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Earth Science

Teacher Resource Guide

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Earth Science

What is the difference between a rock and a mineral?

Minerals are naturally occurring, inorganic solids with a characteristic chemical composition. Minerals have a crystalline structure and may be a single element such as copper or gold, or may be a complex compound.

Rocks are a combination of one or more minerals. For example, limestone is almost entirely a single mineral, calcite. Granite is made up of feldspar, quartz, and mica.

Classification of Rocks

Igneous Rocks form when molten magma from deep in the earth cools and solidifies.

- Intrusive igneous rocks form when cooling and hardening occur within the earth's crust. An example of an intrusive igneous rock is granite.
- Extrusive igneous rocks form when magma erupts from a volcano as lava and cools on the surface of the earth. Examples of extrusive igneous rocks are obsidian (often called natural glass) and pumice (volcanic froth full of air).

Sedimentary Rocks form when loose mud or sand is carried by wind or water and deposited on a riverbed or seabed. The accumulated particles combine under pressure of their combined weight to form rock.

- Limestone, sandstone, and shale are examples of sedimentary rocks.
- Many sedimentary rocks contain fossils.

Metamorphic Rocks form when igneous or sedimentary rocks are exposed to extreme heat and/or pressure and transform.

- Metamorphic is a Greek word meaning "changes of form."
- Limestone changing to marble and shale changing to slate are examples of metamorphic rocks.

Classification Exploration

Is it animal, vegetable or mineral?

Scientists use classifications, dichotomous keys, and other methods to help identify specimens – from plants to rocks, dinosaurs to insects. Using identifying or distinguishing characteristics, scientists sort and categorize as they try to identify new objects. This is an extremely important tool used in all types of science.

Try to create your own classifications! As a warm-up activity, have students try to classify their shoes. Sneakers versus boots, white versus black, high top versus low top. What methods could they use?

Materials

collection of marbles, small plastic animals, shells, or balls
15-30 small rock specimens
field guides for plants, trees, or insects with dichotomous keys

Procedure

1. Work in small student groups to create different classifications for the objects.
2. Share student group strategies with the class.
3. Share examples of dichotomous keys used to identify plants and insects.
4. Try to create a classification key for rocks – notice which distinguishing characteristics are important to help identify new specimens.
5. Use rock specimens from the schoolyard to try out your classification systems.

History of the Earth

Take a look as you walk around the schoolyard. Every rock and pebble represents a piece of the earth's history. They can be millions of years old, and each tells a story about how they were formed, and how the earth has changed over time. Rocks are important because we build with them, refine them into metals, and burn them as fuel. More importantly, weathering of rocks produces soil, which is essential for growing plants and food.

Rocks are formed in three different ways – moving water, heat, or enormous pressure. Have the students each choose a different rock sample from the playground or the classroom collection, then write or illustrate a "life history" on their chosen rock. Perhaps they might even like to write and perform a short play. Where was the rock "born" and what were conditions like at that time? What was it before it became the rock it is today? Where was it found? How did it get there? What else could it be used for?

Igneous Fudge

Materials

⅔ cup evaporated milk
1⅔ cups sugar
½ tsp. salt
1½ cups miniature marshmallows
1 tsp. vanilla

Procedure

Combine milk, sugar, and salt in saucepan. Bring to boil over low heat. Cook 5 minutes. Remove from heat and stir in remaining ingredients until all are melted. Pour into 8”x8” buttered pan. Cool. Cut. How have the materials changed with heat? Have students sketch pictures of the ingredients before and after cooking.

Sedimentary Sandwich

Sedimentary rock is like a peanut butter sandwich! Different bits and pieces of material, small pieces of sand or mud or clay, are laid down and over time get pressed and glued together into rock. Try making this sedimentary sandwich to illustrate the formation of sandstone.

Materials

white bread
wheat bread
peanut butter
grape jelly
raisins
paper towels
knives

Procedure

Imagine a long time ago a river flowed out to the sea carrying white sand. The sand sank to the bottom of the sea and cemented into a layer of white sandstone (white bread slice.) Later, there was a big flood. Mud and rock were carried out to the sea and sink to the bottom, covering the white sandstone. (Spread a layer of peanut butter, the "mud and rock" of the story, on the white bread slice.) Colorful shellfish lived for thousands of years on the sea bottom. As they died, their crushed shells formed another layer on the bottom of the sea. (The grape jelly spreads to form the purple layer of "shells" in the story.) The sea dried up for a time and plants covered the former seabed. These plants died and a layer of rich plant material littered the ground. (Sprinkle raisin "plant material" over the jelly, just like coal is formed.) Now, the river slowly brought water and dark brown clay out to the re-forming sea, creating a layer of darker rock. (The wheat bread slice is placed on top to form the "clay" layer.)

Try a bite of Sedimentary Sandwich! What could you do to make your sandwich into igneous rock? How about metamorphic rock?

Metamorphic Bars

Metamorphic rock requires intense heat and pressure to form. These granola bars will "metamorphose" after a period of heating in the oven. Have the students sketch the batter before and after cooking to understand the impact of heat on materials.

Materials

½ cup magma (melted butter)
1½ cups fine sand (graham cracker crumbs)
1 can mud (sweetened condensed milk)
1 cup coal (chocolate chips)
1 cup animal bones (shredded coconut)
1 cup seashells (chopped walnuts)

Procedure

1. Layer all ingredients in order in a 9”X13” pan.
2. Apply pressure.
3. Expose to high heat for millions of years (bake at 350°F for 25 minutes).
4. Cool slowly.
5. Eat and enjoy!

Have the students sketch a cross section of their metamorphic bar. What changes do you notice in the "minerals" of the rock? Have some minerals changed and not others?

Schoolyard Data Collection

Materials

journal
magnifying glass
pencil
ruler
film canister for small specimens

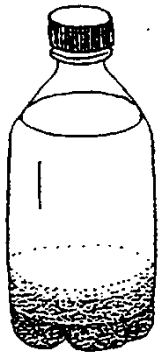
Procedure

Take the students outside to observe, investigate, and record examples of rocks that they find in the schoolyard. Make sure they label their observations, including descriptive words about color, size, texture, composition, hardness, etc. Have them brainstorm questions to research later about their observations. Make sure they don't miss the rocks that may have been used to construct the school building (bricks, concrete). They may collect samples for more investigation later in the classroom.

Extension

Sand provides many opportunities to examine and explore rocks and minerals and is an easy material for students to collect as they travel. The Museum has examples from al over the world, thanks to traveling patrons! Try making sand cards to provide an easy way to examine the sample. Use heavyweight poster board and spread a 2-inch by 2-inch area with glue. Sprinkle sand over the glue to cover the area. Make sure you label where the sand came from. Examine under a hand microscope and you may be able to identify the rocks, shells, and organisms that eroded to create it!

Sedimentation Bottle



Materials

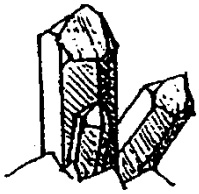
small, clear soda bottles with caps (one per student)
iron filings (½ scoop each)
tan colored sand (2 scoops each)
baking soda (2 scoops each)
containers for iron filings, sand and baking soda
several small scoops (such as those used in powdered drinks or laundry detergent)
several small funnels

Procedure
The material containers can be passed around the room with scoops in them. Using a funnel, students can put the appropriate amount of each material into a bottle in any order they choose. Add water and tightly close the bottle. Shake the bottle vigorously, put it down on a table, and watch what happens to the materials inside. Have the students draw what they see inside their bottle. What happened to the materials and why?

Crystal Cards

Materials
soap solution: 1:8 ratio soap to water
wide, flat tub
clear Contact™ paper
dark blue, black, or purple poster board
scissors
epson salt solution (1:1 with water)
eyedroppers

Procedure
Prepare the cards ahead of time:
- Dip the Contact™ paper (with the backing still on) into the soap solution.
- Hang to dry.
- When dry, carefully remove the backing and stick the Contact™ paper to the poster board.
- Cut the poster board into small squares.



When the cards are ready:
1. Write student names on the backs of the cards.
2. Use an eyedropper to drop 4-5 drops of salt solution onto each card.
3. Spread the solution around by tilting the cards back and forth.
4. Drain off the excess solution.
5. Allow salt solution to dry completely (about 1 hour).
6. Examine the results with a magnifying glass or hand microscope.

Mechanical Weathering and Erosion

Weathering
Weathering is the process where rock is dissolved, worn away, or broken down into smaller and smaller pieces. There are several processes of weathering. Mechanical weathering caused by physical forces that break-up rock, chemical weathering from chemicals found in the air, water, and certain plants that dissolve rock, and organic or biological weathering where rock is broken-up by growth of plants or activity of animals.

Experiments with Mechanical Weathering- physical forces break up rock.
Examples of Mechanical Weathering include frost wedging and abrasion.

Frost Wedging, a process of mechanical weathering, is caused when water seeps into a rock through cracks and repeatedly freezes and thaws, expanding and contracting. The continual expansion and contraction of this water and ice acts as a wedge and eventually can split or cracks the rock.

The power of frozen water.
Using two bottles of the same size and shape, students should fill the bottles with equal amounts of water and place one of them in the freezer for at least 24 hours. Remove the frozen bottle from the freezer and have the students compare the two bottles. What do they notice? Do the two bottles still look identical? Are they the same size and shape?

What is going on?
When water freezes it expands. Here is the evidence! The frozen bottle of water is larger than the bottle of water at room temperature. When water flows into a crack in a rock and freezes, it expands too. This expansion can act as a wedge which overtime will split and crack a rock.

Can you split a "rock" with a wedge?
Ask students to make a ball out of kinetic sand that is about 2 inches in diameter. Imagine this ball is a rock. Using the sharpened end of the pencil as a wedge, the students can gently press the tip into the "rock". What do they notice? Did the rock split or crack? Try it again. This is similar to what frost wedges can do to a rock.

More Mechanical Weathering
Rocks can break down due to another mechanical weathering process known as abrasion. In nature, abrasion occurs when rocks and sediments rub together, creating friction. It is caused by glaciers, moving water, wind, gravity, or wave action.

Try your hand at creating the effects of abrasion.
Have students select two rocks and holding them over a piece of black construction paper, rub them vigorously together. Have them observe the card. What do they notice? Do they see a powder like substance on the card? This powder is made up of little bits of the rock that were scraped off when they rubbed the two rocks together. This occurs naturally in nature when rocks and sediments move past each other such as in the ocean, a flowing river, or a windy terrain.

More Abrasion
Have the students fill a plastic jar with water and five to six small rocks and shake it. Little bits of the rock come off, making the water appear cloudy. Looking at this jar, they might be able to imagine how bits of rock can be carried away and eroded by moving water.

If the jar is not shaken or moved for a period of time, these small particles will settle to the bottom of the jar, similar to what happens in the sediment bottles they make in the workshop. This occurs in nature too. Little bits of rock break off when rocks and sediments rub together. The little bits of rock can be carried away by water, wind, or glaciers and deposited in different locations. The carrying away of the particles is called erosion and the dropping of the particles in new locations is called deposition. This is one way new landforms can be created.

Extensions

Everyday Rock
You would be amazed at the number of uses for rock! Here are just a few surprising places you will find rocks being used: salt, drinking glasses, toothpaste, chalk, pencils, scissors, jewelry, aluminum foil or cans, paper clips, pottery or bricks, cement, blackboards, statues, plastics, petroleum jelly, lipstick, nylon stockings, and polyester clothes. Can you find more examples?

Road Cut Art
The highway provides a wonderful history lesson in rock formation, movement, and change. The road cut, that ledge of rock cut or blasted when building highways, also shows the pushes and pulls, layers and deposits, that formed the bedrock around us. Have students bring their journals home for a field trip to a road cut. Make sure they include descriptive words as they label what they see. Have them imagine what might have happened to form those lines, layers, and materials.

Erosion and Deposition of Sediments
Have the students look for pictures online or in books that show evidence of erosion and deposition of sediments over time.

Resources:

Print Resources

- *If You Find a Rock,* Peggy Christian, Clarion Books, 2008
- *A Rock is Lively*, Diana Hutts Aston, Chronicle Books, 2015
- *Everybody Needs a Rock*, Byrd Baylor with Peter Pamall, illustrator, Aladdin Books, 1985
- *Rhoda's Rock Hunt,* Molly Beth Griffin, Minnesota Historical Society Press, 2014
- *A Rock Can Be…,* Laura Purdie Salas, Millbrook Press, 2015
- *National Geographic Readers: Rocks and Minerals,* Kathleen Zoehfeld, National Geographic Kids, 2012
- *Let's Go Rock Collecting,* Roma Gans, HarperCollins, 2021
- *My Book of Rocks and Minerals*, Devin Dennie, DK Children, 2017
- *Rocks and Minerals,* Seymour Simon, HarperCollins, 2017
- *Rocks in His Head*, Carol Otis Hurst and James Stevenson, Greenwillow Books, New York, 2001
- *Everything Rocks and Minerals (National Geographic Kids)*, Steve Tomecek, National Geographic Kids, 2011
- *The Rock Factory: The Story About the Rock Cycle,* Jacqui Bailey, Picture Window Books, 2006
- *Science Comics: Rocks and Minerals: Geology from Caverns to the Cosmos*, Andy Hirsch, First Second, 2020
- *Rocks and Minerals: A Gem of a Book!,* Simon Basher, Kingfisher, 2009

Online Resources

- http://www.ology.amnh.org/earth
    - Stories, hands-on activities, videos, and games about geology and earth science from the American Museum of Natural History.
- Minerals Education Coalition Website
    - Posters, articles, and adapted lesson plans about mineralogy from MEC.
    - http://www.mii.org
- The Virtual Museum of Minerals and Molecules, via University of Wisconsin Madison
    - https://virtual-museum.soils.wisc.edu/
    - A virtual database of models of crystalline structures, great for showing students the patterns of crystal construction.
- Be a Rock Detective! By SciShow Kids
    - https://www.youtube.com/watch?v=tNs1gqkYerg
- Rocks and Minerals from DK FindOut!
    - https://www.dkfindout.com/us/earth/rocks-and-minerals/
- Smithsonian Mineral Spotlight Gallery
    - https://www.si.edu/spotlight/geogallery
- Earth Science Snacks via the Exploratorium
    - Sedimentary Squeeze Box: https://www.exploratorium.edu/snacks/squeeze-box