

# Cave Formation Age Estimation

**SUBJECTS:** Science and Math

**GRADES:** 8 and Earth Systems

**DURATION:** approximately 45-60 minutes

**ACTIVITY SUMMARY:** 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.

## OBJECTIVES:

Students will be able to:

1. Calculate growth rates for cave formations.
2. Estimate the age of cavern formation from the growth rates.

## REQUIRED MATERIALS:

- Cave Formation Age Estimation handout
- Metric ruler
- Pencil
- Calculator

## 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 was gathered as part of a doctoral dissertation.

This exercise is particularly insightful as a follow-up to a cave fieldtrip.

**EVALUATION:** Students can be evaluated by the accuracy of calculations and answers to discussion questions.

**EXTENSION:** This activity works well as a follow-up to a cave field trip.

Name: \_\_\_\_\_

# Cave Formation Age Estimation

**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.

**Conversions:**

1cm = \_\_\_\_\_mm

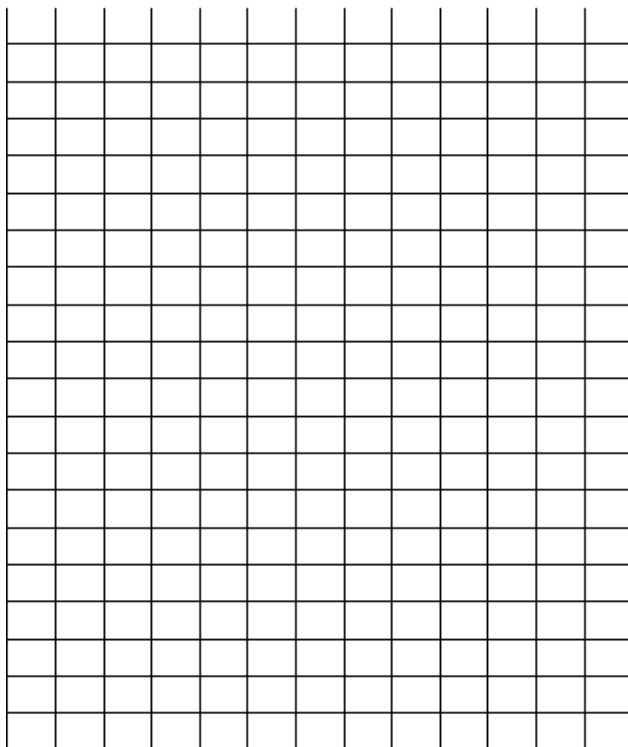
1 century = \_\_\_\_\_years

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:		

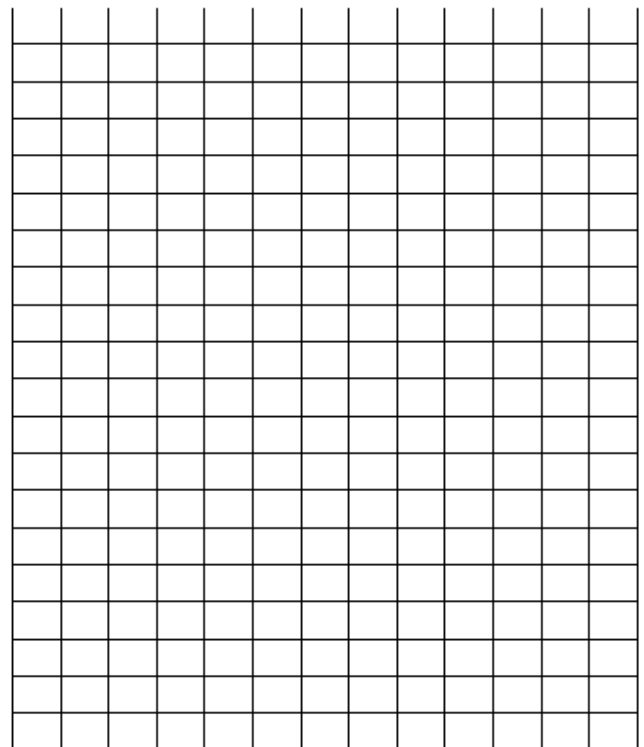
Natural Bridge Caverns Flowstone Sample		
Depth (cm)	Age (years)	Growth Rate (mm/century)
26.70	13,430	X
37.00	13,790	
49.90	14,570	
72.10	15,640	
78.90	16,800	
Mean:		

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 and don't forget your units.

**Inner Space Cavern Flowstone Sample**



**Natural Bridge Caverns Flowstone Sample**



Use the scaled photographs below to estimate the diameter of the formations. Use the radius and the mean growth rate to calculate the approximate age. Be careful of the units. The scale only works for axes shown.



Flowing Stone of Time  
Inner Space Cavern

Diameter: \_\_\_\_\_

Radius: \_\_\_\_\_

Age: \_\_\_\_\_



Flowstone Passage  
Natural Bridge Caverns

Diameter: \_\_\_\_\_

Radius: \_\_\_\_\_

Age: \_\_\_\_\_

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**Analysis Questions:**

1. What are some factors that could influence growth rates?
2. Was the estimated growth rate faster or slower than you predicted?
3. Were the ages of the two formations you calculated younger or older than you hypothesized?
4. Using the growth rate for the Natural Bridge Caverns Flowstone sample, predict the approximate age of the Watchtower, given that it is 50 feet tall and approximately 7 feet in diameter. Assume both formations were formed under similar climatic conditions. (Hint: 1 inch = 2.54cm)

**TEKS ADDRESSED:**

**Science**

**8<sup>th</sup> Grade**

- 1(A)** ask questions and define problems based on observations or information from text, phenomena, models, or investigations
- 1(B)** use scientific practices to plan and conduct descriptive, comparative, and experimental investigations and use engineering practices to design solutions to problems
- 1(C)** use appropriate safety equipment and practices during laboratory, classroom, and field investigations as outlined in Texas Education Agency-approved safety standards
- 1(D)** use appropriate tools such as graduated cylinders, metric rulers, periodic tables, balances, scales, thermometers, temperature probes, laboratory ware, timing devices, pH indicators, hot plates, models, microscopes, slides, life science models, petri dishes, dissecting kits, magnets, spring scales or force sensors, tools that model wave behavior, satellite images, weather maps, hand lenses, and lab notebooks or journals
- 1(E)** collect quantitative data using the International System of Units (SI) and qualitative data as evidence
- 1(F)** construct appropriate tables, graphs, maps, and charts using repeated trials and means to organize data; (G) develop and use models to represent phenomena, systems, processes, or solutions to engineering problems; and
- 2(A)** identify advantages and limitations of models such as their size, scale, properties, and materials
- 2(B)** analyze data by identifying any significant descriptive statistical features, patterns, sources of error, or limitations
- 2(C)** use mathematical calculations to assess quantitative relationships in data; and
- 2(D)** evaluate experimental and engineering designs.
- 3(A)** develop explanations and propose solutions supported by data and models and consistent with scientific ideas, principles, and theories
- 3(B)** communicate explanations and solutions individually and collaboratively in a variety of settings and formats; and
- 3(C)** engage respectfully in scientific argumentation using applied scientific explanations and empirical evidence.

**Math**

**8<sup>th</sup> Grade**

- 1(A)** apply mathematics to problems arising in everyday life, society, and the workplace
- 1(B)** use a problem-solving model that incorporates analyzing given information, formulating a plan or strategy, determining a solution, justifying the solution, and evaluating the problem-solving process and the reasonableness of the solution
- 1(C)** select tools, including real objects, manipulatives, paper and pencil, and technology as appropriate, and techniques, including mental math, estimation, and number sense as appropriate, to solve problems

**Earth Systems**

**High School**

- 1(A)** ask questions and define problems based on observations or information from text, phenomena, models, or investigations
- 1(B)** apply scientific practices to plan and conduct descriptive, comparative, and experimental investigations and use engineering practices to design solutions to problems
- 1(C)** use appropriate safety equipment and practices during laboratory, classroom, and field investigations as outlined in Texas Education Agency-approved safety standards
- 1(D)** use appropriate tools such as a drawing compass, magnetic compass, bar magnets, topographical and geological maps, satellite imagery and other remote sensing data, Geographic Information Systems (GIS), Global Positioning System (GPS), hand lenses, and fossil and rock sample kits
- 1(E)** collect quantitative data using the International System of Units (SI) and qualitative data as evidence
- 1(F)** organize quantitative and qualitative data using scatter plots, line graphs, bar graphs, charts, data tables, digital tools, diagrams, scientific drawings, and student-prepared model
- 1(G)** develop and use models to represent phenomena, systems, processes, or solutions to engineering problems
- 9(C)** model the processes of mass wasting, erosion, and deposition by water, wind, ice, glaciation, gravity, and volcanism in constantly reshaping Earth's surface; and
- 9(D)** evaluate how weather and human activity affect the location, quality, and supply of available freshwater resources.
- 13(A)** analyze the policies related to resources from discovery to disposal, including economics, health, technological advances, resource type, concentration and location, waste disposal and recycling, mitigation efforts, and environmental impacts; and
- 13(B)** explore global and Texas-based careers that involve the exploration, extraction, production, use, disposal, regulation, and protection of Earth's resources.