Chapter Project

Worksheet 1

1. Ethiopia, Tanzania, Zaire.
2. Guadeloupe, Iceland, Indonesia, Japan, Martinique, Montserrat, New Zealand, Papua New Guinea, Philippines, St. Vincent, USA (Hawaii).
3. USA (Alaska, California, Oregon, Washington), Chile, Colombia, Costa Rica, Ecuador, El Salvador, Guatemala, Indonesia, Japan, Kamchatka (Russia), Mexico, New Zealand, Nicaragua, Papua New Guinea, Peru, Philippines.

Worksheet 2

1. paragraphs 4 and 5.
2. Students' notes will vary. Example: Solfatara (Naples, Italy). Steam and sulfur gas believed to have special healing powers. Since the Romans, people take steam baths for arthritis, breathing problems, benefits of "sweat baths," soak in mud pools to soften skin.
3. Myths and legends; geothermal energy; uses of volcanic materials in manufacturing

Volcanoes and Plate Tectonics Guided Reading and Study

Use Target Reading Skills This is one possible way to complete the graphic organizer. Accept all logical answers.

Volcanoes and Plate Tectonics

Question	Answer
Where are volcanoes found?	Volcanoes form along the boundaries of Earth's plates.
What is a hot spot?	An area where material from deep within the mantle rises and then melts, forming magma

1. a weak spot in the crust where molten material, or magma, comes to the surface
2. magma.
3. lava.
4. a major volcanic belt formed by the many volcanoes that rim the Pacific Ocean
5. along diverging plate boundaries such as mid-ocean ridges and along converging plate boundaries where subduction takes place
6. Along the rift valley, lava pours out of cracks in the ocean floor, gradually building new mountains.
7. true
8. true
9. When the older, denser plate sinks beneath a deep-ocean trench into the mantle, some of the rock above the subducting plate melts and forms magma. Because the magma is less dense than the surrounding rock, it rises toward the surface. Eventually, the magma breaks through the ocean floor, creating volcanoes. Volcanoes can also form where oceanic crust is subducted beneath continental crust.
10. island arc.
11. Any three: Japan, New Zealand, Indonesia, the Philippines, the Aleutians, the Caribbean islands
12. b
13. an area where material from within the mantle rises and the melts, forming magma
14. They formed over millions of years as the Pacific plate drifted over a hot spot.
15. false

Volcanoes and Plate Tectonics Review and Reinforce

1. When lava that has erupted from a volcano cools, it forms solid rock. In this way, volcanoes add new rock to existing land and form new islands.
2. At the boundaries where plates diverge (pull apart) or converge (push together), the crust is weak and fractured, allowing magma to reach Earth's surface.
3. Lava erupted from the hot spot and built a volcanic island. The Pacific plate is slowly moving over the hot spot, so it carried the island away from the spot. (To indicate this, students should draw an arrow from right to left on the diagram.) Another volcanic island formed at the hot spot and then was carried away. Over time, a chain of islands formed.
4. Magma is molten, rock-forming material underground. Magma that reaches the surface is called lava.
5a. a weak spot in Earth's crust where magma comes to the surface **b.** a belt of many volcanoes that rim the Pacific Ocean **c.** a chain of volcanic islands that forms at the boundary where two oceanic plates push together and one plate subducts under the other plate

Volcanoes and Plate Tectonics Enrich

1. Arenal, El Chichón, El Misti, Katmai, Mount Rainier, Pinatubo, Rabaul, Ruapehu, Tambora, Unzen, Villarrica
2. Erta Alè, Hekla
3. Falcon, Mauna Loa
4. Ol Doinyo Lengai

Skills Lab

Mapping Earthquakes and Volcanoes

For answers, see the Teacher's Edition.

Properties of Magma Guided Reading and Study

Use Target Reading Skills This is one possible way to complete the graphic organizer. Accept all logical answers. **Details:** Magma is made of elements and compounds, among them silica. Viscosity is a property of magma. Viscosity depends on silica content and temperature.
1. element.
2. true
3. b, c
4. slower; lower
5. a, d
6. temperature and silica content.
7. b, d
8. rhyolite.
9. basalt.
10. It decreases.
11. pahoehoe.
12. aa.
13a. low **b.** lower **c.** higher **d.** lower **e.** Possible answer: The lower the temperature and the higher the silica content of magma is, the higher the viscosity of the magma. The higher the temperature and the lower the silica content of magma is, the lower the viscosity of the magma.

Properties of Magma Review and Reinforce

1. Physical
2. Physical
3. Chemical
4. Chemical
5. Physical
6. Physical
7. Each substance has a particular set of physical and chemical properties. These properties can be used to identify a substance or to predict how it will behave.
8. There is a greater degree of friction among the liquid's particles.
9. Light-colored magma is high in silica. It has a higher viscosity and does not flow very far. Dark-colored magma is lower in silica. It has a lower viscosity and flows readily.
10. Viscosity increases as temperature decreases.
11. compound.
12. element
13. pahoehoe.
14. aa.

Properties of Magma Enrich

1. Water lowers the viscosity of magma.
2. The crystals is pegmatites form from atoms that are able to move long distances because the magma is watery.
3. Petaca, New Mexico
4. Kings Mountain, North Carolina
5. Pegmatites are important because they provide a source for rare elements and gems.

Volcanic Eruptions
Guided Reading and Study

Use Target Reading Skills This is one possible way to complete the graphic organizer. Accept all logical answers.

What You Know
1. Lava flows out of a volcano.
2. Eruptions are not all the same.
3. Some volcanoes are dormant.

What You Learned
1. Magma rises toward Earth's surface through a pipe that leads to a vent.
2. Differences in gas and silica content cause some eruptions to be explosive and others to be quiet.
3. Dormant volcanoes can become active at any time.

1. true
2. true
3. a, b
4a. pipe **b.** crater **c.** vent **d.** magma chamber.
5. the area covered by lava as it pours out of a vent
6. at the top of the volcano around the central vent
7. false
8a. crater **b.** vent **c.** pipe **d.** magma **e.** side vent **f.** to the vent or a side vent
9. a
10. The force of the expanding gases pushes magma from the magma chamber through the pipe until it flows or explodes out of the vent.
11. the magma's silica content and viscosity
12. false
13. c
14. a
15. b
16. an explosive eruption that hurls out a mixture of hot gases, ash, cinders, and bombs
17. false
18. Volcanic ash can bury entire towns. If it becomes wet, the heavy ask can cause roofs to collapse. If a jet plane sucks ash into its engine, the engine may stall. Eruptions can cause landslides and avalanches of mud, melted, snow, and rock.
19. true
20. false
21a. extinct **b.** active **c.** dormant **d.** extinct, dormant, active
22. false
23. The time between volcanic eruptions may span hundreds to many thousands of years.
24. a, d

Volcanic Eruptions
Review and Reinforce

1. The liquid magma is less dense than the solid material around it, so it rises.
2. The gases begin to expand, forming bubbles, because the pressure decreases as the magma rises.
3. A volcano erupts quietly if its magma is low in silica. Low-silica magma has low viscosity and flows easily. A volcano erupts explosively if its magma is high in silica. High-silica magma has high viscosity, making it thick and sticky.
4. Thick, sticky lava builds up in the volcano's pipe and plugs it. The trapped gases build up pressure until they explode. The erupting gases force the magma out with great force, which breaks the lava into fragments that quickly cool and harden into pieces of different sizes.
5. *(Any three)* Lava flows set fire to and then bury objects in their path. Hot clouds of volcanic gases destroy objects and kill people, animals, and plants. Volcanic ash buries towns, damages crops, and clogs car and airplane engines. Eruptions can cause landslides and avalanches.
6. An active volcano is one that is erupting or may erupt in the near future. A dormant volcano is "sleeping," that is, it is likely to awaken in the future and become active. An extinct, or dead, volcano is unlikely to erupt again.
7. pipe.
8. vent.
9. crater.
10. lava flow.
11. magma chamber.

Volcanic Eruptions
Enrich

1. Red foam gushed out of the top of the "volcano" and flowed down its sides.
2. The model volcano erupted because of the pressure of gases inside it.
3. Accept all reasonable responses. *Examples:* The foam is not hot and fiery and is not made of the same materials as lava. The foam erupted because a chemical reaction occurred to create pressure; in a real volcano, lava erupts because an opening develops in weak rock so the gases can rush out.

Volcanic Landforms
Guided Reading and Study

Use Target Reading Skills

Volcanic Landforms

I. Landforms From Lava and Ash
  A. Shield Volcanoes
  B. *Cinder Cone Volcanoes*
  C. *Composite Volcanoes*
  D. Lava Plateaus
  E. *Calderas*
  F. *Soils From Lava and Ash*
II. Landforms From Magma
  A. *Volcanic Necks*
  B. *Dikes and Sills*
  C. *Batholiths*
  D. Dome Mountains
III. *Geothermal Activity*
  A. Hot Springs
  B. *Geysers*
  C. Geothermal Energy

1a. shield volcanoes **b.** cinder cone volcanoes **c.** composite volcanoes **d.** lava plateaus.
2. a, b.
3. false
4. Mount Fuji in Japan and Mount St. Helens in Washington State
5. true
6. e.
7. c.
8. b.
9. a.
10. d.
11. potassium, phosphorus
12a. volcanic necks **b.** dikes **c.** sills **d.** batholiths **e.** dome mountains
13. Left circle: forms across rock layers; Middle area: forms from magma; Right circle: forms between rock layers
14. batholith.
15. the Sierra Nevada mountains in California
16. true
17. true
18. hot springs.
19. geyser.
20. Steam from underground is piped into turbines. Inside a turbine, the steam spins a wheel. The moving wheel in the turbine turns a generator that changes the energy of motion into electrical energy.

Volcanic Landforms
Review and Reinforce

1. A: Cinder cone volcano; lava explodes out of the volcano and hardens to form ash, cinders, and bombs that pile up in layers around the vent, forming a steep, cone-shaped mountain. **B:** Shield volcano; thin layers of lava pour out of a vent and harden on top of previous layers, gradually building a wide, gently sloping mountain. **C:** Composite volcano; lava flows alternate with explosive eruptions of ash, cinders, and bombs, forming a tall, cone-shaped mountain.
2. Thin, runny lava flows out of several long, cracks and travels far before cooling and hardening. Floods of such lava build up on top of other floods. Over millions of years, these layers of lava form a plateau.
3. A volcano's eruption empties its main vent and magma chamber. Without support from below, the top of the mountain collapses inward, leaving a huge hole.
4. When volcanic ash or rock breaks down, it releases potassium, phosphorus, and other plant nutrients.
5. Water heated by magma can be piped into homes to heat them. Steam can be used to drive turbines that generate electricity.
6. A mass of rock formed when a large body of magma cools inside the crust
7. Hardened magma in a crack that crosses rock layers
8. A landform produced when magma hardens in a volcano's pipe and is then exposed when the softer rock around it wears away
9. Hardened magma in a crack between rock layers
10. A fountain of water and steam that erupts from the ground.

Volcanic Landforms
Enrich

1. Lava
2. Layers of lava that flowed from the volcano in different eruptions
3. "Lava" flowed from a crack and spread out over a wide surface; layers of hardened "lava" from different eruptions built up.

Skills Lab

Gelatin Volcanoes

For answers, see Teacher's Edition.

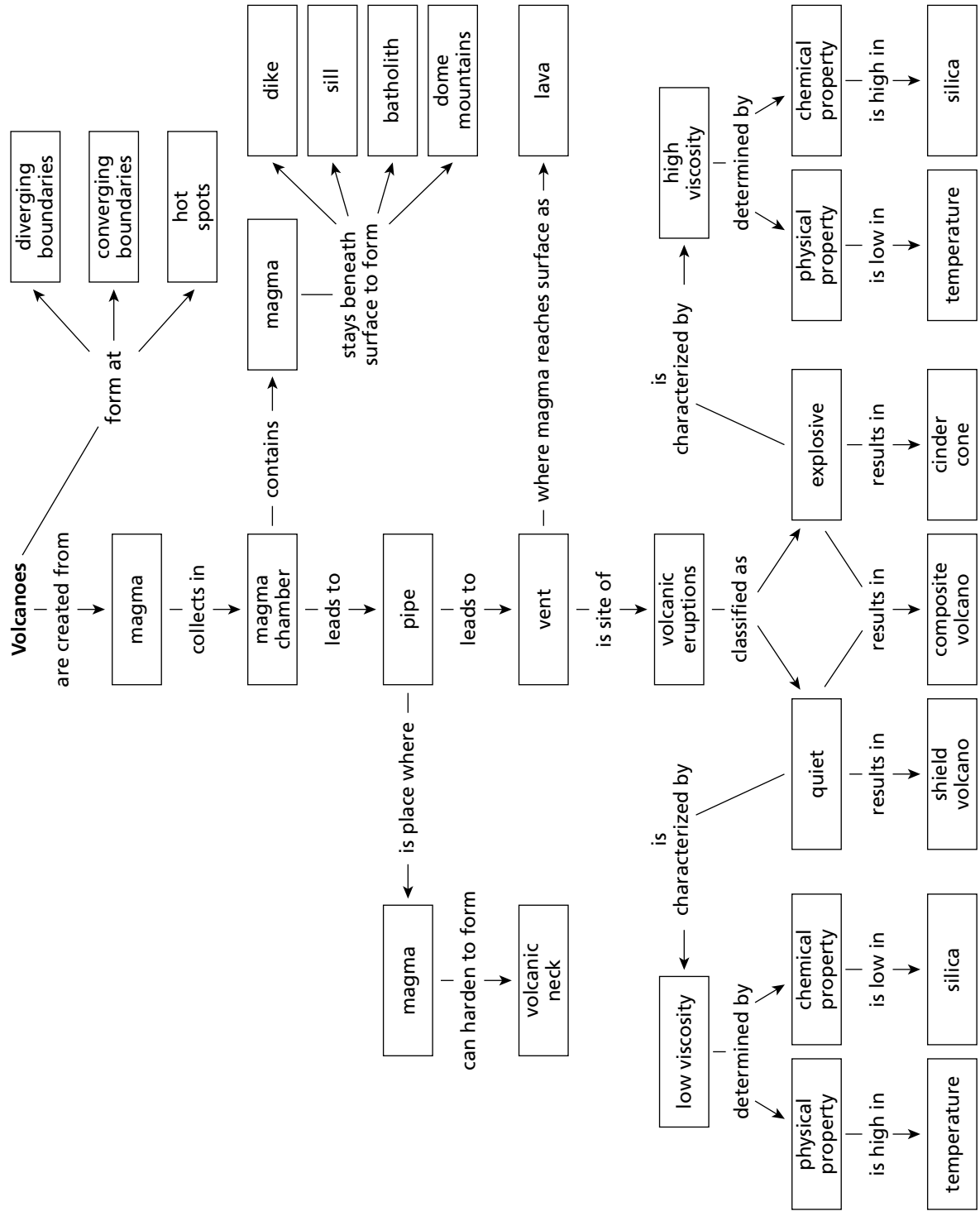
Use Key Terms

1. magma.
2. crater.
3. silica.
4. pahoehoe.
5. aa.
6. geyser.
7. volcano.
8. lava.
9. active.
10. caldera.
11. extinct.
12. batholith.
13. dike.
14. sill. Hidden message: Mars has volcanoes.

Connecting Concepts

Forces inside Earth cause magma to heat, move, and push through the crust to erupt as volcanoes that pose hazards and form land features.

This concept map is only one way to represent the main ideas and relationships in this chapter. Accept other logical answers from students.



Laboratory Investigation

Predicting Lava Flow

Pre-Lab Discussion

1. Temperature and gas content

2. Ease of flow depends on temperature. Cooler lava is thicker than hotter lava. To make an appropriate comparison, you can vary only one factor at a time.

Procedure

Part A 3. Students may predict that the "low-silica lava" will flow faster because it is thinner.
Part B 2. Answers may vary. Sample: The hot molasses will flow faster because it will be thinner than the cool molasses.

Observation

Data Table Students should observe that "low-silica lava" is thinner and flows faster than does "high-silica lava." They should also observe that the hotter "lava" flows faster than does cooler "lava."
1. high-silica lava, room temperature
2. They are similar in that they are both low-silica lava. They differ in temperature: pahoehoe is hotter than aa and flows more easily. The hot molasses represented pahoehoe; the room-temperature molasses represented aa.
3. Students' sketches should show a volcano with gentle slopes—a shield volcano—on the left and a volcano with steep slopes—a cinder cone volcano—on the right.
4. The eruptions would be relatively quiet, with spurting and flowing lava but not explosions.
5. The eruptions would be more explosive than with low-silica lava.

Critical Thinking and Applications

1. The shape of the volcano indicates the amount of silica in the magma that erupted to the surface.
2. Because the magma beneath composite volcanoes is high in silica, these volcanoes alternate between explosive eruptions and eruptions of thick lava.

More to Explore

Analyze and Conclude Observations should show that the more baking soda used, the more gas formed, and the more explosive the eruption. Observations should indicate that the more explosive the eruption, the steeper the slope that formed.

Performance Assessment

1. Magma's thickness is affected by the amount of gas dissolved in it, its temperature, and its silica content. Silica content was modeled.
2. Students' drawings should explain each part of the model as follows: soap/detergent represents lava; flour, silica; cookie sheet/tray, slope of the surface over which the lava flows.
3. The variable that was changed should be the amount of flour (representing silica) in the lava, with little or no "silica" in one sample and increasing amounts in the other samples. Exact amounts may vary.
4. The more silica lava contains, the thicker it is, and the thicker lava is, the slower its flow speed.

Chapter Test

1. magma.
2. Ring of Fire
3. silica
4. pyroclastic flow
5. shield volcano
6. volcanic neck
7. element.
8. chemical property.
9. volcano
10. true
11. quiet
12. geyser
13. caldera
14. true
15. b
16. d
17. c
18. d
19. a
20. c

21. In order for ash, cinders, and bombs to form, lava must be ejected forcefully from a volcano, so it is broken into fragments that cool and harden quickly to form pieces of different sizes.
22. Geothermal energy is energy derived from water that has been heated by magma underground. Hot water is piped to buildings as a heat source and steam is piped into turbines to generate electricity.
23. composite volcano
24. A composite volcano is a tall, cone-shaped mountain in which layers of lava alternate with layers of ash, while the volcanoes that formed the Hawaiian islands are shield volcanoes. These are wide, gently sloping mountains formed by thin layers of lava.
25. Ash, cinders, and bombs, because the last layer is lava, and in a composite volcano, the two types of materials form alternating layers.
26. Tambora.
27. Mt. Pelée.
28. a. 4 **b.** 29.5 **c.** 12. **d.** 18
29. The force of a volcanic eruption depends on its viscosity. The viscosity is determined by its temperature and its silica content. The hotter the magma is, the thinner it is and the quieter its eruption. The more silica the magma contains, the thicker it is and the more explosive its eruption.
30. Accept all reasonable explanations. Example: Earthquakes are produced by movement of Earth's crust along faults. During the most recent earthquake in Yellowstone, underground movements may have changed the channels (cracks in the rock) through which heated water reached geysers on the surface. Some channels may have been blocked, cutting off geysers. Some new channels may have opened, creating new geysers. Other channels may have widened or narrowed, changing their geysers' eruption intervals.