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UTOPIA project

Cave Formation Age Estimation

Subject: Science
Grade level: 8, 9-12

Lab Purpose: Students will investigate actual growth rates of two flowstone formations—one from Inner Space Cavern and one from Natural Bridge Caverns. Students will graph differences in growth rates for each formation to explore variations in past climates. They will then estimate the size of each formation using a scaled photograph. Combining the formation's size and the average growth rate, they will predict the age of the entire formation; such age estimation will provide a better understanding of the dissolution and deposition processes within a karst environment.

Lab Background: The distribution of formations hints at water flow paths into the aquifer. As the slightly acidic rainwater passes through rock, it dissolves away calcite and enlarges cave passages. Cave formations grow as the calcite is deposited. University of Texas scientists have set up experiments to study the relationships between water chemistry, drip rates, and how fast formations grow. Calcite formations preserve records of the Earth's history. Scientists from UT analyze samples in order to investigate the relationship between climatic conditions and how quickly formations grow. The data in this experiment were gathered as part of a doctoral dissertation.

This exercise is particularly insightful as a follow-up to a cave fieldtrip. The Virtual Tours for Inner Space Cavern and Natural Bridge Caverns serve as a good introduction to scientific experiments performed in these two caves. The Inner Space Cavern Virtual Fieldtrip is particularly applicable to this exercise. Find them on the ESI Caves website:
http://www.esi.utexas.edu/outreach/caves/virtualtours.php

Lab Materials:

- **1 worksheet**
- **1 measuring device (can be improvised)**

Lesson Duration: One full class period if a Virtual Fieldtrip presentation precedes the exercise.

Objectives:

Chapter 112
- Subchapter B
  - 112.24
    - 1A- demonstrate safe practices during field and laboratory investigations
    - 2B-collect data by observing and measuring
    - 2C-organize, analyze, evaluate, make inferences, and predict trends from direct and indirect evidence
    - 2D- communicate valid conclusions
    - 2E- construct graphs, tables, maps, and charts using tools including computers to organize, examine, and evaluate data
    - 4A-collect, record, and analyze information using tools
    - 4B- extrapolate from collected information to make predictions
    - 14A- predict land features resulting from gradual changes such as mountain building, beach erosion, land subsidence, and continental drift
- Subchapter C

112.49

1A- demonstrate safe practices during field and laboratory investigations
2B-collect data and make measurements with precision
2C-organize, analyze, evaluate, make inferences, and predict trends from data
2D- communicate valid conclusions
8A- distinguish chemical from mechanical weathering and identify the role of weathering agents such as wind, water, and gravity
8B- identify geologic formations that result from differing weathering processes

Activity:

Step 1: Download or link your computer to a Virtual Fieldtrip found at www.esi.utexas.edu/outreach/caves.

Step 2: Make enough copies of the Cave Formation Age Estimation Student Worksheet for each student.

Step 3: View the Virtual Fieldtrip together as a class either on a projector or on the computer screen. The Virtual Fieldtrips reiterate information explained in the Lab Background section of this lesson plan.

Step 4: Ask a few of these discussion questions:

- How does flowstone form? (see Cave Formation Info sheet on ESI Caves website)
- Using observations from the cave fieldtrip (of drip rates and formation sizes), what is (take a guess) a realistic growth rate for a cave formation?
- How old do you think the Flowing Stone of Time is?
- How you could estimate the age if you were given growth rates and a scaled photo?

Step 5: Hand out student data sheets. Tell students to find their lab stations (if they're working in teams) and begin the lab.

Step 6: Monitor students as they graph rates and calculate ages. In order to get the correct ages they must use the radius (not the diameter) of the formations. This exercise requires lots of unit conversions, verify that the students are paying attention to the units in their calculations.

Step 7: Either collect completed data sheets after students are done or allow students to take them home to finish.

Modifications: Students can either work on this alone or together in a lab group. Each student should fill out their own worksheet showing all calculations. This activity could also serve a homework assignment.

Student Product: Students will complete the worksheet.

Closure: Discussion questions:

- What are some factors that could influence growth rates?
- Was the estimated growth rate faster or slower than you predicted?
- Were the ages of two formations you calculated younger or older than you hypothesized?

Assessment or evaluation: Grade students' work according to the evaluation rubric provided.

Extension: This activity is a fantastic follow-up to a cave fieldtrip.

Name:_____ **Date:**_____

Cave Formation Age Estimation

Student Worksheet

Background: A group of scientists from the University of Texas at Austin is investigating past climate conditions. They have taken two cores of flowstone from two central Texas caves—Inner Space Cavern and Natural Bridge Caverns. They dated the cores at several depths in each sample.

Assignment: You will calculate and graph growth rates for the two formations. Then using an average growth rate and a scaled photograph, you will estimate the age of each formation. Show all calculations on a separate sheet of paper. Pay careful attention to the unit conversions.

Inner Space Cavern Flowstone Sample		
Depth (cm)	Age (years)	Growth Rate (mm/century)
3.90	13,210	X
14.80	14,430	
34.50	27,620	
	Mean:	

Natural Bridge Caverns Flowstone Sample		
Depth (cm)	Age (years)	Growth Rate (mm/century)
26.70	13,430	X
37.00	13,790	
49.90	14,570	
72.10	15,640	
78.90	16,800	
	Mean:	

Create a bar graph showing the different growth rates (include a bar for the mean growth rate also) for the two samples. Label both axes; don't forget your units.

Inner Space Cavern Flowstone Sample

Natural Bridge Caverns Flowstone Sample

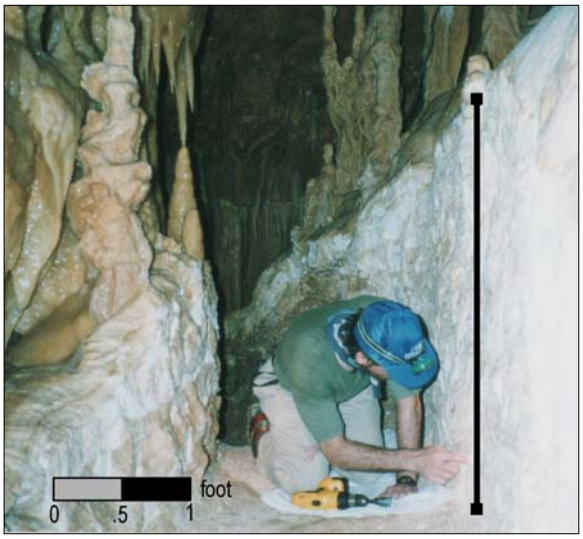
Use the scaled photographs to estimate the diameter of the formations, then use the radius and the mean growth rate to calculate the approximate age. Be careful of the units. The scale is only appropriate along the indicated axes.

Flowing Stone of Time
Inner Space Cavern

Diameter: _____

Radius: _____

Age: _____



Flowstone Passage
Natural Bridge Caverns

Diameter: _____

Radius: _____

Age: _____