Section 2

How Minerals Form

Reading Focus

Key Concepts

- How do minerals form from magma and lava?
- How do minerals form from water solutions?

Key Terms

- geode • crystallization
- magma • lava • solution
- vein

Target Reading Skill

Asking Questions Before you read, preview the red headings. In a graphic organizer like the one below, ask a *how* or *what* question for each heading. As you read, write answers to your questions.

Formation of Minerals

Question	Answer
How do minerals form from magma?	

Lab zone **Discover Activity**

How Does the Rate of Cooling Affect Crystals?

1. Put on your goggles. Use a plastic spoon to place a small amount of salol near one end of each of two microscope slides. You need just enough to form a spot 0.5 to 1.0 cm in diameter.
2. Carefully hold one slide with tongs. Warm it gently over a lit candle until the salol is almost completely melted. **CAUTION:** *Move the slide in and out of the flame to avoid cracking the glass.*
3. Set the slide aside to cool slowly. While the first slide is cooling, hold the second slide with tongs and heat it as in Step 2.
4. Cool the second slide quickly by placing it on an ice cube. Carefully blow out the candle.
5. Observe the slides under a hand lens. Compare the appearance of the crystals that form on the two slides.
6. Wash your hands when you are finished.

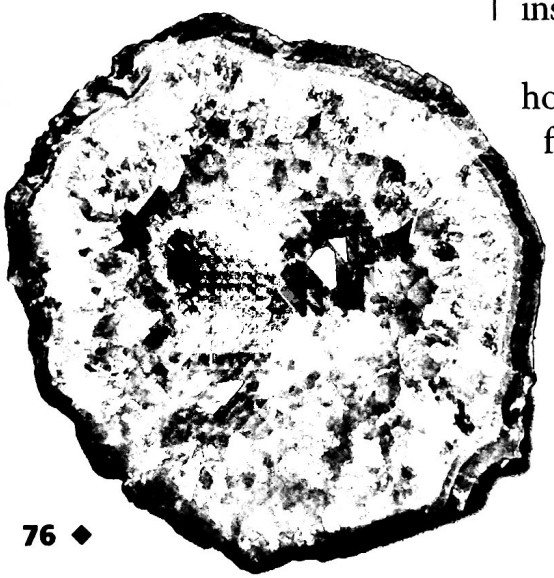
Think It Over

Developing Hypotheses Which sample had larger crystals? If a mineral forms by rapid cooling, would you expect the crystals to be large or small?

On a rock-collecting field trip, you spot an egg-shaped rock about the size of a football. No, it's not a dinosaur egg—but what is it? You collect the rock and bring it to a geologic laboratory. There, you carefully split the rock open. The rock is hollow! Its inside surface sparkles with large, colorful amethyst crystals.

You have found a geode (JEE ohd). A **geode** is a rounded, hollow rock that is often lined with mineral crystals. Crystals form inside a geode when water containing dissolved minerals seeps into a crack or hollow in a rock. Slowly, crystallization occurs, lining the inside with large crystals that are often perfectly formed. **Crystallization** is the process by which atoms are arranged to form a material with a crystal structure. In general, minerals can form in two ways: by crystallization of molten material or by crystallization of materials dissolved in water.

Amethyst geode ▼



Minerals From Magma and Lava

Many minerals form from magma and lava. **Magma** is molten material from inside Earth that hardens to form rock. **Lava** is magma that reaches the surface. Lava also forms rock when it cools and hardens. **Minerals form as hot magma cools inside Earth, or as lava hardens on the surface. When these liquids cool to a solid state, they form crystals.** The size of the crystals depends on the rate at which the magma cools.

When magma remains deep below the surface, it cools slowly over many thousands of years. Slow cooling leads to the formation of large crystals, like the amethyst crystals in a geode. If the crystals remain undisturbed while cooling, they grow by adding atoms according to a regular pattern.

Magma closer to the surface cools much faster than magma that hardens deep below ground. With more rapid cooling, there is no time for magma to form large crystals. Instead, small crystals form. If magma erupts to the surface and becomes lava, the lava will also cool quickly and form minerals with small crystals.

Reading Checkpoint **What size crystals form when magma cools rapidly?**

Minerals From Solutions

Sometimes the elements and compounds that form minerals can be dissolved in water to form solutions. A **solution** is a mixture in which one substance is dissolved in another. **When elements and compounds that are dissolved in water leave a solution, crystallization occurs.** Minerals can form in this way underground and in bodies of water on Earth's surface.

Lab zone Try This Activity

Crystal Hands

1. Put on your goggles.
2. Pour a solution of table salt into one shallow pan and a solution of Epsom salts into another shallow pan.
3. Put a large piece of black construction paper on a flat surface.
   Dip one hand in the table salt solution. Shake off the excess liquid and make a palm print on the paper. Repeat with the other hand and the Epsom salt solution, placing your new print next to the first one. Wash your hands after making your hand prints. **CAUTION:** *Do not do this activity if you have a cut on your hand.*
4. Let the prints dry overnight.

Observing Use a hand lens to compare the shape of the crystals. Which hand print has more crystals?

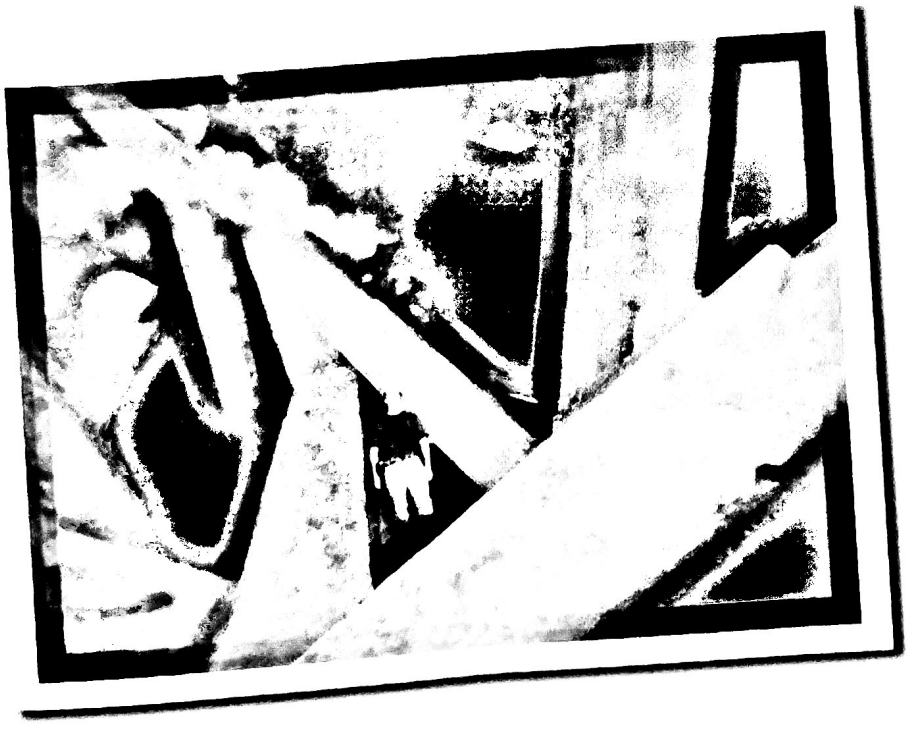
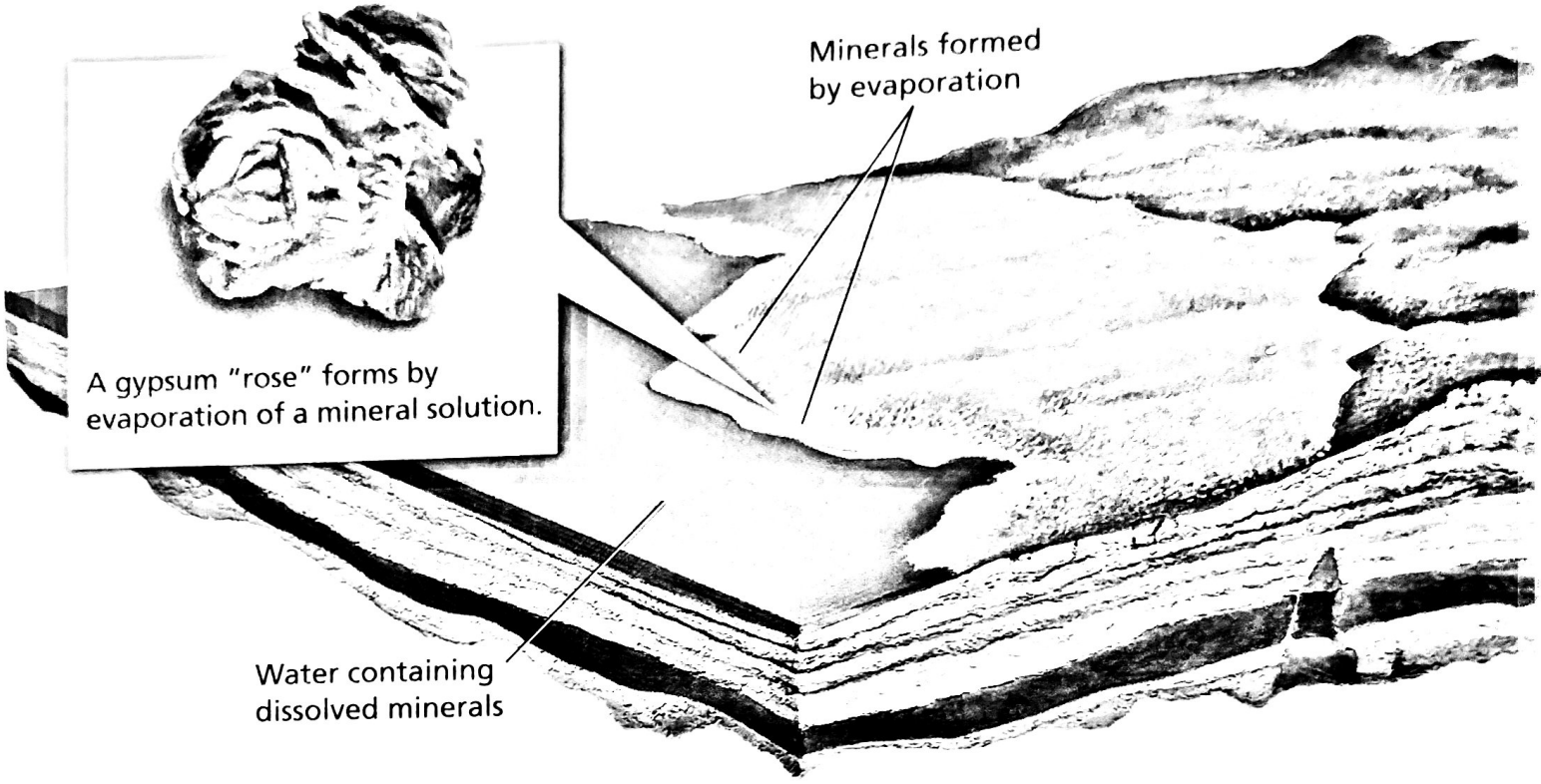


FIGURE 9
Selenite Crystals
These huge selenite crystals in a cave in Mexico formed from the crystallization of minerals in a solution.



Minerals Formed by Evaporation Some minerals form when solutions evaporate. If you stir salt crystals into a beaker of water, the salt dissolves, forming a solution. But if you allow the water in the solution to evaporate, it will leave salt crystals on the bottom of the beaker. In a similar way, deposits of the mineral halite formed over millions of years when ancient seas slowly evaporated. In the United States, such halite deposits are found in the Midwest, the Southwest, and along the Gulf Coast. Other useful minerals that can form by evaporation include gypsum and calcite.

Minerals From Hot Water Solutions Deep underground, magma can heat water to a high temperature. Sometimes, the elements and compounds that form a mineral dissolve in this hot water. When the water solution begins to cool, the elements and compounds leave the solution and crystallize as minerals. The silver in Figure 10 was deposited from a hot water solution.

Pure metals that crystallize from hot water solutions underground often form veins. A **vein** is a narrow channel or slab of a mineral that is different from the surrounding rock. Solutions of hot water and metals often flow through cracks within the rock. Then the metals crystallize into veins that resemble the streaks of fudge in vanilla fudge ice cream.

Reading Checkpoint **What is a vein?**

Go Online
PHSchool.com
For: More on mineral formation
Visit: PHSchool.com
Web Code: cfd-1042

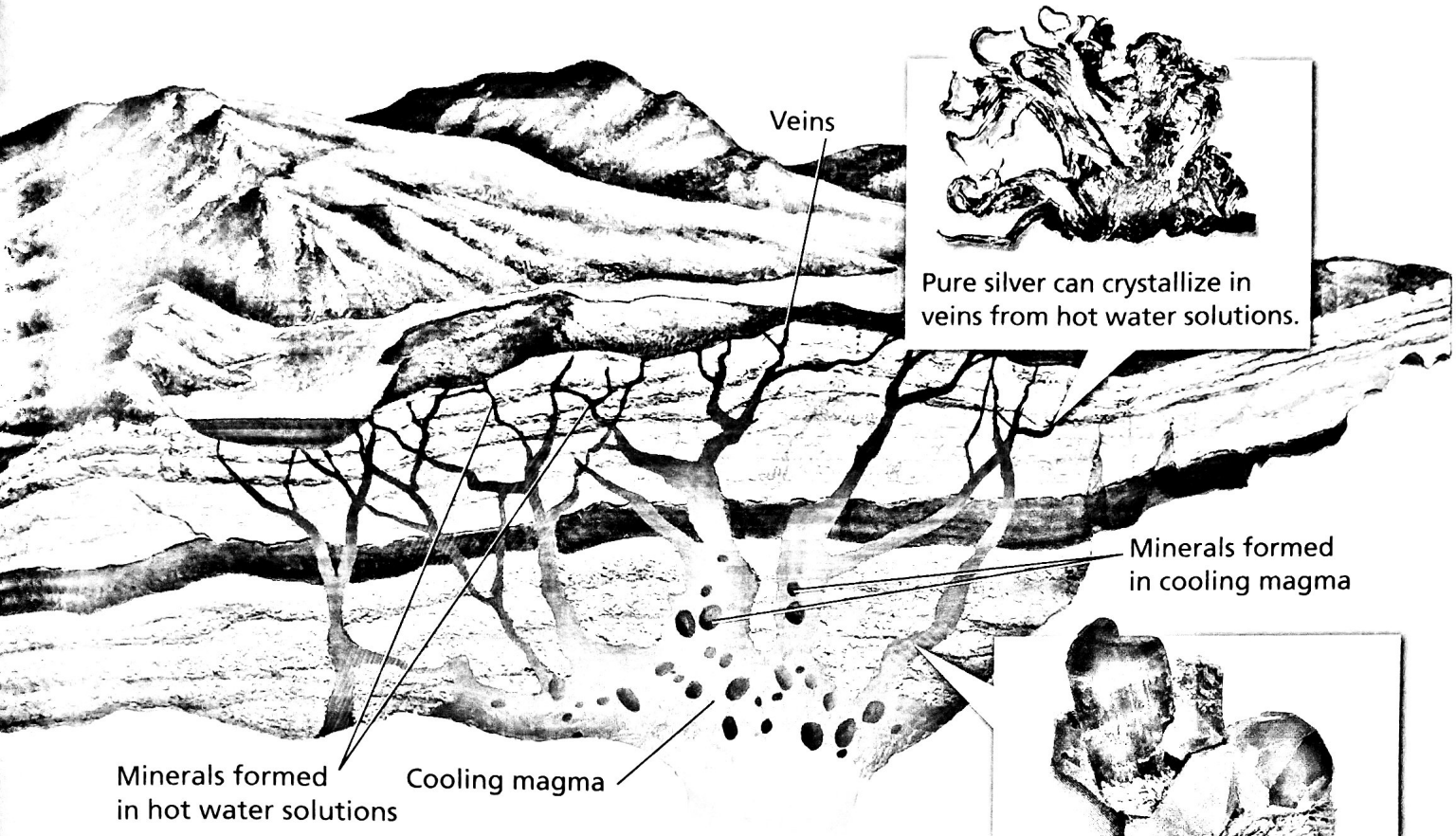


FIGURE 10

Where Minerals Form

Minerals can form on the surface through evaporation of solutions containing dissolved minerals. Minerals can form beneath the surface when dissolved elements and compounds leave a hot water solution or when magma cools and hardens.

Interpreting Diagrams *What process can form veins of underground minerals?*

Section 2 Assessment

Target Reading Skill Asking Questions Use your chart to explain two ways in which minerals can form on Earth's surface.

Reviewing Key Concepts

1. a. **Defining** What is crystallization?
   b. **Relating Cause and Effect** What factor affects the size of the crystals that form as magma cools?
   c. **Predicting** Under what conditions will cooling magma produce minerals with large crystals?
2. a. **Defining** What is a solution?
   b. **Explaining** What are two ways in which minerals can form from a solution?
   c. **Relating Cause and Effect** Describe the process by which a deposit of rock salt, or halite, could form from a solution.

Writing in Science

Dialogue Suppose that you are a scientist exploring a cave. The light on your helmet suddenly reveals a wall covered with large crystals. Scientists on the surface ask you about your observations. Write a dialogue made up of their questions and your replies. Include the different ways in which the minerals you see might have formed.