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Natural Bridge Caverns
Cave Field Activity: Drip Rate Analysis

Subject: Science

Grade level: 6-8, 9-12

Rationale or Purpose: Water plays a major role in cave formation. As rainwater (already acidic with a pH of 6) seeps through leaf litter and decaying matter found in soils, it mixes with carbon dioxide and becomes even more acidic. This water then flows through fractures and faults in limestone and enlarges the passages. Measuring drip rates can provide insight into how large a volume of water is making it down that particular flow path. In this activity, students will compare drip rates at several different locations throughout the cave. They will be able to observe, first hand, the heterogeneity in flow paths present in karst aquifers such as the Edwards aquifer.

Prior Knowledge: This activity assumes students have seen the Virtual Fieldtrip presentation of Inner Space provided at <http://www.esi.utexas.edu/outreach/caves/virtualtours.php> and are familiar with the following:

- Cave rules
- Identifying cave formations

Materials per team (2 students, preferably):

- 1 timing device** (stopwatch or wristwatch with second hand)
- 1 small flashlight**
- 1 data sheet** with cave map of Natural Bridge Caverns
- 1 pencil**

Materials per class:

- 3 1 L sample bottles*** to collect a sample of cavern water from the water fountain outside the visitor's center.

*optional: only necessary if you'll analyze pH in the classroom. See lesson plan: "Is your Water Clean?" for activity.

Lesson Duration: The length of the cave tour plus 10 minutes before and 10 minutes after.

Objectives:

Chapter 112-

Subchapter B-

112.22-

- 1A- demonstrate safe practices during field and laboratory investigations
- 2B- collect data by observing and measuring
- 2D- communicate valid conclusions
- 4A- collect, analyze, and record information using tools
- 14B- identify relationships between groundwater and surface water in a watershed

112.23

- 1A- demonstrate safe practices during field and laboratory investigations
- 2B- collect data by observing and measuring
- 2C- organize, analyze, make inferences, and predict trends from direct and indirect evidence
- 2D- communicate valid conclusions
- 4A- collect, analyze, and record information to explain a phenomenon using tools

112.24

- 1A- demonstrate safe practices during field and laboratory investigations
- 2B- collect data by observing and measuring
- 2C- organize, analyze, make inferences, and predict trends from direct and indirect evidence
- 2D- communicate valid conclusions
- 4A- collect, record, and analyze information using tools
- 14A- predict land features resulting from gradual changes such as mountain building, beach erosion, land subsidence, and continental drift

Subchapter C

112.46

- 1A- demonstrate safe practices during field and laboratory investigations
- 2B- collect data and make measurements with precision
- 2D- organize, analyze, evaluate, make inferences, and predict trends from data
- 2E- communicate valid conclusions
- 5D- evaluate trends in data to determine the factors that impact aquatic ecosystems
- 10A- identify sources and determine the amounts of water in a watershed including groundwater and surface water

112.49

- 1A- demonstrate safe practices during field and laboratory investigations
- 2B- collect data and make measurements using precision
- 2C- organize, analyze, make inferences, and predict trends from direct and indirect evidence
- 2D- communicate valid conclusions
- 8B- identify geologic formations that result from differing weathering processes
- 10A- identify the characteristics of a local watershed such as average annual rainfall, run-off patterns, aquifers, locations of river basins, and surface water reservoirs
- 10B- analyze the impact of floods, droughts, irrigation, and industrialization on a watershed

Activity:

- Step 1: Talk with the cave tour guide and explain your class' experiment (they may already be familiar with the activity).
- Step 2: Group students into teams, hand out test tubes or graduated cylinders and cave maps.
- Step 3: Explain how to time water drips (2 methods)
- Method 1 (less time-consuming than the other method)**
1. Select 1 drip site within the locations listed below.
 2. Start the timer on the first drip.
 3. Count how many drips fall within a 30 second period.
 4. Record your observation in the chart below.
- Method 2**
1. Select 1 drip site within the locations listed below.
 2. Start timing once the first drop falls (count that as zero).
 3. Count 5 drops and stop timing once the 5th drop falls.
 4. Record your observation in the chart below.
- Step 4: When your group enters the cave, find your location on the cave map.
- Step 6: Once you reach the switchbacks. Mark "1" in the appropriate location on the map. Measure a drip rate together as a class. Record answers.
- NOTE:** Not all sample sites are labeled on the map. Students need to pay attention to clues in order to know where they are on the map.
- Step 7: Students should record drip rates and site conditions for the 4 other locations selected throughout the course of the tour and record them by filling out the data sheet and map.

Modification: Natural Bridge Caverns is not wheelchair accessible.

Student Product: Students will fill out a data sheet with the drip rates and general site description and mark sample site locations on the cave map. Data analysis: students will be asked to graph the drip rates and hypothesize what controls the drip rates and what effect rain events would have.

Closure: Discussion questions for once the cave tour is over:

- In what part of the cave were the drip rates the fastest?
- In what part of the cave were the drip rates the slowest?
- Did the locations with faster drip rates have the same site conditions? What about the areas with slower drip rates?
- Generally, were slow rates clustered together and fast rates clustered together (in the same room)?

Assessment or evaluation: Collect data sheets & maps. Grade the students' work according to the evaluation rubric that follows the Cave Field Trip Activity worksheet.

Extension: See post-visit lesson plan: Comparing pH levels (of cave water, drinking water, and rain water)

Team members: _____

Expedition date: _____

Natural Bridge Caverns
Cave Field Activity: Drip Rate Analysis

Goal: To investigate how water enters the aquifer at Natural Bridge Caverns. Variations in the rates at which water drips into the North Cavern will provide information on the controls on recharge to the aquifer.

Methods: Each team will locate and time drip rates at 5 different sites in the cave. Use one of the following methods to determine the drip rate then record your data for each sample site in the table below.

Method 1

1. Select 1 drip site within the locations listed below.
2. Start the timer on the first drip.
3. Count how many drips fall within a 30 second period.
4. Record your observation in the chart below.

Method 2

1. Select 1 drip site within the locations listed below
2. Start timing once the first drop falls (count that as zero).
3. Count 5 drops and stop timing once the 5th drop falls.
4. Record your observation in the chart below.

What factors might control drip rates? State your hypothesis: _____

Locations (marked on map)	Drip Rate (drips/seconds)	Cave Formations (circle yes or no)			
		Stalactites (on the ceiling)	Soda Straws (on the ceiling)	Stalagmites (on the floor)	Flowstone (on the floor or walls)
1 The Switchbacks		Yes No	Yes No	Yes No	Yes No
2 Sherwood Forest		Yes No	Yes No	Yes No	Yes No
3 Purgatory Creek		Yes No	Yes No	Yes No	Yes No
4 Castle of the White Giants		Yes No	Yes No	Yes No	Yes No
5 Emerald Lake		Yes No	Yes No	Yes No	Yes No

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Data analysis: In the space provided below, graph your results using a bar graph and answer the following questions in complete sentences.

1. Using the data you collected and your observations during the cave tour, explain why you think drip rates differ (or not) through the cave.
2. Did the locations with faster drip rates have the same site conditions? What about the areas with slower drip rates?
3. Would a rainstorm increase drip rates for all sites you sampled? Explain your answer.
4. Would increases in drip rates (if any) stop as soon as the rain stop? Explain your answer.

Cave Map

Label the locations of each drip site directly on this map.
(Record the site number)



