HOW DO WEATHERING AND EROSION AFFECT ROCKS?

Overview

In this lesson, students will build a model landform and investigate the rate of change in a game that builds observation skills.

Objectives

On successful completion of this lesson, students will be able to:

- explain the difference between weathering and erosion;
- use models to demonstrate changes over time; and
- explain how erosion has changed local landscapes over time.

Alaska Standards

Alaska Science Standards / Grade Level Expectations

[4, 5] SA1.1 The student demonstrates an understanding of the processes of science by asking questions, predicting, observing, describing, measuring, classifying, making generalizations, inferring and communicating .

[4, 5] SD2.1 The student demonstrates an understanding of the forces that shape Earth by describing how wind and water tear down and build up the Earth's surface [by eroding rock and soil], resulting in new land formations (i.e., deltas, moraines, and canyons).

[5] SE2.2 The student demonstrates an understanding that solving problems involves different ways of thinking, perspectives, and curiosity by comparing multiple explanations (e.g., oral traditions, folklore, scientific theory) of everyday events (e.g., weather, seasonal changes).

[4, 5] SF1.1-SF3.1 The student demonstrates an understanding of the dynamic relationships among scientific, cultural, social, and personal perspectives by: telling a local or traditional story that explains a natural event (e.g., animal adaptation, weather, rapid changes to Earth's surface) and relating it to a scientific explanation.

Alaska Math Standards

4.OA.2 Multiply or divide to solve word problems involving multiplicative comparison.

Alaska Cultural Standards

[D] Culturally knowledgeable students are able to engage effectively in learning

activities that are based on traditional ways of knowing and learning. Students who meet this cultural standard are able to:

[D.4] gather oral and written history information from the local community and provide an appropriate interpretation of its cultural meaning and significance.

[E] Culturally knowledgeable students demonstrate an awareness and appreciation of the relationships and processes of interaction of all elements in the world around them. Students who meet this cultural standard are able to:

[E.2] understand the ecology and geography of the bioregion they inhabit.

Bering Strait School District Scope and Sequence

4th Grade Sequence #7: Physical Features of the Earth

5th Grade Sequence #9: Physical Features of the Earth

Materials

- Clay of at least three different colors (enough for each student to form 10 pea-size balls of each color)
- Forceps (one per team)
- Plastic trays (one per team)
- Cups (3 per team — one for each color of clay)
- Digital camera (optional, for teacher's use)

Materials for Optional Teacher Demonstration (Extension Activity #2)

- Paint tray
- Clay (in blue and green)
- Plastic cup
- Clean sand
- Water
- Spoon
- Kitchen baster

Additional Resources

HSP IV: Ch. 8, Lessons 1, 2; Ch. 7, Lesson 3

HSP V: Ch. 9, Lessons 1, 2; Ch. 7, Lesson 3

HSP V: p. 360 — "Science Spin"

Activity Preparation

1. Take a walk around the village and make note of any areas of weathered rock or erosion.
   a. If you have a digital camera, take a picture of the area(s) and prepare to show to students.
2. Discuss with locals how erosion has affected the village.
   a. What changes have they witnessed?
   b. Are there any pressing concerns?
   c. How are the problems being mitigated?

Whole Picture

Scientists and cultural knowledge bearers alike know that Earth's surface changes slowly over time and have different "stories" to explain how things came to be the way they are. One such story shared by cultural knowledge bearers in Alaska provides history for the rock outcroppings near Togiak. Elders explain that these rock outcroppings are people who were frozen in stone after experiencing some frightening ordeal; because of their history, they remain "animate and responsive to those who seek their help" (Fienup-Riordan and Rearden, 2012, p.48). Other stories about landforms feature Raven as the creator. Michael John, from Newtok, told how Raven created Nelson Island to save his daughter who was lost on an ice floe. "And they said Raven's daughter, when it was time, was fishing for tomcod along a small piece of ice that had stuck to the land. They told Raven that the ice detached and his daughter floated away … He filled the bottom of his garment with land from the surrounding ground, and he splashed it along these evunret [piled ice]. And when he splashed it, this area here became land" (Fienup-Riordan and Rearden, 2012, p.46).

Scientists, too, have stories and explanations for how certain land features came to be; these typically rely on a deep understanding of geological forces, like weathering and erosion, that help shape the Earth slowly over time.

Weathering takes two forms: physical weathering and chemical weathering. Physical weathering causes rocks to fracture and crumble. In the Arctic, a common form of physical weathering is frost wedging. During the spring and summer, water drips into existing cracks; when winter comes, the water freezes and expands, and eventually cracks or breaks the stone. Other forms of physical weathering come from water (think of a beach or river bank slowly changing form over time), wind (imagine the changing shape of dunes), and plants (hearty shrubs and trees have been known to fracture nearby rocks over time). Chemical weathering, on the other hand, dissolves rock and soil. Chemical weathering can result in the creation of underground caves or the discoloration of rocks above ground.

HOW DO WEATHERING AND EROSION AFFECT ROCKS?

Typically, weathering occurs in concert with erosion —the process by which Earth's surface (soil and weathered rock particles) are moved from one place to another. Agents of erosion include gravity, wind, water, glaciers, and waves, which shape Earth's surface. Erosion is a natural process that typically happens slowly, over thousands of years. In coastal areas, for example, the constant crashing of waves weathers large stones into small pebbles and fine sand, eventually shaping the land and beach. Inland, rivers and glaciers carve out valleys, and wind wears down mountains.

Recently, however, the rate of erosion in many parts of the Arctic has rapidly increased as the result of climate change. In Alaska, the impacts include infrastructure failure on such a grand scale that some villages must consider relocation. In other parts of the world, calamitous consequences of excessive erosion include: desertification, agricultural infertility, water contamination, land degradation, and ecological collapse.

One such village experiencing devastating erosion is Shishmaref — a coastal village on Sarichef Island in the Chuckchi Sea. In the past, sea ice and permafrost protected Shismaref's shores from major storms and heavy waves. Climate change, however, has had a drastic impact, causing sea ice and permafrost erosion. The loss of sea ice and permafrost has made the Shishmaref shoreline vulnerable to heavy, crashing waves, which erode the shoreline at such a rate that buildings have crashed into the sea and village residents are scrambling to find solutions.

In addition to eroding coastlines, inland permafrost thaw is causing the land to sink in some areas. These changes have a drastic effect on animal populations, and as a result, on the people who subsist on them. John Phillip from Kongiganak noted that along the Kuskokwim coast "There were many mink [in the past]. Since their birthing dens are sinking into the ground, their numbers are declining" (Fienup-Riordan and Rearden, 2012, p. 309), and John Eric from Chefornak noted that "Although blackfish are still available, their numbers are decreasing" (p. 311).

Many elders believe that the earth is changing following its people. "According to Paul Tunuchuk [from Chefornak], 'Ella is worsening since we are no longer treating it with care and respect.'" Similarly, Paul Kiunya from Kipnuk, noted that his elders told him "if people get bad, the weather will get bad following its people" (Fienup-Riordan and Rearden, 2012, p. 316).

Similarly, scientists agree that climate change is the result of human activity. It is clear, they agree, that though weathering and erosion are both natural processes, the erosion we see in the near future will be much more dramatic, and will happen on a faster timescale, as a result of climate change.

HOW DO WEATHERING AND EROSION AFFECT ROCKS?

Vocabulary

weathering	the breaking down of rocks on Earth's surface into smaller pieces
erosion	the process of moving sediment from one place to another

Activity Procedure

1. Write the words "weathering" and "erosion" on the board; circle the smaller word "weather" in the word "weathering."
   a. Ask students what they think weathering is (guide them to understand the definition; point out that weather has a lot to do with the breakdown of rocks).
   b. Ask students to think about the local area and any weathered rock they may have noticed; instruct them to describe what they have seen.
   c. Ask students to speculate about how weather might have broken down the rocks in their area. Guide them to understand how wind, waves, rain, etc. help break down rocks.
2. Discuss the difference between "weathering" and "erosion."
   a. If you have taken digital pictures, show students weathered rock and an area where erosion is clearly present. (Save any images of recent, rapid erosion for the discussion at the end of the activity.)
   b. Ensure that students understand that erosion depends on weathering. First weathering must break down the rocks; then erosion can carry the particles away.
   c. Note: If you have time, complete Extension Activity #2 as a teacher demonstration to help students understand this concept.
3. Divide students into pairs. To each pair, give the following:
   a. a plastic tray
   b. at least three different colored lumps of clay (instruct students not to mix the colors)
   c. a forceps
   d. three cups (one for each color of clay)
4. Instruct each student to form at least 30 pea-sized balls of clay (10 from each color).
5. Together with their partner, students use the balls of clay to build a "landform" on the plastic tray (emphasize that students must not squish the balls together — the balls must remain distinct and easily separable).
   a. Note: Ensure that students build a "landform" big enough that they will be able to remove approximately 30 balls.

6. When the team has built a "landform," instruct each student to draw a quick sketch of it on their Student Worksheet: Erosion Takes Time.
7. Once each team has built a "landform" and sketched a picture of it, students take turns closing their eyes while the other partner removes one ball from the "landform" and places it into the cup (remind students to ensure that the colors remain separate).
    a. After each ball is removed, the partner whose eyes were closed, observes the "landform" for any change.
    b. Students continue taking turns in this manner until a change in the "landform" is observable and students can describe the change they see.
8. When students are able to observe a change, instruct them to sketch a picture of the new "landform" shape on their Student Worksheet: Erosion Takes Time.
    a. Below this second sketch, students write a sentence explaining how they know the landform "eroded."
9. Instruct students to count the number of clay balls in each cup.
    a. Each ball represents a change that took place over 1000 years.
    b. Instruct students to determine how many "years" it took before a change in the "landform" was observed. Students should do the math problem, showing their work on their worksheet (Answer: Number of balls x 1000).
10. When all students have finished, ask the following question: Why did you have to use a model to investigate how a landform changes? (Answer: landforms are too large and change too slowly to see the changes in real life.)
    a. Discuss how weathering and erosion typically happen slowly, over long periods of time.
    b. Discuss "rapid erosion" — erosion that happens quickly as the result of storm surges, melting permafrost, earthquakes, floods, etc. Share with students that climate change has scientists worried about rapid erosion, especially in areas along the coast and where permafrost is melting at a faster-than-normal rate.
    c. Note: If you have taken any pictures of the village that show rapid erosion, show these to students now. Have them speculate about the problems this kind of erosion can create and reasons it might be happening. Explain that traditional culture bearers believe that rapid erosion is happening because Ella is following its people (refer to the "Whole Picture" section for more detail).
11. After discussing erosion in the area (and showing pictures if you have them), invite students to draw a three- or four-step diagram that shows stages in the weathering or erosion process.
    a. Students can choose to show weathering or erosion by plants (plants

pushing through stone), weathering by flowing water, weathering by wind, or weathering by ice.

b. Have students label each step in the chosen process. Display the drawings in class.

12. Instruct students to talk to their family members, neighbors, and other community members about erosion in the community. Upon their return to class, have students share these stories with the class and suggest possible solutions.

Extension Activities

1. Contact community members who are involved in public works. Invite them to your classroom to share how erosion is affecting the community and what is being done to mitigate the problems.
2. Use this activity as a teacher demonstration to help students understand how mater is moved, once it has been broken down by weathering.
   a. Cover the slope of a paint tray with a thin layer of green clay. Press and mold the clay to form a shoreline and a beach.
   b. Cover the flat part (at the end of the slope) of the paint tray with blue clay to represent a lake or the ocean.
   c. Form a channel in the green clay to model a riverbed. NOTE: you can fill the riverbed with blue clay, just be sure to have a sloping bank.
   d. Add equal amounts of sand and water to a cup. Stir the mixture so the sand becomes suspended in the water. Then fill a kitchen baster with the mixture.
   e. Place the baster at the top of the river channel. Squeeze the bulb to release a flow of the sand-and-water mixture.
   f. Release the mixture several times, changing the speed of the flow. Observe the behavior of the sand and water as the mixture runs down the channel.
   g. Expected Results: The sand will spread out in a fan shape at the mouth of the river. A slower release speed will result in more sand being deposited closer to the mouth of the river. Students should understand that the sand in the water comes from the riverbed and riverbank. They should also understand that water can form new land at the mouth of the river by depositing sand and soil.
3. Visit the below sites for video on damage to permafrost cellars:
   i. http://vilda.alaska.edu/cdm/singleitem/collection/cdmg3/id/71/rec/1
   ii. http://uniteusforclimate.org/climate_resources_mm.html

Answers

1. Student drawings will vary depending on the shape of their "landform."
2. Student drawings will vary depending on the balls they removed from their "landform."
3. Student answers will vary, but should mention the "landform" changing shape or getting smaller.
4. Student answers will vary, but should be somewhere near 30 balls.
5. Student answers will vary depending on the number of balls they removed. Student work should show this number multiplied by 1000.
6. Student diagrams will vary. However, each diagram should clearly label the force (wind, water, ice, etc.), and should show rock breaking (weathering) or particles being carried away (erosion).

References

Fienup-Riordan, Ann, and Alice Rearden. (2012). Ellavut: Our Yup'ik World and Weather. Continuity and change on the Bearing Sea Coast. Seattle and London: University of Washington Press.

Student Worksheet: Erosion Takes Time

Name: _____

1. In the space below, draw a picture of your "landform" before it begins to "erode."

2. In the space below, draw a picture of your "landform" after it has "eroded."

3. Write a sentence explaining how you know your landform eroded. _____

_____

_____

4. How many balls of clay did you and your partner remove before you noticed a change in your landform? _____

5. If each ball of clay represents 1000 years, how many "years" did it take before erosion was visible in your model? (Multiply the number of balls you removed by 1000).

Show your work in the space below.

6. In the space below, draw a three- to four-step diagram that shows the process of erosion or weathering. Be sure to label your diagram.