NPS Photo by Rick Wood

CAVES AND KARST

An educational curriculum guide on cave and karst resources.

2 week unit

Prepared by the National Park Service
and their partners at the
University of Colorado at Denver.

DENVER

NPS Photo by Rick Wood

Table of Contents

NPS Photo by Rick Wood

Foreword

"Views of the National Parks" (Views) is a multimedia education program that presents stories of the natural, historical, and cultural wonders associated with America's parks. Through the use of images, videos, sounds and text, Views allows the public to explore the national parks for formal and informal educational purposes. By employing the resources of the parks for educational purposes we hope to increase public awareness, interest and appreciation of our parks, while helping to satisfy the need for authentic education.

Nationwide interest of the National Parks makes them an easy fit into the growing demand for more authentic and meaningful curricula. In fact, "virtually all the standards documents that have been published over the past decade entreat teachers to involve students in tangible, genuine, authentic, real-world materials and experiences."[1] The motivation for creating educational curriculum guides that support the Views Program was to connect formal educational topics to real-world experiences, and to offer students a real world connection to standards-based curricula.

This educational curriculum guide was designed to compliment the View's **Caves and Karst Knowledge Center,** and the intended audience is students at the middle and high school grade levels. This guide aligns national park resources pertaining to caves and karst with National Education Standards through the use of interactive inquiry-based activities and instructional lesson plans. There are teacher

1 Best Practice: New Standards for Teaching and Learning in America's Schools; 2nd Edition. Zemelman, Daniels, and Hyde. Copyright 1998 by S. Zemelman, H. Daniels, and A. Hyde.

NPS Photo by Rick Wood

copies and answer keys for all applicable activities. This guide was developed as an introduction to caves and karst, and all activities are designed to be used together in a 2-week unit. Activities, although designed as a unit, may also be used independently at a teacher's discretion. Some activities were adapted from existing cave and karst educational resources. In these instances, a reference is provided to the original activity.

This curriculum guide was developed by Kristen Lucke with the support from the rest of the Views team: Bruce Nash, David Krueger, and Erika Matteo. We would like to thank the following people who helped contribute to this project: Mike Marlow, a professor at the University of Colorado at Denver, for providing professional and educational support; Ron Kerbo, the NPS Cave Coordinator, and Jim F. Wood from the Geologic Resources Division of the National Park Service for providing support and subject-matter expertise; and Andrea Croskey for taking time to review and edit this curriculum guide.

For more information concerning this guide or the Views program, or to request a Views CD or DVD, contact:

Bruce Nash: Program Manager
National Park Service - Natural Resource Program Center
P.O. Box 25287
Denver, Colorado 80225
Email: Bruce_Nash@nps.gov
Phone: (303) 987 - 6697
Fax: (303) 987 – 6704

Kristen Lucke: Education Specialist
University of Colorado at Denver
Email: Kristen_Lucke@partner.nps.gov

NPS Photo by Rick Wood

National Standards applicable to this curriculum guide:

Science

Technology

Language Arts

Math

National Education Standards **Science**	Cave & Karst 2 Week Curriculum Guide Activities						
	Interactive Reading Guide	Making a Cave	Growing Speleothems	Speleothems: A Webquest	Cave Life: A Jigsaw Activity	Present a Cave	Cave Quiz Game
Science (Grades 5-8)							
NS. 5-8. 1 Science As Inquiry							
• Abilities necessary to do scientific inquiry.		☑	☑			☑	
NS. 5-8. 2 Physical Science							
• Properties, and changes of properties, in matter.	☑	☑	☑	☑			☑
NS. 5-8. 3 Life Science							
• Structure and function in living systems.	☑	☑	☑	☑	☑	☑	☑
• Populations and ecosystems.	☑				☑	☑	☑
• Diversity and adaptations of organisms.					☑		☑
NS. 5-8. 4 Earth & Space Science							
• Structure of the earth system.	☑	☑	☑	☑		☑	☑
NS. 5-8. 6 Personal & Social Perspectives							
• Populations, resources, and environments.	☑	☑	☑		☑	☑	☑
• Science and technology in society.	☑						
NS. 5-8. 7 History & Nature of Science							
• Science as a human endeavor.	☑					☑	
• Nature of science.	☑	☑				☑	
• History of science.	☑					☑	

National Education Standards **Science**	Cave & Karst 2 Week Curriculum Guide Activities						
	Interactive Reading Guide	Making a Cave	Growing Speleothems	Speleothems: A Webquest	Cave Life: A Jigsaw Activity	Present a Cave	Cave Quiz Game
Science (Grades 9-12)							
NS. 5-8. 1 Science As Inquiry							
• Abilities necessary to do scientific inquiry.		☑	☑			☑	
NS. 5-8. 2 Physical Science							
• Properties, and changes of properties, in matter.	☑	☑	☑				☑
NS. 5-8. 3 Life Science							
• Structure and function in living systems.	☑	☑	☑		☑	☑	☑
• Populations and ecosystems.	☑				☑	☑	☑
• Diversity and adaptations of organisms.					☑		☑
NS. 5-8. 4 Earth & Space Science							
• Structure of the earth system.	☑	☑	☑	☑		☑	☑
NS. 5-8. 6 Personal & Social Perspectives							
• Populations, resources, and environments.	☑	☑			☑	☑	☑
• Science and technology in society.	☑						
NS. 5-8. 7 History & Nature of Science							
• Science as a human endeavor.	☑					☑	
• Nature of science.	☑	☑				☑	
• History of science.	☑					☑	

National Education Standards **Technology** and **Language Arts**	Cave & Karst 2 Week Curriculum Guide Activities						
	Interactive Reading Guide	Making a Cave	Growing Speleothems	Speleothems: A Webquest	Cave Life: A Jigsaw Activity	Present a Cave	Cave Quiz Game
Technology (Grades K-12)							
NT.K-12. 1 Basic Operations & Concepts							
• Students are proficient in the use of technology.	☑			☑			
NT.K-12. 2 Social, Ethical, & Human Issues							
• Students practice responsible use of technology systems, information, and software.	☑			☑			
NT.K-12. 3 Technology Productivity Tools							
• Students use technology tools to enhance learning, increase productivity, and promote creativity.	☑			☑			☑
NT.K-12. 5 Technology Research Tools							
• Students use technology to locate, evaluate, and collect information from a variety of sources.	☑			☑			
Language Arts (Grades K-12)							
NL-ENG.K-12. 1 Reading for Perspective							
• Students read a wide range of print and nonprint texts...to acquire new information.	☑	☑	☑	☑	☑	☑	
NL-ENG.K-12. 7 Evaluating Data							
• Students...gather, evaluate, and synthesize data from a variety of sources to communicate their discoveries in ways that suit their purpose and audience.					☑	☑	
NL-ENG.K-12. 8 Developing Research Skills							
• Students use a variety of technological and information resources to gather and synthesize information and to create and communicate knowledge.						☑	

National Education Standards **Math**	Cave & Karst 2 Week Curriculum Guide Activities						
	Interactive Reading Guide	Making a Cave	Growing Speleothems	Speleothems: A Webquest	Cave Life: A Jigsaw Activity	Present a Cave	Cave Quiz Game
Math (Grades 5-8)							
NM-ALG. 6-8. 2 Represent and analyze mathematical situations and structures using algebraic symbols.							
• Explore relationships between symbolic expression and graph of lines, paying particular attention to the meaning of intercept and slope.			☑				
NM-ALG. 6-8. 3 Use mathematical models to represent and understand quantitative relationships.							
• Model and solve contextualized problems using various representations, such as graphs, tables and equations.			☑				
NM-ALG. 6-8. 4 Analyze change in various contexts.							
• Use graphs to analyze the nature of changes in quantities in linear relationships.			☑				
Math (Grades 9-12)							
NM-ALG. 9-12. 4 Analyze change in various contexts.							
• Approximate and interpret rates of change from graphical and numerical data.			☑				

NPS Photo by Rick Wood

Caves and Karst Curriculum Guide

2 -week Unit

Activity Objectives

NPS Photo by Rick Wood

ACTIVITY OBJECTIVES

INTERACTIVE READING GUIDE

Lesson Objective: This extended interactive reading guide was developed to compliment the "Views of the National Parks" Knowledge Center for Caves and Karst, and the design of this guide will help students focus their attention on key concepts as they are introduced to cave and karst resources.

Key Concepts: cave basics, karst basics, cave and karst locations, types of caves, processes that form caves and karst, cave and karst formation, and the environmental conditions inside a cave.

MAKING A CAVE

Lesson Objective: After making clay models of caves students will learn about weathering processes and be able to conceptualize how water creates caves and cave formations.

Key Concepts: physical, biological, and chemical weathering; dissolution; precipitation; carbonic acid.

NPS Photo by Rick Wood

ACTIVITY OBJECTIVES

GROWING SPELEOTHEMS

Lesson Objective: After completing this 2-day 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; stalagmites and stalactites; rate of solution; slope.

SPELEOTHEMS: A WEBQUEST ACTIVITY

Lesson Objective: Upon completion of this webquest, students will have learned the fundamental characteristics of 14 of the most common types of speleothems.

Key Concepts: cave balloons, boxwork, cave flowers, coatings, columns, coralloids, draperies, flowstone, frostwork, helictites, moonmilk, cave pearls, stalactites, and stalagmites.

NPS Photo by Rick Wood

ACTIVITY OBJECTIVES

CAVE LIFE: A "JIGSAW" ACTIVITY

Lesson Objective: After reading an assigned text on cave animal classifications or cave zones, students will be able to answer questions relative to their text and then present the information to their cooperative group members.

Key Concepts: cave life; cave zones: entrance zone, twilight zone, variable temperature zone and complete darkness, and dark zone; cave animal classification: trogloxenes, troglophiles, and troglobites; cooperative learning.

PRESENT A CAVE

Lesson Objective: After completing this cooperative learning activity students will be able to create an oral and visual presentation on a national park cave and karst resource.

Key Concepts: National Park Service cave and karst resources; investigation; cooperative learning.

CAVE QUIZ GAME: AN INTERACTIVE REVIEW GAME

Lesson Objective: This interactive activity uses the Microsoft PowerPoint program to review key cave concepts presented throughout the Caves and Karst Curriculum Guide.

Key Concepts: speleothem formation, types of caves, ways that caves form, fossils, names of speleothems.

NPS Photo by Rick Wood

Interactive Reading Guide

Lesson Objective: This interactive reading guide was developed to compliment the "Views of the National Parks" Knowledge Center for Caves and Karst, and the design of this guide will help students focus their attention on key concepts as they are introduced to cave and karst resources.

Key Concepts: cave basics, karst basics, cave and karst locations, types of caves, processes that form caves and karst, cave and karst formation, and the environment conditions inside a cave.

Duration: 1 55-minute class period

Audience: Middle school and high school students

NPS Photo by Rick Wood

Interactive Reading Guide

Teacher Copy and Answer Key

CAVES AND KARST

(To compliment the NPS Views Caves and Karst Knowledge Center)

Interactive Reading Guide #1

Interactive reading guides are excellent strategies to use when assisting students in productive reading. They allow students to find the essential ideas within a text without being distracted by large amounts of information. Students who may find it difficult to differentiate key ideas from the supporting detail benefit from the clues and guidance of reading guides. Essentially, interactive reading guides are developed to assist students with text materials that may be too difficult for independent reading.[1]

This particular interactive reading guide has been developed to supplement the "Views of the National Parks" (Views) Knowledge Center for Caves and Karst, and the design of this guide will help students focus their attention as they interact with the Caves and Karst module. The introduction segment of this module is an excellent way to introduce students to cave and karst topics, and this guide has been developed in order to maximize their learning of key topics.

The instructor can download the Views DVD to the school's public server, or if the instructor does not have a DVD they can have the students access the Knowledge Center via the internet.

Enter the knowledge center by clicking on the "Explore Caves and Karst" link.

Click on the link to Cave Basics

1. **How does the Federal Cave Resource Protection Act of 1988 define a cave?**

   "ANY NATURALLY OCCURRING VOID, CAVITY, RECESS, OR SYSTEM OF INTERCONNECTED PASSAGEWAYS BENEATH THE SURFACE OF THE EARTH."

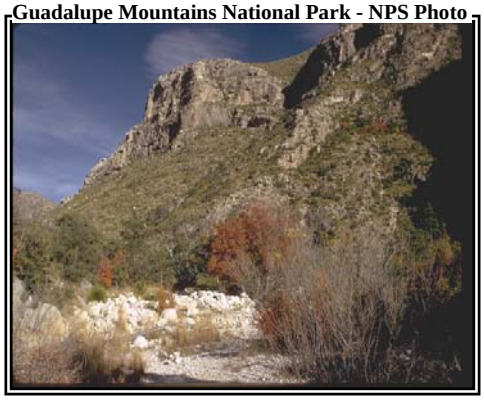
2. **True or False: Caves can be filled with air, but not water. Circle one: True (False)**
3. **What are 4 things that can be housed within a cave?**

   - *FRAGILE MINERAL FORMATIONS*
   - *RARE FLORA AND FAUNA*
   - *IRREPLACEABLE ARTIFACTS*
   - *DISTINCTIVE FOSSILS*

[1] Source: Classroom Strategies for Interactive Learning, 2nd Edition. Written by Doug Buehl; Copyright 2001 by the International Reading Association, Inc.

What is karst?

Guadalupe Mountains National Park - NPS Photo



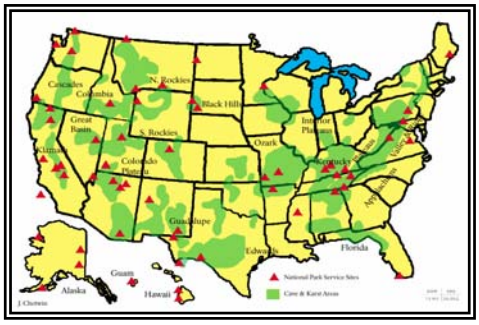
Karst is a type of topography. If we think of topography as the different features in a landscape, then karst landscapes are characterized as being formed on limestone, gypsum, and other types of rocks that dissolve in natural acid.

Click on the link to Karst Basics

1. **What type of topography does karst describe? What happens to streams in karstic areas?**
   KARST DESCRIBES LANDSCAPES CHARACTERIZED BY CAVES, SINKHOLES, AND UNDERGROUND DRAINAGE.

   IN KARSTIC LANDSCAPES, STREAMS DISAPPEAR INTO THE GROUND AND REAPPEAR ELSEWHERE AS LARGE SPRINGS.
2. **Name 5 surface features that are found in regions with karst:**
   - *VALLEYS*
   - *PLATEAUS*
   - *TOWERS*
   - *PINNACLES*
   - *PONDS*
3. **Name 3 components of a drainage network:**
   - *CAVES*
   - *FRACTURES*
   - *PARTINGS*

NPS Map - Cave and Karst Locations in the USA



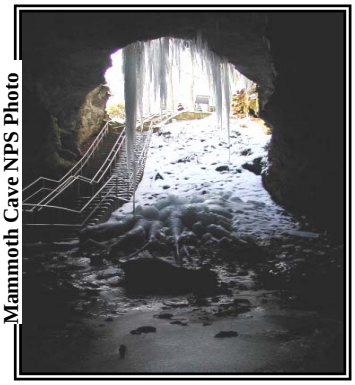
Where are Caves and Karst?

Now that you know the cave and karst basics, let's learn about where they are found. Karst landscapes are found just about everywhere on Earth: frigid tundra, dry deserts, and tropical jungles. In temperate & tropical climates flowing water dissolves rocks. In arid environments, sulfuric acid can dissolve rocks and form caves.

Click on the link to Cave and Karst Locations

1. **What portion of the landscapes in the United States is karstic?** *1/5 (A FIFTH OF THE LANDSCAPE)*

TEACHER COPY AND ANSWER KEY



Mammoth Cave NPS Photo

Types of Caves

There are many different types of caves that can form in many different types of locations: there are long caves, deep caves, caves that form in the desert, and caves that form near the sea.

Click on the link to Types of Caves

1. **What is the longest cave?** *MAMMOTH CAVE*
2. **Where is the longest cave located?** *KENTUCKY*
3. **The deepest cave in the world is the** _____*KRUBERA (VORONJA)*_____ **cave.**
4. **How many types of caves are there?** _____*23*_____

   (Hint: you have to click on the "next->" link)

What Processes Form Caves and Karst?

Click on the link to Cave and Karst Formation

(Use the link to the glossary to fill in the following blanks)

Caves are typically formed in rocks through processes like *dissolution* and *carbonation*. *Dissolution* is the act or process of ___ *DISSOLVING* ___**. If an area is warm and humid there is more water available to dissolve rock, increasing the rate of erosion and cave formation. Carbonate rocks are those that primarily consist of** _____ *CARBONATE* _____ **minerals. Specifically, carbonate rocks are** ____ *SEDIMENTARY* _____ **rocks, and go through a process called "*carbonation*". *Carbonation* is an activity of chemical** _____ *WEATHERING* _____**. It is a** ____*CHEMICAL*_____ **reaction of carbonic acid in rainwater, soilwater, and groundwater, with** _____*MINERALS*_____**. *Carbonation* most strongly affects carbonate minerals and rocks, such as** _____ *LIMESTONE* ____ **and** _____ *MARBLE* _____**.**

TEACHER COPY AND ANSWER KEY

Different Ways that Caves and Karst Form

Caves and karst can form in many different ways. They can form in areas where abundant rainfall increases the rate of dissolution and carbonation. Although this type of formation is common, it is not the only way to form caves and karst. Other processes are at work forming caves and changing karstic landscapes. The following examples are common ways that caves and karst are forming all around us.

Click on the link to Cave and Karst Formation

(Use the "next ->" link to see different ways that caves and karst form)

1. Collapse

- **Collapse is part of cave _____ *FORMATION* _____ and _____ *EVOLUTION* _____.**
- **When do the ceilings of cave rooms and passages collapse?**

WHEN THEY BECOME TOO WIDE TO SUPPORT THE BEDROCK OVERLYING THEM

- **The ceilings of water-filled caves may be supported by the buoyant force of the water inside. If this water drains out, why is there a greater potential for the cave to collapse?**

BECAUSE THE BUOYANT FORCE IS NO LONGER PRESENT TO HELP SUPPORT A CAVE'S CEILING.

2. Solution Caves

- ***Finish the following paragraph*:**

Earth movements cause cracks to form in the *bedrock*, which is the solid rock below the surface. These cracks, which are natural pipelines for water to seep into the ground, are called _____ *FRACTURES* _____ and _____*JOINTS*_____. When the water mixes with the natural acids in the ground, rocks such as limestone are dissolved.

- **What remains after the dissolved particles are carried away with the water?**

HOLLOW SPACES

- **<u>WHERE</u> does most cave formation and enlargement take place, and <u>WHY</u> is the circulation and dissolution of bedrock greatest at this place?**

FORMATION AND ENLARGEMENT TAKES PLACE AT OR JUST BELOW THE WATER TABLE;
THE CIRCULATION IS GREATEST HERE BECAUSE FRACTURES ARE CONNECTED AND MOST OPEN.

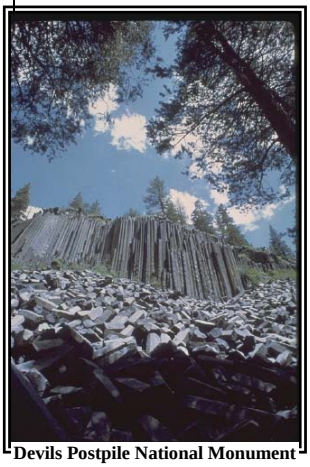
3. Lava Caves

- **What is another name for a lava cave?** *LAVA TUBE*

- ***Finish the following paragraph*:**

When molten, fluid _____ *LAVA* _____ flows out of a volcano, it works its way downhill. In contact with _____ *AIR* _____, the surface of this lava stream cools and hardens into a _____ *CRUST* _____. The lava inside remains _____ *MOLTEN* _____, however, and continues to _____ *FLOW* _____ downhill. When the molten lava eventually _____ *DRAINS* _____ out of the interior of the hard-crusted passage, a lava _____ *TUBE* _____ or _____ *CAVE* _____ remains.

4. Talus Caves



Devils Postpile National Monument
NPS Photo

- **Rockslides and rockfalls produce piles of irregular shaped rocks and boulders. The spaces between these rocks are sometimes big enough to produce a cave-like configuration.**
  What is the name for these piles of rocks?
  TALUS

- **Because these types of caves can be formed when rocks break off and fall or slide into narrow canyons, talus caves are also referred to as:**
  BREAKDOWN CAVES

5. Sea Caves

- **What are sea caves?**

SEA CAVES ARE CLEFTS OR CAVITIES IN THE BASES OF CLIFFS AT THE EDGES OF LARGE BODIES OF WATER, TYPICALLY THE SEA BUT ALSO LARGE LAKES.

- ***Finish the following sentence about the formation of sea caves:***

The action of _____ *WAVES* _____ pounding against rocks that line the shores of _____ *OCEANS* _____ and large _____ *LAKES* _____ form sea caves.

6. Ice Caves

- **Ice caves that form in ice are also called:**

  GLACIER CAVES

- **Ice caves that are formed in rock that contain ice all year round are also referred to as:**

  FROZEN CAVES

7. Sandstone Caves

Mesa Verde National Park
NPS Photo

- **Early people used sandstone caves for** *SHELTER*

  Why?

SANDSTONE CAVES ARE USUALLY SHALLOW AND ARE EASILY ACCESSIBLE.

- **Define *contact*:** *GEOLOGICALLY SPEAKING, CONTACT IS THE SURFACE BETWEEN 2 TYPES OR AGES OF ROCKS.*
- **Fluids, like groundwater, move through sandstone, easily. However, when the water reaches a layer of shale, it cannot pass through because the pore spaces are too small.**

When this happens, what is groundwater forced to do?

THE GROUNDWATER IS FORCED TO MOVE LATERALLY ALONG THE CONTACT BETWEEN THE TWO ROCK UNITS UNTIL IT SEEPS OUT ON THE FACE OF THE CANYON WALL OR AT THE BACK OF AN ALCOVE, CREATING A SPRING OR SEEP.

8. Tectonic Caves

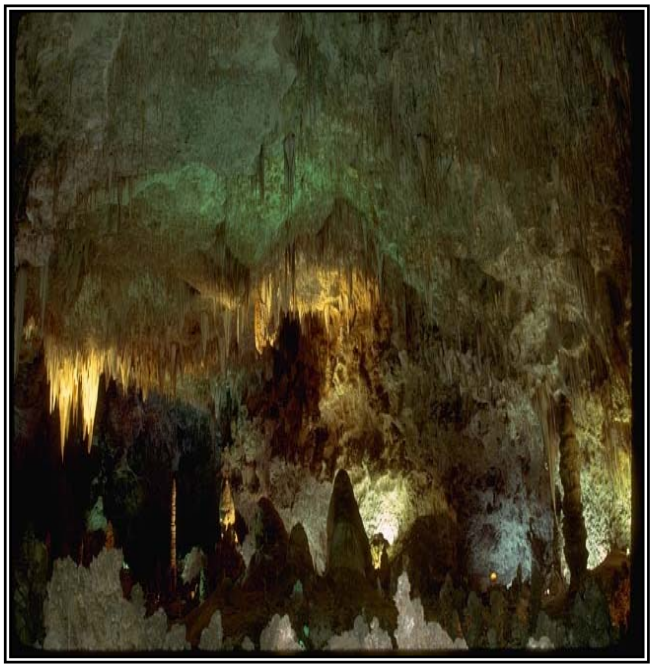
Finish the following sentence about the formation of tectonic caves:

The action of ____ *EARTHQUAKES* ____ form natural ____ *CRACKS* _____ in rock that can be considered _____ *CAVES* _____.

Wupatki National Monument - NPS Photo

Inside a Cave

Click on the "Inside a Cave" link



Carlsbad Caverns National Park – NPS Photo

What do you see when you step into a cave? What do you hear? If you are near the entrance of the cave you may see bats flying in and out. You may also hear the trickling of water as it drips down the cave walls. Although, there are times that you don't see anything at all. In fact, sometimes you don't hear anything either. Stepping inside a cave is almost like stepping into another world. The following exercises are meant to help you understand what's going on inside a cave when the lights go out.

DARKNESS

If you turn the lights out in a room, chances are your eyes will eventually adjust and you will start to see vague images of what's around you. In a cave, this may or may not be true depending on where you are. If you are near the entrance, light from outside the cave helps you to see what's around you. However, if you are in the DARKZONE, light from the outside doesn't reach you and you are in complete darkness.

- **Is the following statement true or false? Circle one: TRUE or (FALSE)**

*If you are in the **darkzone** of a cave, your eyes will eventually adjust to the blackness and you will be able to see your hand if your hold it up close to your face.*

- **What are 3 reasons these worlds without sunlight are important?**

1. *CAVES CHALLENGE OUR ASSUMPTIONS ABOUT ECOSYSTEMS AND LIFE.*
2. *CAVES PROVIDE A SENSE OF DISCOVERY.*
3. *CAVES OPEN UP NEW AVENUES IN RESEARCH AND SCIENCE.*

SILENCE

In general, what kinds of worlds are caves? *SILENT*

What is an example of a sound you may hear in a cave? *DRIPPING WATER*

TEMPERATURE

The daily and seasonal fluctuations that we experience on the surface of the Earth are not seen inside a cave. This is because any change in temperature on the surface fades as heat passes through the bedrock and into the caves.

- **As a result, cave temperatures are approximately equal to:**

...THE AVERAGE ANNUAL TEMPERATURE AT THE SURFACE.

Based on this information above, answer the following questions:

- **During SUMMER, are caves warmer or cooler than the outside temperature?** *COOLER*
- **During WINTER, are caves warmer or cooler than the outside temperature?** *WARMER*

RELATIVE HUMIDITY

Timpanogos Cave National Monument – NPS Photo

Name 3 things that seeping water moistens in a cave:

1. *CEILINGS*
2. *WALLS*
3. *FLOORS*

- **What is responsible for allowing the inner part of a cave to maintain its high humidity?**

  CONSTANT TEMPERATURE

- **Why is the humidity at the cave entrances relatively lower than the humidity found in the interior portions of the cave?**

  THE HUMIDITY IS LOWER AT THE ENTRANCE BECAUSE CAVE ENTRANCES ARE AT THE INTERFACE BETWEEN THE SURFACE AND UNDERGROUND.

AIR CURRENTS

The air in most caves is constantly in motion, and at times these air currents can blow up and out of the cave. This is how caves some caves were discovered, like *Wind Cave* in South Dakota and *Lechuguilla Cave* in Carlsbad Caverns National Park, New Mexico.

Carlsbad Caverns National Park - NPS Photo

- **What is the exchange of air between a cave and the surface a function of?**

  CHANGING PRESSURE OF THE OUTSIDE ATMOSPHERE

- **The air inside a cave is constantly in motion because it is constantly adjusting itself to what?**

  SURFACE CHANGES

- **If a cave has extremely strong air currents, what does it probably have 2 of?**

  ENTRANCES

- **What is the difference between a blowing cave and a breathing cave?**

A BLOWING CAVE IS CAVE THAT HAS AN ANNUAL CYCLE IN WHICH AIR BLOWS OUT OF THE LOWER ENTRANCE ALL SUMMER AND OUT OF THE UPPER ENTRANCE ALL WINTER.

A BREATHING CAVE HAS A SHORTER CYCLE THAN A BLOWING CAVE; THE AIR MOVES INWARD FOR A FEW MINUNTES AND THEN OUTWARD FOR A FEW MINUTES.

NPS Photo by Rick Wood

Interactive Reading Guide

Student Copy

Carlsbad Canyon National Park NPS Photo

CAVES AND KARST

(To compliment the NPS Views Caves and Karst Knowledge Center)

Enter the knowledge center by clicking on the "Explore Caves and Karst" link.

Introduction to Caves

Hearing the word "caves" can bring about a variety of responses. Some people associate caves with a feeling of being trapped and lost, while others fear them because they are home to bats and other creatures of the dark. Yet, there are many people in this world that love caves for the sense of adventure and exploration that they provide.

Whatever your feelings of caves are, there is no denying their importance as unique environments that are warehouses for unique species, important geological resources, and irreplaceable artifacts.

The best way to learn what caves have to offer is to explore them, and the best way to start exploring caves is to start from the beginning. Let's start with some important definitions and concepts about caves and karst:

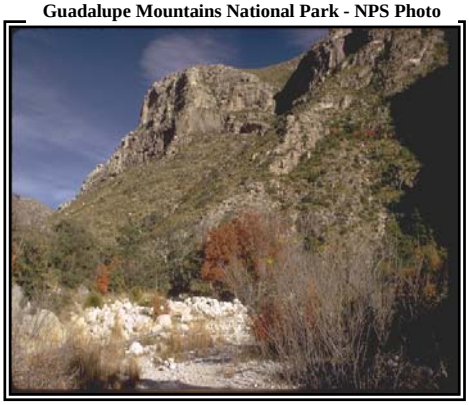
Click on the link to Cave Basics

1. **How does the Federal Cave Resource Protection Act of 1988 define a cave?**

2. **True or False: Caves can be filled with air, but not water. Circle one: True False**
3. **What are 4 things that can be housed within a cave?**
   -
   -
   -
   -

What is karst?

Guadalupe Mountains National Park - NPS Photo



Karst is a type of topography. If we think of topography as the different features in a landscape, then karst landscapes are characterized as being formed on limestone, gypsum, and other types of rocks that dissolve in natural acid.

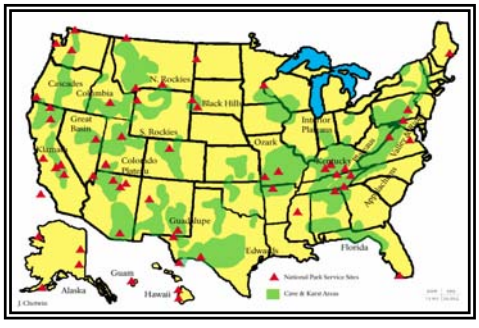
Click on the link to Karst Basics

1. **What type of topography does karst describe? What happens to streams in karstic areas?**

2. **Name 5 surface features that are found in regions with karst:**
   -
   -
   -
   -
   -

3. **Name 3 components of a drainage network:**
   -
   -
   -

NPS Map - Cave and Karst Locations in the USA

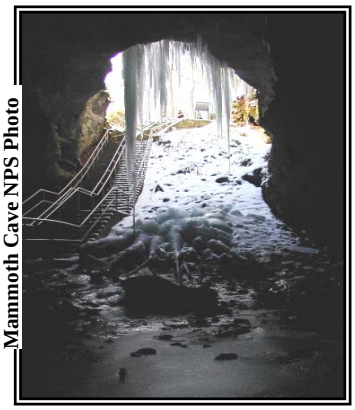


Where are Caves and Karst?

Now that you know the cave and karst basics, let's learn about where they are found. Karst landscapes are found just about everywhere on Earth: frigid tundra, dry deserts, and tropical jungles. In temperate & tropical climates flowing water dissolves rocks. In arid environments, sulfuric acid can dissolve rocks and form caves.

Click on the link to Cave and Karst Locations

1. **What portion of the landscapes in the United States is karstic?** _____



Mammoth Cave NPS Photo

Types of Caves

There are many different types of caves that can form in many different types of locations: there are long caves, deep caves, caves that form in the desert, and caves that form near the sea.

Click on the link to Types of Caves

1. **What is the longest cave? _____**
2. **Where is the longest cave located? _____**
3. **The deepest cave in the world is the _____ cave.**
4. **How many types of caves are there? _____**

   (Hint: you have to click on the "next->" link)

What Processes Form Caves and Karst?

Click on the link to Cave and Karst Formation

(Use the links to the glossary to fill in the following blanks)

Caves are typically formed in rocks through processes like *dissolution* and *carbonation*. *Dissolution* is the act or process of _____. If an area is warm and humid there is more water available to dissolve rock, increasing the rate of erosion and cave formation. Carbonate rocks are those that primarily consist of _____ minerals. Specifically, carbonate rocks are _____ rocks, and go through a process called "*carbonation*". *Carbonation* is an activity of chemical _____. It is a _____ reaction of carbonic acid in rainwater, soilwater, and groundwater, with _____. *Carbonation* most strongly affects carbonate minerals and rocks, such as _____ and _____.

Different Ways that Caves and Karst Form

Caves and karst can form in many different ways. They can form in areas where abundant rainfall increases the rate of dissolution and carbonation. Although this type of formation is common, it is not the only way to form caves and karst. Other processes are at work forming caves and changing karstic landscapes. The following examples are common ways that caves and karst are forming all around us.

Click on the link to Cave and Karst Formation

(Use the "next ->" link to see different ways that caves and karst form)

1. COLLAPSE

- **Collapse is part of cave _____ and _____.**
- **When do the ceilings of cave rooms and passages collapse?**
- **The ceilings of water-filled caves may be supported by the buoyant force of the water inside. If this water drains out, why is there a greater potential for the cave to collapse?**

2. SOLUTION CAVES

- ***Finish the following paragraph*:**

  Earth movements cause cracks to form in the *bedrock*, which is the solid rock below the surface. These cracks, which are natural pipelines for water to seep into the ground, are called _____ and _____. When the water mixes with the natural acids in the ground, rocks such as limestone are dissolved.

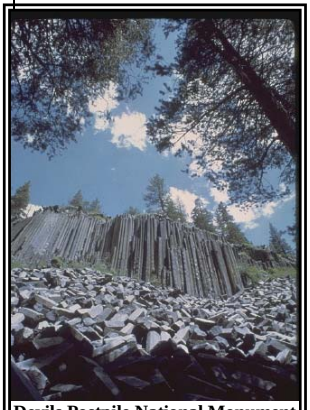
- **What remains after the dissolved particles are carried away with the water?**
- **<u>WHERE</u> does most cave formation and enlargement take place, and <u>WHY</u> is the circulation and dissolution of bedrock greatest at this place?**

3. LAVA CAVES

- **What is another name for a lava cave? _____**
- ***Finish the following paragraph*:**

When molten, fluid _____ flows out of a volcano, it works its way downhill. In contact with _____, the surface of this lava stream cools and hardens into a _____. The lava inside remains _____, however, and continues to _____ downhill. When the molten lava eventually _____ out of the interior of the hard-crusted passage, a lava _____ or _____ remains.

4. TALUS CAVES



Devils Postpile National Monument NPS Photo

- **Rockslides and rockfalls produce piles of irregular shaped rocks and boulders. The spaces between these rocks are sometimes big enough to produce a cave-like configuration.**
  What is the name for these piles of rocks?
  _____
- **Because these types of caves can be formed when rocks break off and fall or slide into narrow canyons, talus caves are also referred to as:**
  _____

5. SEA CAVES

- **What are sea caves?**

- ***Finish the following sentence about the formation of sea caves:***

The action of _____ pounding against rocks that line the shores of _____ and large _____ form sea caves.

6. ICE CAVES

- **Ice caves that form in ice are also called:**

- **Ice caves that are formed in rock that contain ice all year round are also referred to as:**

7. SANDSTONE CAVES

Mesa Verde National Park
NPS Photo

- **Early people used sandstone caves for _____. Why?**

- **Define *contact*:**

- **Fluids, like groundwater, move through sandstone, easily. However, when the water reaches a layer of shale, it cannot pass through because the pore spaces are too small.**

When this happens, what is groundwater forced to do?

8. TECTONIC CAVES

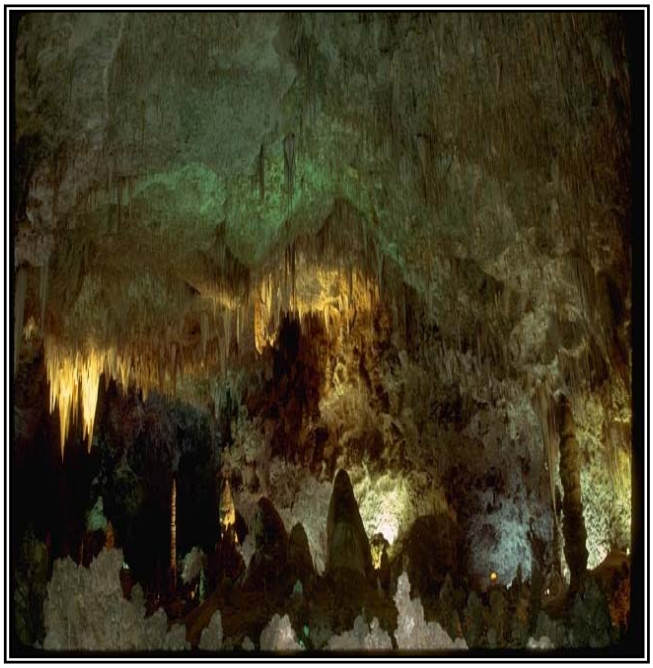
Finish the following sentence about the formation of tectonic caves:

The action of _____ form natural _____ in rock that can be considered _____.

Wupatki National Monument - NPS Photo

Inside a Cave

Click on the "Inside a Cave" link



Carlsbad Caverns National Park – NPS Photo

What do you see when you step into a cave? What do you hear? If you are near the entrance of the cave you may see bats flying in and out. You may also hear the trickling of water as it drips down the cave walls. Although, there are times that you don't see anything at all. In fact, sometimes you don't hear anything either. Stepping inside a cave is almost like stepping into another world. The following exercises are meant to help you understand what's going on inside a cave when the lights go out.

DARKNESS

If you turn the lights out in a room, chances are your eyes will eventually adjust and you will start to see vague images of what's around you. In a cave, this may or may not be true depending on where you are. If you are near the entrance, light from outside the cave helps you to see what's around you. However, if you are in the DARKZONE, light from the outside doesn't reach you and you are in complete darkness.

- **Is the following statement true or false? Circle one: TRUE or FALSE**

If you are in the darkzone of a cave, your eyes will eventually adjust to the blackness and you will be able to see your hand if your hold it up close to your face.

- **What are 3 reasons these worlds without sunlight are important?**

1.

2.

3.

SILENCE

In general, what kinds of worlds are caves? _____

What is an example of a sound you may hear in a cave? _____

TEMPERATURE

The daily and seasonal fluctuations that we experience on the surface of the Earth are not seen inside a cave. This is because any change in temperature on the surface fades as heat passes through the bedrock and into the caves.

- **As a result, cave temperatures are approximately equal to:**

Based on this information above, answer the following questions:

- **During SUMMER, are caves warmer or cooler than the outside temperature? _____**
- **During WINTER, are caves warmer or cooler than the outside temperature? _____**

RELATIVE HUMIDITY

Timpanogos Cave National Monument – NPS Photo

Name 3 things that seeping water moistens in a cave:

1.

2.

3.

- **What is responsible for allowing the inner part of a cave to maintain its high humidity?**
- **Why is the humidity at the cave entrances relatively lower than the humidity found in the interior portions of the cave?**

AIR CURRENTS

The air in most caves is constantly in motion, and at times these air currents can blow up and out of the cave. This is how caves some caves were discovered, like *Wind Cave* in South Dakota and *Lechuguilla Cave* in Carlsbad Caverns National Park, New Mexico.

Carlsbad Caverns National Park - NPS Photo

- **What is the exchange of air between a cave and the surface a function of?**

- **The air inside a cave is constantly in motion because it is constantly adjusting itself to what?**

- **If a cave has extremely strong air currents, what does it probably have 2 of?**

- **What is the difference between a blowing cave and a breathing cave?**

NPS Photo by Rick Wood

Making a Cave

Lesson Objective: After making clay models of caves students will learn about weathering processes and be able to conceptualize how water creates caves and cave formations.

Key Concepts: physical, biological, and chemical weathering; dissolution; precipitation; carbonic acid.

Duration: 1 55-minute class period

Audience: Middle school and high school students

NPS Photo by Rick Wood

Making a Cave

Teacher Copy and Answer Key

MAKING A CAVE[1] - TEACHER COPY

Lesson Objective:

After making clay models of caves students will learn more about weathering processes, and be able to conceptualize how water creates caves and cave formations.

Background:

Weathering occurs when rocks and minerals are broken down into smaller particles or sediment. There are 3 different types of weathering: physical or mechanical, biological, and chemical. **Physical weathering**, also referred to as mechanical weathering, is when the shape or size of a rock is changed without changing the chemical composition. **Biological weathering** occurs when organisms assist in breaking down rocks into smaller sediments. **Chemical weathering** refers to the process when rocks react with water, solutions, or gases and their chemical structure is changed. During this process, elements may be added or removed from the rocks. This lab activity will focus on a chemical weathering process called dissolution.

Dissolution occurs when rocks are dissolved. Caves are formed when dissolved particles are washed away and leave hollow spaces behind. One type of rock that is easily dissolved is carbonate rocks, and caves are often formed in this type of sedimentary rock. **Sedimentary rocks** are formed when other rocks are broken down into smaller pieces, called sediments, and are then cemented back together as new rocks.

Precipitation is the deposit of water on Earth from the atmosphere, and can present itself as hail, mist, rain, sleet, or snow. Precipitation, such as rainwater or snowmelt, can pick up carbon dioxide from the air and also from decaying plants in the soil. When this water mixes with carbon dioxide it forms carbonic acid. The acidic water flows through cracks on the earth's surface and seeps down into the rocks below. There, carbonic acid dissolves certain kinds of rock, like limestone, which is a type of sedimentary rock. Once the acidic water reaches the carbonate rocks under the soil, it enters into the cracks and dissolves away the rock to create the rooms, passageways and speleothems of a cave.

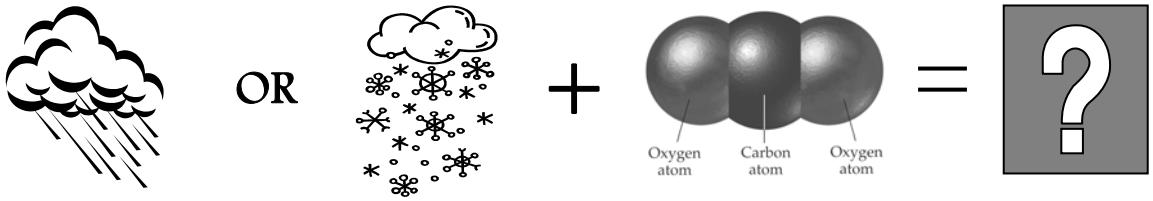
[1] Activity adapted from *Exploring Caves and Karst: A Curriculum Guide* The American Cave Conservation Association. Inc.

Test Your Cave Formation Knowledge:

A. Match the following terms with their definitions.

Matching Definition		Term		Definition
E	1.	Carbonic Acid	A.	This type of rock is created when rocks are broken down and then cemented back together as a new rock.
C	2.	Chemical Weathering	B.	The deposition of water on Earth from the atmosphere.
F	3.	Dissolution	C.	A process that occurs when rocks react with water, solutions, or gases and their chemical structure is changed.
G	4.	Physical Weathering	D.	A process that occurs when organisms assist in breaking down rocks into smaller sediments.
B	5.	Precipitation	E.	This is produced when water mixes with carbon dioxide.
A	6.	Sedimentary Rock	F.	The act or process by which rocks are dissolved.
D	7.	Biological Weathering	G.	A process that changes the shape or size of a rock without changing its chemical composition.

B. Use the following picture clues to complete the sentence:



When *RAIN* or *SNOW* mixes with *CARBON DIOXIDE* it forms *CARBONIC ACID*.

Creating a Cave:

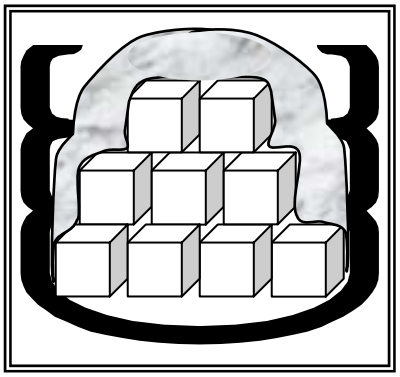
You will now make a cave using sugar cubes, modeling clay, and water.

- The sugar cubes will represent the limestone that comes into contact with the carbonic acid.
- The clay will represent the rocks that remain undissolved.
- The water sprayed on the cave will represent the carbonic acid found in precipitation.

Materials:

1. Modeling clay (4 oz. per student or small group)
2. Sugar cubes (3-6 per cave)
3. 1 see-through bowl per student or group (Cutting the top off of 2-liter bottles works well).
4. Toothpick
5. Spray bottle filled with warm water.

Procedure:



1. Organize the sugar cubes into a half pyramid along the bottom of the bowl.
    a. Make sure the sugar is pressed up against one side of the bowl.
2. Seal the cubes tightly with the modeling clay, making sure there are no gaps.
    a. The clay layer should be about 1/8 inch deep.
    b. The sugar cubes that are pressed up against the glass should remain visible. This will act as a window into your cave.
3. Poke holes through the top of the clay with the tooth pick, making sure that the holes go all the way through to the sugar cubes.

Questions:

- What do the holes in the clay represent?

  THE HOLES REPRESENT THE CRACKS AND HOLES IN THE EARTH'S SURFACE

- What do you think will happen to the sugar cubes when water is sprayed over the top of the clay? **Be specific**…what do you think it will look like?

  RESULTS MAY VARY

4. Use the spray bottle with warm water and begin spraying the top of the cave.
    a. The holes may need to be made bigger to get the water percolating.
5. As the water seeps through the clay and into the sugar cubes, record your observations below.
6. Continue spraying until the sugar cubes are no longer in their original shape or they have completely dissolved.

Observations:

1. Describe what happened to the sugar cubes as the water seeped into your cave.

RESULTS MAY VARY

2. Draw a picture or describe what your cave looked like when finished.

RESULTS MAY VARY

Interpretation:

1. The caves of our National Parks house some extraordinary formations. How do you think water contributed to the formation of these real cave formations?

Stalactites from Timpanogos Cave National Monument, Utah. NPS Photo

SIMPLE ANSWER:

AS WATER SEEPS FROM A CAVE CEILING IT DRIPS DOWN DUE TO GRAVITY. THE MINERALS IN THE DROPS ACCUMULATE AND CAN FORM FORMATIONS SUCH AS STALACTITES.

ADVANCED ANSWER:

THIN HOLLOW TUBES GROW FROM THE CEILINGS OF CAVES AS WATER RUNS DOWN INSIDE THEM AND DEPOSITS RINGS OF CALCITE AT THEIR TIPS. THESE ARE CALLED "SODA STRAWS". STALACTITES, WHICH ARE ICICLE-LIKE DEPOSITS, FORM AFTER THE CENTER OF SODA STRAWS BECOME PLUGGED AND CALCITE IS DEPOSITED ON THE OUTSIDE OF THE STRAW.

NPS Photo by Rick Wood

Making a Cave

Student Copy

MAKING A CAVE

Background:

Weathering occurs when rocks and minerals are broken down into smaller particles or sediment. There are 3 different types of weathering: physical or mechanical, biological, and chemical. **Physical weathering**, also referred to as mechanical weathering, is when the shape or size of a rock is changed without changing the chemical composition. **Biological weathering** occurs when organisms assist in breaking down rocks into smaller sediments. **Chemical weathering** refers to the process when rocks react with water, solutions, or gases and their chemical structure is changed. During this process, elements may be added or removed from the rocks. This lab activity will focus on a chemical weathering process called dissolution.

Dissolution occurs when rocks are dissolved. Caves are formed when dissolved particles are washed away and leave hollow spaces behind. One type of rock that is easily dissolved is carbonate rocks, and caves are often formed in this type of sedimentary rock. **Sedimentary rocks** are formed when other rocks are broken down into smaller pieces, called sediments, and are then cemented back together as new rocks.

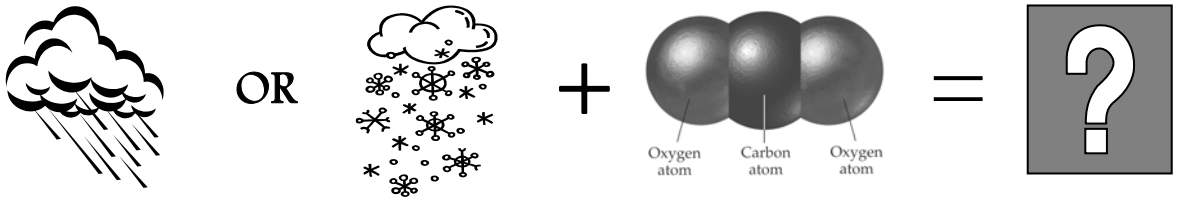
Precipitation is the deposit of water on Earth from the atmosphere, and can present itself as hail, mist, rain, sleet, or snow. Precipitation, such as rainwater or snowmelt, can pick up carbon dioxide from the air and also from decaying plants in the soil. When this water mixes with carbon dioxide it forms **carbonic acid**. The acidic water flows through cracks on the earth's surface and seeps down into the rocks below. There, carbonic acid dissolves certain kinds of rock, like limestone, which is a type of sedimentary rock. Once the acidic water reaches the carbonate rocks under the soil, it enters into the cracks and dissolves away the rock to create the rooms, passageways and speleothems of a cave.

Test Your Cave Formation Knowledge:

A. Match the following terms with their definitions.

Matching Definition	Term		Definition	
_____	1.	Carbonic Acid	A.	This type of rock is created when rocks are broken down and then cemented back together as a new rock.
_____	2.	Chemical Weathering	B.	The deposition of water on Earth from the atmosphere.
_____	3.	Dissolution	C.	A process that occurs when rocks react with water, solutions, or gases and their chemical structure is changed.
_____	4.	Physical Weathering	D.	A process that changes the shape or size of a rock without changing its chemical composition.
_____	5.	Precipitation	E.	This is produced when water mixes with carbon dioxide.
_____	6.	Sedimentary Rock	F.	The act or process by which rocks are dissolved.
_____	7.	Weathering	G.	A process that occurs when organisms assist in breaking down rocks into smaller sediments.

B. Use the following picture clues to complete the sentence:



When _____ or _____ mixes with _____ it forms _____.

Creating a Cave:

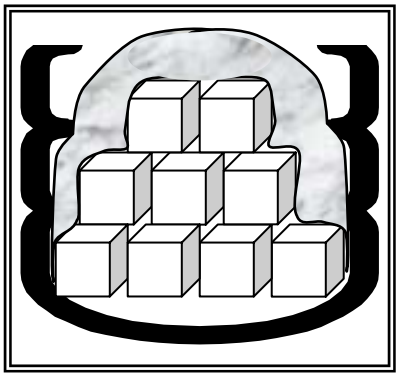
You will now make a cave using sugar cubes, modeling clay, and water.

- The sugar cubes will represent the limestone that comes into contact with the carbonic acid.
- The clay will represent the rocks that remain undissolved.
- The water sprayed on the cave will represent the carbonic acid found in precipitation.

Materials:

1. Modeling clay (4 oz. per student or small group)
2. Sugar cubes (3-6 per cave)
3. 1 see-through bowl per student or group (Cutting the top off of 2-liter bottles works well).
4. Toothpick
5. Spray bottle filled with warm water.

Procedure:



1. Organize the sugar cubes into a half pyramid along the bottom of the bowl.
    a. Make sure the sugar is pressed up against one side of the bowl.
2. Seal the cubes tightly with the modeling clay, making sure there are no gaps.
    a. The clay layer should be about 1/8 inch deep.
    b. The sugar cubes that are pressed up against the glass should remain visible. This will act as a window into your cave.
3. Poke holes through the top of the clay with the tooth pick, making sure that the holes go all the way through to the sugar cubes.

Questions:

- What do the holes in the clay represent?

- What do you think will happen to the sugar cubes when water is sprayed over the top of the clay? **Be specific**…what do you think it will look like?

4. Use the spray bottle with warm water and begin spraying the top of the cave.
    a. The holes may need to be made bigger to get the water percolating.
5. As the water seeps through the clay and into the sugar cubes, record your observations below.
6. Continue spraying until the sugar cubes are no longer in their original shape or they have completely dissolved.

Observations:

1. Describe what happened to the sugar cubes as the water seeped into your cave.

2. Draw a picture or describe what your cave looked like when finished.

Interpretation:

1. The caves of our national parks house some extraordinary formations. How do you think water contributed to the formation of these real cave formations?

Stalactites from Timpanogos Cave National Monument, Utah. NPS Photo

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.

NPS Photo by Rick Wood

Growing Speleothems

Student Copy

GROWING SPELEOTHEMS

Lesson Objective:

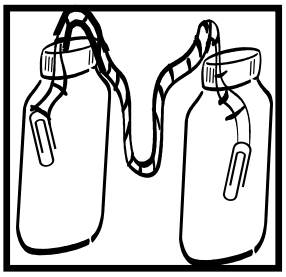
After completing this activity you will be able to understand and simulate the processes involved with speleothem formation, as well as plot data and extrapolate information from the graphs.

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

Procedure:

1. Pour warm water into the 2 jars until they are almost full.
2. Add half of the Epsom salts into each of the jars.
3. Stir until the solution is saturated. (Most of the Epsom salts will not dissolve and will remain at the bottom of the jars.)
4. Tie a paper clip to each end of the string
5. Wet each end of the string well with tap water.
6. Place the ends of the string into the jars.
   a. The paper clips should rest on the bottom of the jars.
7. Place the jars so that the string sags in the middle.



8. Place a saucer or piece of aluminum foil beneath the sag in the string.
9. Place your experiment in a location where it will be away from drafts and disturbance.
10. Use the rest of the class period to read the **Background** section on the following page and complete the questions.
11. Record your **Observations** at the end of Day 1 and Day 2 in the table provided.
12. Complete the **Results** and **Conclusions** section on Day 2.
13. After you have completed step 12, complete the **Solution Activity** at the end of the handout.

Background:

Carbon dioxide can enter the soil in different ways. One way it can enter the soil is from decaying organic material, like plants. As the organic material decomposes it releases carbon dioxide into the soil where it can interact with groundwater. Carbon dioxide is also found in the air, and may be picked up by rainwater as it falls to earth and then seeps into the soil.

When water and carbon dioxide combine they form a weak acid called **carbonic acid**. As the acidic water seeps through the soil it may flow down through bedrock and dissolve minerals, commonly calcite, along the way. When the water reaches a cave, the carbon dioxide in the water is released and the minerals are deposited on the cave walls, ceilings and floors as cave formations. This is the reason why so many cave formations consist of calcite.

Cave formations are referred to as "**speleothems**". The word speleothem is derived from the Greek words "spelaion" meaning cave, and "thema" meaning deposit. There are many varieties of speleothems, and some have been said to resemble beehives, toadstools, bacon, and waterfalls.

Questions:

1. How does carbon dioxide get into the soil?

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

3. What is the term used for cave formations?

Observations:

	End of Day 1	Day 2
String		
Below Sag in String		

Results:

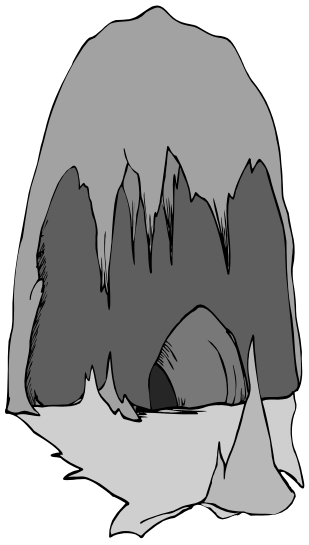
1. What do you see happening to the string?

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

Conclusions:

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

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



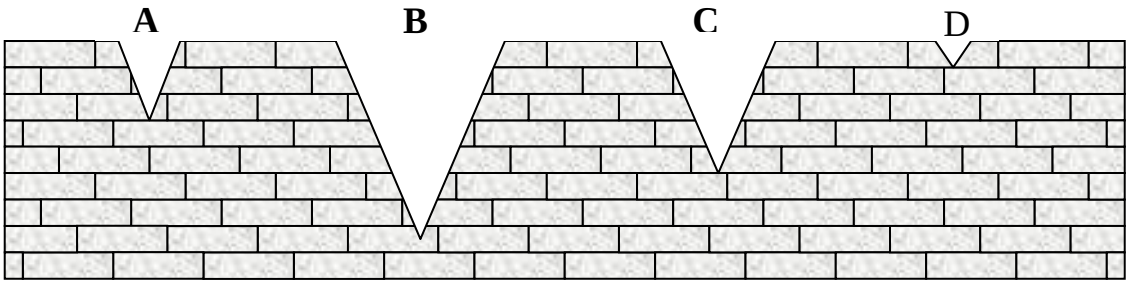
SOLUTION ACTIVITY

THE CREATION OF CARLSBAD CAVERNS NATIONAL PARK

The creation of Carlsbad Cavern began 250 million years ago with the formation of a 400-mile-long reef in an inland sea that covered this region. Cracks developed in the reef as it grew seaward. Eventually the sea evaporated and the reef was buried under deposits of salts and gypsum. Then, a few million years ago, uplift and erosion of the area began to uncover the buried rock reef. Rainwater, made slightly acidic after mixing with carbon dioxide in the air and soil, seeped down into the cracks in the reef. The water slowly dissolved the limestone and began the process that would form large underground chambers.

In this activity the dissolution of limestone will be simulated to help you understand cave forming process.

A block of limestone 26 mm thick was set up in a laboratory underneath a container of dilute carbonic acid. The carbonic acid was allowed to drip onto the limestone block in four locations (A, B, C, and D) which slowly dissolved the block to form small pits. At each location, the solution was allowed to drip for varying periods of time so that each pit is a different size.



The following table showed the measurements for the maximum depth of each pit in millimeters (mm).

Location	Time Period of Dripping	Maximum Depth of Pit (mm)
A	28 days	7 mm
B	68 days	18 mm
C	44 days	11 mm
D	12 days	2.5 mm

1. Using the graph paper on page 8, plot the depth of the pit (y-axis) against the number of days (x-axis).

   Make your **x-axis extend up to 120 days** and your **y-axis extend down to at least negative 10 mm**.

Data Interpretation:

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

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?

3. Follow the steps below 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

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

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

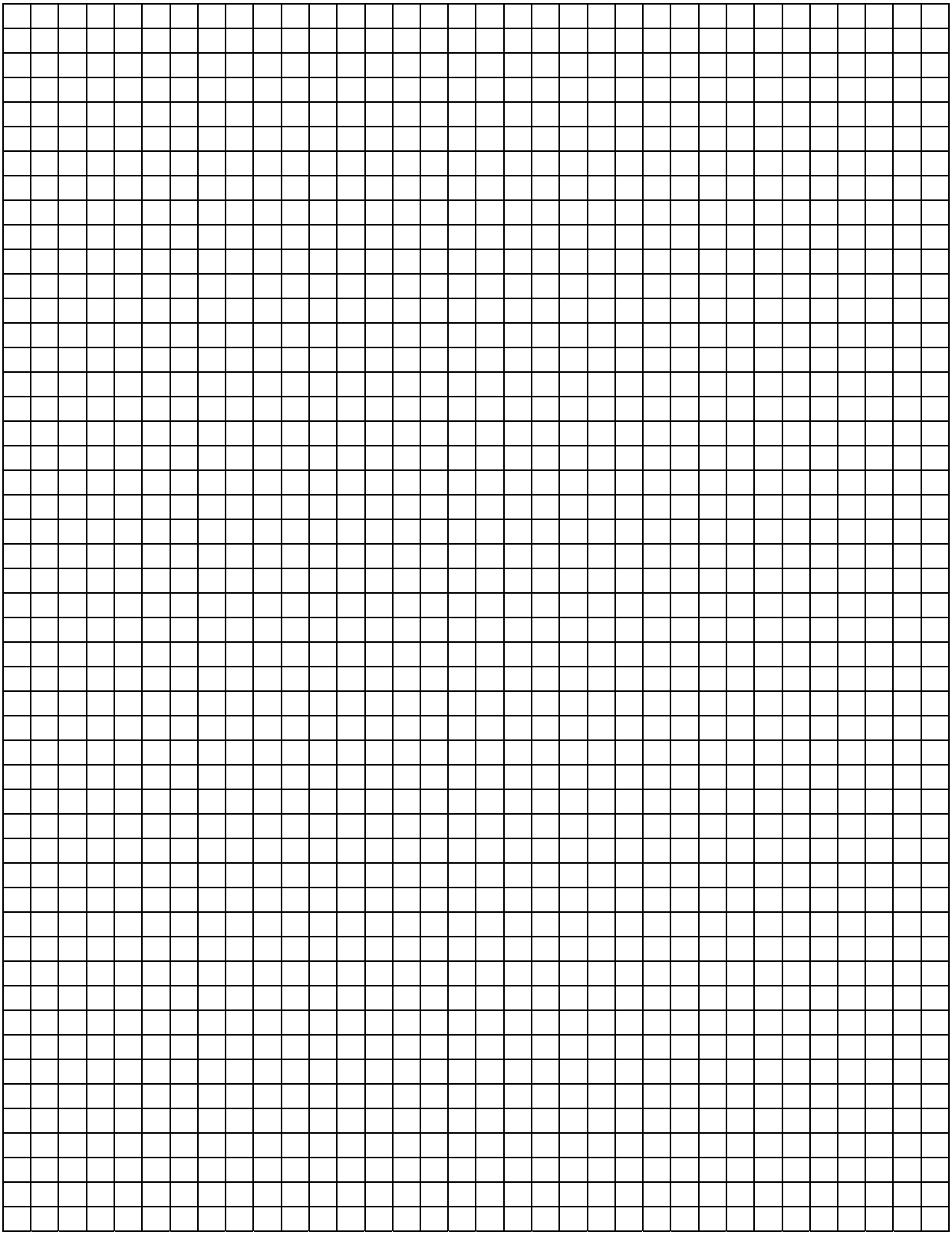
Did your answer using the graph match your answer using mathematical equations? (Circle one)

YES NO

Conclusion

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

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



NPS Photo by Rick Wood

Speleothems: A Webquest

Lesson Objective: After completing this webquest, students will have learned the fundamental characteristics of 14 of the most common types of speleothems.

Key Concepts: cave balloons, boxwork, cave flowers, coatings, columns, coralloids, draperies, flowstone, frostwork, helictites, moonmilk, cave pearls, stalactites, and stalagmites.

Duration: 1 55-minute class period

Audience: Middle school and high school students

NPS Photo by Rick Wood

Speleothems: A Webquest

Teacher Copy and Answer Key

Speleothems

Teacher Copy and Answer Key

Follow the directions below to access the "Views of the National Parks" Multimedia Education Program.

1.) Open the Views of the National Parks program using a Views CD/DVD or the internet at: http://www2.nature.nps.gov/views/#
2.) Select the "Multimedia Version"
3.) Open the "Knowledge Centers"
4.) Click on "Caves and Karst"
5.) Enter the module by clicking on "Explore Caves and Karst"
6.) Click on "Underground" in the top menu bar
7.) Select the "Speleothems" side bar

Answer the following questions as you read through the speleothems section of the Caves and Karst Knowledge Center.

1. **The one thing that all speleothems have in common is where they form. Explain how the water table influences the formation of caves and their speleothems.**

   ALTHOUGH THE FORMATION OF CAVES TYPICALLY TAKES PLACE BELOW THE WATER TABLE IN THE ZONE OF SATURATION, THE DEPOSITION OF SPELEOTHEMS IS NOT POSSIBLE UNTIL CAVES ARE ABOVE THE WATER TABLE IN THE ZONE OF AERATION. AS SOON AS THE CHAMBER IS FILLED WITH AIR, THE STAGE IS SET FOR THE DECORATION PHASE OF CAVE BUILDING TO BEGIN.

2. **What does the term "speleothem" refer to? Give an example.**

   IT REFERS TO THE MODE OF OCCURRENCE OF A MINERAL - I.E., ITS MORPHOLOGY OR HOW IT LOOKS IN A CAVE, NOT ITS COMPOSITION

3. **What is the most common cave mineral?**

   CALCITE

Learn about 14 different types of speleothems by clicking on each type and then answering the following questions.

1. Cave Balloons

a. **Complete the following sentence about cave balloons:**

"Cave balloons are *ROUND* - shaped, *THIN* - walled speleothems with *GAS* inside of a mineralized bag-like *POUCH* ."

b. **Explain why cave balloons are so rare and fragile.**

IT IS BELIEVED THAT BALLOONS ARE SHORT-LIVED; THEY QUICKLY DRY, CRACK, DEFLATE, AND CHANGE IN LUSTER (ESPECIALLY IN LOW HUMIDITY ENVIRONMENTS).

c. **The picture shown is from Mammoth Cave National Park. Name another national park would you could find an impressive display of cave balloons?**

JEWELL CAVE NATIONAL MONUMENT

2. Boxwork

a. **What does boxwork resemble?**

BOXWORK RESEMBLES A MAZE OF POST OFFICE BOXES

b. **What does a mineral need to be in order for it to create boxwork?**

BOXWORK CAN BE COMPOSED OF ANY MINERAL MORE RESISTANT THAN IT'S SURROUNDING MEDIUM.

c. **Boxwork is mostly composed of what mineral?**

CALCITE

3. Cave Flowers

a. **What is the mineral that typically forms cave flowers?**

GYPSUM

b. **Use the picture and text to name 2 national parks where you can find gypsum flowers.**

CARLSBAD CAVERNS and MAMMOTH CAVE NATIONAL PARKS

4. Coatings

a. List 4 places in a cave that you could find cave coatings:

- *WALLS*
- *FLOORS*
- *CEILINGS*
- *POOLS*

b. What type of cave mineral can form cave coatings? Be specific and use examples.

PRACTICALLY EVERY CAVE MINERAL KNOWN CAN FORM COATINGS. THIS INCLUDES COMMON MINERALS, LIKE CALCITE AND ARGONITE, AS WELL AS RARE MINERALS THAT CONTAIN ELEMENTS SUCH AS MAGNESIUM AND IRON.

5. Columns

a. How is a column formed?

COLUMNS FORM WHEN A STALAGMITE GROWS TOGETHER WITH ITS COUNTERPART FEEDER STALACTITE.

b. Why are the largest cave columns usually found along ceiling joints?

THIS IS WHERE THE GREATEST AMOUNT OF WATER IS DRIPPING INTO A CAVE.

6. Coralloids

a. What does the term coralloid describe?

CORALLOID (OR CORALLITE) IS A CATCHALL TERM THAT DESCRIBES KNOBBY, NODULAR, BOTRYOIDAL, OR CORAL-LIKE SPELEOTHEMS.

b. List 3 examples of speleothems that can be considered coralloids:

Possible answers include:

- *CAVE POPCORN*
- *GRAPES*
- *KNOBSTONE*
- *CORAL*
- *CAULIFLOWER*
- *GLOBULARITES*
- *GRAPEFRUIT*

c. Where can coralloids form?

CORALLOIDS CAN FORM BOTH IN THE OPEN AIR AND UNDERWATER.

7. Draperies

a. Describe the formation of cave draperies.

DRAPERIES FORM WHEN WATER DROPS FLOW DOWN A SLOPED CEILING BEFORE DRIPPING TO THE FLOOR, AND CALCITE BUILDS UP IN A LINE. THESE LINES GRADUALLY BUILD UP TO FORM DRAPERIES.

b. What are 2 sources that can give draperies bacon-like stripes?

IRON OXIDE OR ORGANIC SOLUTIONS

8. Flowstone

a. What is flowstone usually composed of?

CALCITE OR OTHER CARBONATE MINERALS

b. How are the minerals of flowstones deposited?

FLOWING WATER DEPOSITS MINERALS IN LAYERS OR BANDS

c. Explain the difference between flowstone and coatings.

FLOWSTONES FORM FROM DEPOSTS OF FLOWING WATER;
COATINGS FORM FROM DEPOSITS OF SEEPING WATER.

d. Flowstones can resemble a petrified or frozen _____*WATERFALL*_____.

9. Frostwork

a. The needle-like habit of what type of mineral gives most frostwork their particular appearance?

ARAGONITE

b. Frostwork is most commonly found with _____ *CORALLOIDS*_____ .

c. Explain a downside to the dazzling beauty of frostwork.

THEIR BEAUTY MAKES THEM PRIME TARGETS FOR VANDELISM.

10. Helictites

a. **What is the Greek root for the term helictite, and what does it mean?**

IT COMES FROM THE GREEK ROOT "HELIX", MEANING "TO SPIRAL".

b. **What is the one thing that all helictites have in common?**

THEY ALL POSSESS TINY CENTRAL CHANNELS THROUGH WHICH THEIR EXTREMITIES AND DIAMETERS ARE FED AND INCREASED BY SEEPING CAPILLARY WATER.

11. Moonmilk

a. **What does the milky appearance of moonmilk form from?**

MOONMILK'S FINE-GRAINED PARTICLES BECOME SUSPENDED IN WATER WHICH GIVES IT THE APPEARANCE OF MILK.

b. **What are 4 medicinal purposes of moonmilk?**

- *A POULTICE TO STOP BLEEDING*
- *FOR DIARRHEA*
- *FOR FEVERS*
- *AS AN ANTACID*

12. Cave Pearls

a. **List 4 objects that cave pearls have been compared to:**

Possible answers include:

- *MARBLES*
- *HAILSTONES*
- *CUPCAKES*
- *CIGARS*
- *ORANGES*
- *PIGEON'S EGGS*
- *BALLS*
- *PEARLS*

b. **Where do cave pearls normally grow?**

IN SHALLOW CAVE POOLS

c. **How do sand grains and bat bones influence the growth of cave pearls?**

THEY CAN ACT AS NUCLEI FOR CAVE-PEARL GROWTH; THEY BECOME ROUNDED AS THEY GROW INTO CAVE PEARLS OF DIFFERENT SHAPES.

13. Stalactites

a. What do stalactites resemble and where are they found?

STALACTITES RESEMBLE ICICLES OR CARROTS HANGING FROM CAVE CEILINGS

b. What do all stalactites begin their growth as?

SODA STRAWS

c. Describe the first stage in the growth of a stalactite.

A WATER DROPLET COLLECTS ON THE CAVE CEILING BY CONDENSATION OR BY WATER COMING THROUGH A FRACTURE IN A ROCK.

d. What sticks or "adheres" the thin film of carbonate material left behind by a water droplet to the ceiling of a cave?

SURFACE TENSION

e. As long as water continues to drip, what eventually develops and is enlarged by the dripping water?

A HOLLOW TUBE (OR SODA STRAW)

14. Stalagmites

a. What are stalagmites?

THEY ARE CONVEX FLOOR DEPOSITS BUILT UP BY WATER DRIPPING FROM AN OVERHEAD STALACTITE OR FROM THE CAVE CEILING.

b. How does the splash of falling water droplets affect the growth of stalagmites?

IT CAUSES THE STALAGMITES TO SPREAD OUT AS THEY GRADUALLY BUILD UP FROM THE FLOOR

c. Describe the difference between the top of a stalagmite and the tip of a stalactite.

STALAGMITES HAVE ROUNDED TOPS; STALACTITES HAVE POINTED TIPS.

NPS Photo by Rick Wood

Speleothems: A Webquest

Student Copy

Speleothems

Follow the directions below to access the "Views of the National Parks" Multimedia Education Program.

1.) Open the "Views of the National Parks" program using a Views CD/DVD or the internet at: http://www2.nature.nps.gov/views/#
2.) Select the "Multimedia Version"
3.) Open the "Knowledge Centers"
4.) Click on "Caves and Karst"
5.) Enter the module by clicking on "Explore Caves and Karst"
6.) Click on "Underground" in the top menu bar
7.) Select the "Speleothems" side bar

Answer the following questions as you read through the speleothems section of the Caves and Karst Knowledge Center.

1. **The one thing that all speleothems have in common is where they form. Explain how the water table influences the formation of caves and their speleothems.**

2. **What does the term "speleothem" refer to? Give an example.**

3. **What is the most common cave mineral?**

Learn about 14 different types of speleothems by clicking on each type and then answering the following questions.

1. Cave Balloons

a. Complete the following sentence about cave balloons:

"Cave balloons are _____ - shaped, _____ - walled speleothems with _____ inside of a mineralized bag-like _____."

b. Explain why cave balloons are so rare and fragile.

c. The picture shown is from Mammoth Cave National Park. Name another national park would you could find an impressive display of cave balloons?

2. Boxwork

a. What does boxwork resemble?

b. What does a mineral need to be in order for it to create boxwork?

c. Boxwork is mostly composed of what mineral?

3. Cave Flowers

a. What is the mineral that typically forms cave flowers?

b. Use the picture and text to name 2 national parks where you can find gypsum flowers.

4. Coatings

a. List 4 places in a cave that you could find cave coatings:

-
-
-
-

b. What type of cave mineral can form cave coatings? Be specific and use examples.

5. Columns

a. How is a column formed?

b. Why are the largest cave columns usually found along ceiling joints?

6. Coralloids

a. What does the term coralloid describe?

b. List 3 examples of speleothems that can be considered coralloids:

-
-
-

c. Where can coralloids form?

7. Draperies

a. **Describe the formation of cave draperies.**

b. **What are 2 sources that can give draperies bacon-like stripes?**

8. Flowstone

a. **What is flowstone usually composed of?**

b. **How are the minerals of flowstones deposited?**

c. **Explain the difference between flowstone and coatings.**

d. **Flowstones can resemble a petrified or frozen _____.**

9. Frostwork

a. **The needle-like habit of what type of mineral gives most frostwork their particular appearance?**

b. **Frostwork is most commonly found with _____.**

c. **Explain a downside to the dazzling beauty of frostwork.**

10. Helictites

a. What is the Greek root for the term helictite, and what does it mean?

b. What is the one thing that all helictites have in common?

11. Moonmilk

a. What does the milky appearance of moonmilk form from?

b. What are 4 medicinal purposes of moonmilk?

-
-
-
-

12. Cave Pearls

a. List 4 objects that cave pearls have been compared to:

-
-
-
-

b. Where do cave pearls normally grow?

c. How do sand grains and bat bones influence the growth of cave pearls?

13. Stalactites

a. **What do stalactites resemble and where are they found?**

b. **What do all stalactites begin their growth as?**

c. **Describe the first stage in the growth of a stalactite.**

d. **What sticks or "adheres" the thin film of carbonate material left behind by a water droplet to the ceiling of a cave?**

e. **As long as water continues to drip, what eventually develops and is enlarged by the dripping water?**

14. Stalagmites

a. **What are stalagmites?**

b. **How does the splash of falling water droplets affect the growth of stalagmites?**

c. **Describe the difference between the top of a stalagmite and the tip of a stalactite.**

NPS Photo by Rick Wood

Cave Life: A "Jigsaw" Activity

Lesson Objective: After reading an assigned text on cave animal classifications or cave zones, students will be able to answer questions relative to their text and then present the information to their cooperative group members.

Key Concepts: cave life; cave zones: entrance zone, twilight zone, variable temperature zone and complete darkness, and dark zone; cave animal classification: trogloxenes, troglophiles, and troglobites; cooperative learning.

Duration: 1 55-minute class period

Audience: Middle school and high school students

NPS Photo by Rick Wood

Cave Life

Teacher Copy and Answer Key

CAVE LIFE: TEACHER COPY

A "Jigsaw" Cooperative Learning Strategy

Lesson Objective:

After reading an assigned text on cave life, students will be able to answer questions about the text and present the information to their group members.

Materials:

1. Cave Life Facts Sheets (4 different fact sheets for each group).
2. Cave Life Worksheets for each student

Teacher Instructions:

1. Predetermine groups of 4 students and assign a different cave animal fact sheet to each group member.
2. At the beginning of class, have students get together in their assigned groups.
3. Explain how a jigsaw works:
    a. Explain that the students will have 10 minutes to independently read their assigned section and answer the questions.
    b. Next, the students will get together in 4 large groups to briefly discuss the answers to the questions for their assigned selections and share key concepts. (Should take no more than about 8 minutes).
    c. Finally, they will get back together in their original groups of 4 and report out their answers and key concepts to their group members.
        i. This will take the rest of the class period: Approximately 8 minutes per group member.
4. After the activity has been explained, begin by passing out the 4 different fact sheets to each group.
    a. Depending on the nature of the class/groups, the teacher may decide to assign selections because some have more text than others.
5. The teacher's role for the rest of the class is to keep track of time and monitor that each student/group remains on-task.

Suggested Answers:

The 4 Life Zones of Cave

- **1st Zone =** *ENTRANCE ZONE*

  a. This life zone supports what kind of organisms?

  ORGANISMS THAT NEED FULL SUNLIGHT FOR SURVIVAL

  b. What are 3 examples of organisms that are found here?

  POSSIBLE ANSWERS: FERNS, MOSSES, SNAILS, SPIDERS, MOTHS, AND WILDFLOWERS

- **2nd Zone =** *TWILIGHT ZONE*

  a. Where does this zone start and extend to?

  THIS ZONE STARTS AT THE ENTRANCE OF THE CAVE AND EXTENDS TO THE FARTHEST POINT IN THE CAVE THAT SUNLIGHT REACHES.

  b. What are 3 examples of organisms that are found here?

  MOSS, BATS, SKUNKS, FROGS, AND PACK RATS

- **3rd Zone =** *VARIABLE TEMPERATURE ZONE AND COMPLETE DARKNESS*
- **4th Zone =** *DARK ZONE*

  a. What characterizes this zone?

  A COMPLETE LACK OF SUNLGHT

  b. Describe what organisms in this zone must have in order to survive?

  THE ORGANISMS MUST HAVE SPECIAL ADAPTATONS THAT ALLOW THEM TO SURVIVE IN DARK CONDITIONS.

Trogloxenes

1.) What are the Greek words that "trogloxene" came from and what do the words mean?

"TROGLOS" (CAVE) AND "XENOS" (GUEST)

2.) What are 3 possible reasons for these animals to spend their time in caves?

- *TO FIND REFUGE FROM THE ELEMENTS*
- *TO HIBERNATE*
- *TO BEAR THEIR YOUNG*

3.) What are 3 examples of trogloxenes:

POSSIBLE ANSWERS: BATS, SKUNKS, RACOONS, MOTHS, FROGS, BEETLES, SOME BIRDS, AND PEOPLE.

4.) What are the special adaptations these organisms have that help them survive in caves?

NONE - THESE ANIMALS SHOW NO SPECIAL ADAPTATIONS TO CAVE ENVIRONMENTS.

Troglophiles

1.) What are the Greek words that "troglophile" came from and what do the words mean?

"TROGLOS" (CAVE) AND "PHILEO" (LOVE)

2.) How can troglophiles live outside of a cave?

IF THE ENVIRONMENT IS MOIST AND DARK

3.) Why do you think a troglophile would venture outside of the cave?

TO FIND FOOD

4.) What are 3 examples of troglophile:

POSSIBLE ANSWERS: EARTHWORMS, SALAMANDARS, BEETLES, CRUSTEANS (CRAYFISH).

5.) If an animal of a particular species is a troglophile, do all the other animals of the same species also have to be one? Explain.

SOME TROGLOPHILES MAY SPEND THEIR ENTIRE LIFE CYCLE IN A CAVE, BUT OTHER INDIVIDUALS OF THE SAME SPECIES LIVE OUTSIDE.

Troglobites

1.) What are the Greek words that "troglobite" came from and what do the words mean?

"TROGLOS" (CAVE) AND "BIOS" (LIFE)

2.) Where are troglobite found?

THEY LIVE PERMANENTLY IN THE DARK ZONES OF CAVES AND ARE FOUND EXCLUSIVELY IN CAVES.

3.) Describe how the physical adaptations of these organisms are devoted to sustaining energy.

THE PHYSICAL ADAPTATIONS THAT PROVIDE A BENEFIT ARE ENHANCED, AND THOSE THAT DO NOT ARE DEGENERATED.

4.) What are 2 features that these organisms do not have that are adaptations to the lack of sunlight?

EYES AND PIGMENT (COLOR)

5.) From which group of cave animals did troglobites evolved from?

TROGLOPHILES

As a group:

Cave animals have developed different adaptations depending on where, and how long, they live in caves. **Give a brief explanation of another group of animals that have developed adaptations specific to where they live.**

Example Answers:

1. THE LONG NECK OF A GIRAFFE ALLOWS THEM TO FEED ON THE PLANT MATERIAL AT THE TOPS OF TREES. IN AN ENVIRONMENT WHERE VEGETATION CAN BECOME SCARCE DURING THE DRY SEASONS, THIS HELPS GIRAFFES EAT FOOD THAT ISN'T AVAILABLE TO OTHER (SHORTER) SPECIES.

2. THE KIDNEYS OF DESERT ANIMALS, SUCH AS THE KANGAROO MOUSE, HAVE EVOLVED TO RETAIN AS MUCH WATER AS POSSIBLE. THIS ALLOWS THESE SPECIES TO SURVIVE IN ARID ENVIRONMENTS.

NPS Photo by Rick Wood

Cave Life

Activity Fact Cards

The 4 Life Zones of Caves

Diagram courtesy of Ron Kerbo

Cave experts are now acknowledging 4 life zones within caves: the entrance zone, the twilight zone, the zone of variable temperatures and total darkness, and the dark zone.

The **entrance zone** supports those organisms that need full sunlight for survival. For example, ferns and mosses thrive in the cool, moist condition of a cave, but require sunlight for photosynthesis. Other examples of plants and animals that may live in this zone are snails, spiders, moths and wildflowers.

The **twilight zone** is next in the series of cave zones. This area extends from the entrance of the cave to the farthest point in the cave that sunlight reaches. Some plants may be able to grow in these conditions, like moss, and many animals are found living or visiting this zone. Examples include bats, skunks, frogs, and pack rats.

There is a transition zone between the twilight zone and the final zone and it is appropriately named the **variable temperature zone and total darkness**. This zone has only recently been considered to be a distinct cave life zone, but is becoming increasingly acknowledged by cave experts.

The final zone is the **dark zone**, which is characterized by a complete lack of sunlight. Organisms that live in this zone must have special adaptations that allow them to survive in dark conditions, such as the adaptations of the non-green plants and blind cave fish. These organisms are called troglobites, and live no where else on earth but in the dark depths of caves.

NPS Photo by Rick Wood

Trogloxenes

The word trogloxene comes from the Greek words "troglos" (cave) and "xenos" (guest). They are cave visitors or temporary cave residents, and move freely in and out of caves.

For trogloxenes, caves provide refuge from the elements, a cozy place to spend the winter, or an acceptable environment to bear their young. For example, some trogloxenes, like bears, prefer the constant cave temperatures for hibernation. No matter how much time they spend in caves, trogloxenes never complete their entire life cycle in them.

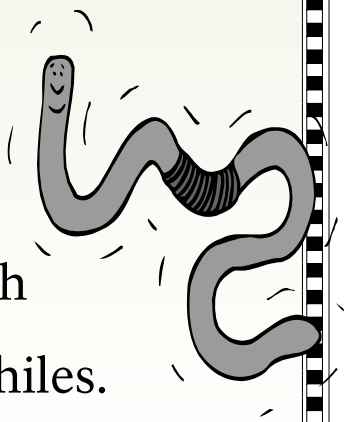
Bats are probably the best known trogloxene. Skunks, raccoons, packrats, moths, frogs, beetles, some birds, and people are other examples of trogloxenes. Because these animals are not dependent on caves for their survival, they show no special adaptations to cave environments.

NPS Photo by Rick Wood

Troglophiles

Troglophiles ***love*** caves. The name troglophile itself comes from the Greek words troglos (cave) and phileo (love).

Troglophiles normally live in the dark zones of caves, but they can and do survive outside caves, provided the environment is moist and dark. For example, although some troglophiles prefer to stay in the cave, sometimes they have to venture out to find food.

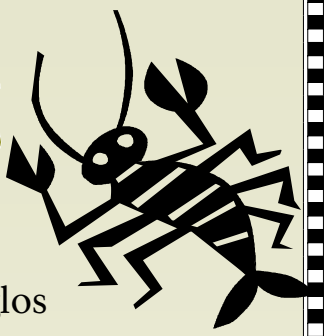


Earthworms are a good example; some types of salamanders, crustaceans (such as crayfish), and beetles are also troglophiles.

Some individual troglophiles may spend their entire life cycle in a cave, but other individuals of the same species live outside.

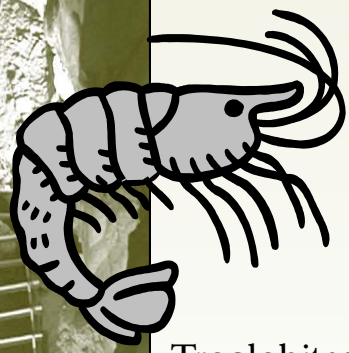
NPS Photo by Rick Wood

Troglobites



The word troglobite comes from the Greek words troglos (cave) and bios (life). Troglobites are life forms that live permanently in the dark zones of caves and are found exclusively in caves. Troglobites cannot survive outside of the cave environment, and they have developed special adaptations for living their entire lives in caves.

Because food sources in caves are meager, the sensory organs and physical adaptations of troglobites are devoted to sustaining energy and finding food: those that provide a benefit are enhanced; those not necessary are degenerated.



While some physical structures have been lost, others have been enhanced, Examples include longer legs and antennae, or feelers. These types of adaptations enable them to go for long periods of time with little food.

Troglobites have no eyes or eyes that are poorly developed. Eyes are not necessary because of the lack of light. Most troglobites are white to pinkish in color. They lack pigment (color) because they have no need for protection from the sun's rays or for camouflage to hide them from predators.

In general, existing troglobites have evolved from troglophiles. Examples include cave fish, cave crayfish, cave shrimp, some cave salamanders and insects.

NPS Photo by Rick Wood

NPS Photo by Rick Wood

Cave Life

Student Copy

CAVE LIFE

Cave animals fit into three categories: **trogloxenes**, **troglophiles**, and **troglobites**. These categories are based on the amount of time cave animals spend in caves. Are they just visitors? Can they survive outside the cave environment? And what do you call the places in a cave where these animals live?

During this activity you will learn the differences between the 3 categories of cave life, and become familiar with the 4 cave life zones. You will work cooperatively with your group members to learn the material and answer the questions below.

The 4 Life Zones of Cave

- **1st Zone** = _____
    a. This life zone supports what kind of organisms?

    b. What are 3 examples of organisms that are found here?

- **2nd Zone** = _____
    a. Where does this zone start and extend to?

    b. What are 3 examples of organisms that are found here?

- **3rd Zone** = _____
- **4th Zone** = _____
    a. What characterizes this zone?

    b. Describe what organisms in this zone must have in order to survive?

Trogloxenes

1.) What are the Greek words that "trogloxene" came from and what do the words mean?

2.) What are 3 possible reasons for these animals to spend their time in caves?

-
-
-

3.) What are 3 examples of trogloxenes:

-
-
-

4.) What are the special adaptations these organisms have that help them survive in caves?

Troglophiles

1.) What are the Greek words that "troglophile" came from and what do the words mean?

2.) How can troglophiles live outside of a cave?

3.) Why do you think a troglophile would venture outside of the cave?

4.) What are 3 examples of troglophiles:

-
-
-

5.) If an animal of a particular species is a troglophile, do all the other animals of the same species also have to be one? Explain.

Troglobites

1.) What are the Greek words that "troglobite" came from and what do the words mean?

2.) Where are troglobites found?

3.) Describe how the physical adaptations of these organisms are devoted to sustaining energy.

4.) What are 2 features that these organisms do not have that are adaptations to the lack of sunlight?

5.) From which cave animal group have troglobites evolved?

As a group:

Cave animals have developed different adaptations depending on where, and how long, they live in caves. **Give a brief explanation of another group of animals that have developed adaptations specific to where they live.**

NPS Photo by Rick Wood

Present a Cave

Lesson Objective: After completing this cooperative learning activity students will be able to create an oral and visual presentation on a national park cave and karst resource.

Key Concepts: National Park Service cave and karst resources; investigation; cooperative learning.

Duration: 3-4 55-minute class periods (1-day for introduction and initial investigation; 1-2 days for research and project design; 1-2 days for presentations).

Audience: Middle school and high school students

NPS Photo by Rick Wood

Present a Cave

Teacher Copy and Answer Key

PRESENT A CAVE: TEACHER COPY

Lesson Objective:

After completing this lesson the students will be able to create an oral and visual presentation on a National Park cave and karst resource.

Materials:

1. 1 National Park Service Caves and Karst Facts Sheet for each group (8 total fact sheets available).
2. Present a Cave: Investigation and Planning Worksheet for each student.
3. Peer Evaluation Form for each student.
4. Group Member Evaluation Form for each student.
5. Access to the internet (for additional research).

Teacher Instructions:

1. Divide the class into cooperative learning groups of 3 to 4 students.
2. Assign each group one of the fact sheets.
3. Ask the students to read the fact sheet as a group and take notes on important concepts using the Jigsaw Worksheet.
4. Using the worksheet, groups should also plan how they will visually present information about their topic to their classmates.
    a. Examples might include a poster, a diorama, overheads, a power point presentation, a brochure, or a picture book.
    b. Encourage students to be creative, but emphasize that they need to present the information in a way that provides their classmates with the key information of the resource.

c. Encourage students to include information on not only the cave formation topics, but also any other cultural or historic information relating to the cave.

5. Give the students adequate time to prepare their presentations.
   a. Presentations should include:
      i. General information on their designated cave and karst resource.
      ii. Information that incorporates their designated topic with what they have learned already about cave and karst formation, fossils, sedimentation, porosity, etc.
      iii. Pictures and/or illustrations of their cave and karst resource.
   b. Students will benefit from having a class period to do additional research via the internet.
      i. The Views of the National Parks website and the National Park Service Caves and Karst Program website can both be invaluable resources for additional information.

   The National Park Service Caves and Karst website: http://www2.nature.nps.gov/geology/caves/program.htm

   The Views of the National Parks website is located at: http://www2.nature.nps.gov/views/

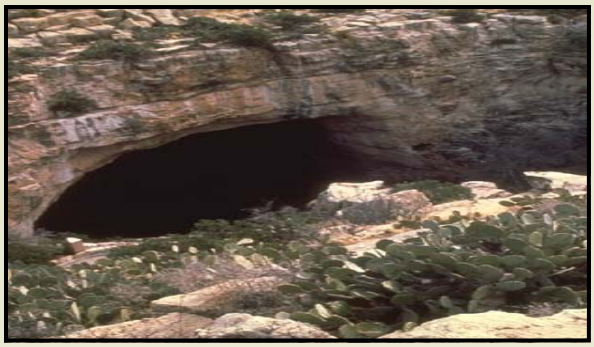
6. At the end of each presentation, students will fill out a:
   a. **Peer Evaluation Form** for each group.
   b. **Group Member Evaluation Form** for each of their group members.

NPS Photo by Rick Wood

Present a Cave

Activity Fact Cards

Carlsbad Caverns . . . New Mexico



NPS Photo by Rick Wood

A Journey Underground

Your encounter with Carlsbad Caverns National Park begins near the Chihuahuan Desert of the Guadalupe Mountains. But beyond the somewhat familiar surroundings of rugged mountains and broad plains is another world. Away from the sunlight, away from the flowering cactus, away from the songs of the desert birds and the howl of the coyote, lies the celebrated underground world of Carlsbad Cavern. It is an incomparable realm of gigantic subterranean chambers, fantastic cave formations, and extraordinary features.

The Formation of the Cavern

The story of the creation of Carlsbad Cavern begins 250 million years ago with the creation of a 400-mile-long reef in an inland sea that covered this region. This horseshoe-shaped reef formed from the remains of sponges, algae, seashells and from calcite that precipitated directly from the water. Cracks developed in the reef as it grew seaward. Eventually the sea evaporated and the reef was buried under deposits of salts and gypsum.

Then, a few million years ago, uplift and erosion of the area began to uncover the buried rock reef. Rainwater, made slightly acidic from the air and soil, seeped down into the cracks in the reef, slowly dissolving the limestone and beginning the process that would form large underground chambers. Many geologists believe that the fresh rainwater mixed with deeper salty water to form sulfuric acid. The added power of this very corrosive substance could explain the tremendous size of the passageways that formed. The exposed reef became a part of the Guadalupe Mountains and the huge underground chambers far below the surface became the natural wonders of Carlsbad Cavern.

The Cave is Decorated, Drop by Drop

The decoration of Carlsbad Cavern with stalactites, stalagmites, and an incredible variety of other formations began more than 500,000 years ago after much of the cavern had been carved out. It happened slowly, drop by drop, at a time when a wetter, cooler climate prevailed. The creation of each formation depended on water that dripped or seeped down into the limestone bedrock and into the cave. As a raindrop fell to the ground and percolated downward, it absorbed carbon dioxide gas from the air and soil, and a weak acid was formed. As it continued to move downward the drop dissolved a little limestone, absorbing a bit of the basic ingredient needed to build most cave formations the mineral calcite. Once the drop finally emerged in the cave, the carbon dioxide escaped into the cave air. No longer able to hold the dissolved calcite, the drop deposited its tiny mineral load as a crystal of calcite. Billions and billons of drops later, thousands of cave formations had taken shape.

And, oh, the shapes they took!

Carlsbad Cavern photos from the National Park Service Digital Image Archives

NPS Photo by Rick Wood

Jewel Cave . . .

South Dakota

Exploring Jewel Cave

The exploration of Jewel Cave began about 1900 when two South Dakota prospectors, Frank and Albert Michaud, and a friend, Charles Bush, happened to hear wind rushing through a hole in the rocks in Hell Canyon. Enlarging the hole, they found a cave full of sparkling crystals. They filed a mining claim on the "Jewel Lode," but they found no valuable minerals. Therefore, instead of mining the cave they tried turning the cave into a tourist attraction.

The business was never a success, but the cave did attract attention. In 1908 Jewel Cave National Monument was established to protect the small but extraordinary cave. Fifty years later exploration of the cave suddenly intensified.

Into the Unknown

When Herb and Jan Conn were first persuaded to join a caving expedition in Jewel Cave in 1959, the couple responded without enthusiasm. Their passion was rock climbing, not crawling around in dark, gloomy holes. Little did they know they would spend much of the next 21 years in Jewel Cave, lured by the thrill of discovering the secrets of yet another mile of never before-seen cave.

“Our exploration of Jewel Cave, which started out as a mild diversion, quickly mushroomed into an all-absorbing interest," the Conns explain in their book *The Jewel Cave Adventure*. On a typical day, the Conns and their fellow cavers spent 12 to 14 hours underground. Outfitted in hard hats, carbide lamps, gloves, loose fatigues, elbow and knee pads, and boots, the explorers squeezed, crawled, and climbed their way through Jewel Cave's complicated maze. The going was rough. During rest stops they munched on mangled sandwiches and squashed fruit while massaging sore muscles. Names they gave to some passages, such as Contortionist's Delight and The Miseries, tell the story.

As years passed and more miles of cave were found, it became apparent that Jewel Cave was one of the world's most extensive caves, full of scenic and scientific wonders. The explorers found chambers with exquisite calcite crystals and rare cave formations. One much-decorated room discovered by the Conns - the Formation Room - is a highlight of the Scenic Tour today. They also found rooms as large as 150 by 200 feet, passageways as long as 3,200 feet, and a place where the cave wind blows at speeds of up to 32 miles per hour. The cave, they discovered, is truly a rare and precious jewel.

The caving parties led by this husband-and-wife team would make 708 trips into the cave and log 6,000 hours exploring and mapping. Modern-day cavers have discovered new wonders with more than 80 miles of passages, and today the cave is among the world's longest and is renowned for its variety of formations.

In 1980, after discovering more than 65 miles of cave, the Conns retired. A new generation of cavers has already pushed the known boundaries of the cave to more than 80 miles. But the mystery remains. As the Conns have said, "We are still just standing on the threshold."

Jewel Cave photos from the National Park Service Digital Image Archives

NPS Photo by Rick Wood

Wind Cave...

South Dakota

To witness the beginning of the formation of Wind Cave, one of the world's oldest caves, you would have to have been here 320 million years ago. At that time parts of the limestone that constitute the upper levels of Wind Cave were being dissolved into cave passage-ways. As ancient ocean levels fluctuated, these passages were filled with sediments. Beneath the ocean, a thick layer of sediments continued to be deposited above that limestone.

About 60 million years ago, the forces that uplifted the Rocky Mountains also uplifted the modern Black Hills producing large fractures and cracks in the overlying limestone. Over millions of years, water moving slowly through those cracks dissolved the limestone to produce the complex maze of the cave's passages.

Erosion later changed surface drainage patterns and caused subsurface water levels to drop, draining the cave passages. As the modern Wind Cave formed, many of these newer passages intersected the original cave, revealing the red clay and sandstone sediments from 320 million years ago.

It was after the cave formed that most of the colorful cave formations began to decorate its walls. One of the most prominent features in Wind Cave is **boxwork** (see photo below) - thin, honeycomb-shaped structures of calcite that

protrude from the walls and ceilings. Nowhere else in the world can such a large display be seen. Some of the better known cave formations, such as stalactites and stalagmites, are rare here.

You might wonder if after more than 100 years of exploration there is anything new to discover in Wind Cave. Barometric wind studies estimate that approximately five percent of the total cave has been discovered. In 1891 Alvin McDonald wrote in a diary of his cave trips:

"*Have given up the idea of finding the end of Wind Cave.*"

The better equipped cavers of today have not given up. They are continuing to push farther and farther into the cave's cool, black recesses.

Photos from the National Park Service Cave and Karst Program

Timpanogos Cave . . .

Utah

Photo Source: NPS Digital Image Archives

Underground Delights

Some of the earth's most powerful and most delicate forces combined to create the wonders of Timpanogos cave, beginning when the Wasatch Range was building 65 million years ago.

Many different types of cave formations have been created by water simply dripping or flowing into the caves. Perhaps the most well known of these are stalactites and stalagmites, which can be seen throughout the caves.

Photo Source: NPS Cave and Karst Program

Stalactites, which hang like icicles from the ceiling, form as drop after drop of water slowly trickles down through the cave roof. The smallest stalactites may be hollow and as thin and straight as a soda straw (see photo on left), and so are called soda straw stalactites. Others may be massive: The Great Heart of Timpanogos in Timpanogos Cave - 5¼ feet long, 3 feet wide, 4,000 pounds - is composed of three, or possibly more, tremendous stalactites that have grown together. The many colors of stalactites, and indeed all of the formations in the caves, are caused by traces of iron, nickel, magnesium, and organics.

Stalagmites are formed when mineral-laden water strikes the floor. The tallest stalagmite is about six feet high in Timpanogos Cave; most are smaller. Occasionally stalagmites and stalactites merge, forming a floor-to-ceiling column.

The caves' largest column, 13 feet high, is found in Hansen Cave.

The Cascade of Energy and the Chocolate Fountain, both in Timpanogos Cave, are examples of still a different type of formation - flowstone. As its name implies, the smooth coatings or sculpted terraces of flowstone are created when water flows down a wall or across a floor.

Another common formation - draperies - are created when water trickles down an inclined ceiling. Water, flowing down a sloped surface, can form draperies. If the chemical content of the water changes, staining can cause it to take on the appearance of bacon (see photo on right). A spectacular example of such a formation is the Frozen Sunbeam, a thin translucent sheet of orange-colored calcite in Timpanogos Cave. Draperies in these caves are seldom more than one inch thick.

Photo Source: NPS Cave and Karst Program

Still another, not quite so common type of formation that occurs in the caves is cave popcorn. Popcorn occurs where water seeps slowly through walls or ceilings. These knobby lumps are particularly abundant in Timpanogos Cave, where they occur mixed with helictites.

Today, the caves still are changing: new formations are being created, and existing ones are growing where mineral-laden water continues to enter. As long as water - the master architect and interior decorator - continues to trickle into the caves, creation will continue.

NPS Photo by Rick Wood

Oregon Caves...

NPS Photo by Rick Wood

Oregon Caves may surprise you. Small in size, it is rich in diversity. That richness can be found both underground amidst narrow, winding passageways and above ground where old growth forest harbors a fantastic array of animals and plants found nowhere else. You will discover a land rich in conifers, wildflowers, birds, and amphibians. An active marble cave and underground stream reveal the inside of one of the world's most diverse geologic realms.

Photos from the National Park Service Cave and Karst Program

Discovery, Development and Rebirth

As his last match flickered out, 24-year-old hunter Elijah Davidson found himself in the total blackness of the cave. Davidson was chasing after his dog Bruno, who in turn was pursuing a bear. One following the other, the dog and bear entered a dark hole high on the mountainside. Davidson stopped at the mysterious dark entrance. He could see nothing, but an agonizing howl pulled him into the cave to save his dog. Now the matches were gone and Davidson was in total darkness. Fortunately, he was able to wade down a gurgling, ice-cold stream and find his way back into daylight. Bruno soon followed. It was 1874.

Later, other brave souls explored deeper into the cave, returning home to tell of its great beauty and mystery. In 1907, a party of influential men, including Joaquin Miller, the "poet of the Sierras," visited the cave. Charmed by it, Miller wrote of the "Marble Halls of Oregon." The ensuing publicity alerted federal officials to the possibility of preserving the cave. In 1909 President William Howard Taft proclaimed a

Oregon

area of 480 acres as Oregon Caves National Monument. In 1922 an automobile road reached the park, and 12 years later a six-story hotel, the Chateau, was constructed. The same year, 1934, Oregon Caves National Monument was transferred from the Forest Service to the National Park Service, which still administers it.

Workers blasted tunnels and widened passages in the cave during the 1930s. They put waste rocks in side passages, covering many limestone formations. Changes in air flow patterns altered the growth of formations and caused greater swings in temperature. Freezing water now cracked rock layers. Lights in the cave promoted the growth of algae, which turned portions of the cave green and dissolved some formations. Smoke from torches and lint coming off visitors' clothing blackened other portions.

Since 1985 the National Park Service has removed more than a thousand tons of rubble in its efforts to restore the cave. Transformers, asphalt trails, and cabins were removed to prevent sewage or oils from leaking into the cave from the surface. Thousands of formations buried under rubble were uncovered. Crystal clear water once again cascades over white marble. Some broken formations have been repaired with epoxy and powdered marble. Airlocks have restored natural cave winds by blocking airflow in artificial tunnels. Spraying with bleach keeps the algae under control. The new lighting and trail system will reduce evaporation and unnatural foods, which have attracted surface insects and driven out native species.

Not everything has been or can be restored. For example, the dissolution and formation of cave decorations are in delicate balance with the amount of carbon dioxide in the air and water. A global increase of this gas in the atmosphere, caused largely by deforestation and burning of fossil fuels, is affecting this balance. Still, one can now see a renewed cave, a valuable benchmark against which we can measure human impacts, now and in years to come.

NPS Photo by Rick Wood

Great Basin-Lehman Caves ...Nevada

Great Basin National Park

Great Basin National Park, established in 1986, includes much of the southern Snake Range, a superb example of a desert mountain island. From the sagebrush at its alluvial base to the 13,063-foot summit of Wheeler Peak, the park includes streams, lakes, alpine plants, abundant wildlife, a variety of forest types including groves of ancient bristlecone pines, and numerous limestone caverns, including beautiful **Lehman Caves**.

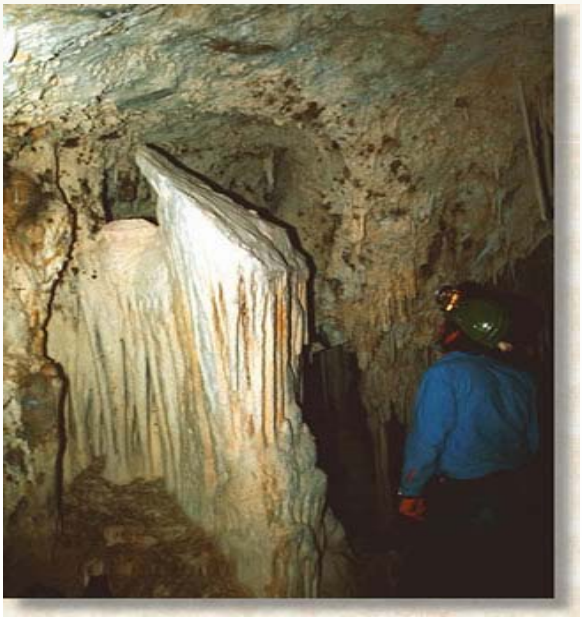
The Underground World of Lehman Caves

A single cavern, despite the name, extends a quarter-mile into the limestone and low-grade marble that flanks the base of the Snake Range. Discovered in about 1885 by Absalom Lehman, a rancher and miner, this cavern is one of the most richly decorated caves in the country, a small but sparkling gem.

What we see today began millions of years ago. The climate then was much wetter than it is now. Rain water, turned slightly acidic by seeping past surface vegetation and humus, found its way into hairline cracks deep in the native limestone. Trickling downward, the water dissolved the stone, enlarging the cracks, eventually reaching the water table. There it collected in sufficient quantity to create whole rooms. At one time, an underground stream flowed here, leaving behind tell-tale ripple marks.

Eventually the climate turned drier; water drained from the cave, leaving smooth walls and hollow rooms. Then came the second stage of cave development. Small amounts of water still percolated down from the surface. But now, instead of enlarging the cavern, the mineral-rich fluid began filling it once again. Drop by drop, over centuries, seemingly insignificant trickles worked wonders in stone. The result is a rich display of cave formations, or as scientists call them, speleothems. Lehman Caves contains familiar structures such as stalactites, stalagmites, columns, draperies, and flowstone, along with some interesting and delicate rarities.

Lehman Caves is most famous for the rare and mysterious structures called **shields (see photo below)**. Shields consist of two roughly circular halves, almost like flattened clam shells. How they are formed remains a subject of controversy - another of the pleasant mysteries to be found in the underground world.



Photos from the National Park Service Cave and Karst Program

Mammoth Cave...

Kentucky

NPS Photo by Rick Wood

NPS Photo by Gary Berdeaux

The Longest Cave:

The total surveyed extent of Mammoth Cave currently stands at 580 kilometers (360 miles) with potential for a 1600 kilometer (1000 mile) system. In addition, there are more than 200 caves within the park which are disconnected fragments of the larger system or associated with local drainage features. The geology and geography of the area has resulted in a variety of karst basins, which have become the most thoroughly understood conduit flow aquifer in the world.

Mammoth Cave Aquifer

Flow through the Mammoth Cave Karst aquifer can be very rapid, on the order of 1000's to 10,000's of feet per day. Contaminants entering the karst aquifer can thus be rapidly transported, unfiltered through the conduit system. The karst aquifer is very dynamic, that is, it responds nearly instantaneously to rainfall. The aquifer stage can rise 10's of feet in a matter of hours, with numerous records showing stage rises of more than 100 feet over the course of one day. Also, chemical and bacteriological properties of the groundwater can change dramatically following rainfall events.

Cave Entrances

Natural, modified natural, and artificial cave entrances pose some of the greatest challenges in the management of karst resources. This is because provision must be made for movement of air, water and wildlife within acceptable tolerances while simultaneously providing an adequate deterrent to illegal human entry. United States Fish and Wildlife Service- approved bat gates have been installed on the entrances of caves supporting major bat hibernation areas. Cave gates are designed to accommodate bat movement and natural rates of air exchange, provide greater security, and restore endangered Indiana and gray bat habitat. Airlocks have been installed on man-made entrances to restore cave atmospheric conditions.

Speleothems

Within the cave, a vast array of subterranean geologic features have developed over millennia, including stalactites, stalagmites, helictites, and travertine dams. There are also several types of gypsum formations, such as the aptly-named "gypsum flowers" (see photo below).

Photo Source: National Park Service Cave and Karst Program

NPS Photo by Rick Wood

Russell Cave . . .

Alabama

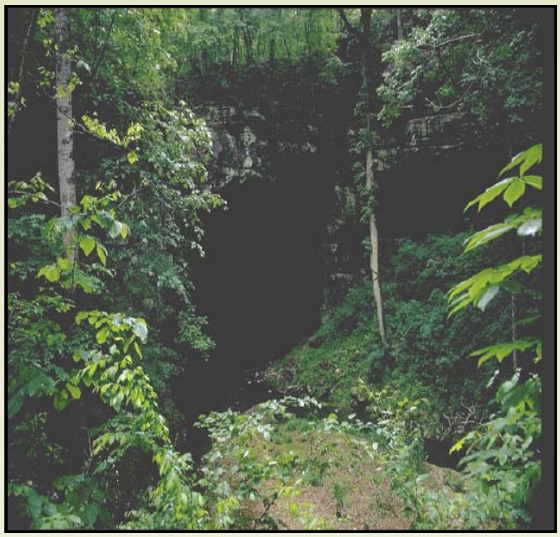


Photo Source: National Park Service Digital Image Archives

Indians Find Shelter in the Cave

Thousands of years ago nomadic bands of Indians stumbled upon Russell Cave in the hill country of northern Alabama. We know little about them except that they were few in number, probably less than 15 or 20, and that the only durable possessions they carried with them were a handful of chipped flint points with which they tipped their short hunting spears. These few possessions were found 12 feet below the present floor of the cave.

This evidence, supported by charcoal from their campfires, tells us that about 9,000 years ago these Archaic Period Indians first began to occupy Russell Cave. This is long before the rise of the civilizations of Egypt and the Near East. They could not have lived there earlier, because a stream of water filled the whole cavern until a great rock-fall from the roof shunted the stream to one side and raised the floor of the cave well above its waters. They lived there only during the autumn and winter seasons, maintaining their primitive existence by hunting game and gathering wild plants. Agriculture was probably known, but little used by the Indians of the Archaic Period.

The cave was a great boon to these Indians because it provided ready protection from the elements. This freed them from the need to build a shelter in the forest and gave them more time to find food. Successive bands of hunters with their women and children took shelter in this cave until A.D. 1000. The records of their seasonal occupations, including several burials of adults and children, have been uncovered by archeological digs. The charcoal from their fires, the bones of the animals they ate, the tools they fashioned from animal bones, their spear and arrow points, and their broken pottery accumulated layer upon layer as thousands of years passed.

The first party of cave dwellers camped on the irregular floor of rock slabs. Archeologists have been able to date the arrival of these people at some time between 6550 and 6145 B.C. by measuring the radioactive carbon remaining in the charcoal of their fires. Russell Cave was a seasonal haven for these early forest-dwelling Indians. They survived by hunting and gathering wild plants in the great hardwood forests of the region. After they had depleted the supply of animals and edible plants in one area, they would move on to another section of the forest.

Probably a number of related families used the cave as a place of shelter and safety mostly in the autumn and winter. The relative warmth of the cave probably prevented the stream from freezing and thus they had a constant supply of water. The forest bore a rich crop of nuts that must have been an important source of food during the worst winter months when game in this mountain-valley country was scarce. In spring and summer, small bands - several families - probably camped along the shore of the Tennessee River only a few miles from the cave. Fish, birds, and small mammals could be obtained in the river environment.

When the last occupants departed, Russell Cave held beneath its surface the record of at least 9,000 years of human life upon this continent.

Studies in historical geology and paleobotany have shown that the plant and animal life of the Eastern Forest Region remained virtually unchanged for thousands of years, until European settlers felled the trees for lumber and opened up extensive acreages for subsistence and commercial farming.

NPS Photo by Rick Wood

Present a Cave

Student Worksheets

PRESENT A CAVE

Investigation and Planning Worksheet

Group Members:

National Park Service Cave and Karst Resource:

How will you present your information?

Examples might include a poster, a diorama, overheads, a power point presentation, a brochure, or a picture book.

Key Facts and Information:

From the Fact Sheet:

Information from additional research:

Your presentation should include all members of your team.

Identify at least one part of your presentation for which each group member is responsible.

Group Member	What are they responsible for?

PRESENT A CAVE

Peer Evaluation Form

TOPIC OF PRESENTATION: _____

GROUP MEMBERS:

PLEASE RATE YOUR CLASSMATES ON THEIR PRESENTATIONS:

1 = Superior
2 = Above Average
3 = Average
4 = Below Average
5 = Weak

★ You shared important facts:

1 2 3 4 5

★ You were easy to hear and understand:

1 2 3 4 5

★ Your visual aid was appropriate to the topic:

1 2 3 4 5

★ Your visual aid was carefully prepared:

1 2 3 4 5

3 THINGS I LEARNED FROM YOUR PRESENTATION:

1.

2.

3.

PRESENT A CAVE

Group Member Evaluation

Please rate yourself and your team members on the contributions they made in researching, preparing and presenting your project.

Your ratings will not be disclosed to other students.
Be honest in this evaluation!

In rating yourself and your peers, use a one to five point scale:

5 = Superior
4 = Above Average
3 = Average
2 = Below average
1 = Weak

Insert **your name** in the first column and your peers' names in the remaining spaces. (One name at the top of each column)

Group Member Names					
Participated in group discussions					
Helped keep the group focused and on the task					
Contributed useful ideas					
Quantity of work done compared to other group members					
Quality of work done					
Enter Total Scores Here					

NPS Photo by Rick Wood

Cave Quiz Game:
An Interactive Review Game

Lesson Objective: This interactive activity uses the Microsoft PowerPoint program to review key cave concepts presented throughout the Caves and Karst Curriculum Guide.

Key Concepts: speleothem formation, types of caves, ways that caves form, fossils, names of speleothems.

Duration: 1 55-minute class period

Audience: Middle school and high school students

NPS Photo by Rick Wood

Cave Quiz Game

Teacher Copy and Answer Key

CAVE QUIZ GAME
TEACHER INSTRUCTIONS

Playing the Game:

1. **Organize students into small cooperative groups. Depending on the nature of the group, either assign groups or allow students to self-select their groups.**

2. **Access the game via the internet or a CD. The individual slides can be viewed using Adobe Reader, but open and run the game using the Microsoft PowerPoint program.**

3. **Start the game by clicking the Slide Show button from the top toolbar and select "View Show". The review game is now ready to begin.**

4. **When a question slide is opened, you need to click on the grey background for the question to appear. If you click again the answer will appear. Once the question has been answered, use the button on the bottom left side of the page to return to the main page.**

5. **Students can select from any of the five categories. Once a selection has been chosen, it will disappear so that it cannot be chosen again.**

Helpful Hints:

1. **If you need to exit the game once it is running, use the "Esc" key on your keyboard.**

2. **If you need to go back, use the arrow on your keyboard that points to the left.**

Cave Quiz Game Questions
2 week Unit

Quiz Board Heading	Value	Question	Answer	Location in Curriculum Guide
Speleothems	100	Speleothems are frequently formed when this fluid drips from a cave ceiling.	Water	Making a Cave (page 1); Speleothems-Webquest (page 6)
	200	Speleothems form as these precipitate out of fluids and are deposited onto cave ceilings and walls.	Minerals	Growing Speleothems (page 2); Speleothems-Webquest (page 1)
	300	Speleothems consist mainly of this type of mineral:	Calcite	Growing Speleothems (page 2); Speleothems-Webquest (page 1)
	400	True of False: The term "speleothem" refers to what a cave formation looks like (its morphology), and not its composition.	True	Speleothems-Webquest (page 1)
	500	One thing that all speleothems have in common is that they cannot form until the level of the cave is above this:	Water Table	Interactive Reading Guide (page 4); Speleothems-Webquest (page 1).
Types of Caves	100	These types of caves are produced from the action of waves pounding against rocks that line the shores of oceans and lakes.	Sea Caves	Interactive Reading Guide (page 5).
	200	This type of cave was commonly used by early people for shelter.	Sandstone Cave	Interactive Reading Guide (page 6).
	300	This is another name for a lave cave:	Lava Tube	Interactive Reading Guide (page 5).
	400	The name of this cave is named for the piles of rocks that are produced from rockslides.	Talus Caves	Interactive Reading Guide (page 5).
	500	Name the 2 types of ice caves: 1.) This type is formed in ice. 2.) This type is formed in rock, but stays frozen year around.	1.) Glacier Cave 2.) Frozen Cave	Interactive Reading Guide (page 6).

Cave Quiz Game Questions
2 week Unit

The Formation of Caves	100	This type of cave is formed when acidic water dissolves rocks like limestone.	Solution Cave	Interactive Reading Guide (page 3); Making a Cave (page 1).
	200	This type of cave is formed when the action of earthquakes form natural cracks in rock.	Tectonic Cave	Interactive Reading Guide (page 6).
	300	The hard upper crust of lava caves is formed as this touches the flowing lava and cools it down.	Air	Interactive Reading Guide (page 5).
	400	This is the term used when referring to the act or process of dissolving.	Dissolution	Interactive Reading Guide (page 3).
	500	The ceilings of water-filled caves are supported by this type of force:	Buoyant Force	Interactive Reading Guide (page 4).
Cave Life	100	What name is given to the animals that love to spend time in caves?	Troglophiles	Cave Life (*Troglophiles* Fact Sheet)
	200	What is the name for the cave animal that is only a periodic visitor?	Trogloxene	Cave Life (*Trogloxenes* Fact Sheet)
	300	What name is given to those animals that are adapted to spend their entire life in caves?	Troglobites	Cave Life (*Troglobites* Fact Sheet)
	400	What factor is used to determine in which category a cave animal is classified?	The amount of TIME an animal spends in the cave.	Cave Life (student worksheet page 1)
	500	Name the 4 life zones in a cave.	4 Life Zones = Entrance Zone; Twilight Zone; Variable Temperature Zone and Total Darkness; and the Dark Zone	Cave Life (*The 4 Life Zones of Caves* Fact Sheet)

Cave Quiz Game Questions
2 week Unit

Name That Speleothem	100	What 2 types of speleothems have joined together to make this column? [Picture of a column]	1. Stalactite 2. Stalagmite	Speleothems-Webquest (page 3).
	200	This speleothem sometimes resembles bacon…what is it? [Pictures of draperies]	Drapery	Speleothems-Webquest (page 4).
	300	What type of speleothems are these? [Picture of a cave flower]	Cave Flowers	Speleothems-Webquest (page 2).
	400	This speleothem can eventually grow into a stalactite. What is it?]Picture of a soda straw]	Soda Straw	Speleothems-Webquest (page 6); Present a Cave- Timpanogos Cave Fact Sheet
	500	What type of speleothems are these? [Picture of boxwork]	Boxwork	Speleothems-Webquest (page 2); Present a Cave- Wind Cave Fact Sheet

NPS Photo by Rick Wood

Caves and Karst

Glossary of Terms

1	**Bedrock**	The solid rock below any soil, gravel, or other superficial material. Source: National Park Service
2	**Buoyant Force**	In nature and the science of nature, called physics, buoyancy is an upward force on an object immersed in a fluid (i.e., a liquid or a gas); this buoyant force enables an object to float or at least to appear lighter. Buoyancy is important for many vehicles such as boats, balloons, and airships (e.g., the Hindenburg). In caves, the buoyant force of water aids in keeping ceilings of flooded passages from collapsing. Sources: Wikipedia at http://en.wikipedia.org/wiki/Buoyancy and Katie KellerLynn
3	**Carbonate Rock**	A carbonate rock consist chiefly of carbonate minerals (i.e., calcium, magnesium, or iron) such as limestone, dolomite, or carbonatite. Specifically, carbonate rocks are sedimentary rock composed of more than 50% carbonate minerals by weight. Source: Neuendorf et al. (2005)
4	**Carbonation**	Carbonation is an activity of chemical weathering. It is a chemical reaction of carbonic acid in rainwater, soil water, and groundwater with minerals. Carbonation most strongly affects carbonate minerals and rocks, such as limestone and marble. Source: Katie KellerLynn
5	**Cave**	Any naturally occurring void, cavity, recess, or system of interconnected passageways beneath the surface of the earth. Source: Federal Cave Resource Protection Act of 1988
6	**Contact**	Geologically speaking, a contact is the surface between two types or ages of rocks. Source: Katie KellerLynn
7	**Dissolution**	Dissolution is the act or process of dissolving. Source: Merriam-Webster's Collegiate Dictionary (11th ed.)
8	**Earth**	Earth is the planet we call home. It revolves around the Sun and is the third planet out from it. Source: National Park Service
9	**Earthquake**	An earthquake is a sudden motion or trembling in the Earth caused by the abrupt release of slowly accumulated strain. Source: Bates and Jackson (1984)
10	**Ecosystem**	An area where communities of species (plants, animals, and other organisms) interact with one another and the surrounding environment (water, sunlight, soil). Source: National Park Service.

11	**Groundwater**	The part of subsurface water that is in the zone of saturation, including underground streams, is referred to as groundwater. Loosely, all subsurface water, as distinct from surface water, is called groundwater. Source: Bates and Jackson (1984)
12	**Humidity**	Humidity is the concentration of water vapor in the air. Water vapor gets into the air by evaporation—a process by which fast-moving, liquid molecules manage to escape from the liquid and pass into the vapor above. Because molecules in a vapor move randomly in all directions, some of the gas molecules in the vapor will also move back into the liquid. When the number of evaporating molecules (going from liquid to gas) equals the number of condensing ones (going from gas to liquid), the vapor is "saturated." Meteorologists (and speleologists) use the term relative humidity when they are discussing saturated and "undersaturated" air. Relative humidity does not refer to a specific amount of water vapor in the air; rather it refers to the ratio of water vapor that is present at a given temperature to the maximum possible amount that the air could hold at that same temperature. Relative humidity can be changed in two ways: by addition of water vapor or by change of temperature. Sources: Skinner and Porter (1995) and Katie KellerLynn
13	**Karst**	Landforms produced primarily through the dissolving of rock, such as limestone, dolomite, marble, gypsum, and salt, are collectively known as karst. Features of karst landscapes include sinkholes, caves, large springs, dry valleys, and sinking streams. These landscapes are characterized by efficient flow of groundwater through conduits that become larger as the bedrock dissolves. Source: Veni et al. (2001)
14	**Lava**	The word for magma (molten rock) when it erupts onto Earth's surface is lava. It is from the Italian word for stream, which is derived from the verb "lavare" meaning to wash. Source: U.S. Geological Survey
15	**Lava Tube**	Natural conduits through which lava travels beneath the surface of a lava flow are lava tubes. They form by the crusting over of lava channels and pahoehoe flows. Source: U.S. Geological Survey
16	**Limestone**	Limestone is a sedimentary rock consisting chiefly of the mineral calcite (calcium carbonate, $CaCO3$). Limestone is the most important and widely distributed of carbonate rocks and is the consolidated equivalent of limy mud, calcareous sand, or shell fragments. Source: Bates and Jackson (1984)
17	**Marble**	Marble is a metamorphic rock consisting predominantly of fine- to coarse-grained recrystallized calcite or dolomite. Source: Bates and Jackson (1984)

18	**Minerals**	A mineral is a naturally occurring inorganic element or compound having an orderly internal structure and characteristic chemical composition, crystal form, and physical properties. Source: Bates and Jackson (1984)
19	**Pores**	see "Porosity"
20	**Porosity**	The percentage of bulk volume of a rock or soil that is occupied by interstices (spaces), whether isolated or connected is referred to as porosity. Source: Bates and Jackson (1984)
21	**Sandstone**	Sandstone is a sedimentary rock composed mainly of feldspar and quartz and varies in color (in a similar way to sand), through grey, yellow, red, and white. Source: Wikipedia
22	**Science**	see "Scientific Method"
23	**Scientific Method**	What distinguishes science from other fields of study is the method that scientists use to acquire knowledge and the special significance of this knowledge. Scientific knowledge can be used to predict future events. The scientific method originated in the 17th century with people such as Galileo, Francis Bacon, and Isaac Newton. The key to the method is to make no initial assumptions, but rather to make careful observations of natural phenomena. The scientific method is the combination of observations, experimentation, and the formulation of laws, hypotheses, and theories. Source: Petrucci and Harwood (1993)
24	**Sediment**	In general, sediment is solid fragmental material transported by wind, water, or ice, chemically precipitated from solution, or secreted by organisms, and that forms in layers in loose unconsolidated form, e.g., sand, mud, till. Source: Bates and Jackson (1984)
25	**Sedimentary Rocks**	Sedimentary rocks result from the consolidation of sediment; for example, a clastic rock such as sandstone, a chemical rock such as rock salt, or an organic rock such as coal. Sedimentary rocks constitute one of the three main classes into which rocks are divided, the others being igneous and metamorphic. Source: Katie KellerLynn
26	**Shale**	Shale is a fine-grained sedimentary rock whose original constituents were clays or muds. It is characterized by thin laminae breaking with an irregular curving fracture, often splintery, and parallel to the often indistinguishable bedding planes. Non-fissile rocks of similar composition but made of particles smaller than 1/16 mm are mudstones. Rocks with similar particle sizes but with less clay and therefore grittier are siltstones. Source: Wikipedia

27	**Solution**	Solution is a process of chemical weathering by which mineral and rock material passes into solution (homogeneously mixed with a liquid). An example is the removal of calcium carbonate in limestone by carbonic acid derived from rainwater containing carbon dioxide, acquired during its passage through the atmosphere. Source: Katie KellerLynn
28	**Talus**	Talus are rock fragments of any size (usually coarse and angular) derived from and lying at the base of a cliff or very steep, rocky slope. Source: Neuendorf et al. (2005)
29	**Tectonic**	"Tectonic" pertains to the forces involved in, or the resulting structure of, tectonics (see Tectonics). Source: Bates and Jackson (1984)