Oregon Caves

National Park Service
U.S. Department of the Interior

Oregon Caves National Monument
Cave Junction, Oregon

Teacher's Guide to

Geology: Our Changing World

The Outdoor Education Program

at Oregon Caves National Monument

Grades 3-5

"In the longest time of all come the rock's changes,

Slowest of all rhythms, the pulsations

That raise from the planet's core the mountain ranges

And weather them down to sand on the sea-floor, "

Kathleen Raine, Rock, 1978.

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Teacher's Guide to
Geology: Our Changing Earth

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Teacher's Guide to
Geology: Our Changing Earth

Subject Areas: *Science:* math, earth science, and chemistry
Language Arts: writing and public speaking

Grade Levels: 3-5

How to Use This Booklet:

This booklet is divided into various sections and is intended to be used for teacher participating in the geology program at Oregon Caves National Monument. In this booklet after the unit objectives, summary, and introduction pages, you will find Background Knowledge For Teachers section. Please note that this section is intended to help teachers become familiar with caves, weathering, and the three rock types. After you read the information you can share the knowledge with your students. Included in the booklet are seven lesson plans. It is not expected that you conduct all these with your students, but they are included to give you more options. Three lesson plans are ideal to conduct before the field trip to the caves (pre-visit lesson plans). Two lesson plans can be used before or after the field trip to the caves (pre/post-visit lesson plans) and the last two are for after the field trip to the caves (post-visit lesson plans). Following the lesson plans are a Ranger Classroom presentation quiz and answer sheet that can be used after a Ranger visits your school. Found next in the booklet are worksheets and handouts for you to use throughout the program as you see fit. Throughout the booklet, you will find some words in bold and they are defined in the glossary section. The last section of the booklet contains Oregon, California, and Common Core Standards for grades 3-5.

You may also find it helpful to show your students the 24-minute documentary entitled *The Marble Halls of Oregon: Exploring the Oregon Caves National Monument.* It was produced by Southern Oregon Public Television in conjunction with Greg Frederick Productions, LLC, 2011. The video is intended to support teachers focused on bringing nature and history alive through the use of primary source documents, historical records, and hands-on activities.

When finished with the videos and lesson plans, explore even further! Visit Oregon Caves virtual tour on-line at: **www.gotouroregoncaves.com.** This online adventure transports you to the marble world beneath the ancient forest for an interactive experience.

Unit Objectives:

Students will:

- name the three major rock categories and explain the rock cycle;
- identify examples of weathering and erosion and describe their impact on landforms and caves;
- determine the relationships between regional geology and living organisms, including people;
- understand that observations of today's ongoing processes explain changes in Earth's past;
- describe how Oregon Caves National Monument protects geologic resources and list three ways people can help protect and preserve resources.

Summary:

Studying the geology of Oregon Caves National Monument will help orient students to the nature of the Earth's changing landscape. By understanding

and observing the present landscape, students can uncover mysteries of the Earth's past and make predictions for its future. Emphasizing the National Park Service's mission and the ***Leave No Trace*** ethics will encourage students toward responsible action and behavior while visiting other natural areas.

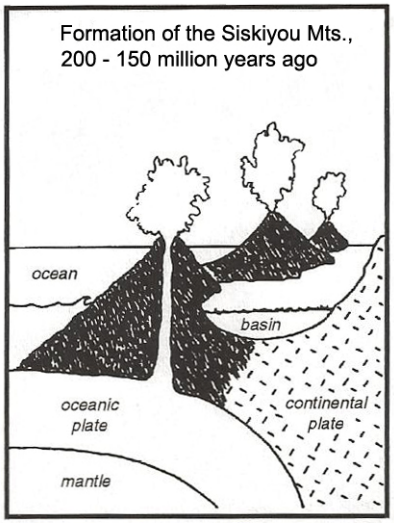
Introduction:

This program offers students multiple opportunities to uncover the mysteries of how the Earth has changed in its past and will change in the future. Sometimes we witness changes to the landscape because they occur very quickly, such as those caused by volcanoes, earthquakes, and human actions. Other changes are harder to detect like those from relatively slow and subtle processes such as plate movements, weathering, and erosion. Processes that have changed the Earth in the past still happen today. This concept is known as the **principle of uniformity**, and it helps us understand the Earth's varying surface. By studying the Earth's dynamic geologic makeup, processes, and rock cycles, students can understand the forces and processes that create and continue to shape landforms.

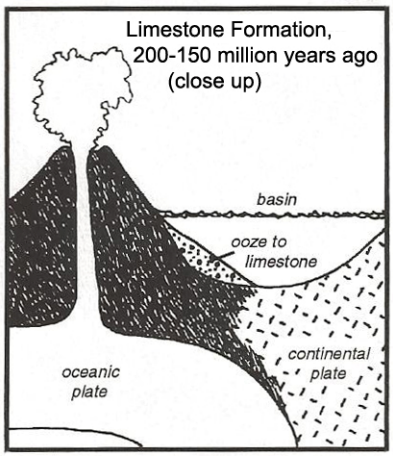
The cave at Oregon Caves National Monument is a solution cave formed in a metamorphic marble outcrop located in the Siskiyou Mountain range of southwestern Oregon. The marble formed as a result of tectonic activity. You may be wondering: How did these mountains get here? What's so special about these rocks anyway? How did the cave form? Why is this cave here and not somewhere else?

The Formation of the Siskiyou Mountains

Great and powerful forces are constantly working at or near the Earth's surface. The top layer of the Earth, called the crust, is actually broken up into

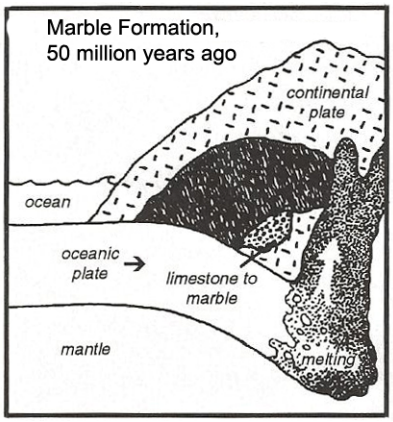


several slabs or plates, much like a broken egg shell. Each of these plates is moving very slowly (only about 1 to 2 inches per year) relative to the other plates and move due to the convection of molten magma deep within the Earth. This movement is known as the **theory of plate tectonics**. Some plates are moving side-by-side past each other (**transverse plate boundary**), like two cars going in opposite directions on the highway. Some plates are moving away from each other (**divergent plate boundary**), while other plates are crashing into each other head-on (**convergent plate boundary**). The story of the formation of the Siskiyou Mountains and the birth of Oregon Caves began about 200 million years ago when two large plates were sliding past each other. One of them was the continental plate of North America and the other was an oceanic plate beneath the Pacific Ocean. The rocks of these crustal plates cracked and sagged, allowing molten magma to escape and form a volcanic island chain off the coast. Between these islands and the mainland, a small sea formed.



Limestone Formation

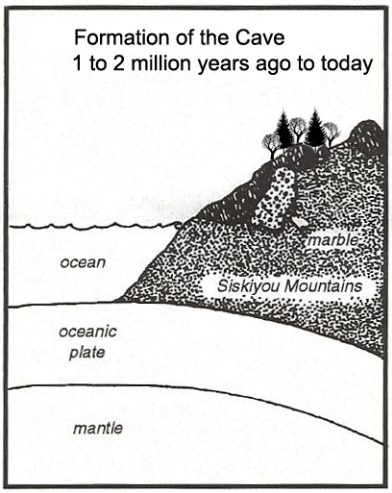
Millions of microscopic sea creatures and bacteria lived in this warm and tropical sea between the continent and the islands to create a bacterial reef. The sea creatures extracted carbon dioxide from the seawater to use for photosynthesis. As carbon dioxide was removed from the seawater, calcium carbonate, or **calcite** precipitated out of the water and sank to



the ocean floor. As time went by and the layers of calcite ooze got thicker, compression from the water and compacting weight of more rock changed, or **lithified**, the ooze into a rock called **limestone**. The main ingredient in limestone is the mineral calcite, which is also found in snail shells.

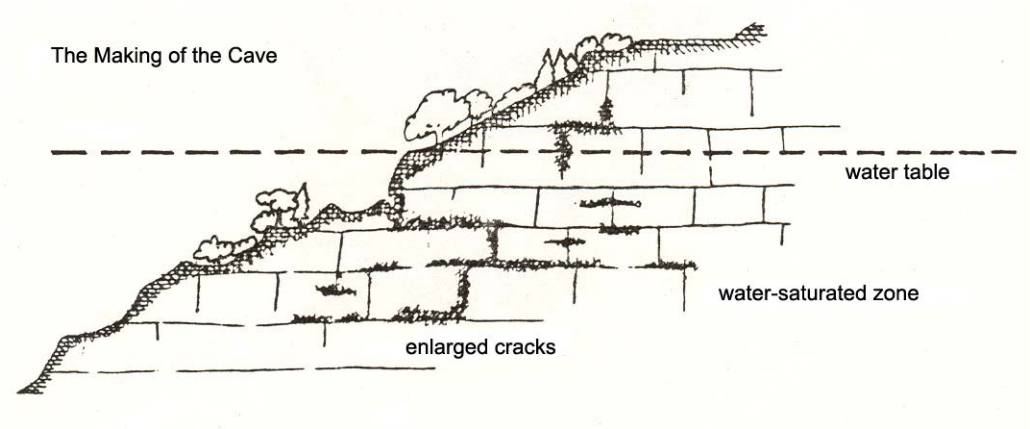
Marble Formation

After the formation of the limestone rock, the crustal plates changed their direction and began colliding head-on with each other for millions of years. The oceanic plate containing the limestone migrated northeast, towards the continental plate, and created a convergent plate boundary. The oceanic plate was denser and sank, or **subducted**, under the more buoyant continental plate. As the oceanic plate descended it was forced into higher temperature and pressure environments. The intense heat from the Earth's mantle melted the rocks, forming volcanic material or magma. The magma was lighter, so it began to rise up from below. The intense heat of the magma, combined with the pressure of being buried deep underground cooked the limestone from a sedimentary rock to a metamorphic rock called **marble**. This marble now makes up the walls of Oregon Caves.



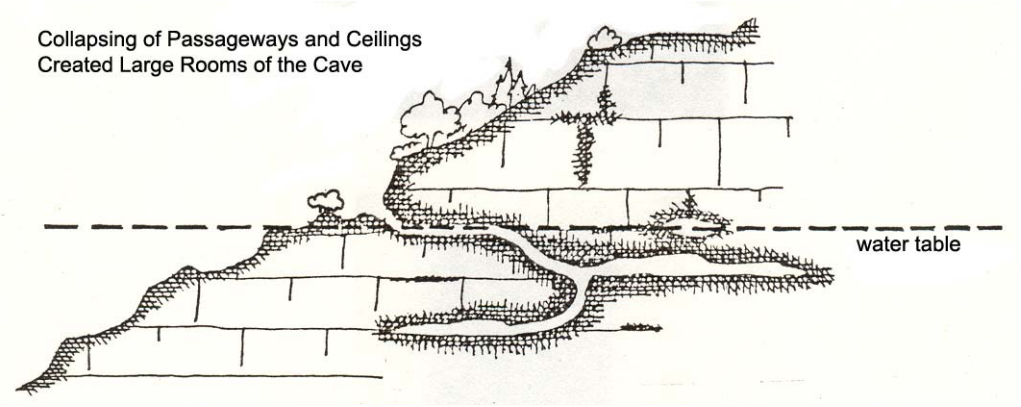
The Making of a Cave: Speleogenesis

The mountains continued to form over the next several million years. As the land **uplifted**, or lifted up, and folded, the belt of marble within the mountain cracked while the top of the mountains **weathered** and exposed the marble to the



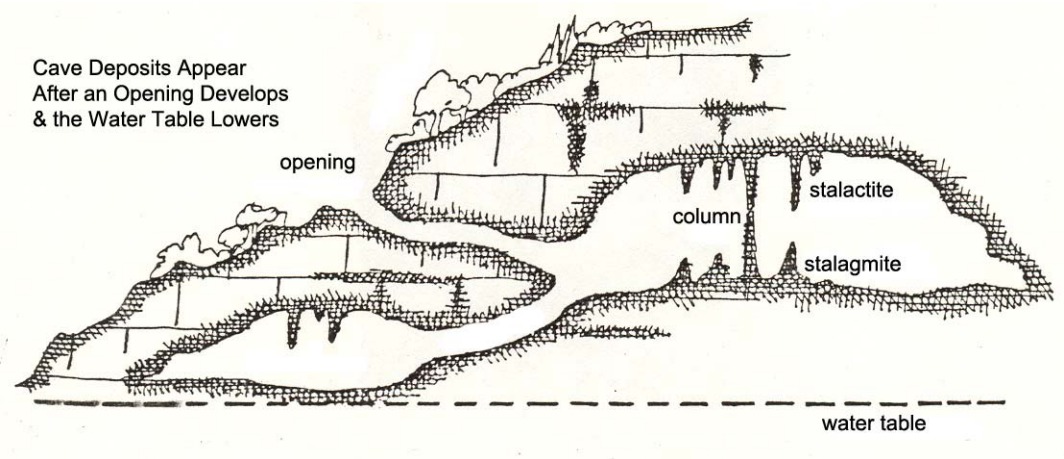
surface of the Earth. In the forest which grew over the marble, fungi, bacteria, and mold in the soil decomposed dead plants and animals releasing carbon dioxide. Precipitation **percolated** through the soil and captured the carbon dioxide to create **carbonic acid**. This mild acid is the same stuff that gives soda pop its fizz.

The acidic water chemically weathered the marble as it traveled downward through the cracks and holes in the rocks until it reached the **water table.** The greatest amount of marble dissolved just below the water table where the



highest concentration of carbonic acid occurred. The liquid then moved sideways following the cracks in the marble, and carbonic acid slowly dissolved the rock. Over hundreds of thousands of years, a system of passages formed.

Large rooms formed when ceilings and passageways collapsed as carbonic acid continued to dissolve the marble. As long as the cave was filled with water, the solution continued to dissolve the marble and the cave grew in size. The process of dissolving marble and opening up spaces within it is called **speleogenesis**. This is the first step in cave development. Speleogenesis is derived from the Greek words "spelaion" (cave) and "genesis" (beginning).



At this time, the passageways and rooms inside the cave were bare of any of the cave deposits seen today. In order for the second stage of cave development to occur, the creation of cave deposits, several things must change in the cave. The water table must lower and there must be air flow exchange between the cave and forest.

The Creation of Cave Deposits: Speleothems

When the water table lowered and openings in the cave formed, the passageways and rooms filled with air. The process that makes solution caves is similar to how cave deposits form. As carbonic acid drips through cracks in the marble, it picks up calcium carbonate from the marble. When it comes in contact with the cave air the carbon dioxide bubbles out of solution, similar to

opening up a can of soda. The calcium carbonate is then deposited on the ceilings, walls, and floors as the water drips creating calcite deposits. Calcite deposits can also be called cave formations or **speleothems**. These terms are used interchangeably. Speleothem is derived from the Greek words "spelaion" (cave) and "thema" (deposit).

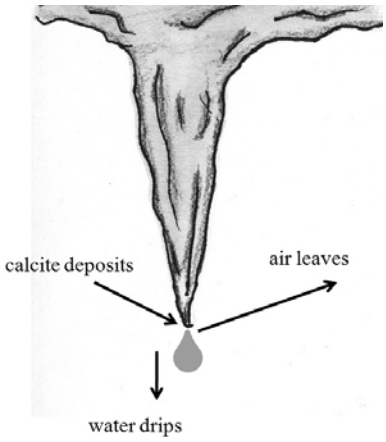
Calcite deposition continues today. Drip by drip, hour by hour, year by year, calcite constantly deposits. It is this slow change caused by the transformation of water from its origin in the forest into calcite deposits that make Oregon Caves a living cave.

Weathering vs. Erosion

Weather and erosion change rocks at Oregon Caves, but why do rocks weather? What causes erosion? **Erosion** occurs when rocks are transported by water, wind, or ice. When it rains, water washes rocks down into a river. This is erosion. Weathering is the response of Earth materials to a changing environment. It occurs when forces of weather such as rain, snow, ice, and wind mechanically fragment or chemically alter rocks. Mechanical weathering is accomplished by physical forces that break rocks into smaller pieces without changing the rocks' mineral composition. Examples of mechanical weathering include frost wedging, thermal expansion, and biological activity. Chemical weathering involves a chemical transformation of rock into one or more new compounds. For example, carbonic acid chemically weathered the marble rocks at Oregon Caves and formed a cave. Weathering occurs all over the Earth's landscape and at Oregon Caves, yet it is easy to underestimate its importance because it is such a slow and subtle process.

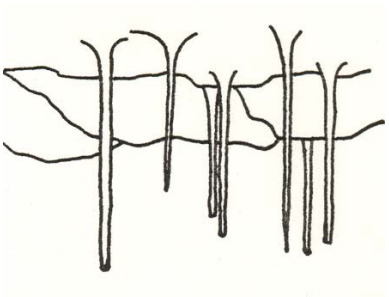
Speleothems (Cave Deposits)

Although speleothems form inside caves, the process begins in the forest. As water filters through the forest soil, it captures carbon dioxide to form carbonic acid. The acid dissolves marble and carries bits of calcite, the mineral found in marble, with it. This solution, called calcium bi-carbonate, journeys into the cave. Then, carbon dioxide leaves the solution which causes the calcite mineral to deposit on the ceilings, floors, or walls of the cave creating speleothems. Later the water drops may eventually rejoin the River Styx in the cave.

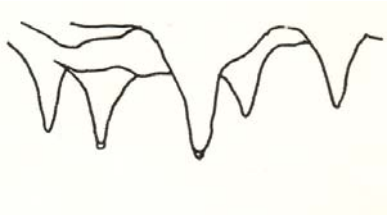


Soda Straws or Baby Stalactites

Soda straws form where the solution enters the cave slowly such as on the ceilings of caves. As the solution enters the cave, carbon dioxide leaves and calcite is deposited leaving a thin layer of mineral around the ring of the water droplet. As the water droplet falls, a new drop of solution takes its place. Each successive drop deposits a little more mineral before falling, and eventually a hollow tube is built up. Soda straws are some of the most fragile speleothems because they are hollow.

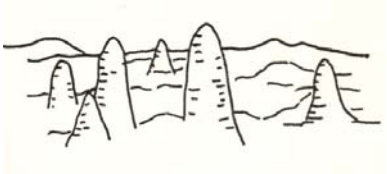


Stalactites



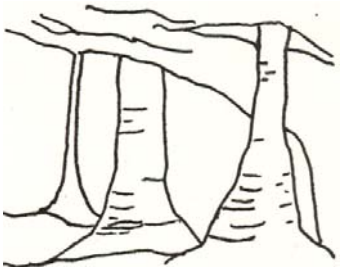
As soda straws grow drip by drip, sediment or calcite may clog the hollow end of the tubes. Instead of going down the tube, the calcium bi-carbonate solution runs down the outside of the calcite deposit. This effect causes the formation to be wider at the top. Instead of looking like a soda straw, stalactites look more like a carrot: wider at the top and pointed at the end.

Stalagmites



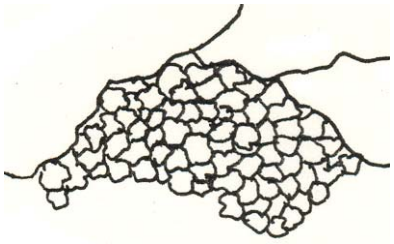
Stalagmites form where the solution enters the cave relatively fast: before carbon dioxide degasses or leaves. As the solution drops, the impact causes carbon dioxide to leave. Calcite deposits as the water drips away and forms a stalagmite from the ground up. Often, a stalagmite has a matching stalactite above it.

Columns



Columns are formed when stalactites and stalagmites grow together.

Cave Popcorn

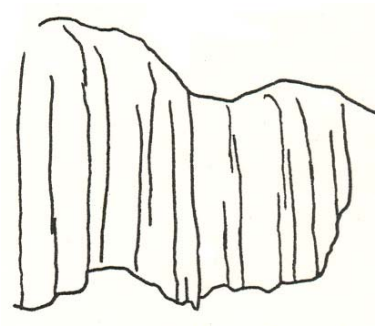


Cave popcorn usually forms through a combination of evaporation and loss of carbon dioxide from the calcium bi-carbonate solution. Typically cave popcorn is found near current or past openings of caves where there is or was a great deal of airflow. The calcite is deposited in bumpy irregular formations that look much like coral, grapes, or popcorn.

Flowstone

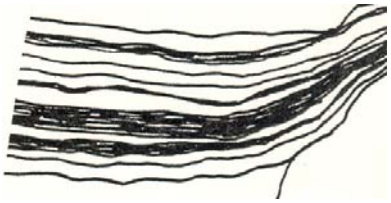
Flowstone forms as the solution flows along walls and ledges of the cave. As it flows, carbon dioxide leaves from the solution or is forced out. Flowstone often sparkles and deposits calcite in smooth layers or sheets.

Drapery



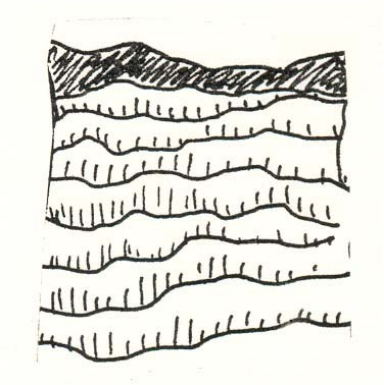
Drapery occurs when the solution trickles down a back slope of a ceiling or wall. The calcite is deposited in irregular sheets that often look like drapes or curtains.

Cave Bacon



Cave bacon is drapery that has alternating layers of pure white calcite deposit and reddish colored deposit. The calcite deposit can be white because the solution entering the cave was free of any impurities. Impurities such as iron or sediment can cause calcite deposits to appear red. Cave bacon indicates a change in water flow or water source from the forest.

Rimstone Dams

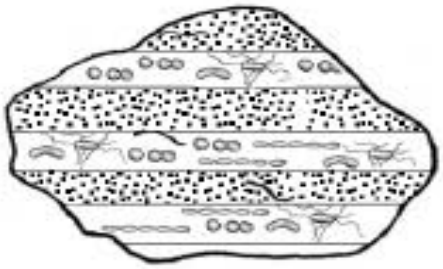


Rimstone dams develop in streams of water containing calcium bi-carbonate solution. The water becomes agitated as it moves over irregular surfaces creating ripples in the stream. Some of the carbon dioxide in the solution escapes as it moves, leaving a deposit of calcite below in the shape of the ripple. Eventually, layers of calcite build up forming small dam-like deposits.

The Three Rock Types

Sedimentary Rocks

are formed through erosion as sediments are transported and then deposited. Layers of sediment cement together through compaction and pressure. Sedimentary rocks often have visible layers.



Metamorphic Rocks

are formed when rocks are squeezed and baked by heat and pressure below the earth's surface. Some metamorphic rocks have wavy layers.

Igneous Rocks

are formed by the cooling and hardening of hot liquid rocks. Liquid rock underground is called magma and when it reaches the surface, it is called lava. Most igneous rocks are very hard.

Settle Down Like Sedimentary Rock!

Duration: One class period for activity; 48 hours to dry; one class period for observation and follow-up activities.

Objectives

Students will be able to:

- observe and explain how sediments settle and form sedimentary rocks.

Materials

- pebbles
- sand
- twigs
- leaves
- 8 ounce paper cups
- glass jar (optional)
- Epsom salts—1/4 cup per student (available at drug stores)
- water
- magnifying lens (optional)
- samples of sedimentary rocks (e.g. sandstone, limestone, chalk, shale, chert, or coal)

Settle Down Like Sedimentary Rock

Purpose

Through a simple experiment students will be able to observe how sediments settle down at different rates and create layers with similar sized particles in the formation of sedimentary rocks.

Anticipatory Set

Have children examine and compare samples of sedimentary rocks.

Ask students:

- What is a sedimentary rock? (one made of sediments and broken rock, cemented by compaction and pressure)
- Where are they found? (everywhere and especially near river beds)
- Can you name some examples of sedimentary rocks? (sandstone or limestone)

Background Information

Sedimentary rocks are one of three main rock types or families. The other types are igneous and metamorphic rocks. Sedimentary rocks are composed of layers of sediments or broken pieces of rocks. Fossils are also considered sedimentary rocks and one type can be formed when an organism dies and is covered with sediments. Sedimentary rocks are formed by erosion as sediments transport and then deposit layers of sediments to other locations. These layers of sediment cement together through compaction and pressure. Sedimentary rocks often have visible layers because of how they are formed. In this activity, we will be making sediment soup and recreating conditions of still waters like a lake. Instead of natural minerals found in the water, we will use Epsom salt to help cement our rock into one piece. Later, we will let the soup completely dry and be able to investigate a homemade sedimentary rock.

Directions

1. Fill a paper cup with about a tablespoon each of pebbles, sand, twigs, and leaves.
2. Add 1/4 cup Epsom salt.
3. Add 1/2 cup of water.
4. Stir well to mix up the Epsom salt and sediments.
5. Place the cup on a flat surface and leave it undisturbed for several days until it is dry.
6. Once dry, carefully tear the paper cup away from the sediments.
7. Predict, describe, and draw how the homemade sedimentary rock will look. Which sediments will drop to the bottom first? Why? After the mixture dried, was your guess correct?

*Option for teachers: Make one sedimentary soup in a glass jar instead of a paper cup. Although the finished product will not be removable, the students can watch through the glass as the process takes place.

Check for Understanding

Ask students (after the rock has dried):

- What do you notice about your sedimentary soup?
- How has it changed from the original sediments you used to make it?
- What holds the sediments together?
- How did your homemade sedimentary rock get its shape?
- How are sedimentary rocks formed?

Guided Practice

Bring out the samples of the real sedimentary rocks again. Ask students to try to identify the rocks before identifying them for the class. How do they

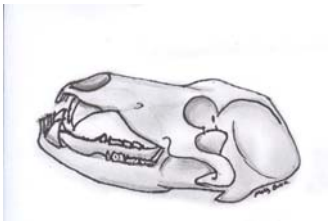
look similar and different? Layering or bedding is the most distinctive feature of sedimentary rocks. Do any of the rock samples exhibit layering? Can any loose sediment be identified? Do any of the rock samples look similar to the home-made sedimentary rock made in class? Use magnifying lenses to examine rocks more closely. Instruct students to record their observations using pictures and words.

Closure

In this experiment, various sediments were cemented together by the dissolved minerals present in the Epsom salt. The Epsom salt worked as a glue to hold it all together, similarly to how dissolved calcite minerals helped glue the limestone rock together. Limestone is made up of layers of calcite minerals and sediment. It formed in the ocean and once was an ancient bacterial reef. The rock walls of Oregon Caves are made out of the metamorphic rock marble, but marble was once limestone, a sedimentary rock. The cave deposits at Oregon Caves are also considered sedimentary rocks because they are made in layers, drip by drip, of calcite minerals and are cemented together by the calcite crystals.

Independent Practice

Make sedimentary rock food for a rockin' good time! Suggestions include layered cake, sandwiches, Jell-o, or pudding. Ask students to share with the class what each layer in their edible rock represents. For example when making a layered Jell-o mold different colors could represent different types of sediments: red could indicate an iron rich mud layer, yellow could represent a sandy layer, and gummy bears could indicate fossils. To make serving easier, prepare in individual cups or muffin tins.



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Can't Take the Heat?
Can't Take the Pressure?
Then Change.

Duration: 30 to 45 minutes.

Objectives

Students will be able to:

- demonstrate how heat and pressure can make substances change form.
- recognize how the layers in sedimentary rocks change shape when exposed to heat and pressure.

Materials

- different colors of clay or Play-Doh
- waxed paper
- several heavy books
- samples of metamorphic rocks (e.g. marble, serpentinite, quartzite, or schist)

Purpose

Through a simple experiment students will be able to observe how different colors of layered Play-doh can change color given enough heat, pressure, and time. Each color of Play-doh represents different rock layers and minerals of a sedimentary rock. First students will make Play-doh limestone and then this

"parent rock" will metamorphose marble, a metamorphic rock.

Anticipatory Set

Have children examine and compare samples of metamorphic rocks.

Ask students:

- What is a metamorphic rock? (a rock formed through heat, pressure, and time)
- Where are they found? (They are found wherever metamorphic processes have occurred such as deep underground, at the base of mountains, or the top of eroded mountains.)
- Can you name some examples of metamorphic rocks? (marble, serpentinite, quartzite, or schist)

Background Information

Metamorphic rocks are produced from preexisting igneous, sedimentary, or metamorphic rocks. Every metamorphic rock has a **parent rock,** the rock from which it was formed. Metamorphism means to "change form." To help remember this, think about the *metamorphosis* of a butterfly and how it changes during its life cycle. Rocks are typically brittle and tend to break when exposed to different stresses. In a metamorphic environment the rock acts **ductile**, like the flexibility of taffy, and the minerals in the rock can flatten and elongate. The minerals can also become more compact causing the grains or crystals in the rocks to blend together. Metamorphic rocks can have visible wavy layers.

Directions

1. Form 3 marble-sized balls out of different colored clay or Play-Doh.
2. Flatten the balls to form squished circles and stack them on top of each

other on a sheet of waxed paper.

3. Cover the Play-Doh with another piece of waxed paper and pile several heavy books on top.

This is a diagram of the squished balls stacked on top of each other.

4. Remove the books and look at the shapes of the newly formed “rocks.” Describe and sketch them. You have now created a sedimentary rock from compaction and pressure.

Students will now create a metamorphic rock out of the sedimentary rock by adding heat, pressure, and time. Instruct students to:

1. Form one large ball out of the Play-Doh sedimentary rock. Continue to form the ball for 5 minutes or until the “minerals” (different colors) start to mix and blend together from the warmth of their hands.
2. Place the Play-Doh back on the sheet of waxed paper, cover it with another piece of waxed paper, and pile several heavy books on top.
3. Leave the books for 10 minutes.
4. Remove the books and look at the colors of the newly formed “rocks.” Describe and sketch them. You have now created a metamorphic rock from heat, pressure, and time.

This is a diagram of the blended “metamorphic rock..”

Check for Understanding

Ask students:

- What did the different colors of Play-Doh represent?
- Are rocks all the same colors? What are rocks made of?
- What happened when pressure was applied to the Play-Doh?
- What happened when heat *and* pressure were applied to the Play-Doh?
- How are sedimentary rocks formed? How are metamorphic rocks formed?

Guided Practice

If possible, have samples of limestone and marble for the class to examine or samples of a metamorphic rock and its parent rock. How are they similar? How are they different? Have students example to each other in small groups how the metamorphic rock changed from its parent rock.

Closure

The walls of Oregon Caves are made out of the metamorphic rock marble. This marble formed after limestone, its parent rock, was subducted underneath the North American plate and then exposed to heat and pressure deep underground. Over time, the limestone changed into a new rock called marble. When exploring Oregon Caves, you can see the original bedding planes that formed when limestone lithified into a rock. The bedding planes are now wavy because of the metamorphic process. It is a rare treat to visit a marble cave because most caves in the world are limestone and less than 5% are marble.

Independent Practice

Have students make even more metamorphic rocks with food and report how their "rocks" were formed. Suggestions include Rice Krispies bars, different colors of taffy, cheese and bean tortillas, and chocolate chip swirl pancakes.

References

Blobaum, Cindy. *Geology Rocks! 50 Hands-On Activities to Explore the Earth*. Nashville, TN. Williamson Books. 1999. Print.

Tarbuck, Edward & Frederick Lutgen. *Earth An Introduction to Physical Geology Eight Edition*. Upper Saddle River, New Jersey: Pearson Prentice Hall. 2005. Print.

Born of Fire

Duration: Prep time- 15 minutes; Class time- 30 minutes; Dry time- 24 hours.

Objectives

Students will be able to:

- explain how igneous rocks form.
- describe the relationship between the cooling rate of igneous rocks and their crystal size.
- categorize igneous rocks based on their cooling rate.

Materials (for each group)

- large pitcher
- Epsom salts
- water
- two small jars
- two pipe cleaners
- crushed ice
- medium sized bowl or bucket
- magnifying glass (optional)
- samples of an intrusive igneous rock (e.g. granite, diorite, and gabbro)
- samples of an extrusive igneous rock (e.g. pumice, obsidian, scoria, and, basalt)

Purpose

The rate at which magma or lava cools contributes to the textures of igneous rocks. Through a simple experiment students will be able to observe the relationship between the rate of cooling and crystal size.

Anticipatory Set

Ask students:

- What is an igneous rock? (molten rock that has cooled from volcanic lava at various rates)
- Where do you usually find igneous rocks? (in areas of current or past volcanic activity)
- What are examples of an igneous rock? (pumice, diorite, or obsidian)

Background

Extremely high temperatures originating deep within the Earth melts minerals to form red-hot liquid called magma. Magma is under tremendous pressure from the overlying rocks and contains gasses and steam. When the magma finds a weak spot in the Earth's outer layer, it pushes its way through and erupts as lava. When the molten minerals cools it forms igneous rock. The size of the grains (crystals) in an igneous rock will depend on the rate of cooling. The faster it cools, the smaller the crystals. Igneous rocks that form when molten rock cools or solidifies at the surface are classified as extrusive or volcanic. These are found in abundance in the Cascade Range in Oregon. Igneous rocks that form underground are called intrusive or plutonic. Intrusive igneous rocks are found on the surface after overlying rocks are eroded or after portions of the crust have been uplifted like the intrusive igneous dike that splits the Ghost Room of Oregon Caves.

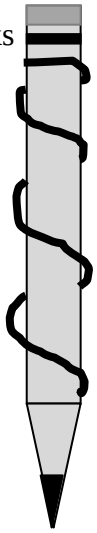
Directions

For the Teacher:

1. Prepare the Epson salt solution by filling a large container with 16 ounces of water.
2. Add Epson salt until the water cannot dissolve anymore salt in order for the solution to reach the highest possible concentration of Epson salt.
3. Pour equal amounts of the salt solution into two small jars.

For Students:

1. Wrap a pipe cleaner around a pencil to form it into a shape that looks like a stretched spring.
2. Remove the pipe cleaner from the pencil and place it inside one jar.
3. Repeat steps 2-3 for the other pipe cleaner.
4. Fill up a bowl with ice and put one jar inside of the bowl.
5. Place the other jar next to the bowl with ice and them all where they will not be disturbed.
6. Allow the crystals to form overnight.
7. Remove the pipe cleaners and compare the sizes of the crystals.



Check for Understanding

Ask students:

- Compare the sizes of the crystals from both jars.
- Which ones are bigger? Smaller? (Slow cooling promotes the growth of large crystals, whereas rapid cooling tends to generate smaller crystals.)

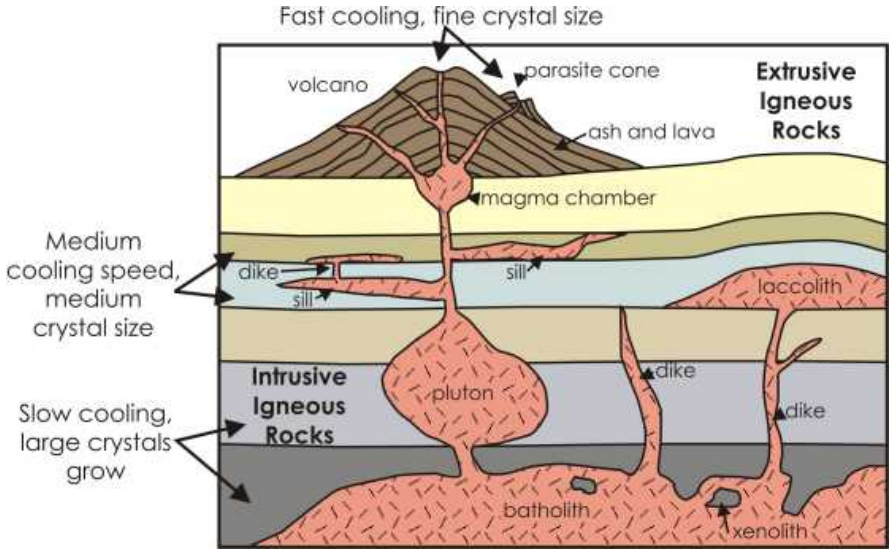
Guided Practice

Have students compare the intrusive and extrusive igneous rock samples. Which rocks have larger crystals? Which rocks have very small crystals or no

crystals? Categorize the igneous rocks based on crystal size. Where did the intrusive igneous rock cool? Where did the extrusive igneous rock cool?

Closure

This experiment is used to prepare students for a visit to Oregon Caves. Talk about the different types of rocks present in the cave and tell them to look for the igneous intrusion found in the Ghost Room. Igneous rocks form when magma cools and solidifies. Magma that solidified at depth produces intrusive igneous rocks. Extrusive igneous rocks results when lava cools at the surface.



Independent Practice

Have student draw a picture of a volcano and label where extrusive and intrusive igneous rocks form. Have them draw a generic extrusive and intrusive igneous rock with crystal size detail.

References

Planet Earth Outer Core. March 3, 2012.<http://gamediv1.weebly.com/igneous-rocks.html>

Recipe for a Cave

Duration: 45 minutes

Objectives

Students will be able to:

- explain how the caves formed and changed over time.
- formulate hypothesis on how the caves will change in the future.

Materials/Resources Needed

- scissors
- construction paper
- glue
- colored pencils, crayons, or markers

Anticipatory Set

Ask students:

- How do you think the caves were formed?
- What do you think was here before the cave?
- Do you think the cave is still changing today? How?

Purpose

This activity helps reinforce how the caves were formed in nine simple

steps. Using, baker's language, geological concepts are more accessible for students. Explain to students that they will be bakers and they will make a batch of Oregon Caves.

Background Information

Review the Background Information Section in this lesson packet on pages 8-18 and watch *The Marble Halls of Oregon: Exploring the Oregon Caves National Monument* movie. You may also want to visit Oregon Caves virtually on-line at: **www.gotouroregoncaves.com**.

Directions

1. Make copies of *Recipe for Oregon Caves*
2. Review the steps and have students read each one out loud.
3. Ask students to color the pictures, cut them out, and put them in the correct order on "Cave Recipe Cards" sheet.

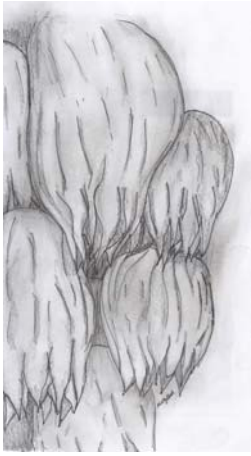
Check for Understanding

Review the answers and ask students:

- What ingredients did living creatures add to help make the caves? (calcite or calcium carbonate)
- What did baking do to the limestone rock? (changed it from limestone to marble) What do you think geologist call it when a rock gets baked? (metamorphosed)
- What caused the cracks in the marble to enlarge? (carbonic acid)
- What three rock types were formed during the recipe for Oregon Caves?
- (sedimentary, igneous, and metamorphic)
- Which rock type was created first? Hint: this rock was "kneaded" and

"compressed." (limestone)

Guided Practice



Have students draw what they think they will see when they visit Oregon Caves (or what they saw). Have them write in baker's language how the rocks were formed using the following terms: Bake, Boil, Combine, Cool, Cream, Dash, Drizzle, Dust, Fold, Glaze, Grind, Knead, Mix, Peel, Refrigerate, Softened, Steam, Stir, Toss, Whip, or Zest. For example, if students draw a stalactite, they could write, "Fold in rainwater with calcite to create a stalactite hanging from the ceiling."

Closure

Create a chart on the board with three columns. At the top of each column, write, "Bake" (heat), "Knead" (pressure) and "Drippings" (water) respectively. Divide students into small groups. Have them decide which recipe steps belong in each category. Ask students if there should be more columns. Relate the processes with rock types. Heat-igneous rocks, pressure-sedimentary rocks, heat and pressure—metamorphic rocks.

Independent Practice

Have a rock party with edible rocks! Have students bake dishes to symbolize various steps in *Recipe for Oregon Caves*. Ask students for their ideas of food that might represent various cave elements.

Oregon Caves Recipe Cards

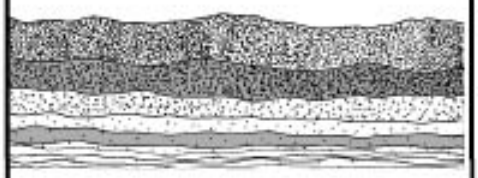
Preheat oven to 1000 F. Make sure you have the following ingredients:
1) tiny sea creatures 2) diorite spice 3) plenty of rain water 4) old-growth forest 5) lots of time!

Step 1	Step 2	Step 3
Step 4	Step 5	Step 6
Step 7	Step 8	Step 9

Recipe for Oregon Caves

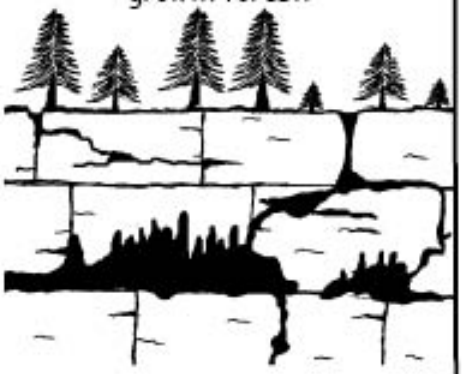
Color all the pictures of the recipe steps below. Then cut out the squares and glue them to the correct boxes on the recipe card. Make sure you put them in the correct order so your recipe will turn out just right!

Knead in even more sea creatures and let the layers compress until the sedimentary rock, limestone, is formed.

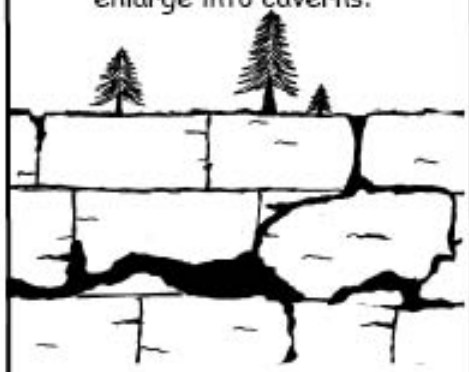


Serve to students as they visit Oregon Caves National Monument!

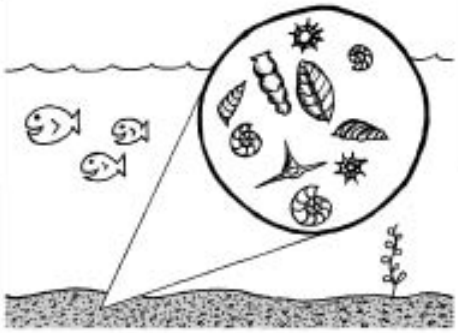
Allow drippings to accumulate within the cave for 200,000 years or so. Sprinkle the top with old growth forest.



Add rainwater and a dash of carbon dioxide. Watch the marble dissolve and the cracks enlarge into caverns.

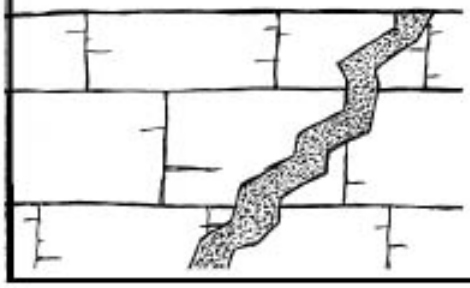


Mix in billions of tiny sea creatures with bodies made of calcite. Let this settle for several thousand years.

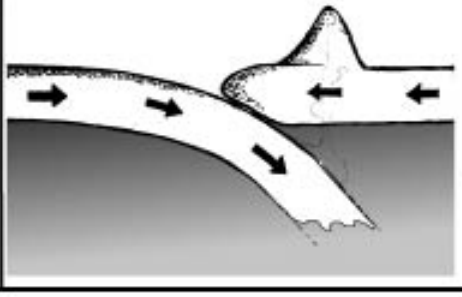


Have the National Park Service preserve the finished product for present and future generations to enjoy.

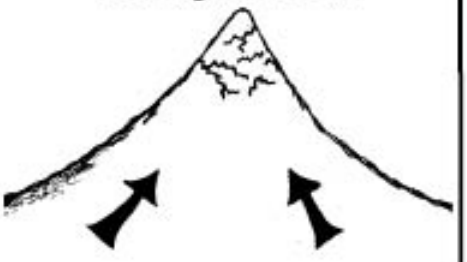
Spice up the ingredients by salting and peppering it with intrusions of molten rock. Allow it to cool and form igneous rocks of diorite dikes.



Put it all into the oven at the subduction zone and allow it to bake for a few thousand years, or until the metamorphic rock, marble, is formed.



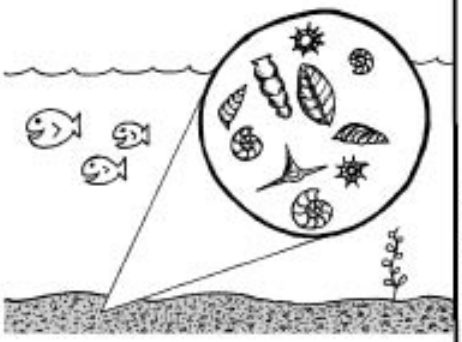
Allow it to rise for about 170 millions years, or until steep-sided mountains develop. Cracking will occur.



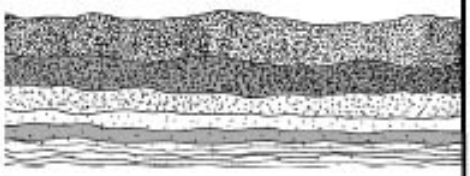
Recipe for Oregon Caves

Answer Key

Mix in billions of tiny sea creatures with bodies made of calcite. Let this settle for several thousand years.



Knead in even more sea creatures and let the layers compress until the sedimentary rock, limestone, is formed.



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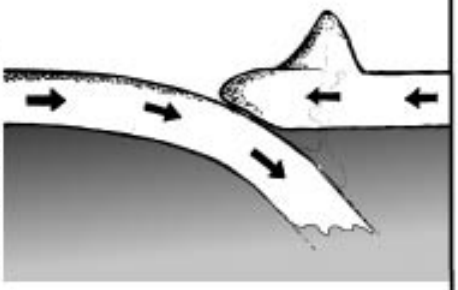

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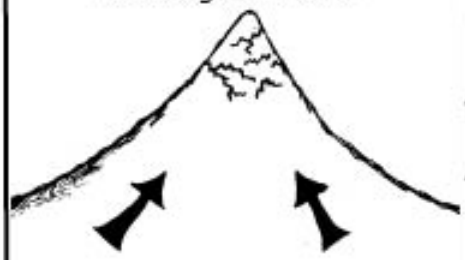

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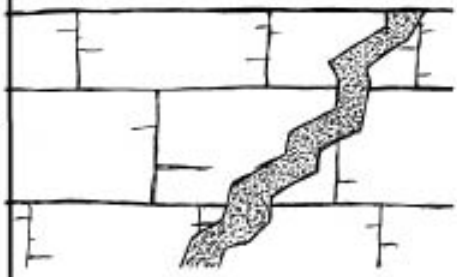
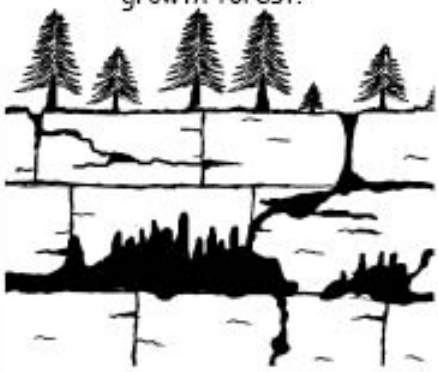
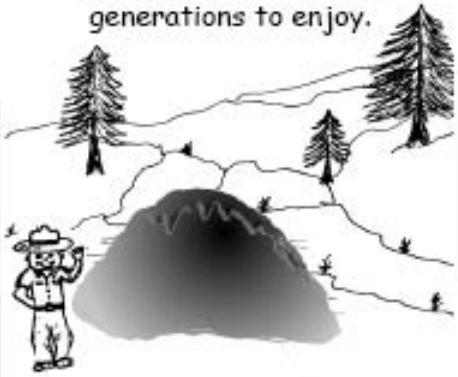


Add rainwater and a dash of carbon dioxide. Watch the marble dissolve and the cracks enlarge into caverns.

Allow drippings to accumulate within the cave for 200,000 years or so. Sprinkle the top with old growth forest.



Have the National Park Service preserve the finished product for present and future generations to enjoy.



Serve to students as they visit Oregon Caves National Monument!

Make your own recipe Card

Imagine what you will see during your field trip to Oregon Caves. Draw a picture of formations found inside of the cave. Using baker's language, write a recipe card on how it was formed.

Baking Terms: Bake, Boil, Combine, Cool, Cream, Dash, Drizzle, Dust, Fold, Glaze, Grind, Knead, Mix, Peel, Refrigerate, Softened, Steam, Stir, Toss, Whip, or Zest

The Cave Dance

Duration: 15 to 30 minutes

Objectives

Students will be able to:

- explain how the caves developed and have changed over time.
- demonstrate how the caves formed through interpretive dancing.

Materials

- enough space for students to move around
- *Cave Dance: The Story of Oregon Caves* visual guide (attached)
- *Oregon Caves Development* visual guide (attached)
- picture of the ocean (attached)
- pictures of the inside and the outside of Oregon Caves (attached)

Purpose

With practice this routine can be done in less than a minute, yet it represents a long span of geological time (200 million years). This activity condenses the story of how Oregon Caves formed into physical movements that engages the senses and creates body memory of the caves' origin.

Anticipatory Set

Ask students:

- How many of you have been to Oregon Caves?
- How were the caves were formed?
- Do you think the cave is still changing today? How?

Background Information

Places have an origin and a story to tell, just like each of us has a life history. Review the Background Information Section in this lesson packet on pages 8-13 and watch *The Marble Halls of Oregon: Exploring the Oregon Caves National Monument* movie. You may also want to visit Oregon Caves virtually on -line at: **www.gotouroregoncaves.com**.

Directions

Before starting the cave dance, get students thinking about how the Earth changes. Ask students, "What causes the Earth to change?" (floods, earthquakes, volcanoes, human development, etc.) Write a list on the board. Now show students a picture of the ocean and ask them, "Could this be the future site of Oregon Caves?" Show students pictures of the inside and the outside of Oregon Caves. Remind them that the caves did not always look the way it does today. It has changed!

In an open area, have students form a circle and ask them to space themselves arm-length apart. Use the *Cave Dance: The Story of Oregon Caves* visual guide for assistance with understanding the physical movements. Repeat the dance several times until you are sure the majority of the students have it memorized. You can ask for volunteers to come into the center of the circle and perform the dance for the class. You can also have the entire class perform the

dance without anyone talking or giving verbal queues.

Step 1. "The formation of Oregon Caves started in an ancient ocean."

Wave your arms side to side like ocean waves

Step 2. "In the ocean, there were sea creatures. "

Touch your thumb to your finger tips to mimic clams and sea creatures.

Step 3. "These sea creatures died, their bodies sank to the bottom of the ocean, and formed layers. This created a sedimentary rock known as limestone."

Put your arms in front of your body and move one arm over the other to create layers with your arms in a "genie style."

Step 4. "The surface of the Earth started to move and it caused the ocean plate with the limestone to move towards the North American plate. They slammed into one another and the limestone went underground towards the Earth's mantle."

Make a fist with one hand and push it towards your other hand which cups the fist. Then the fist opens and moves under the cupped hand. This represents the limestone hitting the plate and moving underground.

Step 5. "Beneath the surface, that limestone was exposed to intense heat…

Rub your hands together until you feel warmth from the friction.

Step 6. "…and pressure."

Stomp your feet on the ground and push your hands together.

Step 7. "This heat and pressure metamorphosed the limestone into marble, a metamorphic, or changed rock. However, the marble didn't stay deep underground. It uplifted, or rose, to 4,000 feet and is now part of the mountain, Mount Elijah"

Do a jumping jack and end it by forming a triangle with your hands above your head.

Step 8. "Trees grew on the mountain and formed an old-growth forest."

Extend your arms out to the side like tree branches.

Step 9. "When it rains or snows, water drips down through the trees and their roots and then into the soil."

Starting at your shoulders with your arms out to the side, wiggle your fingertips and move you arms down towards your thighs to create falling water.

Step 10. "As the water travels through the soil, it picked up carbon dioxide and became carbonic acid."

Put your finger to your lip (as if to get it wet) and place your finger on your hip making a "ssssss" sound.

Step 11. "The acid seeps down through cracks in the marble and makes those cracks bigger and bigger. The acid dissolves the rocks until a cave is formed.

Make two "C's" with your hands and hold your hands together. Now slowly move apart your hands creating an opening with your thumbs and fingers facing each other.

Check for Understanding

Allow students to return back to their seats and ask:

- How did water help make the caves?
- How did living creatures help make the caves?
- How many years do you think passed from the start of the story (the ocean and sea creatures) to the end of the story (cave is formed)?

Guided Practice

Give students copies of the *Cave Development* page. As they look at the images, have them physically perform the cave dance to reinforce the lesson.

Closure

Create a chart on the board with three columns. At the top of each column, write: “life,” “weather,” and “earth forces” respectively. Divide students into small groups. Give out copies of the *Cave Dance: The Story of Oregon Caves* visual guide. Have students cut out each hand motion and decide which category the hand motion event belongs to. Let each group put up at least one hand motion event on the board. Reinforce that the cave dance is a story on how the Earth changes and that they just categorized different types of forces that help create the cave.

Ask students:

- Should there should be more columns, or hand motions in the cave development.
- Can the hand motions be categorized other ways (slow events versus fast events, or “plants,” “animals,” “rocks,” and “water”).

Independent Practice

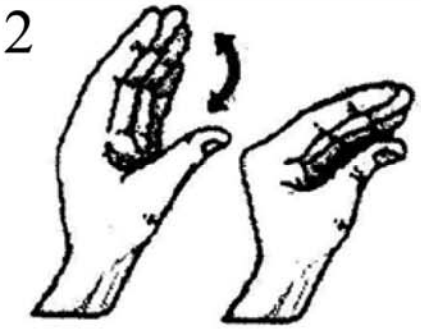
Have students write a scientific story predicting how the caves will change in 100,000 years. After writing the story, ask students to create a dance move representing the event that takes place in the story and notify them they might be asked to teach them to other students. At the end of the extended lesson, ask student if anyone told a story in which no change occurred. Discuss this point.

Cave Dance The Story of Oregon Caves

1

Ocean

2

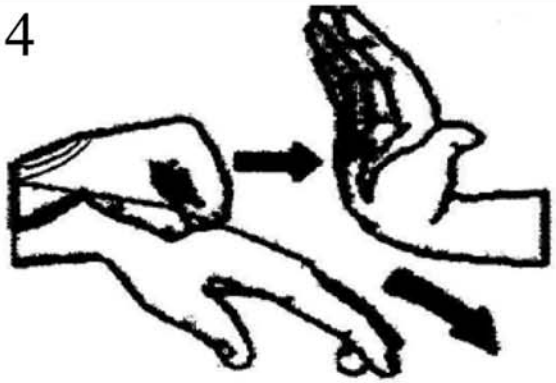


Clams

3

Layers

4



Subduction

5

Heat

6

Pressure

7

Uplift

8

Trees

9

Rain

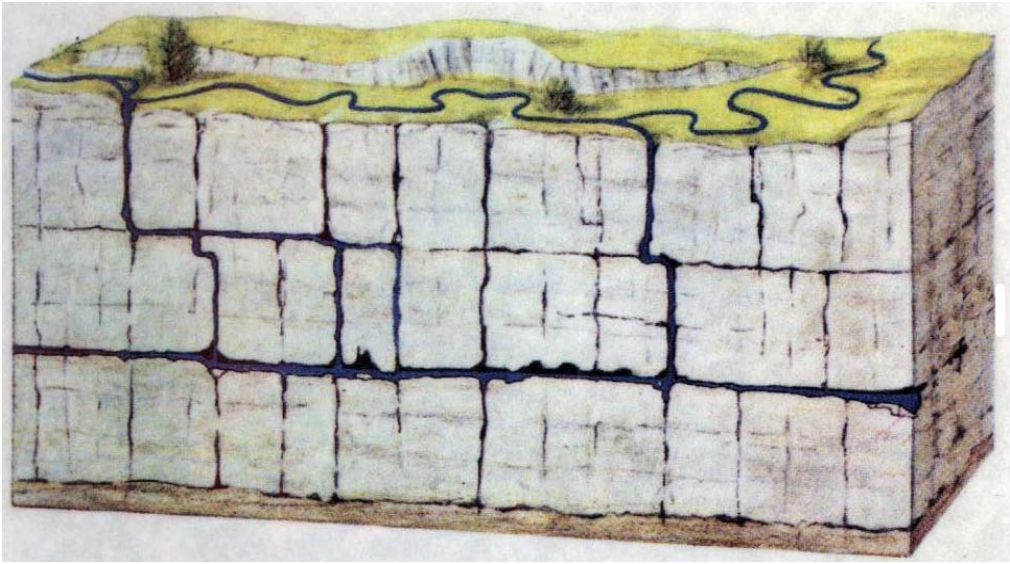
10

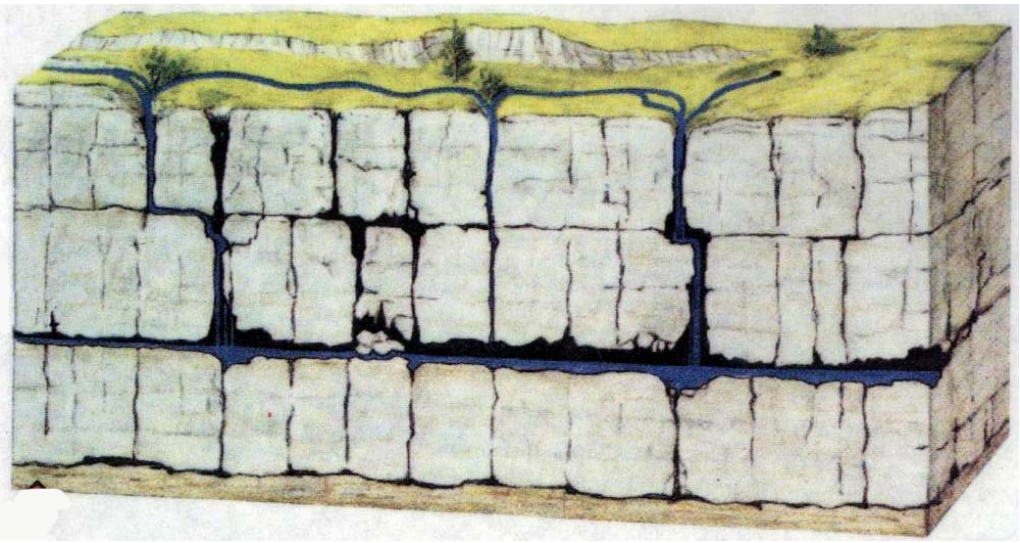
Acid

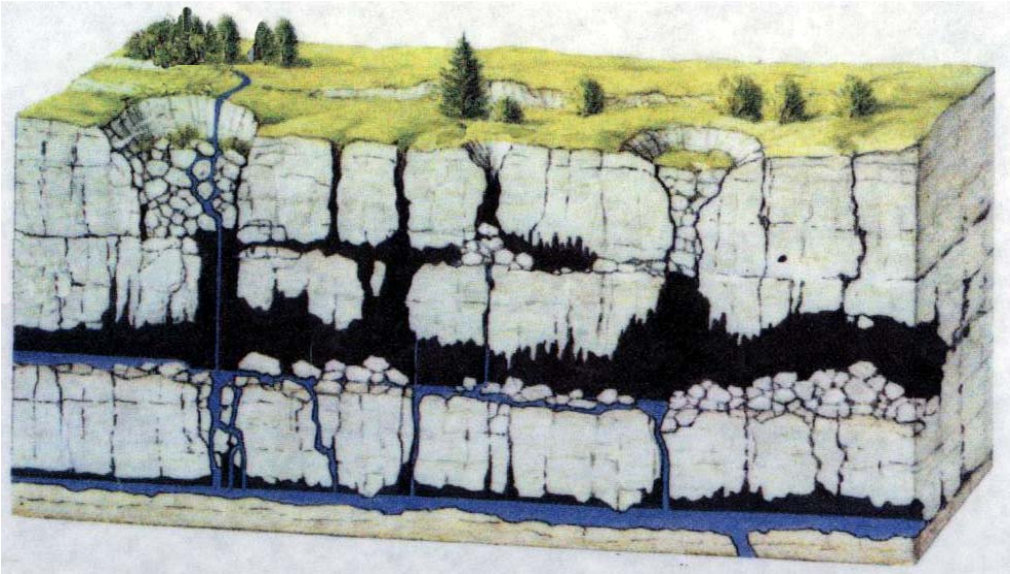
11

Caves

Oregon Caves Development







The Ocean

The River Styx

Joaquin Miller’s Chapel

Field Trip Reflections

Duration: 45 minutes in class and homework

Objective

Students will be able to:

- recall specific events, emotions, and impacts of the field trip to Oregon Caves.
- write about the experience using revealing details.

Materials

- pen or pencil
- *Field Trip Reflection* worksheet (attached)

Purpose

This writing assignment gives students an opportunity to remember their field trip to Oregon Caves.

Anticipatory Set

Ask students:

- What do you remember about your field trip to Oregon Caves?
- What parts of the field trip were the most fun and interesting?

Field Trip Reflections

Background Information

Your class visited Oregon Caves for a field trip. You went inside the cave and may have hiked in the old growth forest. Now, remember your field trip and think about what you saw, discovered, and learned.

Directions

1. As a class, review the details of the field trip to Oregon Caves. In what order did the events occur (what happened first, second, third)?
2. During what parts of the program did you use your senses? What do you remember seeing, hearing, or touching during the program?
3. Next review what was discovered and learned during the field trip. What created the caves? Did any activities at the Monument help teach them how the caves were formed? (the Cave Dance or the treasure box activities?) What are the three rock types? (sedimentary, metamorphic, and igneous)

Check for Understanding

As a class, review the events of the program to create a timeline on the board. Ask students to brainstorm a list of the activities they found most interesting or fun. Have students write on the board two main things they saw and two main things they learned. What parts of the program did they like the best? Least? Did they learn something completely new? When did they use their senses? Which senses? Have students use this brainstorming session to assist them in writing.

Closure

Tell students that the program organizers want to know what the students learned from their experiences at Oregon Caves. Their stories will be read by by the Monument's staff and their perspectives could change how the program is delivered in the future!

Independent Practice

Design a brochure for Oregon Caves. The brochure should tell visitors what they can expect to see in the cave. Are there special formations? How did the cave form? What lives inside it? What grows inside it? Is there still water in it? How was it discovered? How is it protected? The brochure should also mention ticket information, times of tours, and any other things that visitors might need to know. The most current tour times information and cost per tour can be found at *www.nps.gov/orca*. Remind students that they should present the cave in a way that makes people want to see it and discover the beauty, magic, and mystery that lies deep inside it. Suggest that they use some of the following words in their descriptions: soda straws, cave popcorn, stalactites, stalagmites, marble, crystals, fragile, and bats. These words could also be spelling words for the week.

Design a cave tour. In the early part of the 20th century, visitors to Oregon Caves went on a "Tour of Mystery and Wonder" based largely upon stories of imagination which resulted in the origin of such fanciful names as the Ghost Room, the Imagination Room, and the Belly of the Whale. Today, visitors receive a tour that features scientific explanations for the cave calcite deposits and the organisms that live there. In small groups identify pros and cons of each type of tour. Identify the different values associated with each type of tour. Develop a cave tour script or create a comic strip of the cave tour.

Field Trip Reflections from Oregon Caves

Name:_____ Date:_____

What I Learned

_____

_____

_____

_____

_____

_____

_____

Teacher's Guide to *Geology: Our Changing Earth*

Post-Visit Lesson Plan

Do Rocks Last Forever?

Duration: Activity 1: 30 minutes.

Activity 2: Prep time– 10 minutes; Dry time– up to 4 days;

Class time– 30 minutes

Objectives

Students will be able to:

- explain the concept of weathering.
- distinguish between mechanical and chemical weathering.
- recognize that changes to the Earth's surface can occur at different rates.

Materials for each group of students

Activity 1: Mechanical Weathering,

- 6 sugar cubes
- 6 sugar cubed sized rocks
- 2 plastic containers with a lids
- magnifying glass
- notebook and pen
- newsprint
- small scale

Activity 2: Chemical Weathering,

- 3 pieces of steel wool
- 3 Ziploc sandwich bags
- gloves
- vinegar

Purpose

The Earth's crust continually changes. It can be built up slowly by plate tectonics forming mountains or erode quickly by landslides and floods. In these activities, students will learn about two different kinds of weathering, how they change rocks, and the rate of change.

Anticipatory Set

Do rocks last forever? We may think so because the tombstones in cemeteries where our ancestors lay to rest look unchanging, or the old stone steps leading to the library look permanent. To us, these rocks will last forever. But, closely observing rocks reveal that they change constantly by mechanical and chemical weathering.

Explain to students the difference between mechanical and chemical weathering by cutting up a piece of paper to demonstrate mechanical weathering. Now burn the same piece of paper to demonstrate chemical weathering. Review page 11 for a reference.

Background Information

We may describe rocks as rough, angular, sharp, or unchanging objects. However, rocks change and can be smoothed, rounded, and broken by weathering. Weathering is the breaking up or decomposition of rocks. Many agents can weather rocks such as rain, snow, wind, or other rocks. The two main types of weathering are mechanical and chemical weathering. Mechanical and chemical weathering typically occurs together with erosion, or the physical transportation of rocks by water, ice, or wind. Mechanical weathering breaks up rock into smaller pieces but does not change the chemical composition. One of the most common mechanical weathering process is abrasion. Abrasion occurs as rocks

and sediment grind against each other and wear away surfaces when wind and water rush over rocks. The rocks become smoother as rough and jagged edges break off much like when using sandpaper to smooth rough wood. Mechanical weathering allows more surface area to be exposed to chemical agents and the process of chemical weathering occurs. Chemical weathering transforms rocks and minerals exposed to water and atmospheric gases into new chemical compounds (different rocks and minerals), some of which can be dissolved away. Chemical weathering causes crystal that are tightly bound together to become looser and weathering continues until the rock slowly falls apart into individual grains.

Because weathering is hard to detect and can occur very slowly, it is easy to overlook its importance of shaping the landscape. In these activities, students have the opportunity to weather rocks in various ways representing the multitude of ways rocks are weathered.

Directions– Activity 1: Mechanical Weathering

Have students:

1. Cover their work surface with newspaper.
2. Weigh three sugar cubes and record their weight.
3. Examine the sugar cubes with a magnifying glass. Describe the appearance of the sugar cubes and sketch them.
4. Place them in the small plastic container and close the container gently with the lid.
5. Predict how the sugar cubes will change after they have been shaken inside the container for one minute. Will their weight change?
6. Shake the container with the sugar cubes inside for one minute. (You could play a “rock” song while students do this.)

7. Open the container and pour out the contents on the newspaper. Describe and sketch them.
8. Leave the sugar crystals “sand” on the newspaper and reweigh only the sugar cubes. Did the weight change?
9. Place three fresh sugar cubes into another plastic container along with three “sugar-cubed sized” gravel. Optional: Weigh another three sugar cubes. The weight, on average, should be the same as the first three sugar cubes.
10. Predict how the sugar cubes will change after they have been shaken inside the container with the gravel for one minute. Will their weight change more than the first experiment?
11. Close the container tightly, and shake it for 1 minute.
12. Open the container and pour out the contents on the newspaper. Use the magnifying glass to re-examine the sugar cubes. Observe any changes.
13. Leave the gravel and the sugar crystals “sand” on the newspaper and reweigh only the sugar cubes. What happened this time, and why?
14. Compare and contrast the changes that happened to the sugar cube when it was shaken with and without the gravel.
15. Record if these changes are due to chemical or physical weathering and why.

Guided Practice

Give students three more sugar cubes and another 3 pieces of gravel. Ask students to set up another experiment to determine if the amount of gravel pieces accelerates mechanical weathering.

Check for Understanding

Ask students:

- Which type of weathering occurred, mechanical or chemical?
- Which experiment caused the sugar cubes to crumble quicker?
- What did the gravel symbolize in the sugar cube experiment
- How long would it take for a sugar-cubed sized rock to become sand?

These experiments demonstrated mechanical weathering and specifically abrasion. Abrasion occurs when rocks and sediment grind against each other and wear away surfaces when wind and water rush over rocks. The container with the added gravel should have made the sugar cubes weather faster. The gravel in the experiment symbolized rocks and sediment that grind against each other when wind or water moves over rocks. Although this experiment made abrasion look like a fast process, in nature, rock abrasion takes a long time.

Directions- Activity 2: Chemical Weathering

Have students:

1. Label 3 Ziploc bags. Label one *dry*, one *wet*, and one *vinegar*.
2. Put a piece of steel wool in the bag labeled *dry*.
3. Soak a piece of steel wool in water, remove it from the water, let most of the water drip off, and put it in the bag labeled *wet*.
4. Soak a piece of steel wool in vinegar, remove it from the vinegar, let most of the liquid drip off, and put it in the bag labeled *wet*.
5. Leave bags open and stored them for 3-4 days.
6. Collect the bags and make observations. Write your response on a sheet of paper. In what ways are the steel wool the same? Different?
7. Remove the steel wool from the *dry* bag. Describe and sketch its appearance.

8. Try to pull *the dry* steel wool apart. Is it easy or hard to pull apart?
9. Working over a piece of white paper, carefully roll the piece of *dry* steel wool between your fingers. Describe and draw what has fallen on the white paper.
10. Examine the steel wool from the *wet* bag and repeat steps 7-9.
11. Examine the steel wool from the *vinegar* bag and repeat steps 7-9.
12. How were the *dry*, *wet*, and *vinegar* steel wool different?

Guided Practice

Give students plastic dish scrubbers and conduct the experiment again. How was the reaction different? What does this say about plastic and its presence in the environment?

Check for Understanding

Ask students:

- Which type of weathering occurred, mechanical or chemical?
- What caused the changes in the *wet* and *vinegar* steel wool?
- How can this kind of weathering happen to rock?

This experiment demonstrated chemical weathering, or the breakdown of rocks due to chemical reactions occurring between the minerals in rocks (steel wool) and the environment. The wet steel wool changed because of its composition and how it reacts to water and vinegar. Steel is an alloy that consists mostly of iron and a small amount of carbon. Steel wool is a bundle of strands of very fine steel filaments made with such small amounts of carbon that it is very similar to plain iron. The iron rusts, or oxidizes, when exposed to air and water, which can weaken the rocks (steel wool) and make them crumble. Plastics are usually synthetic and most commonly derived from petrochemicals that only mechanically

weather not chemically weather.

The steel wool chemical weathering experiment demonstrated how oxygen and water can cause rocks to breakdown. Water and oxygen reacts with iron forming rust and creating hydroxide ions which in turn form an acid. Therefore the rate of corrosion is accelerated by the presence of acid. In the Exit Tunnel of Oregon Caves some speleothems have a very rapid growth rate and are almost 2.5 cm (1 inch) in length because sulfuric acid is formed naturally by the oxidation of iron sulfide. The resulting water can be highly acidic and is capable of dissolving and depositing calcite at a much faster rate. The average growth rate of speleothems in the cave is 1 cm per 1000 years.

Closure

We often think of weathering as destructive and negative because it ruins buildings and statues. However, as rock is destroyed, valuable products are created. The major component of soil is weathered rock. The growth of plants and the production of food is dependent on weathering. Some metallic ores, such as copper and aluminum, are concentrated into economic deposits by weathering. Dissolved products of weathering are carried, or eroded, in solution to the sea, where they nourish marine organisms. And finally, as rocks weather and erode, the sediment eventually becomes rock again--a sedimentary rock.

Independent Practice

Glacier Deposits: Make chunky ice cubes with rocks and sticks in them. Have students take the chunky ice cube outside and find a level area such as a sidewalk and push it down on the cube. Watch for scratching and the debris left after the ice has melted. Explain that glaciers change Earth's crust in much the same way - except on a much larger scale.

Windblown Deposits: Collect the following: newspaper, dry sand in jar with lid, box lid, spoon, water, paper, and pencil. Place the box lid on the center of the paper. Remove the lid from the sand and place it inside the box lid near the center. Blow gently on the sand, increase the strength of your breath until sand is being thrown from the lid. Continue blowing for 5 to 10 seconds at this rate. Examine the material in the paper by rubbing your finger over it. Do the same to the material trapped in the box lid. Which is finer? Why?

Sand Dunes: How do sand dunes form? Place sand in a pile and blow gently from one side. Observe what happens. What happens when you blow on the sand? Could you make the whole pile move if you blew long enough?

References

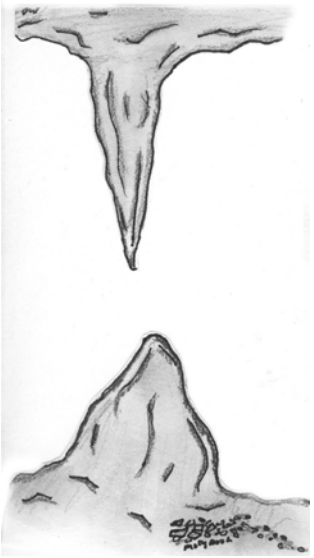
Hayne, Kate. CECsci.210. Youth Net. August 31, 2011 <http://youth.net/cec/cecsci/cecsci.210.txt>

Tolman, Marvin. *Hand-On Earth Science Activities.* San Francisco, CA: Jossey-Bass. 2006. Print.

Oregon Caves Presentation Quiz

Name: _____ Date:_____

Directions: Read the following and circle the best answer. Fill in the blanks when indicated.



1) Which rock type or family is marble?
   a. sedimentary
   b. igneous
   c. metamorphic
   d. lava

2) What two things caused the limestone to change into marble?
   a. ice and wind
   b. heat and pressure
   c. fire and rain
   d. asking it nicely to change

3) In your own words, what is weathering? _____
   _____

4) What happened to the rocks samples when acid was dropped on the limestone, marble, and calcite?_____

5) Stalactites hang tightly to the _____ of the cave.
   a. floor
   b. ceiling

6) What do you call 'em when a stalactite and a stalagmite meet?
   a. popcorn
   b. soda straws
   c. marble
   d. column

Oregon Caves Presentation Quiz

Teacher: please give the worksheet to your students after the Park Ranger leads the classroom presentation.

Name: Teacher's Answer Key **Date:_____**

Directions: Read the following and circle the best answer. Fill in the blanks when indicated.

1) Which rock type or family is marble?
   c. metamorphic

2) What two things caused the limestone to change into marble?
   b. heat and pressure

3) In your own words, what is weathering? Answers will vary, but something like the breakup of rock on the earth's surface due to wind, water, plants, or animals.

4) What happened to the rocks samples when acid was dropped on the limestone, marble, and calcite? Answers will vary, but something like it fizzed, bubbled, reacted, was weathered, or the acid "ate" it.

5) Stalactites hang tightly to the _____ of the cave.
   b. ceiling; hint: there is a "c" in the word

6) What do you call 'em when a stalactite and a stalagmite meet?
   d. column; hint: we call 'em a column!

What Am I?

You can do this activity on the bus ride home from Oregon Caves National Monument or in the classroom sometime after you return from your fieldtrip. Read the following clues aloud to your students and have them guess the answer.

1. I hang around in cool, dark places. Some people think I look like a fat icicles, but I am actually made of rock. (stalactite)

2. Some people say I look good enough to eat. Don't take me to the movies though, because I'd probably crack your teeth! (cave popcorn)

3. Without me, there would be no cave. There would be no you either. I caused the cave to form and the cave deposits to grow. (water)

4. Water tries to take all the credit, but without me, water would have nothing to dissolve. (marble)

5. I grow up with all my might when calcite mineral drops to the floor of the cave and build up for thousands of years. (stalagmite)

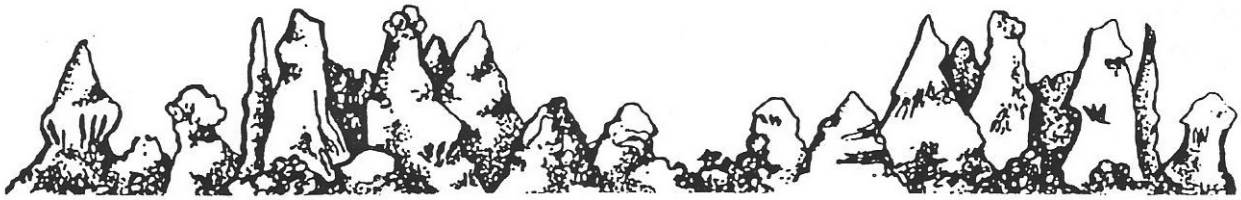
6. I slip and slide through the cave and carve out passageways that animals and people can eventually walk through. You can hear me gurgle when you stop and listen on a cave tour. (River Styx)

7. When you see a stalactite and a stalagmite meet, you should call 'em this. (column)

8. I used to be made out of sea creatures and now I am marble. But in between, I was called something else.

9. Don't drink your soda-pop with me. I'd rather stay on the ceiling of the cave! (soda straws)

10. Green and grey is my thing . I can answer most of your questions off the top of my head, because I keep a lot of information under my flat hat! (park ranger)



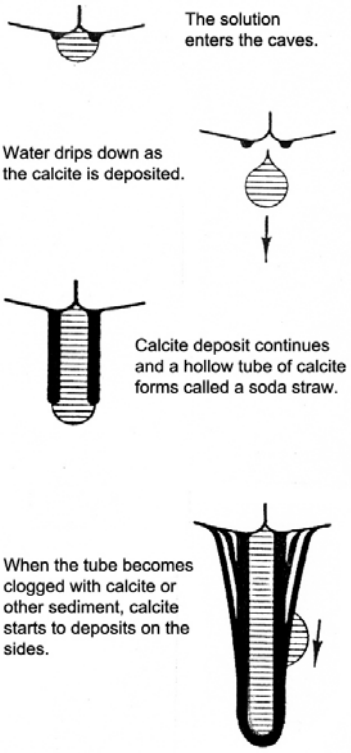
Name: _____

Date: _____

Can you find the names of cave words in the word search?

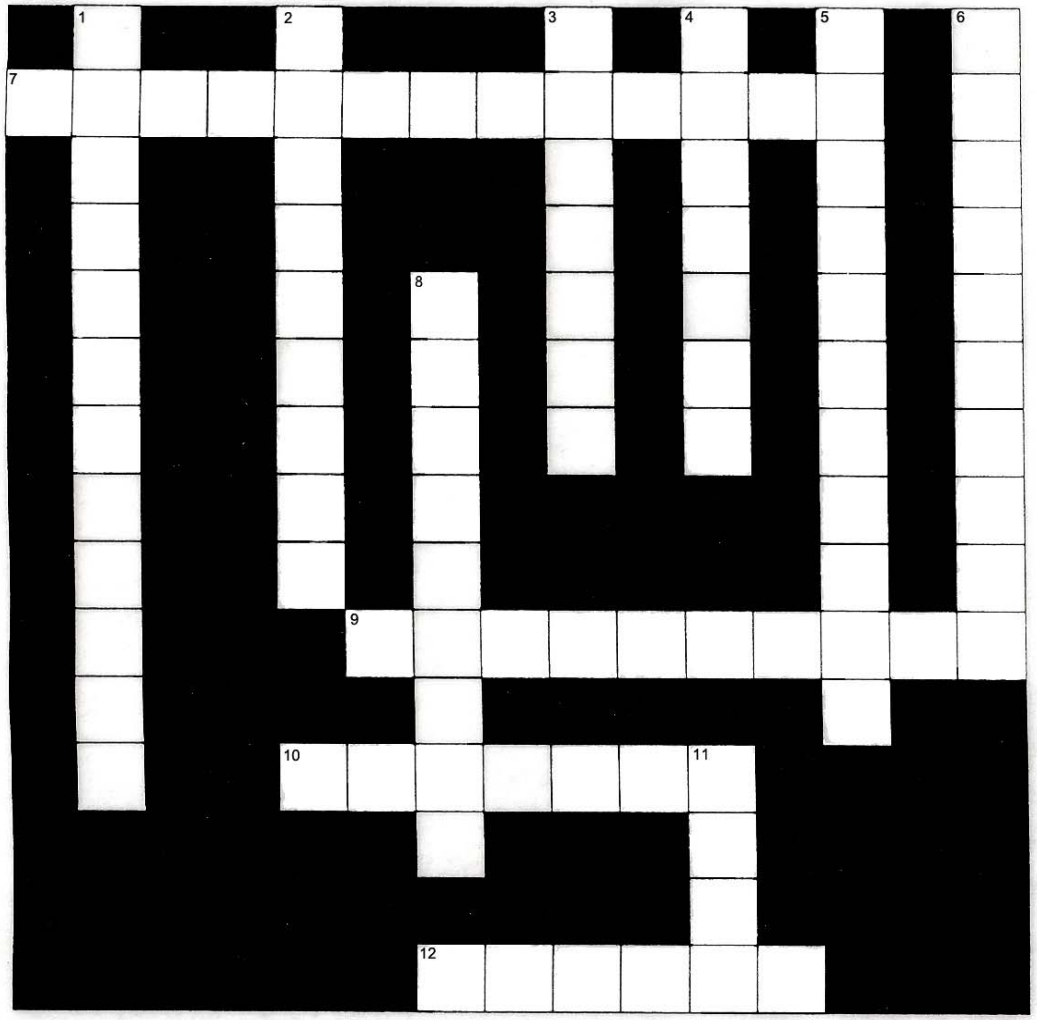
bacon	calcite	cave deposit	cave popcorn	column
drapery	drip	flowstone	Oregon Caves	rimstone
rock	soda straw	stalactite	stalagmite	water

How Soda Straws and Stalactites Form



S	O	D	A	S	T	R	A	W	A	S	T	C	W	V
F	L	O	S	P	E	O	D	E	S	K	C	A	I	A
R	C	K	O	N	V	C	B	R	T	C	A	L	V	E
I	C	O	D	R	E	K	D	G	A	O	B	C	A	B
M	O	R	V	E	S	N	A	R	L	T	I	I	O	A
S	L	N	I	A	L	M	O	N	A	U	M	T	N	C
C	U	M	A	M	B	O	L	R	C	P	F	E	W	O
A	M	S	T	O	S	N	E	C	T	V	E	W	G	N
V	N	D	R	O	P	T	D	C	I	E	O	R	P	S
F	M	A	B	L	A	D	O	A	T	O	M	B	Y	C
B	F	L	O	W	S	T	O	N	E	R	G	R	E	Y
C	A	V	E	D	E	P	O	S	I	T	P	O	K	D
O	R	E	G	O	N	C	A	V	E	S	A	C	M	R
S	T	V	E	S	T	A	L	A	G	M	I	T	E	I
C	A	V	E	P	O	P	C	O	R	N	L	P	O	P

Oregon Caves Geology Crossword Puzzle



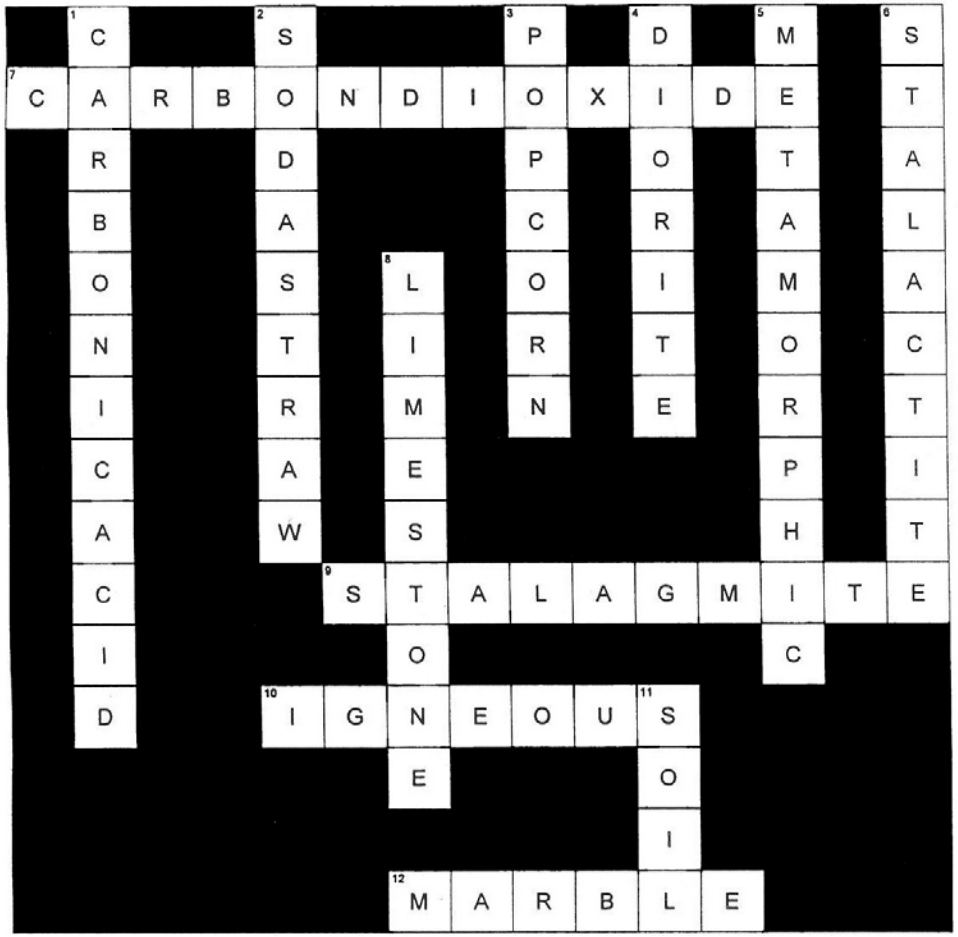
Down

1. An acid made by mixing carbon dioxide and water
2. A long, thin, hollow formation
3. Once called 'compass stone', formed by evaporation of the water from the cave walls or formations
4. A type of igneous rock that looks like salt and pepper
5. A rock that has been changed by high heat or intense pressure
6. Formation that grows down from the ceiling
8. A sedimentary rock that is metamorphosed to form marble
11. What trees and plants grow in

Across

7. A gas that mixes with water and makes an acid
9. Formation that grows up from the floor
10. A rock 'born of fire'
12. The rock that is dissolved to make Oregon Caves

Oregon Caves Geology Crossword Puzzle



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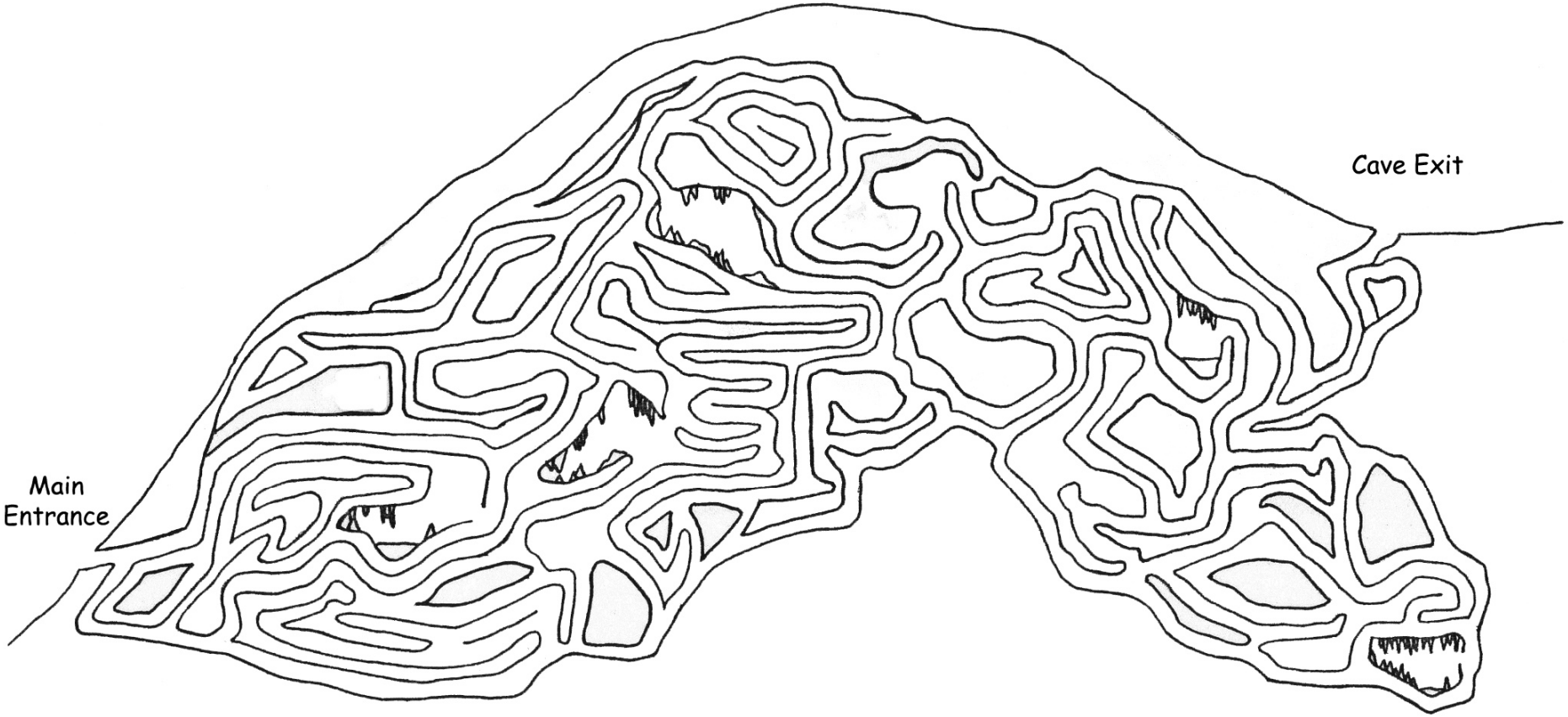
Answer Sheet

Cave Maze

Can you find your way through the passages of the cave from the Main Entrance to the Cave Exit?



The Rock Cycle

Follow the story and fill in the blanks using the words from each illustration.

I started out as _ _ _ _ _ _ way down under the earth.

One day, a _ _ _ _ _ _ _ _ erupted, and out I flew.

I cooled off, and I was an _ _ _ _ _ _ _ _ rock.

Soon I started breaking, and I eroded into _ _ _ _ _ _ _ _ _ _ _ .

The next thing I knew, I was stuck under _ _ _ _ _ _ _ of mud!

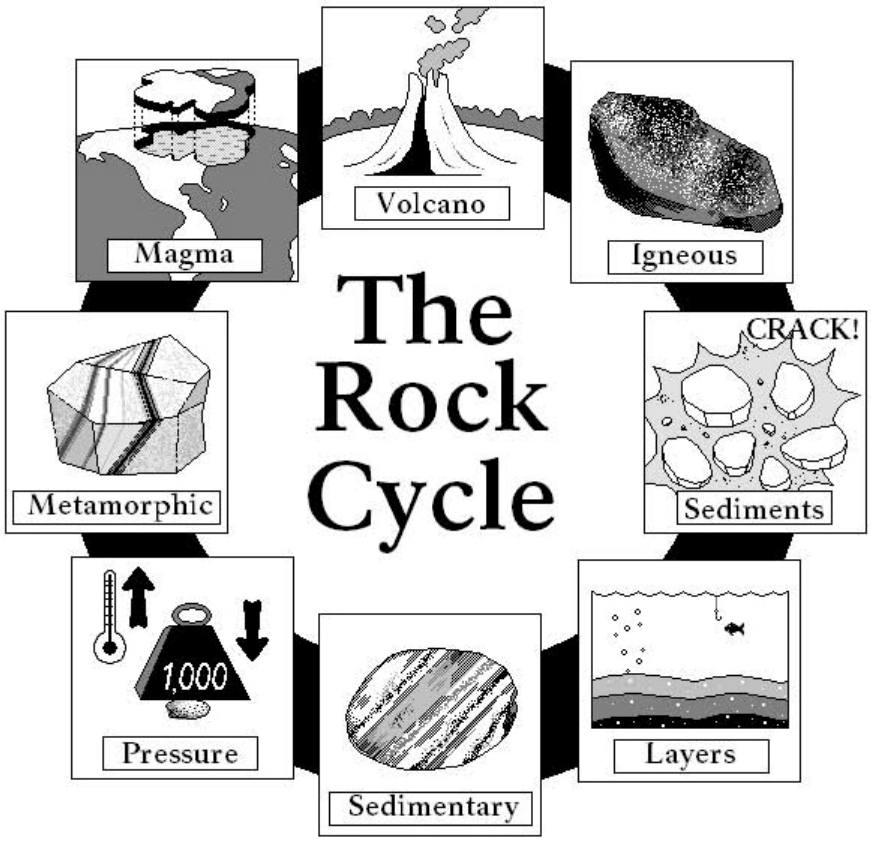
When it all hardened, I was a _ _ _ _ _ _ _ _ _ _ _ _ _ rock.

Then I was trapped under a mountain. My sides were killing me from

the _ _ _ _ _ _ _ _ _ of being squeezed!

I discovered that I had changed into a _ _ _ _ _ _ _ _ _ _ _ _ _ rock.

I look better than ever!



Teacher's Guide to the Videos

Glossary

Calcite- A carbonate mineral and a crystal form of calcium carbonate. This mineral is found in limestone deposits and marble. It has a different crystal lattice than aragonite. Calcite crystals are trigonal-rhombohedral.

Carbonic Acid– is a weak acid found in everything from soda to rain to blood. This acid is responsible for forming Oregon Caves.

Convergent plate boundary– is a tectonic boundary where two plates are moving toward each other.

Decomposers- Organisms that break down (rot) dead or decaying organisms.

Divergent plate boundary- is a tectonic boundary where two plates are moving away from each other.

Ductile- The ability of a solid material to deform under tensile stress.

Erosion- is the physical transportation of rocks by water, ice, or wind

Marble- A metamorphic rock composed of crystals of calcite along with lesser amounts of other minerals like graphite.

Parent rock- The rock from which a metamorphic rock formed.

Percolated- To cause liquid pass through a porous substance or small holes; filter

Principle of Uniformity- The assumption is that the same natural laws and processes that operate in the universe now, have always operated in the universe in the past and apply everywhere in the universe

Leave No Trace– a set of ethics used while encourages responsible, non-motorized outdoor activities with minimal impact on public recreational areas.
You can find more information about LNT at: **http://www.lnt.org/**

Lithified- means to change to stone.

Limestone- a sedimentary rock composed chiefly of the mineral calcium carbonate.

Sedimentation– is the process of sediments or material settling to the bottom of a liquid.

Speleogenesis- is the origin and development of caves.

Speleothem- are depositional features in caves; also know as cave deposits or cave formations These include stalactites, stalagmites, flowstone, and drapery.

Subduct- is the process that takes place at convergent boundaries by which one tectonic plate moves under another tectonic plate

Theory of Plate Tectonics- is the concept that that there are eight major plates on the surface of the Earth. There are also bunches of minor plates. The plates are like the skin of the planet and they constantly move around the planet.

Transverse boundary- occurs when two plates collide, causing great amounts of pressure. The plates crumble, and usually get destroyed.

Uplifted- means to raise or elevate.

Water Table- is the top of an unconfined aquifer; indicates the level below which soil and rock are saturated with water.

Weathering- is the breaking down of rocks, soils and minerals materials through contact with the Earth's atmosphere, biota and waters

Teacher's Guide to the Videos

On-line Resources

Oregon Caves National Monument website
www.nps.gov/orca

Oregon Caves Chateau Virtual Tour
http://www.gotouroregoncaves.com/

Oregon Department of Education Standards by Design
www.ode.state.or.us/teachlearn/real/standards/sbd.aspx

Oregon's Environmental Literacy Plan
www.ode.state.or.us/oregon-environmental-literacy-plan.pdf

Bureau of Land Management Cave Resources from Science & Children
http://www.blm.gov/wo/st/en/res/Education_in_BLM/Learning_Landscapes/For_Teachers/science_and_children/caves/index.html

National Park Service System-wide Cave website
http://www.nature.nps.gov/geology/tour/caves.cfm

United States Geological Survey (USGS) Geology website related to National Parks
http://www.nature.nps.gov/geology/usgsnps/project/home.html

Earth Science Week Resources for Teachers aligned to National Science Standards
http://www.earthsciweek.org/forteachers/classroomactivities.html

Marengo Caves
http://marengocave.com/teachers/

Mammoth Cave National Park Learning Place
http://www.nps.gov/maca/learnhome/learnhome.htm

Carlsbad Caverns About Bats, Caves, Deserts
http://www.nps.gov/cave/teacherguide/abcd.htm

Ohio Caverns School Project Ideas
http://www.cavern.com/ohiocaverns/school.htm

Teacher's Guide to the Videos

Oregon State Standards

Please note the suggested links to and Science for Oregon State Standards for grades 3-5. It is up to the individual teachers to decide how to best relate the lesson plans to the specific objectives appropriate for students' learning within the context of your classroom.

Science

3.1 Structure and Function: Living and non-living things vary in their characteristics and properties.

- 3.1P.1 Compare and contrast the properties of states of matter.

4.2 Interaction and Change: Living and non-living things undergo changes that involve force and energy.

- 4.2P.1 Describe physical changes in matter and explain how they occur.
- 4.2L.1 Describe the interactions of organisms and the environment where they live.
- 4.2E.1 Compare and contrast the changes in the surface of Earth that are due to slow and rapid processes.

5.2 Interaction and Change: Force, energy, matter, and organisms interact within living and non-living systems.

5.2L.1 Explain the interdependence of plants, animals, and environment, and how adaptation influences survival.

Teacher's Guide to the Videos

California State Standards

Please note the suggested links to and Science for California State Standards for grades 3-5. It is up to the individual teachers to decide how to best relate the lesson plans to the specific objectives appropriate for students' learning within the context of your classroom.

Grade Three
Physical Sciences
Energy and matter have multiple forms and can be changed from one form to another. As a basis for understanding this concept:

E. Students know matter has three forms: solid, liquid, and gas.
G. Students know that when two or more substances are combined, a new substance may be formed with properties that are different from those of the original materials.

Life Sciences
Adaptations in physical structure or behavior may improve an organism's chance for survival. As a basis for understanding this concept:

E. Students know that some kinds of organisms that once lived on Earth have completely disappeared and that some of those resembled others that are alive today.

Investigation and Experimentation
5. Scientific progress is made by asking meaningful questions and conducting careful investigations. As a basis for understanding this concept and addressing the content in the other three strands, students should develop their own questions and perform investigations. Students will:

A. Repeat observations to improve accuracy and know that the results of similar scientific investigations seldom turn out exactly the same because of differences in the things being investigated, methods being used, or uncertainty in the observation.
B. Differentiate evidence from opinion and know that scientists do not rely on claims or conclusions unless they are backed by observations that can be confirmed.
D. Predict the outcome of a simple investigation and compare the result with the prediction.
E. Collect data in an investigation and analyze those data to develop a logical conclusion.

Grade Four
Life Sciences
All organisms need energy and matter to live and grow. As a basis for understanding this concept:

A. Students know plants are the primary source of matter and energy entering most food chains.
C. Students know decomposers, including many fungi, insects, and microorganisms, recycle matter from dead plants and animals.

Living organisms depend on one another and on their environment for survival. As a basis for understanding this concept:

A. Students know ecosystems can be characterized by their living and nonliving components.
D. Students know that most microorganisms do not cause disease and that many are beneficial.

Earth Sciences
4. The properties of rocks and minerals reflect the processes that formed them. As a basis for understanding this concept:

A. Students know how to differentiate among igneous, sedimentary, and metamorphic rocks by referring to their properties and methods of formation (the rock cycle).
B. Students know how to identify common rock-forming minerals (including quartz, calcite, feldspar, mica, and hornblende) and ore minerals by using a table of diagnostic properties.

Investigation and Experimentation
6. Scientific progress is made by asking meaningful questions and conducting careful investigations. As a basis for understanding this concept and addressing the content in the other three strands, students should develop their own questions and perform investigations. Students will:

A. Differentiate observation from inference (interpretation) and know scientists' explanations come partly from what they observe and partly from how they interpret their observations.
C. Formulate and justify predictions based on cause-and-effect relationships.
F. Follow a set of written instructions for a scientific investigation.

Grade Five
Physical Sciences
1. Elements and their combinations account for all the varied types of matter in the world. As a basis for understanding this concept:

A. Students know that during chemical reactions the atoms in the reactants rearrange to form products with different properties.

Students know all matter is made of atoms, which may combine to form molecules.

F. Students know differences in chemical and physical properties of substances are used to separate mixtures and identify compounds.

Investigation and Experimentation

6. Scientific progress is made by asking meaningful questions and conducting careful investigations. As a basis for understanding this concept and addressing the content in the other three strands, students should develop their own questions and perform investigations. Students will:

A. Classify objects (e.g., rocks, plants, leaves) in accordance with appropriate criteria.

B. Develop a testable question.

H. Draw conclusions from scientific evidence and indicate whether further information is needed to support a specific conclusion.