

Boulders to Bits

Through a competition to build the strongest mountain, students will explore erosion and weathering; they will conduct experiments to model erosive forces on the land and record their observations.

Grade Level: 3rd grade

Phenomena:

How does weather and erosion affect the landscape ?

Objectives:

- Students will define *erosion*, *weathering*, and *sediments*
- Students will conduct experiments and identify causes of erosion (wind, water, ice)
- Students will conduct experiments to model different types of erosion and explain how they create common geologic formations

Materials:

- Dirt/soil (at least 2 cups per group of 4-5 students)
- Paper bags (1 per group)
- One large container of water
- One small cup per group with which to pour water
- "Rainmakers" (cups with holes poked in the bottom so that when you pour water in, the water comes out the bottom like rain)
- 1 Plastic tray per group. Store-bought cookie and salad containers work well.
- Popsicle sticks (1 per student)
- Rulers (1 per group)
- Paper (1 sheet per student)
- Pencils (not pens!)
- Straws (1 per student)
- Magazines or thick books
- Pictures of landforms created by wind and water erosion (attached)

Time Considerations:

- Preparation: 15 minutes
- Activity 1: 5 minutes
- Activity 2: 40 minutes
- Conclusion: 10 minutes

Related Activities:

Rock in' Rocks, Discovering Minerals,



Next Generation Science Standards

4-ESS2-1. Make observations and/or measurements to provide evidence of the effects of weathering or the rate of erosion by water, ice, wind, or vegetation.

Science and Engineering Practices (SEP):

Planning and Carrying out Investigations.

Disciplinary Core Ideas:

Earth Materials and Systems
Biogeology

Crosscutting Concepts:

Cause and Effect

Excellence in Environmental Education Guidelines

Strand 2—The Earth as a Physical System

A) Processes that shape the Earth: Learners are able to identify changes and differences in the physical environment.

Background

Earth's surface is constantly changing shape as mountains and canyons form or valleys are filled in. Many geological features are formed through a process called weathering, which occurs when natural forces like wind and water break rocks into smaller pieces. Sometimes weathering breaks rocks into small jagged pieces, other times weathering makes the pieces smooth and rounded. This is why 'river rocks' or rocks found on beaches are often smooth instead of rough. These pieces of rock, including sand, are called

sediments. Common causes of weathering include wind, water, ice wedging, and temperature changes.

Water running over rocks can cut deep holes in the earth, forming caves and canyons. Furthermore, sand particles blown by the wind against solid rock can shape rocks in the same way as sandpaper rubbing against wood can shape a board. Ice is another major cause of weathering. Water gets into cracks in the rock and freezes pushing the crack wider. Each time the water melts and refreezes, it

widens the cracks a little more. This is called ice wedging.

Erosion happens when sediments are picked up and moved to another place by wind, water, or ice in the form of glaciers. Many times erosion and weathering occur together. When a river cuts away rock to form a canyon, it also carries away the sediments and drops them off elsewhere to form sand bars and beaches. Similarly, glaciers carve out valleys by crushing and moving dirt and rocks. As the glacier melts, it deposits piles of the sediment to make hills called dells or drumlins.

Water in motion is one of the most powerful causes of both weathering and erosion: canyons are formed by running water; river banks are eroded away by running water; gullies are formed in fields when heavy rains wash away soil; and water in motion can even cause landslides and detach solid blocks of rock. The Grand Canyon (above) is just one of many huge landforms created by water.



The Grand Canyon

Preparation

For Activity 1:

Pass out one piece of paper (it can be scrap) and a pencil to each student

For Activity 2:

Gather a pile of dirt to be used in the lesson. The activity works best if the dirt has some larger sediments (rocks etc.) mixed in with it.

Put down newspaper or some form of covering over each workstation to keep it clean. Hand out all materials to each group.

Doing the Activity

Activity 1:

Land Formation Exploration

Begin the lesson by asking students to name some land formations (mountains, cliffs, valleys, caves, islands, canyons, etc.)

Ask if they have heard of or been to Lovelock Cave*, Water Canyon*, or the Grand Canyon.

Ask students if they know how land formations developed (for example how water can carve out canyons and wind can reshape hills).

Steer the conversation into an introduction about erosion, weathering and sediment. Define these terms with the students' help, writing the definitions on the board to refer back to later.

Have the students take out a sheet of paper and a lead pencil (not a pen or marker). Have them draw a line on the paper.

Explain that the lead in their pencils is like a rock, that it is the mineral *graphite*.

Then have students erase their line but be sure they do not blow or wipe off the particles that are now on their paper.

Ask them what these particles, or sediments, might be made of (graphite, some eraser, some paper).



Classic sheeted granite along the Tioga Road, Yosemite National Park

Explain how they just used force to weather away their pencil line with their erasers.

Finally, have the students blow away or wipe off the particles from their pieces of paper. Explain that they have just modeled erosion from the wind by blowing away the sediments that were on the paper.

Activity 2: **Erosion Competition**

Divide the students into groups of 4-5 students each.

Give each group one paper bag (to collect natural materials from outside), one tray of soil, one rainmaker, one straw per student and one popsicle stick per student.

Have the students measure out centimeter increments on the popsicle sticks, marking each line 1, 2, 3...

Explain that each group is going to build a model of a mountain; the goal is to build the strongest mountain that will withstand the most erosion. Students will model different types of erosion.

Take the students outside for them to collect materials to add to their soil to make their mountains stronger; tell them they are to collect no more than 10 natural objects per group (rock, leaf, twig, piece of bark, handful of grass, feather, etc.).

Note: if only one hour is available, bring these items with you to the lesson.

Once done collecting, bring students back in to build mountains with their groups. Sprinkle their soil lightly with water to help them build up their mountains.

Once they are done building their mountains, have them put a thin book/magazine under

one end of the tray (so water will flow away from their mountain).

Then have them carefully place the popsicle sticks into their mountain on different sides and at different heights/elevations. Only the top band (1 cm) of the sticks should be visible; break sticks as required.

Finally, have each group come up with a name for their group and write them on the board.

Start the erosion competition with earthquakes. Have one student per group shake the tray holding their group's mountain, lightly at first and then more violently.

Ask each group what the results were and record them under each group's name on the board. If the group patted down the mountain, then you should have seen cracks develop, which is a great lead into how earthquakes change the land. Have the students rebuild their mountains.

Next, tell the students they will act as wind. Have them each blow through their own straws at their mountains. Let them decide whether they want to blow all at once, in just one spot, or one at a time, lightly or heavily. Again, have them report their findings and record them. The students may find that they exposed some bigger rocks when they blew on the mountain. Talk about how smaller particles are easier to erode away, leaving the larger ones behind.



Death Valley. Erosion Debris

<http://homepage.mac.com/leonwittwer/images/deathvalley/debris.jpg>

Give each group a small cup of water to pour into their rainmaker. Have one student in each group hold the rainmaker over their group's mountain.

Conclusion

Draw the students' attention to where the sediment is moving. They should notice that it has collected in the bottom of the pan, or the basin. Students should make observations and report back to the class as to what happened. Lastly, have students walk around to look at each others' mountains and modeled affects of erosion.

Assessment

Assess students' understanding of the vocabulary and lesson by asking such questions as:

1. Where did your mountain erode? How can you tell?
2. Where do the eroded particles go? Why? Look for miniature streams, lakes, canyons and landslides.

3. What types of weathering eroded the mountain?
4. What materials help the mountain withstand erosion?
5. Which mountain eroded the least/most and why?

rock. One of those rocks falls into a mountain stream. Over the years that rock in the stream becomes worn smooth and one day a violent rain storm raises the water level and the rock (you) is swept further down stream.

You are worn smaller and smaller as you make your way to the sea. When you get to the sea, you are as small as a grain of sand and you get added to the beach.

Extensions

Have students pour water straight from the cup onto their mountain and note what kind of erosion it causes (a flood).

Thought experiment: This is a good activity to add into the beginning of the lesson as a visual for the entire erosive process:

Have the students close their eyes and tell them you are going to take them on a journey as a rock. Have them imagine them selves as a tall, jagged mountain peak. Then a huge storm comes along and knocks a huge boulder off of the top. You are now the boulder, and when you hit the bottom you smash into small chunks of

Vocabulary

Erosion: The grinding away of and removal of Earth's surface material by moving water, ice or wind.

Ice Wedging: The process in which water trapped in a joint (fracture) freezes, forces the joint open and may cause the joint to grow.

Downcutting: The process in which water flowing through a channel cuts into the underlying material and deepens the channel relative to its surroundings.

Weathering: The process that breaks up and erodes solid rock, eventually transforming it to sediment.

Sediment: An accumulation of loose mineral grains, such as boulders, pebbles, sand, silt or mud, that are not cemented together.

Sedimentary Rock: Rock formed by layers of sediment being cemented or pressed together.

Wind Abrasion: The grinding away at surfaces in a desert by windblown sand and dust.

Sources

- "Boulders to Bits." Bosak, Susan. SCIENCE IS...A source book of fascinating facts, projects and activities. 2 ed. Canada: Scholastic, 1991, p 226-227.
- "Erosion Lesson." Nov. 2007. *Unique Landforms* lesson from DiscoverySchool.com 2002, at <http://www.discoveryschool.com>.
- *Rub Away* activity #134. VanCleave, Janice. 201 *Awesome, Magical, Bizarre & Incredible Experiments*. New York: John Wiley & Sons, 1994, p 74.

Images/Graphics—

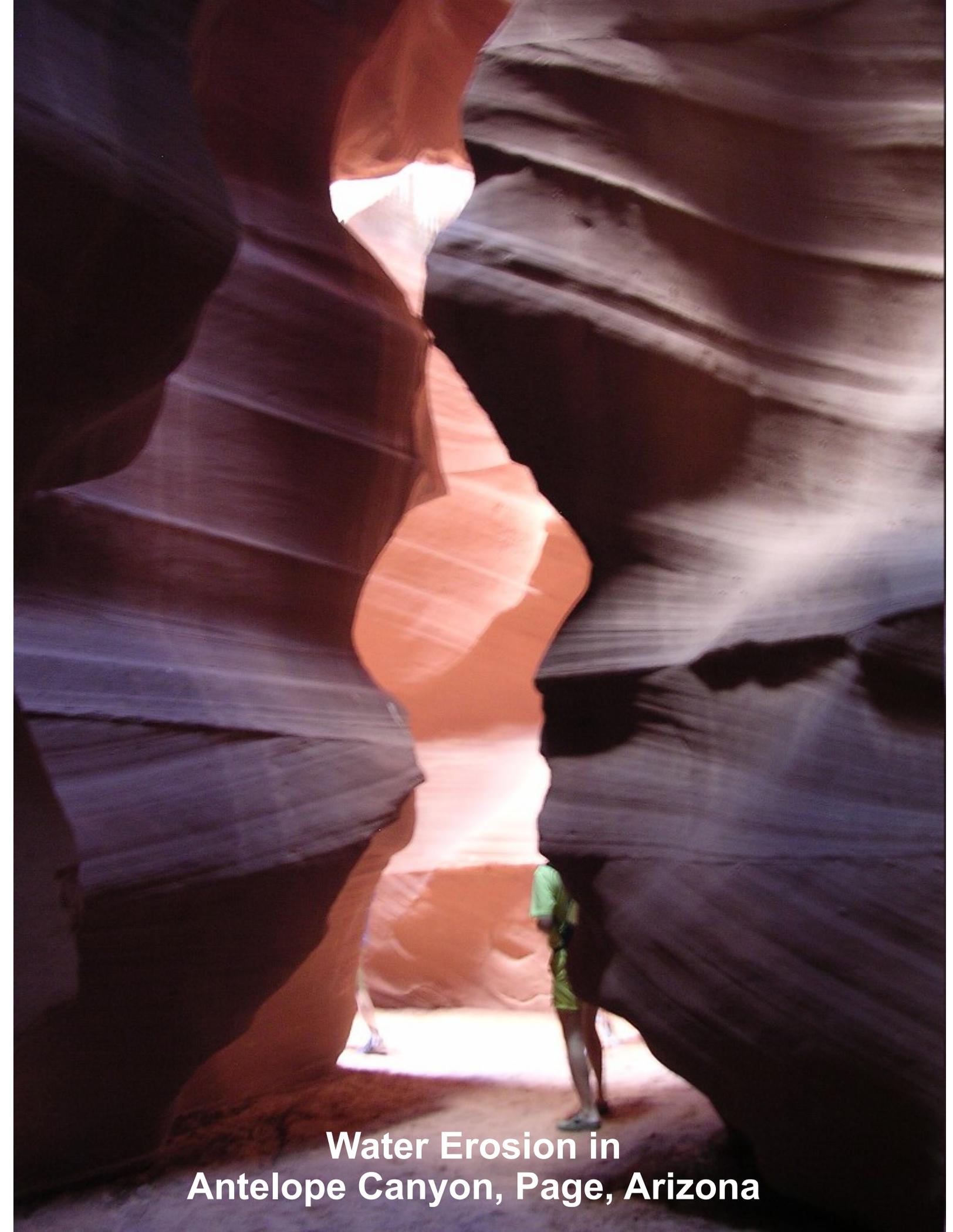
- Classic sheeted granite along the Tioga Road, Yosemite National Park: "Weathering images." Online images. 27 Nov. 2007. <http://www.geosci.unc.edu/faculty/glazner/Images/Weathering/weathering.html>.
- Wittwer, L., *Photo of Death Valley*. Retrieved from <http://homepage.mac.com/leonwittwer/images/deathvalley/debris.jpg>
- Grand Canyon Image 29 June 2010. <http://famouswonders.com/wp-content/uploads/2009/04/grand-canyon.jpg>



**Water Erosion at the
Grand Canyon, Arizona**



**Water Erosion at
Antelope Canyon, Page, Arizona**



**Water Erosion in
Antelope Canyon, Page, Arizona**



**Wind Erosion at
Arches National Park, Utah**

Water Erosion





Wind Erosion

