

# Crystal Growth

Magma forms deep below the Earth's surface at depths of 25 km to 160 km and at extremely high temperatures. Some magma reaches the surface and cools quickly. Other magma gets trapped in cracks or magma chambers beneath the surface and cools very slowly. When magma cools slowly, large, well-developed crystals form. But when magma erupts onto the surface, it cools more quickly. There is not enough time for large crystals to grow. The size of the crystals found in igneous rocks gives geologists clues about where and how the rocks formed.

In this experiment, you will demonstrate how the rate of cooling affects the size of crystals in igneous rocks by cooling crystals of magnesium sulfate at two different rates.

## Using Scientific Methods

### MATERIALS

- aluminum foil
- basalt
- beaker, 400 mL
- gloves, heat-resistant
- granite
- hot plate
- laboratory scoop, pointed
- magnesium sulfate ( $\text{MgSO}_4$ ) (Epsom salts)
- magnifying lens
- marker, dark
- pumice
- tape, masking
- test tube, medium-sized
- thermometer, Celsius
- tongs, test-tube
- watch (or clock)
- water, distilled
- water, tap, 200 mL

### SAFETY INFORMATION



### ASK A QUESTION

1. How does temperature affect the formation of crystals?

### FORM A HYPOTHESIS

2. Suppose you have two solutions that are identical in every way except for temperature. How will the temperature of a solution affect the size of the crystals and the rate at which they form?

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**Crystal Growth** *continued***TEST THE HYPOTHESIS**

- Put on your gloves, apron, and goggles.
- Fill the beaker halfway with tap water. Place the beaker on the hot plate, and let it begin to warm. The temperature of the water should be between 40°C and 50°C. Caution: Make sure the hot plate is away from the edge of the lab table.
- Examine two or three crystals of the magnesium sulfate with your magnifying lens. On a separate sheet of paper, describe the color, shape, luster, and other interesting features of the crystals.
- On a separate sheet of paper, draw a sketch of the magnesium sulfate crystals.
- Use the pointed laboratory scoop to fill the test tube about halfway with the magnesium sulfate. Add an equal amount of distilled water.
- Hold the test tube in one hand, and use one finger from your other hand to tap the test tube gently. Observe the solution mixing as you continue to tap the test tube.
- Place the test tube in the beaker of hot water, and heat it for approximately 3 min. Caution: Be sure to direct the opening of the test tube away from you and other students.
- While the test tube is heating, shape your aluminum foil into two small boat-like containers by doubling the foil and turning up each edge.
- If all the magnesium sulfate is not dissolved after 3 min, tap the test tube again, and heat it for 3 min longer. Caution: Use the test-tube tongs to handle the hot test tube.
- With a marker and a piece of masking tape, label one of your aluminum boats "Sample 1," and place it on the hot plate. Turn the hot plate off.
- Label the other aluminum boat "Sample 2," and place it on the lab table.
- Using the test-tube tongs, remove the test tube from the beaker of water, and evenly distribute the contents to each of your foil boats. Carefully pour the hot water in the beaker down the drain. Do not move or disturb either of your foil boats.
- Copy the table below onto a separate sheet of paper. Using the magnifying lens, carefully observe the foil boats. Record the time it takes for the first crystals to appear.

<b>Crystal-Formation Table</b>			
<b>Crystal formation</b>	<b>Time</b>	<b>Size and appearance of crystals</b>	<b>Sketch of crystals</b>
Sample 1			
Sample 2			

**Crystal Growth** *continued*

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16. If crystals have not formed in the boats before class is over, carefully place the boats in a safe place. You may then record the time in days instead of in minutes.
17. When crystals have formed in both boats, use your magnifying lens to examine the crystals carefully.

**ANALYZE THE RESULTS**

1. Was your prediction correct? Explain.

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2. Compare the size and shape of the crystals in Samples 1 and 2 with the size and shape of the crystals you examined in step 5. How long do you think the formation of the original crystals must have taken?

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**DRAW CONCLUSIONS**

3. Granite, basalt, and pumice are all igneous rocks. The most distinctive feature of each is the size of its crystals. Different igneous rocks form when magma cools at different rates. Examine a sample of each with your magnifying lens.
4. Fill the table on the next page and sketch each rock sample.

**Crystal Growth** *continued*

5. Use what you have learned in this activity to explain how each rock sample formed and how long it took for the crystals to form. Record your answers in your table.

	<b>Granite</b>	<b>Basalt</b>	<b>Pumice</b>
How did the rock sample form?			
Rate of cooling			

**COMMUNICATING YOUR DATA**

Describe the size and shape of the crystals you would expect to find when a volcano erupts and sends material into the air and when magma oozes down the volcano's slope.

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# Crystal Growth

## Teacher Notes and Answer Key

### TIME REQUIRED

Two 45-minute class periods

### LAB RATINGS

Teacher Prep–2  
 Student Set-Up–3  
 Concept Level–2  
 Clean Up–2

Easy ← 1 2 3 4 → Hard



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### MATERIALS

The materials listed are enough for a group of 4–5 students working cooperatively. Using a higher proportion of magnesium sulfate crystals to water will take significantly longer.

### SAFETY CAUTION



Remind students to review all safety cautions and icons before beginning this lab activity.

### PREPARATION NOTES

Samples of igneous rocks may be obtained locally or through various science supply catalogs.

### LAB NOTES

Some volcanic rocks contain both large and small crystals. This is because the magma cooled for a period of time before erupting. This period of time was long enough for some minerals to crystallize but too short for other minerals to form.

# Crystal Growth

Magma forms deep below the Earth's surface at depths of 25 km to 160 km and at extremely high temperatures. Some magma reaches the surface and cools quickly. Other magma gets trapped in cracks or magma chambers beneath the surface and cools very slowly. When magma cools slowly, large, well-developed crystals form. But when magma erupts onto the surface, it cools more quickly. There is not enough time for large crystals to grow. The size of the crystals found in igneous rocks gives geologists clues about where and how the rocks formed.

In this experiment, you will demonstrate how the rate of cooling affects the size of crystals in igneous rocks by cooling crystals of magnesium sulfate at two different rates.

## Using Scientific Methods

### MATERIALS

- aluminum foil
- basalt
- beaker, 400 mL
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### SAFETY INFORMATION



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2. Suppose you have two solutions that are identical in every way except for temperature. How will the temperature of a solution affect the size of the crystals and the rate at which they form?

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Name \_\_\_\_\_ Class \_\_\_\_\_ Date \_\_\_\_\_

**Crystal Growth** *continued***TEST THE HYPOTHESIS**

3. Put on your gloves, apron, and goggles.
4. Fill the beaker halfway with tap water. Place the beaker on the hot plate, and let it begin to warm. The temperature of the water should be between 40°C and 50°C. Caution: Make sure the hot plate is away from the edge of the lab table.
5. Examine two or three crystals of the magnesium sulfate with your magnifying lens. On a separate sheet of paper, describe the color, shape, luster, and other interesting features of the crystals.
6. On a separate sheet of paper, draw a sketch of the magnesium sulfate crystals.
7. Use the pointed laboratory scoop to fill the test tube about halfway with the magnesium sulfate. Add an equal amount of distilled water.
8. Hold the test tube in one hand, and use one finger from your other hand to tap the test tube gently. Observe the solution mixing as you continue to tap the test tube.
9. Place the test tube in the beaker of hot water, and heat it for approximately 3 min. Caution: Be sure to direct the opening of the test tube away from you and other students.
10. While the test tube is heating, shape your aluminum foil into two small boat-like containers by doubling the foil and turning up each edge.
11. If all the magnesium sulfate is not dissolved after 3 min, tap the test tube again, and heat it for 3 min longer. Caution: Use the test-tube tongs to handle the hot test tube.
12. With a marker and a piece of masking tape, label one of your aluminum boats “Sample 1,” and place it on the hot plate. Turn the hot plate off.
13. Label the other aluminum boat “Sample 2,” and place it on the lab table.
14. Using the test-tube tongs, remove the test tube from the beaker of water, and evenly distribute the contents to each of your foil boats. Carefully pour the hot water in the beaker down the drain. Do not move or disturb either of your foil boats.
15. Copy the table below onto a separate sheet of paper. Using the magnifying lens, carefully observe the foil boats. Record the time it takes for the first crystals to appear.

<b>Crystal-Formation Table</b>			
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Sample 1			
Sample 2			

Name \_\_\_\_\_ Class \_\_\_\_\_ Date \_\_\_\_\_

**Crystal Growth** *continued*

- If crystals have not formed in the boats before class is over, carefully place the boats in a safe place. You may then record the time in days instead of in minutes.
- When crystals have formed in both boats, use your magnifying lens to examine the crystals carefully.

**ANALYZE THE RESULTS**

- Was your prediction correct? Explain.

**Answers will vary. A correct prediction would state that a cool solution will produce crystals more quickly than a warm solution. A correct prediction would also state that the crystals produced in a warm solution will be much larger than those produced in a cool solution.**

- Compare the size and shape of the crystals in Samples 1 and 2 with the size and shape of the crystals you examined in step 5. How long do you think the formation of the original crystals must have taken?

**Because the original crystals were small, students may conclude that they formed quickly.**

**DRAW CONCLUSIONS**

- Granite, basalt, and pumice are all igneous rocks. The most distinctive feature of each is the size of its crystals. Different igneous rocks form when magma cools at different rates. Examine a sample of each with your magnifying lens.
- Fill the table on the next page and sketch each rock sample.

**Accept all reasonable sketches.**



Name \_\_\_\_\_ Class \_\_\_\_\_ Date \_\_\_\_\_

**Crystal Growth** *continued*

5. Use what you have learned in this activity to explain how each rock sample formed and how long it took for the crystals to form. Record your answers in your table.

	<b>Granite</b>	<b>Basalt</b>	<b>Pumice</b>
How did the rock sample form?	when magma cools slowly beneath the Earth's surface	when lava cools quickly on the Earth's surface	when magma is ejected from a volcano during a violent eruption
Rate of cooling	cools slowly; large crystals	cools quickly; small crystals	cools very quickly; very small or no crystals

**COMMUNICATING YOUR DATA**

Describe the size and shape of the crystals you would expect to find when a volcano erupts and sends material into the air and when magma oozes down the volcano's slope.

**Volcanic rocks that form in the air as the result of a violent volcanic eruption**

**would cool quickly and have small crystals. Volcanic rocks that form from lava oozing out of a volcano would cool more slowly and have larger crystals.**

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