NPS Photo by Rick Wood

# Growing Speleothems

**Lesson Objective:** After completing this activity students will be able to understand and simulate the processes involved with speleothem formation. Students will also plot solution data on a graph and then use the graph to extrapolate information.

**Key Concepts:** carbon dioxide; carbonic acid; speleothems; calcite; rate of solution; slope.

**Duration:** 2 55-minute class periods

**Audience:** Middle school and high school students

NPS Photo by Rick Wood

## Growing Speleothems

# Teacher Copy and Answer Key

# GROWING SPELEOTHEMS - TEACHER COPY

## Lesson Objective:

After completing this lesson the students will be able to understand and simulate the processes involved with speleothem formation, as well as plot data and extrapolate information from the graphs.

## Speleothem Materials – Each group of students needs:

- 1 cup of Epsom Salts
- 2 identical jars or disposable cups
- 1 spoon
- 1 saucer or piece of aluminum foil.
- Two paper clips
- 20 cm thick cotton string.
- Hot water
- Calculator

## Instructor Directions:

### Day 1

1. Give a brief introduction of the activity to the class and pass out the **Growing Speleothems** handouts.
2. Give a quick demonstration of how to set up the lab.
3. Instruct the students to follow the directions on their handout and set up their experiments.
4. After setting up their experiments, have the students read the **Background** section of their handout and then answer the **Questions**.
5. With about 10 minutes left in class, remind the students that they need to record their observations of their speleothem experiments in the data table provided in the **Observation** section of the handout.
6. Remind the students that they will need the handout again for Day 2!

## Day 2

1. At the beginning of the class period give the students 5-10 minutes to observe their speleothem experiments and record the observations in the **Observations** section of their handout.
2. When the students are back in their seats instruct them to complete the **Results** and **Conclusions** section of their handout. Give them 20 minutes to do this.
3. When the students have finished their conclusions, give a brief introduction to the solution activity.
4. Give them the rest of the class period to complete the solution activity.

# SUGGESTED ANSWERS

## Questions:

1. How does carbon dioxide get into the soil?

***FROM DECAYING ORGANIC MATERIAL (LIKE PLANTS) AND ALSO FROM MOLECULES IN THE AIR.***

2. What is produced when water mixes with carbon dioxide?

***CARBONIC ACID***

3. What is the term used for cave formations?

***SPELEOTHEMS***

## Results:

1. What do you see happening to the string?

*RESULTS MAY VARY*

2. What do you see happening below the sag in the string?

*RESULTS MAY VARY*

## Conclusions:

1. How is this experiment similar to the way speleothems form in caves?

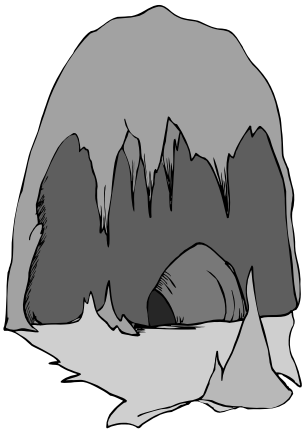
*CRYSTALS FORM FROM DROPLETS OF SATURATED WATER*

2. How is this experiment different from the way speleothems form in caves?

*SPELEOTHEMS GROW DUE TO CHANGES IN $CO_2$ LEVELS INSIDE THE CAVE, AND ALSO DUE TO THE PROCESS OF EVAPORATION AS MINERALS ARE LEFT BEHIND TO COLLECT AND EVENTUALLY BUILD UP TO FORM SPELEOTHEMS.*

3. Use your observations from this experiment to describe the development of speleothems in caves

*IN BOTH SITUATIONS, MINERALS ARE RELEASED FROM A SATURATED SOLUTION AND THE PRECIPITATED MATERIAL COLLECTS AND FORMS DEPOSITS OF DIFFERENT SHAPES.*



# SOLUTION ACTIVITY

## Data Interpretation:

1. Using your graph, how long would it take for a drip of acid to dissolve through 1 **cm** of limestone?

***39 days***

2. Using your graph, how many days would it take for a drip of the same acid to dissolve a pit through the entire block of limestone?

***97 days***

3. Follow the steps to double-check your answer for Question #2.

   Use the following equations:

   Equation for a straight line: $y = mx+b$ "b" = y intercept (0, b)

   Slope: $m = (y_2 - y_1)/(x_2 - x_1)$

**Step 1:** Calculate the slope of the line

Choose 2 points: Location A = (28, 7) Location B = (68, 18)

$m = (y_2 - y_1)/(x_2 - x_1)$

$m = (18 - 7) / (68 - 28)$

$m = 0.275$

**Step 2:** Calculate "b" using a known location point from the graph.

Use the equation for a straight line and solve for "b".

We will use the data point from Question #1 = (39, 10)

$b = y - mx$

$b = 10 - (0.275)*(39)$

$b = - 0.725$

**Step 3:** Calculate the time it would take for the block of limestone to be dissolved by the carbonic acid solution.

**Known Variables:** **point on y-axis = 26 mm**

**slope = 0.275**

**b = - 0.725**

**Use the equation for a straight line and solve for x**

**x = (y – b) / m**

**x = (26 – (-0.725) / 0.275**

**x = 97.18**

## Conclusion

1. What could you change in this experiment to increase the rate at which limestone is dissolved?

***THE CONCENTRATION OF THE ACID; THE RATE THE ACID DRIPPED ONTO THE LIMESTONE; PURITY OF THE LIMESTONE.***

2. What natural changes in the environment could occur that would increase the rate of limestone dissolution?

***EXAMPLE ANSWER:*** ***AN INCREASING IN THE AMOUNT OF DECAYING PLANTS AND ANIMALS WOULD INCREASE THE AMOUNT OF CARBON DIOXIDE IN THE SOIL AND CHANGE THE CONCENTRATION OF THE CARBONIC ACID.***

[iii] Lesson Plan adapted from *Exploring Caves and Karst*; the American Cave Conservation Association, Inc.
[ii] Solution Activity adapted from *Discovering Caves Activities*; Australian Geological Survey Organization, 2000.