Cave of the Winds Activity Eight: Not Just Your Average Decoration

Lesson for Grades 6-12

One 50-minute class for initial lesson. Five to ten minutes daily for one to two weeks thereafter.

Satisfies Colorado Model Content Standard for Science:

Standard 4, Benchmark #8 for grades 6-8. Atmospheric circulation is driven by solar heating (for example: the transfer of energy by radiation, convection, conduction).

Standard 4, Benchmark #9 for grades 6-8. There are quantitative changes in weather conditions over time and space (for example: humidity, temperature, air pressure, cloud cover, wind, precipitation).

Standard 4, Benchmark #8 for grades 9-12. Energy transferred within the atmosphere influences weather (for example: the role of conduction, radiation, convection, and heat of condensation in clouds, precipitation, winds, storms).

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Objectives

Students will:

1. Build a model showing how cave popcorn is formed.
2. Describe how three other types of cave formations are formed.

Vocabulary

Cave pearl
Cave popcorn
Condensation and Corrosion
Frostwork
Saturated

Background

Caves contain many more speleothems than the stalagmites and stalactites most people are familiar with. Three of the other more common speleothems or features found in the caverns are cave pearls, directional frostwork and popcorn (a form of coralloid), and condensation/corrosion features.

Cave pearls grow in shallow pools of water saturated with the mineral calcite. Sand grains, bat bones, rock, shell, wood fragments, or other small pieces of calcite can form the nuclei around which the pearls will grow. As carbon dioxide is lost to the air, calcite is deposited on the object, as well as along the floor and edges of the pool. As more and more calcite is added, the pearls will become rounded. Agitation, typically from dripping water, is believed to keep the pearls from adhering to the bottom of the shallow pool.

Directional frostwork, directional popcorn, and condensation/corrosion features owe their existence to air circulation within a cave. Directional frostwork and popcorn form as cool, drier air descends into a cave during the winter months. For a detailed drawing and discussion of seasonal air circulation in caves, see the activity It's a Small World. This drier air causes water to evaporate faster on the side of formations facing the entrance of a cave. As the water evaporates, calcite will precipitate and form the delicate frostwork forms or the coral-like popcorn.

Condensation/corrosion features are formed when carbon dioxide gas, released from water in the cave, is absorbed by water condensed on the cave wall or ceiling. According to Hill, three atmospheric conditions must be present for this to occur: a high carbon dioxide level in the air, high humidity in the air, and a temperature gradient, or difference, between the air in different passages. The carbon dioxide is released from pools in the cave. If the air near the pool is warmer than air in another upper passage, density driven air currents (see It's a Small World) will cause the warmer, moisture and carbon dioxide laden air to rise up to and along the ceiling. On reaching the ceiling and ceiling formations, the water will begin to condense onto these cooler surfaces. The carbon dioxide will dissolve into this fresh water, causing it to become acidic and aggressive to the calcite bedrock and formations. Over a period of time, the bedrock will become "punky," or soft and marked by corrosion. Speleothems will be etched by acidic water along the side facing into the rising airflow. The water (now saturated with calcium carbonate, or calcite) can then be moved to the edge of the corroded area by the gentle airflow. There, the carbon dioxide might again de-gas, causing the calcite to precipitate and causing rims to grow along the edge of the corroded area.

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Materials

Carbonated soda in a transparent plastic bottle
Tap water
Carbonated water
White vinegar
Three small spray bottles
White chalk
Clay
Aluminum foil or small foil pans (about 10 cm diameter)

Procedure

This activity is designed to simulate condensation/corrosion processes in caves.

Warm up

1. While standing in the middle of the classroom, rapidly shake the soda and act like you are going to open it. When students seem to be concerned about this, ask why you shouldn't open the bottle. Discuss the carbonation of sodas and how it causes soda to fizz. Ask what happens if you leave the soda open overnight. Have students hypothesize what happens to the fizz. Lead them to an understanding of de-gassing, in which most of the carbon dioxide leaves the liquid and returns to the air. Ask students what would they think would happen if the de-gassed carbon dioxide encountered a drop of pure water with no carbon dioxide in it. During the discussion, lead them to understand that carbon dioxide will leave a soda where it is found in excess. It will also reenter, or dissolve into, pure water.
2. Describe and discuss the carbon dioxide de-gassing that occurs from pools in caves. Discuss the background material with students, being sure to cover the manner in which the less dense, warmer air rises and carries the carbon dioxide upward. Be sure to discuss the manner in which the carbon dioxide dissolves into condensed water along the cave wall, causing that water to become mildly acidic.

Activity

1. Place three balls of clay (about 1" diameter) in the bottom of separate aluminum pans. If using aluminum foil, fold the edges and tuck the corners to make trays about 10 cm long. Mark one of the pans ***tap water***, one of the pans ***carbonated water***, and the last ***vinegar***.
2. Stick one piece of chalk upright in each of the balls of clay.
3. In one spray bottle place tap water, in another place carbonated water, and in the third place vinegar. The carbonated water should be refreshed each day.
4. Using the spray bottles, lightly mist each piece of chalk with the liquid for which it is labeled. ***Do not drench the chalk! Take care not to spray the other pieces of chalk.***
5. Place the pans where they will not be disturbed.
6. Once per day, examine the chalk. Have the students record their observations using written descriptions, drawings, or photographs.
7. Continue for one week, or until substantial differences can be seen.

Wrap Up

Have the class summarize what they observed with the chalk. Use class discussion or written work. Ask students to describe the ways in which the demonstration they have done in class is similar to the processes that occur in cave environments.

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Assessment

Have students:

1. Describe condensation/corrosion features found in caves.
2. Explain why popcorn is often found on the side of stalagmites facing the entrance of a cave.

Resources

Hill, Carol, 1987, *Geology of Carlsbad Cavern and Other Caves in the Guadalupe Mountains, New Mexico and Texas*. Socorro, NM: New Mexico Bureau of Mines & Mineral Resources Bulletin 117.

Hill, Carol and Forti, Paolo, 1997, *Cave Minerals of the World*, 2nd ed. Huntsville, AL: National Speleological Society, Inc.

Jagnow, David and Jagnow, Rebecca. 1992. *Stories from Stones: The Geology of the Guadalupe Mountains.* Carlsbad, NM: Carlsbad Caverns Guadalupe Mountains Association.

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