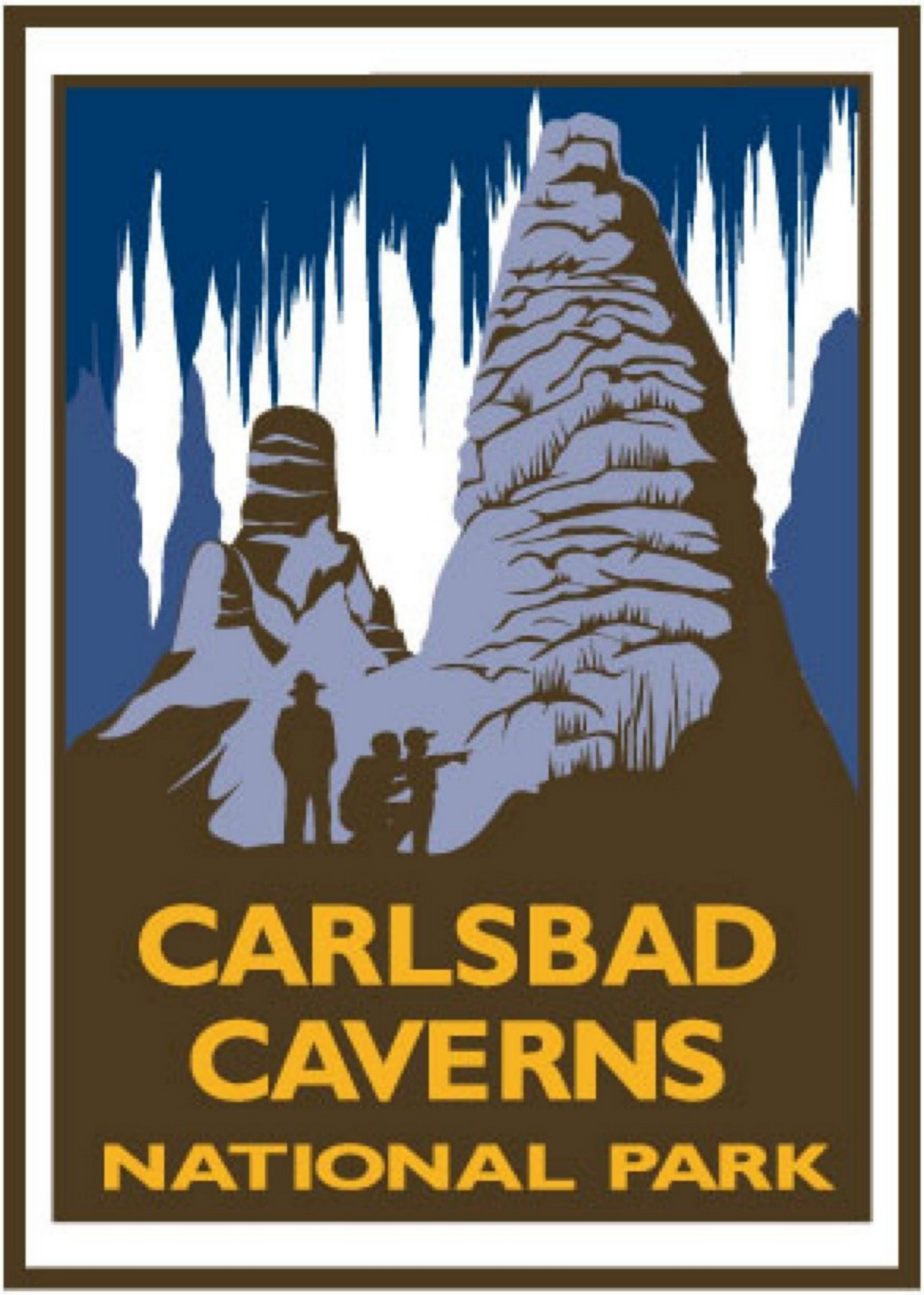
# About Bats, Caves, & Deserts

A curriculum and activity guide for Carlsbad Caverns National Park

## *Elementary School*



# Section 4 – Earth Activities

- **Dissolving Limestone with Acid**
- **Grow Your Own Speleothems**
- **A Recipe for Speleothems**
- **Let's Make a Cave**
- **Are All Caves the Same**
- **How's the Climate Down There?**
- **Mapping a Cave**
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- **A Key to Rocks**
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# Dissolving Limestone with Acid

**Pre-Visit or Post-Visit Activity**

**Primary/Elementary and Intermediate Levels**

**Science** (Unifying Concepts, Physical, Earth)

**45 Minutes**

**Objective(s).** Students will apply the trial and error method to test which rock/shell samples react with hydrochloric acid.

**Related NM Content Standards with Benchmarks.** SC2-E3, SC9-E2, SC9-M2, SC12-E3, SC12-M3

**Method.** In pairs, students place drops of cold, dilute hydrochloric acid on rock/shell samples, then record the results. Students formulate and write their conclusions on the worksheet provided.

**Materials.**

**Each Student:** copy of chart, pencil, safety glasses or goggles

**Each Pair of Students:** bottle of hydrochloric acid, jar or beaker, dropper, student worksheet

**The Class:** rock samples of limestone, granite, sandstone and seashells; paper towels

**Key Vocabulary.** mineral, carbonic acid, limestone, calcite, chemical reaction, hydrochloric acid

**Background.** Limestone is the most common cave-forming rock, composed of a mineral called calcite. When carbonic acid in water comes in contact with calcite, the calcite begins to dissolve. A similar and faster chemical reaction occurs with a stronger acid, such as hydrochloric acid. Cold, diluted, hydrochloric acid, will produce a bubbling reaction upon contact when calcite is present in an object.

See "The Geology of Carlsbad Cavern" in Section 2 – Just the Facts.

**Suggested Procedure**

1. Explain safety procedure to be followed. Because the acid will burn skin and clothing, young students should observe a teacher perform the demonstration.
2. Distribute a chart to each pair of students.
3. Mix a solution of HCL and water in a ratio of 10 parts water to 1 part HCL.
4. Label rock samples A, B and C.
5. Using the dropper, place one drop of hydrochloric acid on each rock sample.
6. Observe what happens and record observations in the proper column.

7. Wipe acid droplets off samples with paper towels, being careful not to allow the acid to touch skin.
8. Test a seashell with the acid. Observe and record observations. Write conclusions on the chart.
9. Use the data in this activity to make generalizations correlating it to geology of Carlsbad Cavern.

**STUDENT WORKSHEET**

| ROCK SAMPLES | ACID REACTION | NO REACTION |
|---|---|---|
| **A** | | |
| **B** | | |
| **C** | | |
| **Seashell** | | |
| **CONCLUSIONS:** | | |

# Grow Your Own Speleothems

**Pre-Visit or Post-Visit Activity**

**Primary/Elementary and Intermediate Levels**

**Science** (Unifying Concepts, Earth)**, Math** (Measurement)

**One 45- Minute Session, then 10 - 15 Minutes Daily (5 Days)**

**Objective(s).** Students will demonstrate knowledge of the scientific method by investigating the growth of models of stalactites and stalagmites.

**Related NM Content Standards with Benchmarks.** SC2-E3, SC12-E3, SC12-M3, MA9-E2, MA9-M3

**Method.** Students review the scientific method, construct a model of a cave, observe the growth of stalagmites and stalactites, and draw conclusions.

**Materials.** Epson salts (magnesium sulfate), pan to heat water, spoon, food coloring, jar for storing extra solution, craft knife, pictures of stalactites and stalagmites, small sturdy cardboard box, 3-5 oz. paper cups, 12 pieces of blue yarn (9" long), 12 pieces of red yarn (14" long), heavy weight aluminum foil, paper towels, copies of *Speleothem Growth Observations* student worksheet

**Key Vocabulary.** speleothem, stalactite, stalagmite

**Background.** See “The Geology of Carlsbad Cavern” and “A Good Scientific Investigation” in Section 2 – Just the Facts.

**Suggested Procedure for Cave Construction**

1. Mix 4 cups of water and 5 cups of Epson salts in a pan. Heat to the boiling point, stirring constantly. Allow students to observe and describe what happens.
2. Turn box on its side with the front facing the students. Using 1 cup as a pattern, trace 3 circles on the top of the box. Poke a series of 6 pencil holes through the top of the box, around the circumference of each of the 3 circles. Two holes are needed for the longer piece of yarn and 1 hole for each of the 4 shorter pieces. These holes should be large enough for the yarn to pass through easily.
3. Place an empty cup right side up on each of the circles. Measure 1 piece of blue yarn approximately 9 inches so that it is lightly stretched from the inside bottom of the cup, up and over the edge, and down through a hole. Use a pencil to poke the yarn through the hole. Cut off the yarn so that it hangs 1 to 2 inches down from the top of the box. Using this measured piece of yarn, cut 11 blue pieces of yarn to this same length. Set all 12 pieces aside. Take a piece of red yarn approximately 14 inches and place one end in the bottom of a cup; draw the other end, down through a hole, up through an adjacent hole, and then back into the bottom of the same cup, leaving a loop hanging down about an inch.

4. Place a sheet of aluminum foil onto your work surface. Turn up and crimp the edges to make a waterproof tray with sides about 1 inch high. Make a pad of a dozen paper towels and place it under the box in the foil tray.
5. Place each of the 3 cups within a circle. Pour solution into the cups until they are half full. Place all yarn pieces into the cups of solution, 4 short and 1 long, to wet them.
6. Remove the yarn. Push the longer red pieces of yarn down through 1 hole and up the next. Leave enough yarn in the cup so that both ends reach the bottom. Place the shorter blue yarn pieces with their ends hanging down into the *cave*. Make sure that all strings are suspended in the solution, gently pushing the strings toward the bottom of the cups using a spoon. Repeat for all cups.
7. Add several drops of food coloring to each cup. Add more solution, filling each cup to the brim. Most of the yarn will be *wicking* the solution.

**Suggested Procedure for Speleothem Growth**

1. Check the fluid level of the cups twice during the day. Add more solution, as needed, to keep them filled to the brim. Store extra solution in closed jars.
2. Distribute copies of the student worksheet. Daily, have students observe the speleothem growth and record their observations on the chart.
3. After 5 days of observation, have students interpret what they observed and formulate their conclusions.

**SPELEOTHEM GROWTH OBSERVATIONS**

Student Worksheet

| | **CUP 1** | **CUP 2** | **CUP 3** |
|---|---|---|---|
| **DAY 1** | | | |
| **DAY 2** | | | |
| **DAY 3** | | | |
| **DAY 4** | | | |
| **DAY 5** | | | |

| **CONCLUSIONS:** |
|---|
| |
| |
| |
| |
| |

# A Recipe for Speleothems

**Pre-Visit or Post-Visit Activity**

**Primary/Elementary and Intermediate Levels**

**Science** (Unifying Concepts, Physical, Earth)

**30 Minutes Each Demonstration, Several Days to See Results**

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**Objective(s).** Students will construct a model to demonstrate the growth of speleothems and crystals.

**Related NM Content Standards with Benchmarks.** SC2-E3, SC9-E2, SC9-M2, SC12-E3, SC12-M3

**Method.** Students mix a solution, then observe the growth of speleothems and crystals during a period of several days.

**Materials.**

> **Growing Speleothems:** water; thick, natural fiber string; cardboard; 2 jars; Epsom salts
>
> **Crystal Garden:** pie tin, pieces of charcoal, ½ cup water, ½ cup salt, ½ cup liquid bluing, 1 cup ammonia, food coloring (do not use red), mixing bowl, spoon

**Key Vocabulary.** speleothem, crystal

**Background.** Speleothem is the name given to any secondary deposit (decoration) inside of a cave. The ones which hang from the cave ceiling are stalactites. The ones that rise from the cave floor are stalagmites. Formation of any speleothem takes a long period of time. Each drop of water leaves a tiny amount of mineral residue on a cave ceiling, floor, wall or other feature, adding to the growth of the speleothem.

Speleothems form at different rates. Several factors can determine the rate of growth. Two important factors are rainfall and the outside temperature. As the temperature goes up, so does the decay rate of plants and animals. The more organic material there is in water, the more calcium bicarbonate there is in the water; and thus, the more acidic the water is. The rate of speleothem growth increases with the amount of water and with the acidity of the water.

See "The Geology of Carlsbad Cavern" in Section 2 – Just the Facts.

**Suggested Procedure for Growing Speleothems**

1. Fill each jar with water.
2. Add enough Epsom salts in each jar of water to form a thick solution.
3. Place the jars on the piece of cardboard about six inches apart.
4. Soak the string in the solution until it is completely saturated.
5. Place one end of the string in one jar of solution. Place the other end of the string in the other jar of solution.

6. Leave enough slack so that there is a bow in the string, but do not let the string touch the cardboard.
7. Leave the jars and the string in an accessible and observable location for several days while a stalactite and stalagmite form.
8. Explain the role of time in this model compared to "The Geology of Carlsbad Cavern" in Section 2 – Just the Facts.

- ***CAUTION:*** Once these *speleothems* begin to form, any movement of the string could cause breakage.

**Suggested Procedure for Growing Crystal Garden**

1. Place pieces of charcoal into pie tin (enough to cover the bottom of the pan).
2. Mix water, salt, bluing and ammonia in the mixing bowl.
3. Carefully pour this solution over the charcoal so that all pieces are wet.
4. Squirt a few drops of food coloring over the charcoal (do not use red).
5. Allow the pan sit overnight. By the next morning, small crystals should have begun to form on the charcoal.

# Let's Make a Cave

**Pre-Visit and Field-Trip Activities**

**Primary/Elementary Level**

**Science** (Unifying Concepts, Physical)

**1 ½-Hours Session plus Field Trip**

**Objective(s).** Students will demonstrate how to avoid touching artificial speleothems while using large motor skills to negotiate an obstacle course.

Students will practice good stewardship behavior, such as not touching speleothems during their field trip.

**Related NM Content Standards with Benchmarks.** SC2-E3, SC7-E1, SC9-E2

**Method.** After studying the main types of speleothems, students exhibit stewardship behavior by negotiating a teacher-constructed obstacle course.

**Materials.** large cardboard box (such as a furniture or appliance box), yarn, large nail, plastic drinking straws, large plastic cups, wooden dowel (height of the box's width), tape

**Key Vocabulary.** secondary deposit, cave, exploration, speleothem

**Background.** Speleothem is the name given to any secondary deposit (decoration) inside of a cave. Stalactites are speleothems that hang down from the cave ceiling, and stalagmites are speleothems that rise up from the cave floor. Formation of any speleothem takes a long period of time. As each drop of water leaves a tiny amount of mineral residue on a cave ceiling, floor, wall or other feature, it adds to speleothem growth. When a speleothem is broken, it will not be replaced within our lifetime, if ever! Therefore, cavers should be extremely careful while exploring.

See "Safe Cave Exploration" in Section 2 – Just the Facts.

**Suggested Pre-Visit Procedure**

1. The cave obstacle course is made up of drinking straw *stalactites*, plastic cup *stalagmites* and a large cardboard box. Lay the box down so that two ends are open. Brace the center of the box with the wooden dowel *column*. Punch a hole in the top of the cave with the nail. Thread yarn through one drinking straw and then through the nail hole and knotted to secure it. Hang numerous straws, at various levels, in one area of the cave. Allow enough room for students to wriggle around without touching them. Make the *stalagmites* by taping large plastic cups together end to end, or mouth to mouth. *Stalagmites* can be one to three cups high. Mark a trail with the *stalagmites* leading to one open end of the box, through it, and out the other end to the other to represent an area of the cave where the explorer can stand upright. The cavers will need to crawl in the area represented by the box.

2. Talk about the terms stalactites and stalagmites.

3. Ask students to pretend that they are cavers exploring a newly discovered cave. It is their responsibility to not damage any speleothems.

4. Individually, the student will approach the cave in an upright position being careful not to kick any *stalagmites*. When the student reaches the box, he/she will crawl through, not hitting any *stalactites* or *stalagmites*. When each student has had a chance to negotiate the cave, lead a short discussion on maneuvering methods that they invented or used. Have students try another trip through the cave to see if there has been any improvement from their first trial.

**Suggested Field-Trip Procedure**

1. As you tour Carlsbad Cavern, remind students of their obstacle course experience.

2. Point out speleothems that have been touched or broken. Look for signs of renewed growth of broken speleothems.

3. Encourage students to protect the cave as they go through it, and to be aware of their impact upon the cave.

# Are All Caves the Same?

**Pre-Visit or Post-Visit Activity**

**Primary/Elementary Level**

**Science** (Unifying Concepts, Earth)**, Mathematics** (Unifying Concepts)**,**
**Social Studies** (Geography)

**1 Hour**

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**Objective(s).** Students will discuss several types of cave environments.

Students will explain one reason why people should not remove rocks, speleothems or other features of the caves.

**Related NM Content Standards with Benchmarks.** SC2-E3, MA1-E1, MA1-E4, MA1-E5, MA3-E1, MA3-E2, MA4-E5, SS12-E3

**Method.** Students compare and contrast rocks representing different cave environments. Students solve mathematical problems to represent visitor impact on the cave environment.

**Materials.** plastic cups, rocks, measuring tape, scale

**Background.** Caves differ in temperature and moisture. Some are cold and wet, others are cold and dry, still others can be warm and wet, or warm and dry.

See "Types of Caves" in Section 2 – Just the Facts.

**Suggested Procedure**

1. Exhibit 4 rocks – one in a cup of water at room temperature, the second in a cup of water that has been refrigerated for several hours, the third dry and at room temperature, and the fourth dry and cold (kept in a refrigerator). Explain that these rocks came from your garden, not a cave or a park.
2. Allow students to touch and handle the rocks.
3. Begin a class discussion contrasting the differences in the rocks (wet, dry, warm, cold). How do rocks feel in a cave? Do rocks in caves feel different than the ones in the classrooms?
4. Have students solve the following problems:
   - How many classes are in your school? __________
   - How many schools are in your community? __________
   - How many schools are in your county? __________
   - How many counties are in your state? __________
   - If each year ________ (fill in the blank) school classes from the state were to remove 4 rocks from Carlsbad Cavern, how many rocks would be removed…

…in a year's time? __________

…in 5 years? __________

…in 10 years? __________

…by the time you graduate from high school? __________

- If each rock weighed 3 lbs., how many tons of rocks would be removed?
- Find a rock that weighs _________ (fill in the blank). Measure the area. Compute the area in square feet that would be missing from the cave yearly. (Use an object like a building to compare your figures to, so you have a visual aid to assist with the concept.)
- Are the rocks/speleothems in Carlsbad Cavern being replaced?
- Do speleothems grow at fast rates?
- How can your students help promote cave conservation?
- ***Note:*** These exercises could also be done using Carlsbad Caverns National Park's annual visitation of 650,000.

# How's the Climate Down There?

**Pre-Visit, Field-Trip and Post-Visit Activities**

**Primary/Elementary and Intermediate Levels**

**Science** (Inquiry)

**30 Minutes Pre-Visit, Field Trip, 30 Minutes Post-Visit**

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**Objective(s).** Students will observe and measure the differences in temperature and humidity within the cave and on the surface.

**Related NM Content Standards with Benchmarks.** SC5-E2, SC5-M2, SC6-M5, SC6-M6

**Method.** Students compare the temperature and humidity at their school site, the park visitor center, the mouth of the cave and various spots within the cave.

**Materials.** thermometer, sling hygrometer, paper, pencil

**Key Vocabulary.** weather, humidity, hygrometer, temperature, thermometer, twilight zone

**Background.** The cave's temperature is a constant 56°F. Humidity is about 95%. Students may notice a temperature change between the parking lot and nature trail. Relative humidity and temperature will change dramatically between the amphitheater and the end of the twilight zone. If differences are noted between the elevator area and other areas of the cave, it may be due to air coming down the elevator shaft, refrigeration equipment in the rest area or the large number of people in the general vicinity.

**Suggested Pre-Visit Procedure.** Introduce students to the concepts of temperature and relative humidity. Demonstrate how to use the thermometer and the hygrometer. Prepare a worksheet to record these measurements. Each entry should include date, time, place, temperature, relative humidity, plant life and wildlife. Take several measurements and record data for several days prior to the field trip.

**Suggested Field-Trip Procedure**

1. On the morning of your trip, have students measure and record the temperature and relative humidity at the school.
2. Upon arrival at Carlsbad Caverns National Park, have students measure and record the temperature and relative humidity in the parking lot. Also take measurements in front of the visitor center, on the trail to the cave entrance, in the cave entrance amphitheater, at the end of the twilight zone, at the elevators and at two or three spots along the cave trail. Have students make notes about the kinds of plant life seen along the nature trail and on into the entrance. Record any wildlife seen along the way.

**Suggested Post-Visit Procedure**

1. Have students hypothesize reasons for the differences noted in their observations.

2. Facilitate a discussion on the impact of visitors on the temperature and humidity of the cave. Does the weather of the surface affect the type of wildlife and plant life found on the surface? How does the plant life change as one approaches the entrance to the cave? Why?

***Note:*** This activity can also be used on a visit to Slaughter Canyon Cave. Take measurements at the parking lot, beginning of the trail, halfway point (sign), cave entrance and several stopping points in the cave.

# Mapping a Cave

**Pre-Visit or Post-Visit Activity**

**Intermediate Level**

**Science** (Inquiry, Earth)**, Mathematics** (Unifying Concepts, Measurement)**,**
**Social Studies** (Geography)

**1 Hour**

**Objective(s).** Students will interpret a written set of instructions and a pattern of markers.

Students will use mathematical procedures and measurements to accurately solve problems.

**Related NM Content Standards with Benchmarks.** SC5-M2, SC12-M6, MA2-M3, MA4-M4, MA9-M3, SS12-M1, SS12-M2

**Method.** Students use a compass and make a map similar to those made by explorers.

**Materials.** The Class: 36 paper cups (recycled), something to weigh down the cups

Each Group of 3: compass, tape measure, graph paper, student sheet

**Key Vocabulary.** topographic

**Background.** Proper documentation of a cave is important in determining its scientific value and significance. Cave mapping is the foundation of any type of cave research.

Since the 1960s, Carlsbad Caverns National Park has had coordinated survey groups for both Carlsbad Caverns and some the park's remote caves. The largest mapping project at the park began in 1986 and is Lechuguilla Cave. Thus far, more than 100 miles of passages have been surveyed and the end is not in sight. It is the deepest known cave in the continental United States.

Cave survey teams have three or four members. At Carlsbad Caverns National Park each survey team consist of four people—a sketcher, an instrument person, a lead tape person and one person taking inventory of cave features. The collected data is entered in a computer mapping program and database.

Recently, cave mapping has taken a new turn with the Geographic Information Systems (GIS). Archeological, historical, biological, paleontological and mineralogical sites will be tied into the nearest survey station GIS for cave management and is limited only by the imagination.

**Suggested Procedure**

1. Have students arrange the paper cup markers on the gym floor or outdoors. Set the markers in a grid with each cup being of equal distance (at least 10 feet) from the cup behind, in front, and to each side of the other cups. Put a weight in each cup to keep it from moving around. The grid can be 6 rows by 6 columns, or larger, as long as the number of columns equals the number of rows.

| | | | | | |
|---|---|---|---|---|---|
| X | X | X | X | X | X |
| X | X | X | X | X | X |
| X | X | X | X | X | X |
| X | X | X | X | X | X |
| X | X | X | X | X | X |
| X | X | X | X | X | X |

2. Teach students how to find direction by using a compass. Show them the four cardinal directions of north, south, east and west; how to find northeast, southeast, northwest and southwest; and, how to use a tape measure.
3. Divide the class into groups of three students. (A caver has at least two other cavers with him/her.) Give each group a copy of the student sheet. Assign group numbers 1 through 5. The written instructions will direct each group along its personalized path through the grid markers. Any marker may be the starting point.
4. After each group has finished going through the course, have students plot the information on graph paper and show the route they took through the grid.

# Mapping a Cave

Student Sheet

You are a group of cavers about to enter a wild cave. One caver reads the instructions and the compass to direct the group. One caver takes measurements from marker to marker and labels each marker with a number. One caver records the path: number of marker, direction to next marker and distance from the last marker.

**GROUP ONE**

| | |
|---|---|
| Marker 1 | Enter cave at SW corner. |
| Marker 2 | Move to next NE marker. |
| Marker 3 | Move to next N marker. |
| Marker 4 | Move to next NE marker. |
| Marker 5 | Move to next N marker. |
| Marker 6 | Move to next W marker. |
| Marker 7 | Exit cave at next SW marker. |

**GROUP TWO**

| | |
|---|---|
| Marker 1 | Enter cave at SE corner. |
| Marker 2 | Move to next W marker. |
| Marker 3 | Move to next W marker. |
| Marker 4 | Move to next N marker. |
| Marker 5 | Move to next NE marker. |
| Marker 6 | Move to next S marker. |
| Marker 7 | Exit cave at next NE corner. |

**GROUP THREE**

| | |
|---|---|
| Marker 1 | Enter cave at NE corner. |
| Marker 2 | Move to next SW marker. |
| Marker 3 | Move to next SE marker. |
| Marker 4 | Move to next S marker. |
| Marker 5 | Move to next NW marker. |
| Marker 6 | Move to next N marker. |
| Marker 7 | Exit cave at next E marker |

**GROUP FOUR**

| | |
|---|---|
| Marker 1 | Enter cave at NW corner. |
| Marker 2 | Move to next SE marker. |
| Marker 3 | Move to next S marker. |
| Marker 4 | Move to next E marker. |
| Marker 5 | Move to next SW marker. |
| Marker 6 | Move to next S marker. |
| Marker 7 | Exit cave at next NW marker. |

**GROUP FIVE**

| | |
|---|---|
| Marker 1 | Enter cave at N side, one marker from the NE corner. |
| Marker 2 | Move to next SW marker. |
| Marker 3 | Move to next S marker. |
| Marker 4 | Move to next W marker. |
| Marker 5 | Move to next W marker. |
| Marker 6 | Move to next NW marker. |
| Marker 7 | Exit cave at next N marker. |

## Down to the Core

**Pre-Visit or Post-Visit Activity**

**Primary/Elementary Level**

**Science** (Unifying Concepts, Earth)

**45 Minutes**

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**Objective(s).** Students will make a model of the earth in order to reinforce vocabulary, issues of geology and the general make up of the earth.

**Related NM Content Standards with Benchmarks.** SC2-E2, SC2-E3, SC12-E1

**Method.** By cutting through clay and cupcakes, students learn how the earth is layered.

**Materials.** clay (brown, gray, red, black), clear straws, layered cupcakes, plastic knives, scales, rulers, paper, pencils

**Key Vocabulary.** hypothesis, crust, mantle, core, mineral

**Background.** Earth is made of layers. The top layer, on which we live, is the earth's crust. Below this is a thick layer called the mantle. Still deeper within the earth's crust is the outer core. In the center is the inner core. The deepest drillings have only penetrated the earth's crust.

Geologists explore the earth by sampling the top layer of the earth—the crust. Some knowledge has been gathered by using other methods, such as analysis of earthquake waves passing through the earth (seismology); analysis of the composition of meteorites; and by calculations using the earth's size, shape and density.

Scientists believe that the inner core is a solid ball of iron and nickel. They believe the mantle is made of molten iron and nickel.

**Suggested Procedure**

1. In partners, have students construct a clay model of the earth showing four layers, each a different color. After the ball is completed, allow the clay set for thirty minutes. Cut ball in half.

2. Have students record their findings. The Earth has different layers and together they are the Earth as a whole.

3. Cupcake core sampling: Independently, have students predict the inner layer of the Earth's crust and use a cupcake as a model. Have students establish a hypothesis, sample the cupcake models using clear straws, write a conclusion and eat!

4. Remind students that at Carlsbad Cavern is almost 800 feet below the surface—not enough to put a scratch the Earth's crust.

# A Key to Rocks

**Pre-Visit or Post-Visit Activity**

**Intermediate and Secondary Levels**

**Science** (Inquiry)

**50 Minutes**

**Objective(s).** Students will identify *unknown* minerals by testing their properties.

**Related NM Content Standards with Benchmarks.** SC6-M4, SC6-M6, SC6-H4, SC6-H6

**Method.** Using a dichotomous key, students identify minerals.

**Materials.** variety of minerals and/or rocks or a pre-made sampling set of minerals; copies of mineral identification key (dichotomous key); small panes of glass; unglazed porcelain tiles; rock and mineral, geology or mineralogy book for reference; pencils, paper, chart paper, marker

**Key Vocabulary.** karst land, dichotomous key, rock, mineral

**Background.** Most karst lands are underlain by rocks, such as limestone, dolomite, gypsum or marble. These rocks are called solutional rocks because they can be dissolved by acidic rainwater to form cave. Most large caves are formed in solutional rocks. The most common solutional rocks is limestone. Limestone, composed of the mineral calcite, is a sedimentary rock formed in layers.

Rocks are made up of minerals. There are hundreds of different minerals in the world, each with unique physical properties, chemical composition and origin. Geologists can determine a mineral's name by classifying its properties. Those who do have little experience classifying minerals are able to identify some of the more common ones by using a dichotomous key. Dichotomous keys are used in fields, such as biology, botany and entomology.

**Suggested Procedure**

1. Before identifying rocks, facilitate a class discussion of terminology. Have students define the following terms: acid test, cleavage, conchoidal fracture, florescence, hardness, luster, specific gravity, streak color and surface color.
2. Divide students into pairs.
3. Distribute copies of the *Mineral Identification Key*. (You may prefer to use a key from your textbook or another source.)
4. Using the key, have pairs determine the names of minerals specimens or identify individual bits of a mineral in a rock, using the key.
5. Have students write their findings.
6. Facilitate a class discussion and make a classroom chart of the mineral specimens the class has identified.

# Mineral Identification Key
## How to Identify 26 Common Minerals

Identification keys are useful for the study of natural objects. Use this key to identify a specimen of a single mineral, or to identify individual bits of a mineral in a rock. First find the hardness, cleavage, color, color of the streak and luster of the mineral, as explained in a general physical geology book or a book about rocks and minerals. From your findings, answer *Question A*. Your **yes** or **no** answer will guide you to the next question to answer. By moving step by step through the key as directed, you can identify the mineral, if it is one of the 26 listed.

Many of the minerals you find will not be included here. If this is the case, check your findings of the physical properties with the mineral descriptions in a book about rocks and minerals.

**Question A.** Is the specimen's hardness less than 2? (Can you scratch it with your fingernail?)

If yes, see **#1** below.

If not, go to *Question **B***.

#1 Is cleavage perfect in one direction?

If yes, see **a**, **b** and **c** below.

a. If thin sheets are transparent, if thicker pieces are colorless or light in color and if the cleavage surfaces are very shiny, the mineral is <u>MUSCOVITE MICA</u>.

b. If the description above applies, except the color is dark brown to black, the mineral is <u>BIOTITE MICA</u>.

c. If there is a second cleavage direction, and if a silky to satiny luster is evident, the mineral is <u>GYPSUM</u>.

If not, see **# 2** below.

#2 If there is no definite cleavage, see **a**, **b** and **c** below.

a. If the mineral is mostly white with a dull luster and has an earthy odor when moistened the mineral is <u>KAOLIN</u>.

b. If the mineral is mostly white or greenish white, with a silky luster, and feels slippery to the touch the mineral is <u>TALC</u>.

c. If the mineral is mostly black, with a metallic luster, and feels slippery to the touch, the mineral is <u>GRAPHITE</u>.

**Question B.** Is the hardness more than 2 ½, but less than 5 ½? (Is it too hard to be scratched by a fingernail, but will not scratch glass?)

If yes, see **#1** below.

If not, go to *Question **C***.

#1 Is cleavage three-directional?

If yes, see **a** below.

a. Do all cleavage surfaces join at right angles?

If yes, see **(1)** and **(2)** below.

(1) If the mineral is black, with a metallic luster and shows a black streak, the mineral is GALENA.

(2) If the mineral is light in color, and tastes salty, the mineral is HALITE.

If not, see **b** below.

b. If the cleavage surfaces fail to meet at right angles, and if the mineral is mostly white or milky white in color with a pearly luster, the mineral is CALCITE.

#2 Is the cleavage generally two-directional?

If yes, see **a** below.

a. If the two cleavage surfaces are at acute angles, if the mineral appears translucent to transparent, and if it shows a rather glassy luster, the mineral is FLUORITE.

If not, see **#3** below.

#3 If there is no definite cleavage, see **a** below.

a. Is the luster metallic?

If yes, see **(1)** and **(2)** below.

(1) If the mineral has brownish red streak, the mineral is HEMATITE.

(2) If the mineral is yellow, has a brassy luster, and leaves a black streak, the mineral is CHALCOPYRITE.

If not, see **b** below.

b. Is the luster dull?

If yes, see **(1)** below.

**(1)** If the mineral has a rusty yellow to pale orange streak, the mineral is LIMONITE.

**Question C.** Is the hardness more than 5 ½, but less than 7? (Will the mineral scratch glass?)

If yes, see **#1** below.

If not, go to *Question **D***.

#1 When you press a sharp edge of the mineral against the glass, does it leave only a faint scratch?

If yes, see **a** below.

If no, skip to **b**.

a. Is cleavage two-directional?

If yes, see **(1)** below.

(1) Do the cleavage surfaces join at right angles?

If yes, see **(A)**, **(B)**, **( C)** and **(D)**.

(A) If the mineral is salmon pink or tuna-fish pink, the mineral is ORTHOCLASE FELDSPAR.

(B) If the mineral is white or gray, and contains very faint parallel striations on a well developed cleavage surface, the mineral is ALBITE FELDSPAR.

(C) If the mineral is dark gray, contains very faint parallel striations on a well-developed cleavage surface, and shows an internal peacock blue and iridescent blue-green play of color, the mineral is LABRADORITE FELDSPAR.

(D) If the mineral is dark green to black, the mineral is AUGITE.

If not, see **(2)** below.

(2) If the two cleavage surfaces do not meet at right angles, and the color is dark green to black, the mineral is HORNBLENDE.

b. If there is no definite cleavage, see **(1)** below.

(1) Is the luster metallic?

If yes, see **(A)** and **(B)** below.

(A) If the mineral is yellow, and leaves a black streak, the mineral is PYRITE.

(B) If the mineral is black, leaves a black streak, is quite dense and may be magnetic, the mineral is MAGNETITE.

#2 When you press a sharp edge of the mineral against glass, does it leave a deep scratch?

If yes, see **a** below.

a. Is the luster glassy, rather than metallic?

If yes, see **(1)**, **(2)** and **(3)** below.

(1) If the mineral is deep wine-red in color, the mineral is GARNET.

(2) If the mineral is colorless, milky, or smoky, the mineral is QUARTZ.

(3) If the mineral shows a granular texture, and is rather olive green, the mineral is OLIVINE.

If not, see **b** below.

b. Is the luster dull and rather waxy? If yes, see **(1)** below.

(1) If the mineral shows a distinct conchoidal fracture which leaves smooth curved surfaces that have sharp edges and corners, the mineral is QUARTZ CHALCEDONY.

**Question D.** Is the hardness greater than 7? (Does the mineral leave a deep scratch on the glass and a faint scratch on the porcelain tile plate?) If yes, see **#1** and **#2** below.

#1 If the mineral is commonly black, green or pink in color, with a glassy luster, and the long crystals show numerous fine grooves running parallel to each other for the length of the crystal faces, the mineral is TOURMALINE.

#2 If the mineral is generally greenish blue, pale yellowish, yellowish green, or pale pink to lilac in color, and shows an irregular to conchoidal fracture with a glassy luster, the mineral is BERYL.

# Make a Fossil

**Pre-Visit or Post-Visit Activity**

**Primary/Elementary and Intermediate Levels**

**Science** (Unifying Concepts, Earth)

**45 Minutes**

**Objective(s).** Students will demonstrate how a fossil is formed.

**Related NM Content Standards with Benchmarks.** SC2-E3, SC12-E5

**Method.** Students make models of fossils.

**Materials.** clay, plaster of Paris, water, old bowl and spoon, shells or bumpy rocks

**Key Vocabulary.** fossils, brachiopods, trilobites, sediments, organism

**Background.** Most animals and plants never become fossils. Most sediments are laid down at sea, so most fossils are of creatures which lived and died in the sea.

Carlsbad Caverns lies in an ancient fossil reef. Most scientists believe that a sea existed in the Delaware Basin nearly 250 million years ago. In this ocean lived many sea creatures such as brachiopods (clam-like animals), trilobites, sponges, nautiloids (nautilus-like animals) and algae. When these organisms died they built up and turned to rock, making the Capitan reef today. A fossil was made when an organism died and its body settled into the sediments on the sea floor. More sediments covered the organism; and over time, the organism became rock.

**Suggested Procedure.**

1. Pass around fossils to show students. Ask students to describe fossils and to explain how they think fossils were formed. Inform students that they will make their own model of a fossil to better understand how they are formed.
2. Give each student a lump of clay. Flatten the clay a little. This represents the mud on the bottom of the sea.
3. Give each student a shell or rock. Press it gently into the clay, not too far. This represents an organism that has died and settled at the bottom of the sea.
4. Carefully take the shell or rock out of the clay. This represents the organism turning to rock.
5. Mix Plaster of Paris according to the directions. Spoon the plaster into the print in the clay. This represents the next layer of sediment and mud that covers the organism and print.
6. When the plaster is dry, peel away the clay to reveal the fossil.