Chapter 7
Volcanoes

Includes:

**LEVELED ASSESSMENT**
Chapter Review
Chapter Tests
  - Test A (Below Level) **BL**
  - Test B (On Level) **OL**
  - Test C (Advanced Learner) **AL**

**LABS**
For leveled labs, use the CD-ROM.
Lab worksheets from Student Edition Labs
  - MiniLab
  - Lab: Version A (Below Level) **BL**
  - Lab: Version B (On Level) **OL**
  - (Advanced Learner) **AL**

**UNIVERSAL ACCESS/LEVELED RESOURCES**
Target Your Reading
Chapter Content Mastery English
  - (Below Level) **BL**
Chapter Content Mastery Spanish
  - (Below Level) **BL**
Reinforcement (On Level) **OL**
Enrichment (Advanced Learner) **AL**

**READING SUPPORT**
Content Vocabulary
Chapter Outline

**TEACHER SUPPORT AND PLANNING**
Chapter Outline for Teaching
Teacher Guide and Answers
Photo Credits

Cover: Alamy Images
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Additional Assessment Resources available with Glencoe Science:
- ExamView® Assessment Suite
- Assessment Transparencies
- Performance Assessment in the Science Classroom
- Standardized Test Practice Booklet
- MindJogger Videoquizzes
- Vocabulary PuzzleMaker at science.glencoe.com
- Interactive Classroom
- The Glencoe Science Web site at science.glencoe.com
- An interactive version of this textbook along with assessment resources are available online at mhn.com.
Student Lab/Activity Safety Form

Student Name: ________________________________
Date: ________________________________
Lab/Activity Title: ________________________________

In order to show your teacher that you understand the safety concerns of this lab/activity, the following questions must be answered after the teacher explains the information to you. You must have your teacher initial this form before you can proceed with the activity/lab.

1. How would you describe what you will be doing during this lab/activity?

2. What are the safety concerns associated with this lab/activity (as explained by your teacher)?
   • ________________________________________________________________________
   • ________________________________________________________________________
   • ________________________________________________________________________
   • ________________________________________________________________________
   • ________________________________________________________________________
   • ________________________________________________________________________

3. What additional safety concerns or questions do you have?

MiniLab

How do volcanoes form?

Buoyant forces push up on magma and cause it to rise to Earth’s surface. This building of pressure causes volcanic eruptions. Volcanic eruptions allow heat to escape from Earth’s interior. Can you model how volcanoes form and erupt?

Procedure

1. Read and complete a lab safety form.
2. Obtain a beaker with hardened wax in the bottom from your teacher.
3. Layer 1 cm of sand on top of the wax.
4. Pour 8 cm of cold water onto the sand.
5. Set up a ring stand with wire gauze to hold your beaker over a Bunsen burner. Light the burner.
6. Observe the wax as it erupts through the sand and water.
7. Extinguish the burner. Allow the wax to cool.
8. Record your observations of the exposed wax formations.
9. Compare your volcano to your classmates’.

Analysis

1. **Sequence** how your volcano developed, erupted, and formed volcanic features. Draw this sequence in the space below.

2. **Infer** how the density of the wax changed as it was heated.

3. **Compare** and **contrast** your model to a real-life volcano.
Volcanic eruptions can change human and wildlife habitats. Scientists make models of volcanoes and their landscapes to test how lava might flow during an eruption.

**Procedure**

1. Read and complete a lab safety form.
2. Make a volcano on an **aluminum pizza pan** with **modeling clay**. Include trees and buildings on the landscape.
3. Draw a topographic map of your landscape to record your results.
4. Design a procedure to test different types of materials to imitate lava, such as **frosting**, **molasses**, **syrup**, **honey**, and **water**. Measure the same amount of each material.
5. Pour the lava from the top of the volcano. Record the path, area, and distance of the lava flow over your topographic map in the table below.
6. Wash and dry the landscape. Repeat with the same amount of each lava sample.

**Data and Observations**

<table>
<thead>
<tr>
<th>Imitation Lava Materials</th>
<th>Path of Flow</th>
<th>Area of Flow</th>
<th>Distance of Flow</th>
</tr>
</thead>
<tbody>
<tr>
<td>Frosting</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Molasses</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Syrup</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Honey</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Water</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Analysis**

1. **Describe** the viscosity of each lava sample.

2. **Sequence** the lava flows from fastest to slowest.

3. **Compare** the rate of lava flow to the viscosity for each sample.

4. **Infer** how each type of lava would affect the environment. Use a separate sheet of paper for your answer.
**Problem** As Earth’s lithospheric plates move in relation to one another, magma rises to the surface, and erupts as lava containing gases, solids, and tephra. How can scientists predict catastrophic volcanic events and their hazards in an attempt to avoid dangers to humans and wildlife habitats?

**Form a Hypothesis** Make a prediction about how the location of volcanoes relates to the movements of lithospheric plates to create volcanic eruptions.

**Materials**
- world tectonic plate map
- 3–in × 5–in cards
- colorful yarn
- pushpins
- computer with internet access

**Collect Data and Make Observations**

**Directions:** Check the boxes below as you complete each step of the procedure.

- □ 1. Use the data table shown on the next page.
- □ 2. Visit ca6.msscience.com to research the three volcanoes your teacher has assigned to you.
- □ 3. For each volcano, record the location, type of volcano, date of most recent eruption, and magnitude in your data table.
- □ 4. For each volcano, copy this information on one 3–in × 5–in card.
- □ 5. Use the latitude and longitude to plot the location of your volcanoes on a world map.
- □ 6. Compare your data to the results of your classmates.
- □ 7. Refer to the location and distribution of active volcanoes on the world map as you respond to the Analyze and Conclude section of this lab.
Lab: Version A  CONTINUED

<table>
<thead>
<tr>
<th>Locations of Active Volcanoes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Name of Volcano</td>
</tr>
<tr>
<td>------------------</td>
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<tr>
<td></td>
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<tr>
<td></td>
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<tr>
<td></td>
</tr>
</tbody>
</table>

Analyze and Conclude

1. **Identify** the location of the three most recent volcanic eruptions. Record this information in your data table.

2. **Infer** the movement of the lithospheric plates at the location of the three most recent volcanic eruptions.

3. **Relate** the locations of volcanoes and earthquakes to plate boundaries and their movement.
Lab: Version A CONTINUED

4. **Predict** the locations, frequency, and magnitude of volcanoes to earthquakes and plate movements.

**Communicate**

**Create a Travel Brochure** Design a travel brochure for a tour group. Include an itinerary with a plan to visit several different types of volcanic landforms. Include information about the date, type, and magnitude of each volcano’s last eruption. Present your colorful brochure to the class.
**Problem**  As Earth’s lithospheric plates move in relation to one another, magma rises to the surface, and erupts as lava containing gases, solids, and tephra. How can scientists predict catastrophic volcanic events and their hazards in an attempt to avoid dangers to humans and wildlife habitats?

**Form a Hypothesis**  Make a prediction about how the location of volcanoes relates to the movements of lithospheric plates to create volcanic eruptions.

**Materials**
- world tectonic plate map
- 3–in × 5–in cards
- colorful yarn
- pushpins
- computer with internet access

**Collect Data and Make Observations**

**Directions:** Check the boxes below as you complete each step of the procedure.

- ☐ 1. Use the data table shown below.
- ☐ 2. Visit ca6.msscience.com to research the three volcanoes your teacher has assigned to you.
- ☐ 3. For each volcano, record the location, type of volcano, date of most recent eruption, and magnitude in your data table.
- ☐ 4. For each volcano, copy this information on one card.
- ☐ 5. Plot the location of your volcanoes on a world map using pushpins, yarn, and your card.
- ☐ 6. Compare your data to the results of your classmates.
- ☐ 7. Refer to the location and distribution of active volcanoes on the world map as you respond to the **Analyze and Conclude** section of this lab.

**Locations of Active Volcanoes**

<table>
<thead>
<tr>
<th>Name of Volcano</th>
<th>Latitude</th>
<th>Longitude</th>
<th>Type of Volcano</th>
<th>Date of Most Recent Eruption</th>
<th>Magnitude of Most Recent Eruption</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
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<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Lab: Version B CONTINUED

Analyze and Conclude
1. **Identify** the location of the three most recent volcanic eruptions. Record this information in your data table.

2. **Infer** the movement of the lithospheric plates at the location of the three most recent volcanic eruptions.

3. **Relate** the locations of volcanoes and earthquakes to plate boundaries and their movement.

4. **Predict** the locations, frequency, and magnitude of volcanoes to earthquakes and plate movements.
Lab: Version B  CONTINUED

Going Further

Challenge
7. Dr. Trahan and his research team would like to research an active volcano and observe an eruption. **Recommend** where the team should conduct research. What signs would help them select a site?

8. Locate Mt. Shasta in California. **Determine** which tectonic plates contributed to the growth of this volcano, and how they did so.

9. **Imagine** you are assigned to a team that is creating a hazard plan for a potential eruption of Mt. Shasta. What are some of the factors your team would need to consider?

Extension
Use modeling clay to create models showing the shape of the four major volcano types found on land surfaces: composite, shield, cinder cone, and lava dome. Conduct research to discover what type of plate boundary each type of volcano is most likely to form along.

Communicate
**Create a Travel Brochure**  Design a travel brochure for a tour group. Include an itinerary with a plan to visit several different types of volcanic landforms. Include information about the date, type, and magnitude of each volcano’s last eruption. Present your colorful brochure to the class.
Use this to focus on the main ideas as you read the chapter.

1. **Before you read** the chapter, respond to the statements below on your worksheet or on a numbered sheet of paper.
   - Write an A if you agree with the statement.
   - Write a D if you disagree with the statement.

2. **After you read** the chapter, look back to this page to see if you’ve changed your mind about any of the statements.
   - If any of your answers changed, explain why.
   - Change any false statements into true statements.
   - Use your revised statements as a study guide.

<table>
<thead>
<tr>
<th>Before You Read A or D</th>
<th>Statement</th>
<th>After You Read A or D</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Most volcanic eruptions occur at plate boundaries.</td>
<td>A</td>
</tr>
<tr>
<td></td>
<td>Magma rises buoyantly and exerts an upward force on Earth’s surface.</td>
<td>A</td>
</tr>
<tr>
<td>3.</td>
<td>Scientists are able to predict when a volcano will erupt.</td>
<td>A</td>
</tr>
<tr>
<td>4.</td>
<td>Volcanic ash is dangerous in the air and on the ground.</td>
<td>A</td>
</tr>
<tr>
<td>5.</td>
<td>Hot spots form where two oceanic plates converge.</td>
<td>A</td>
</tr>
<tr>
<td>6.</td>
<td>Lava flows are the most dangerous type of volcanic hazard.</td>
<td>A</td>
</tr>
<tr>
<td>7.</td>
<td>A lava dome is filled with thick, viscous lava.</td>
<td>A</td>
</tr>
<tr>
<td>8.</td>
<td>Lava that contains high amounts of silica can be extremely explosive.</td>
<td>A</td>
</tr>
<tr>
<td>9.</td>
<td>Shield volcanoes are the smallest type of volcano.</td>
<td>A</td>
</tr>
<tr>
<td>10.</td>
<td>Composite volcanoes are composed of alternating layers of lava and tephra.</td>
<td>A</td>
</tr>
</tbody>
</table>
Chapter Content Mastery

Volcanoes and Plate Boundaries

Directions: Study the following diagram. Then label each part with the letter of the correct description below.

A. When diverging plates separate, fissure eruptions can occur. If the plate boundary is underwater, a mid-ocean ridge will form, creating new ocean crust as rising magma cools.

B. When an oceanic plate converges with a less dense continental plate, the denser oceanic plate sinks, forming a volcanic arc near the leading edge of the continent.

C. When two oceanic plates converge, the denser plate is forced beneath the other plate and an island arc forms above the sinking plate.

Directions: Circle the word or phrase in parentheses that best completes each sentence below.

4. Volcanoes known as (vents/hot spots/fissures) do not form along plate boundaries.

5. In order for a volcano to form, (gas/magma/plates) must rise to Earth’s surface.

6. Volcanoes occur where the flow of (heat/water/minerals) from Earth’s interior is high.
Volcanic Eruptions and Features

Directions: Decide whether each statement below refers to basaltic magma and lava (B) or granitic magma and lava (G). Then write either B or G in each blank provided.

1. contains a low percentage of silica
2. has high viscosity
3. contains a high percentage of silica
4. has low viscosity
5. flows quietly without explosive eruptions
6. traps gases and produces explosive eruptions

Directions: Fill in the correct name of each type of volcano described in the table below.

<table>
<thead>
<tr>
<th>Type of Volcano</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>7.</td>
<td>a volcano composed of alternating layers of lava and tephra; this type of volcano often forms very tall, majestic mountains</td>
</tr>
<tr>
<td>8.</td>
<td>a huge, gently sloping landform composed mainly of basaltic lava; this type of volcano is named for its resemblance to the slightly bent shape of a warrior’s shield</td>
</tr>
<tr>
<td>9.</td>
<td>a volcano composed mainly of tephra and other solid fragments; this type of volcano forms a distinctly shaped, steep-sided landform</td>
</tr>
</tbody>
</table>

Directions: Write the correct volcanic feature next to the description of how it is formed.

batholith  dike  dome  neck  sill

10. Magma cools slowly and solidifies before reaching the surface. ____________________________
11. Magma is forced into a crack that cuts across rock layers. _____________________________
12. Magma is forced into a crack parallel to rock layers. _________________________________
13. Magma hardens inside a vent, and the volcano cone erodes away. _______________________
14. A mass of thick, highly viscous lava piles up instead of flowing freely. ________________
Hazards of Volcanic Eruptions

Directions: Write the letter of the answer that completes each sentence in the space at the left.

1. Volcanic ash is made up of ____________________________.
   A. light, harmless powder
   B. large, soft, feathery particles
   C. large chunks of burning rock
   D. tiny, sharp mineral and glasslike particles

2. The greatest danger of a lahar is its ability to ____________________________.
   A. start forest fires
   B. spread poisonous gases
   C. contaminate water supplies
   D. bury human and wildlife habitats

3. A pyroclastic flow is a ____________________________.
   A. rapidly moving mixture of hot gases and solids
   B. rapidly moving river of basaltic magma and lava
   C. stiff, slow-moving river of granitic magma and lava
   D. rapidly moving mixture of volcanic debris and water

4. A series of small ____________________________ can indicate that a volcano will erupt soon.
   A. landslides
   B. earthquakes
   C. windstorms
   D. thunderstorms

5. Scientists can closely monitor volcanic activity with the use of ____________________________.
   A. sonar
   B. telescopes
   C. barometers
   D. satellite imaging
**Instrucciones:** Estudia el siguiente diagrama. Entonces, etiqueta cada parte con la letra de la descripción correcta.

A. Cuando las placas divergentes se separan, erupciones de fisuras pueden ocurrir. Si la frontera de la placa está bajo el agua, se formará una cresta en medio del océano, creando un nuevo estrato mientras la magna que está subiendo se enfría.

B. Cuando una placa oceánica converge con una placa continental menos densa, la placa oceánica más densa se hunde, formando un arco volcánico cerca de la orilla principal del continente.

C. Cuando dos placas oceánicas convergen, la placa más densa es forzada a la parte de abajo de la otra placa y una isla se forma en cima de la placa que se está hundiendo.

**Instrucciones:** Circula la palabra entre paréntesis que mejor completa cada una de las siguientes oraciones.

4. Los volcanes que se conocen como (rejillas de ventilación/puntos calientes/fisuras) no se forman a lo largo de las fronteras de placas.

5. Para que un volcán se forme, (el gas/el magma/las placas), tiene(n) que subir a la superficie de la Tierra.

6. Los volcanes ocurren donde el flujo (del calor/del agua/de las placas) del interior de la Tierra está alto.
**Instrucciones: Decide si cada una de las siguientes oraciones refiere a magma basáltica y lava (B) o a magma granítica y lava (G). Entonces, escribe una B o una G en el espacio.**

1. contiene pequeñas cantidades de sílice  
   
2. tiene una viscosidad alta  
   
3. contiene grandes cantidades de sílice  
   
4. tiene una viscosidad baja  
   
5. fluye silenciosamente sin erupciones explosivas  
   
6. atrapa gases y produce erupciones explosivas  

**Instrucciones: Escribe el nombre correcto para cada clase de volcán descrito en la siguiente tabla.**

<table>
<thead>
<tr>
<th>Clase de volcán</th>
<th>Descripción</th>
</tr>
</thead>
<tbody>
<tr>
<td>7.</td>
<td>un volcán compuesto de capas alternadas de lava y tefra; esta clase de volcán frecuentemente forma montañas muy altas y majestuosas</td>
</tr>
<tr>
<td>8.</td>
<td>una forma morfológica muy grande e inclinada levemente, compuesta principalmente de lava basáltica; esta clase de volcán se nombra por su semejanza a la forma de un escudo de guerrero que está suavemente curvado</td>
</tr>
<tr>
<td>9.</td>
<td>un volcán compuesto principalmente de tefra y otros fragmentos sólidos; esta clase de volcán hace una forma morfológica distinta y muy empinada</td>
</tr>
</tbody>
</table>

**Instrucciones: Escribe el nombre correcto del rasgo volcánico a un lado de la descripción de cómo se formó.**

<table>
<thead>
<tr>
<th>alféizar</th>
<th>batolito</th>
<th>cuello</th>
<th>cúpula</th>
<th>dique</th>
</tr>
</thead>
<tbody>
<tr>
<td>10.</td>
<td>La magna se enfria lentamente y se solidifica antes de llegar a la superficie.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>11.</td>
<td>La magna es forzada en una grieta que corta a través de capas de roca.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>12.</td>
<td>La magna es forzada en una grieta que está paralela a las capas de roca.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>13.</td>
<td>La magna se endurece dentro de una rejilla de ventilación, y el cono del volcán se erosiona.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>14.</td>
<td>Una masa de lava gruesa y muy viscosa se amontona en lugar de fluir libremente.</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Los peligros de las erupciones volcánicas

Instrucciones: Escribe la letra en el espacio al lado izquierdo de la respuesta que completa cada oración.

1. La ceniza volcánica está hecha de __________________________.
   A. un polvo liviano e inofensivo
   B. partículas grandes, suaves y plumosas
   C. pedazos grandes de rocas que se están quemando
   D. partículas de mineral pequeñas, filosas y semejantes al vidrio

2. El peligro más grande de un lahar es su habilidad de __________________________.
   A. comenzar fuegos en los bosques
   B. extender gases venenosos
   C. contaminar los suministros de agua
   D. enterrar habitantes humanos y habitantes de fauna y flora

3. Un flujo piroclástico es un(a) __________________________.
   A. mezcla de gases y sólidos calientes que están moviéndose muy rápidamente
   B. un río de magma basáltica y lava moviéndose muy rápidamente
   C. un río duro de magma granítica y lava moviéndose lentamente
   D. una mezcla de escombros volcánicos y agua moviéndose muy rápidamente

4. Una serie de __________________________ pequeños que puede indicar que un volcán va a entrar en erupción dentro de poco.
   A. corrimientos de tierras
   B. terremotos
   C. tormentas de aire
   D. tormentas eléctricas

5. Los científicos pueden seguir de cerca la actividad volcánica usando __________________________.
   A. sonar
   B. telescopios
   C. barómetros
   D. imágenes de satélites
**Reinforcement  Volcanoes and Plate Boundaries**

**Directions:** Fill in the blanks in the paragraph below using the following terms.

- dense
- divergent
- fissure eruptions
- hot spots
- interior
- magma
- rises
- vent
- volcano

Heat and pressure from Earth’s (1) __________________________ cause rock to melt and become (2) __________________________. Because magma is less (3) __________________________ than the surrounding rock, it (4) __________________________ to Earth’s surface. The opening of a (5) __________________________ is called a (6) __________________________.

(7) __________________________ occur when magma escapes from cracks in Earth’s crust. Most volcanoes form at (8) __________________________ or convergent plate boundaries. Volcanoes that do not form along plate boundaries are called (9) __________________________.

**Directions:** Answer each of the following questions in complete sentences.

10. How are volcanoes formed at divergent plate boundaries?

11. How are volcanic arcs formed?

12. How are island arcs formed?
**Volcanic Eruptions and Features**

**Directions:** Correct each of the following statements by replacing the italicized term with the correct term and writing it in the blank.

1. Scientists can predict the energy of a volcanic eruption based on the percentage of water in the magma. __________________

2. Granitic lava typically has a low viscosity. __________________

3. Aa lava develops a smooth skin and forms ropelike patterns as it cools. __________________

4. Basaltic lava tends to trap gases, producing explosions. __________________

5. Shield volcanoes form distinctly steep-sided landforms. __________________

6. The Hawaiian Islands are examples of composite volcanoes. __________________

7. Cinder cone volcanoes are formed by alternating layers of lava and tephra. __________________

8. Most California volcanoes formed at divergent plate boundaries as part of volcanic arcs. __________________

**Directions:** Define each volcanic feature named below.

9. batholith __________________

10. caldera __________________

11. lava tube __________________

12. lava dome __________________

13. volcanic neck __________________

14. dike __________________

15. sill __________________
Reinforcement Hazards of Volcanic Eruptions  

Directions: The four terms below all refer to volcanic hazards. Define each and describe how it can endanger humans and wildlife.

1. volcanic ash

2. lahar

3. pyrocastic flow

4. gases

Directions: Answer each of the following questions in complete sentences.

5. Why are lava flows usually of less immediate danger to human beings than some other volcanic hazards?

6. If you lived near an active volcano, what factors would you measure and what tools would you use in order to predict the next eruption?
Formation of Ophiolites

Ophiolites are typical layers of rock from an oceanic plate that escaped subduction, or being shoved under a continental plate and recycled by magma. They are formed at divergent boundaries where two oceanic plates are forced apart by hot magma. At these ridges, lava and fluids from Earth’s crust and mantle combine with seawater. This combination results in the alteration of the existing material along the spreading ridges, as well as the creation of new rocks. These new rocks, layered with ocean sediment, igneous rocks, limestone, basalt, and other matter, form an ophiolite sequence.

Once ophiolites are formed, they are exposed by obduction (when a section of the ocean crust is thrust up onto a continental plate). While they are formed underwater, ophiolites are obducted above water and can eventually be found in mountains or on islands.

Locations of Ophiolites

Many ophiolites are believed to have formed over 200 million years ago. They have been found in mountains in Oman on the Arabian Peninsula, the Pacific Coastal Ranges of California, the Andes along the west coast of South America, Cyprus in the Mediterranean, New Guinea, and Newfoundland. The Samail ophiolite, pushed onto the Arabian shield in Oman near the Persian Gulf, has been the most studied ophiolite.

Importance of Ophiolites

Studying ophiolites can give geologists a picture of how Earth formed. They are much older than any other samples of the oceanic crust, so they also act as models for early oceanic crust and what may be occurring at mid-ocean ridges.

Directions: Respond to each statement or question as instructed.

1. Conclude Why are ophiolites found on land even though they are formed underwater?

2. Speculate about why ophiolites are important to understanding Earth’s history.

3. Investigate the ophiolites in California’s Pacific Coastal Ranges. Use your library to find out more about the natural history of these areas and to map their locations. Use a separate piece of paper to write up your findings and draw your map.
Lava tubes form when lava flows through a channel, cools, and hardens (beginning with its outer surface). Many tubes are large enough to be considered caves and even contain cavelike formations. Lavacicles hang down like limestone stalactites, and driblet spires thrust upward like their cave counterparts, stalagmites. One major difference between limestone caves and lava tubes is their lifespan. Whereas caves are often tens of millions of years old, lava tubes are relatively young—usually less than 10,000 years old. Scientific exploration of lava tubes is also relatively new. It was not until the 1970s that scientists discovered that lava tubes host thriving communities of living things.

Lava Tube Habitats
Scientists have identified five major habitats in lava tubes. These are the entrance zone, the twilight zone, the transition zone, the deep cave zone, and the stagnant air zone—each one more distant from the light and outside air. Each zone has its own distinct forms of life.

For many years, no one thought that animals could live in lava tubes because the conditions were so hostile. Life forms must adapt to permanent darkness, high humidity, and unusual concentrations of gases, in addition to living in a confined space. As a result, many lava tube animals are blind, colorless, and flightless. Lava cracks and bubbles, however, provide hiding places for animal life. In addition, seeds, insects, and plant fragments blown onto the flows by wind collect in pockets, providing food.

Animal Inhabitants
Most of the animals living in lava tubes are arthropods, insects, and their relatives, including arachnids and crustaceans. Animals found in Hawai’i’s lava tubes include planthoppers, sandhoppers, centipedes, earwigs, and water treaders, as well as several species of spiders. The top predator in the food chain of the Kauai Island lava tubes is the “no-eyed big-eyed hunting spider.” Many lava-tube arthropods are unique not only to this type of environment, but sometimes even to specific tubes. The fact that diverse animal species can evolve so quickly in extreme environments is of tremendous interest to scientists.

Directions: Respond to each statement on the lines provided.

1. Compare lava tubes and limestone caves.

2. Infer why different species of life would inhabit each zone in a lava tube.

3. Speculate about why the evolution of animals in lava tube environments would be of interest to scientists.
When the volcano Vesuvius erupted on August 24 in the year A.D. 79, it buried the city of Pompeii beneath layers of volcanic ash and debris. Because of this event, people today know much about what life was like in an ancient city in Italy. For the people who lived there, however, the eruption was an unforeseen disaster. Few cities in history have been destroyed so swiftly and so completely.

The Volcano

Vesuvius was located about 8 km north of Pompeii. When dark clouds, hot cinders, and ash began to pour from its cone, the citizens of Pompeii were caught by surprise. Two thousand of the city’s 20,000 inhabitants were killed trying to flee, as ash rained around them, buildings collapsed, and gases poisoned the air. The city was buried under 3 to 6 meters of cinders and volcanic ash. Within two days, Pompei, a thriving city that was home to many wealthy Romans, was gone.

Pompeii’s Legacy

The city lay buried for almost 2,000 years, until Charles III, King of Naples and Sicily, ordered the beginning of its excavation. Since then, the city has been almost completely unearthed. What people found was that the volcanic ash had preserved an amazingly accurate record of everyday Roman life. Archaeologists found rich country homes complete with gardens and pools. Many pieces of jewelry, cooking utensils, household furniture, and other implements were discovered still intact. The imprints of people’s bodies were found in the hardened ash. Even dogs were found preserved in the debris. In one house, a meal was left unfinished on a table.

Today, visitors can see the remains of the original site or view many of the artifacts in exhibits at the Naples National Museum and around the world.

Directions: Respond to each question or statement below using complete sentences.

1. Assess which types of volcanic hazards were probably most responsible for the deaths in Pompeii.

2. Judge whether you think a volcanic eruption in modern times could result in a disaster like that in Pompeii. How do you think our awareness and understanding of volcanoes has changed?

3. Decide whether you think people should be forbidden to build towns or cities near volcanoes. Explain your answer.
Directions: Unscramble the words below. Then match them to their definitions.

1. noaclov ________ A. physical property that describes a material’s resistance to flow
2. tevn ________ B. feature that forms when magma reaches Earth’s surface
3. harpet ________ C. localized area of high heat in Earth’s interior
4. istcoyvis ________ D. fine-grained tephra made of tiny, sharp particles
5. oth pots ________ E. rapidly flowing mixture of volcanic debris and water
6. rahla ________ F. solid fragments that erupt from a volcano
7. locavinc has ________ G. fast-moving body of hot gases and solids
8. erisufs tipnoreu ________ H. magma escaping along cracks in Earth’s crust
9. ryostaclip wolf ________ I. the opening of a volcano

Directions: Write the letter of the correct type of volcano next to each of the descriptions below.

A. cinder cone volcano
B. composite volcano
C. shield volcano

10. composed mainly of alternating layers of lava and tephra
11. composed of smoothly flowing layers of basaltic lava
12. composed mainly of solid fragments known as tephra
13. forms a distinctly steep-sided landform
14. forms a huge, gently sloping landform
15. forms tall, majestic mountains
16. usually occurs along convergent plates, where one plate is oceanic
Content Vocabulary CONTINUED

Directions: Use each of the following terms in a sentence that demonstrates its meaning.

17. caldera

18. batholith

19. silica

20. volcanic arc

21. lithospheric plate

22. magma

23. lava

24. satellite imaging

25. seismic waves
Part A. Vocabulary Review

Directions: Write the term that correctly completes each sentence below.

hot spot  lahar  tephra
vent  viscosity  volcano

1. A volcano that does not form along plate boundaries is a ________________________.
2. Lava with a high ________________________ flows slowly.
3. The solid fragments that erupt from a volcano are called ________________________.
4. A ________________________ occurs where the flow of heat from Earth’s interior is high.
5. A lava dome forms when thick lava slowly erupts from a volcano’s ________________________.
6. Scientists refer to a ________________________ as a rapidly flowing mixture of volcanic debris and water.

Part B. Concept Review

Directions: Compare and contrast the following pairs of terms.

1. basaltic lava, granitic lava ________________________
   ________________________

2. pyroclastic flows, lava flows ________________________
   ________________________

3. dikes, sills ________________________
   ________________________

4. volcanic arcs, island arcs ________________________
   ________________________
Directions: Respond to each question or statement using complete sentences.

5. **Classify** the three types of volcanoes described in the chapter and describe the characteristics of each.

6. **Distinguish** among the three places that volcanoes occur with respect to plate boundaries.

7. **Clarify** the relationship among silica content, viscosity, and lava flow.

8. **Analyze** how most volcanic mountains formed in California.

9. **Present** an argument for locating a new housing development a safe distance from a volcano that last erupted 500 years ago. Be specific about potential dangers.

10. **Imagine** that you have just been hired to oversee the monitoring of volcanic activity in California. What would you look for, and what types of tools would you use?
Lesson 1: Volcanoes and Plate Boundaries

A. A ___________________________ occurs when magma reaches Earth’s surface on land or underwater.

1. ___________________________ is molten rock; when magma rises to the surface, it is called ___________________________.

B. Heat and pressure in Earth’s interior cause rocks to ___________________________, forming magma.

1. Magma rises to the surface because it is less ___________________________ than the rock it rises through.

2. A ___________________________ is the oval or circular opening of a volcano through which heat escapes Earth’s interior.

3. A ___________________________ occurs when magma escapes from elongated cracks in Earth’s crust.

C. Volcanoes occur where the flow of ___________________________ from Earth’s interior is high.

1. Volcanoes can occur at ___________________________ plate boundaries.

   a. When an oceanic plate sinks beneath a continental plate, a ___________________________ forms.

   b. A volcanic arc is a string of volcanoes that form ___________________________ to a continent’s leading edge.

   c. When two oceanic plates are pushed together, an ___________________________ forms.

   d. An island arc is a long, curved string of volcanic ___________________________.

2. Fissure eruptions can occur at ___________________________ plate boundaries, forming new crust.

   a. When they occur in the ocean, they form ___________________________.

   b. When they occur at continental plate boundaries, ___________________________ form.

3. Volcanoes that form over localized areas of high heat instead of along plate boundaries are known as ___________________________.
Lesson 2: Volcanic Eruptions and Features

A. The ________________ of magma controls a volcano’s eruption and lava flow.
   1. Scientists make predictions about a volcanic eruption’s energy from the percentage of _______ and oxygen in magma.
      a. Magma with a high silica content has a high ______________, meaning it is thick and slow moving.
      b. Magma with less silica and more iron and magnesium has ______________ viscosity, meaning it flows easily.

2. The amount of ______________ and magma temperature also affect eruption.
   a. ________________ is the most common dissolved gas in magma; carbon dioxide, sulfur dioxide, and hydrogen sulfide are also present.
   b. The more gas present, the greater the chance of a(n) ______________ eruption.

B. Two types of magma and lava are ______________ and granitic.
   1. Magma with a ______________ percentage of silica is basaltic.
      a. Basaltic lava has a low _________________, is thinner and more fluid, and tends to flow quietly.
      b. Basaltic lava pours over the _______________ and runs down the sides of the volcano.
      c. _______________ lava develops a smooth skin and forms ropelike patterns; _______________ lava is stiffer and more slow-moving.
      d. Basaltic lava that flows underwater forms bubble-like _______________ lava.

2. Magma with a high percentage of silica is _________________.
   a. Granitic lava has a _________________ viscosity, is sticky and lumpy, and tends to trap gases.
   b. Granitic lava produces _________________ eruptions.

C. ________________ types of volcanoes are common: shield, cinder cone, and composite volcanoes.
   1. A ________________ is a huge, gently sloping landform composed of basaltic lava.
      a. Shield volcanoes develop from the buildup of _______________ of gently flowing lava.
Chapter Outline CONTINUED

b. Shield volcanoes resemble the slightly ________________ shape of a warrior’s shield.

2. A ________________ is composed mainly of solid fragments called tephra.
   a. Falling ________________ forms a distinctly steep-sided, cone-shaped landform.
   b. Cinder cone volcanoes produce ________________ eruptions.

3. A ________________ is composed of alternating layers of lava and tephra.
   a. Layers accumulate through ________________ quiet and explosive eruptions.
   b. Composite volcanoes often occur at ________________ plate boundaries and form tall, majestic mountains.

D. California volcanoes formed at convergent plate boundaries as part of
   a ________________.

E. Most of a volcano’s magma cools underground, forming ________________ volcanic features.
   1. ________________ are the largest intrusive feature, forming when magma cools ________________ before reaching the surface.
   2. ________________ form when magma is forced into cracks that cut across rock layers.
   3. ________________ form when magma is forced into cracks parallel to rock layers.
   4. ________________ form when erosions wears away the volcano, ________________ magma that has hardened inside the vent.
   5. ________________ form when highly viscous granitic lava piles up to form a rounded feature.
   6. ________________ are hollow channels that form when the surface of swiftly moving lava cools and hardens first.
   7. A ________________ is a large, sunken crater that forms when the top of a volcano collapses into the nearly empty magma ________________.

Lesson 3: Hazards of Volcanic Eruptions

A. Volcanic eruptions produce many ________________ that can affect humans and wildlife.
Chapter Outline CONTINUED

1. Clouds of ___________________ contain tiny particles of sharp mineral and glasslike particles.
   a. The ___________________ of large amounts of volcanic ash can damage buildings.
   b. Volcanic ash can bury plants, animals, and food sources and ___________________ water.

2. A ___________________ is a rapidly flowing mixture of volcanic debris and water.
   a. ___________________ occurring from eruptions can trigger lahars.
   b. Lahars can quickly ___________________ human and wildlife habitats.

3. ___________________ can be a silent hazard to humans and wildlife.
   a. Sulfur dioxide and hydrogen sulfide gases can form ___________________.

4. ___________________ are fast-moving bodies of hot gases and solids.
   a. Pyroclastic flows can ___________________ everything in their paths.
   b. Intensely hot gas within the flow can contaminate surrounding ___________________.

5. ___________________ can occur from explosive or quiet volcanic eruptions.
   a. Lava flows can destroy property, start ___________________, and release smoke, which pollutes the air.
   b. Lava flows are usually ___________________ giving people time to get out of their paths.

B. It is possible to ___________________ volcanic eruptions by monitoring certain activity.
   1. Before an eruption, small ___________________ usually occur, ranging from magnitude 1 to 3.
   2. The location, type, and amount of gases such as ___________________ can signal an eruption.
   3. ___________________ temperature and ground movement can also indicate that an eruption is near.

C. Technologies such as ___________________ allow volcanoes to be monitored from space.
   1. Scientists use ___________________ and global positioning systems to observe slight changes in land temperature, elevation, and slope.
   2. ___________________ of volcanic eruptions save lives and can help avoid costly repairs.