. **Explain** how volcanic activity can affect global weather.
34. **Draw** a diagram of the three volcano types, showing their relative sizes.
35. **Analyze** why smaller plutons are more likely to be fine-grained, and larger plutons more likely to be coarse-grained.

Think Critically

Use the table below to answer Questions 36 and 37.

Magma Composition and Characteristics			
	Basaltic Magma	Andesitic Magma	Rhyolitic Magma
Source material	upper mantle	oceanic crusts and sediments	continental crust
Viscosity	low	intermediate	high
Gas content	1–2%	3–4%	4–6%
Silica content	about 50%	about 60%	about 70%
Location of magma	both oceanic and continental crust	continental margins associated with subduction zones	continental crust

- Analyze** and rank the types of magma in terms of explosiveness based on the data. Explain your reasoning.
- Categorize** each of the three types of volcanoes in terms of the characteristics of magma shown in the table.
- Predict** what would happen if there were no plate tectonics.

Concept Mapping

- Create a concept map using the following terms: *pluton, vertical, batholith, cuts across, stock, parallel, laccolith, sill, and dike*. For more help refer to the *Skillbuilder Handbook*.

Challenge Question

- Formulate** a way to recognize the difference between an ancient lava flow and an intrusive igneous rock.

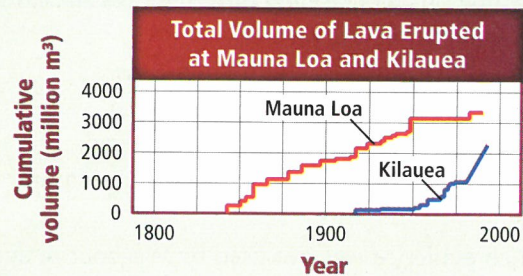
Additional Assessment

- WRITING in Earth Science** Imagine you are in charge of a volcano observatory. One day, GPS measurements indicate that a volcano is expanding, there have been several earthquakes, and the flux of volcanic gases has increased. Should you issue a warning of an impending eruption? Write a press release to warn people about the situation.

DBQ Document-Based Questions

Data obtained from: Takada, A. 1999. Variations in magma supply and magma partitioning: the role of tectonic settings. *Journal of Volcanic Geothermal Research* 83:93–110.

Studying the history of past eruptions yields important data for making estimations about predicting eruptions. The graph below shows the total volume of lava erupted at two Hawaiian islands over 200 years.



- In what years did the two largest eruptions occur at Mauna Loa?
- What is the average volume of lava at Mauna Loa between 1840 and 1990?
- Can you predict when the next eruption will occur? Explain your answer.
- Eruptions at Mauna Loa are large and last a short length of time. What feature of the graph shows this? Compare and contrast the last eruption at Kilauea with eruptions at Mauna Loa.

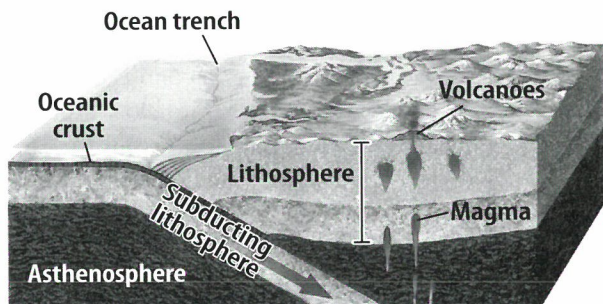
Cumulative Review

- List six of the most important mineral properties used in mineral identification. (Chapter 4)
- What observations support the theory of plate tectonics? (Chapter 17)

Standardized Test Practice

Multiple Choice

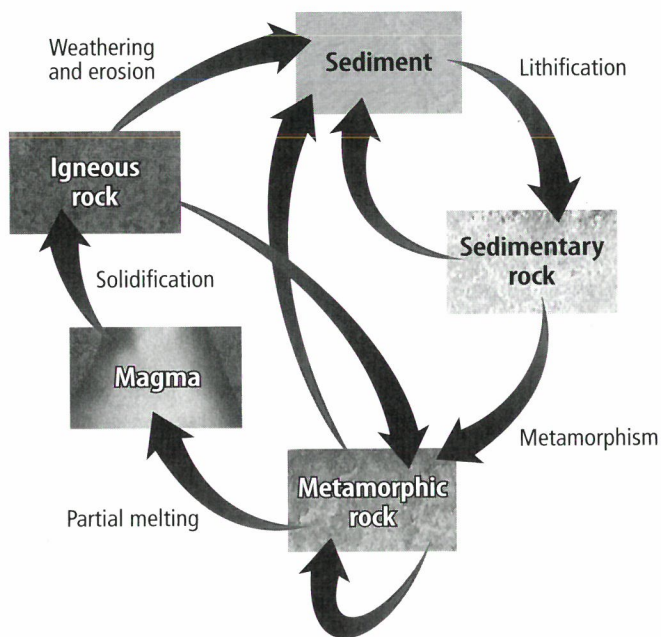
Use the figure below to answer Questions 1 and 2.



- What process is occurring in the figure above?
 - continental-continental divergence
 - oceanic-continental divergence
 - continental-continental subduction
 - oceanic-continental subduction
- How does an increase in confining pressure affect a rock's melting temperature?
 - The melting temperature increases.
 - The melting temperature decreases.
 - The melting temperature is stabilized.
 - It has no effect on the melting temperature.
- Which evidence was not used by Wegener to support his hypothesis of continental drift?
 - coal beds in America
 - fossils of land-dwelling animals
 - glacial deposits
 - paleomagnetic data
- What is the name for the constant production of new ocean floor?
 - continental drift
 - hot spot
 - seafloor spreading
 - subduction
- The weight of a subducting plate helps pull the trailing lithosphere into a subduction zone in which process?
 - ridge pull
 - ridge push
 - slab pull
 - slab push

- What type of model uses molded clay, soil, and chemicals to simulate a volcanic eruption?
 - conceptual model
 - physical model
 - mathematical model
 - computer model
- Which of these processes of the water cycle is a direct effect of the Sun's energy?
 - formation of precipitation
 - runoff of water over soil
 - evaporation
 - seeping of water into soil

Use the figure below to answer Questions 8 and 9.



- Which process brings rocks to Earth's surface where they can be eroded?
 - lithification
 - weathering
 - solidification
 - metamorphism
- What rock type is produced when magma solidifies?
 - metamorphic rock
 - sedimentary rock
 - igneous rock
 - lava

Short Answer

Use the table below to answer Questions 10–12.

Notable Volcanic Eruptions			
Volcano	Date	Volume Ejected	Height of Plume
Toba	74,000 years ago	2,800 km ³	50–80 km
Vesuvius	A.D. 79	4 km ³	32 km
Tambora	1815	150 km ³	44 km
Krakatau	1883	21 km ³	36 km
Mount St. Helens	1980	1 km ³	19 km
Mount Pinatubo	1991	5 km ³	35 km

- Order the volcanic eruptions according to the quantities of pyroclastic material produced.
- Hypothesize why the eruption of Vesuvius in A.D. 79 was more deadly than the eruption of Mount Pinatubo in 1991, even though the eruptions were approximately the same size.
- Calculate the difference in plume height of volcanic debris during the eruption of Tambora in 1815 compared to the plume from the 1980 eruption of Mount St. Helens.
- Distinguish between the everyday use of the term *theory* and its true scientific meaning.
- When a tropical rain forest is cleared, why does the soil usually become useless for growing crops after only a few years?
- What role do glaciers play in Earth's rock cycle?
- Write a list of numbered statements that summarizes the major steps in the water cycle.

Reading for Comprehension

Eruption of Mount Pinatubo

On June 15, 1991, Mount Pinatubo roared awake after a six-century sleep. The 1760-m volcano belched clouds of gas and ash known as pyroclastic material. Their temperature: 816°C. Streams of ash and sulfur dioxide rocketed 40 km into the stratosphere. Another blast at dawn blew away the side of the mountain. So much ash and pumice choked the air that the sky grew black by afternoon, and chunks of volcanic rock fell with a force similar to hail. That evening, earthquakes struck the already-damaged city. Pinatubo's eruption had created an underground cavern that caved in on itself.

- What can be inferred from this text?
 - Volcanoes are unpredictable and can erupt at any time.
 - Volcanoes always erupt explosively.
 - Volcanoes can change the surface of Earth in many ways.
 - Volcanoes are always accompanied by earthquakes.
- According to this text, which statement is false?
 - Volcanoes can release gases into the stratosphere.
 - The eruption of Mount Pinatubo was caused by the collapse of an underground cavern.
 - The gas and ash released during the 1991 eruption was as hot as 816°C.
 - Volcanic eruptions can change the shape of the mountain.
- In the days leading up to the June 15th eruption, towns in areas surrounding Mount Pinatubo were evacuated. Based on the text above, explain why it would be necessary to evacuate these areas.

NEED EXTRA HELP?

If You Missed Question . . .	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
Review Section . . .	17.3	5.1	17.1	17.2	17.4	1.3	9.1	6.1	5.1	18.1	18.3	18.3	1.3	8.3	3.3	9.1