Weathering and erosion

Modified version of a typical weathering and erosion stations activity in order to emphasize how scientists use initial observations to inform and then test a hypothesis. For examples, see similar activity 1 and similar activity 2.

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Overview: Students will conduct a series of experiments in pairs through which they will explore the processes and effects of weathering and erosion. Using the results from these explorations, they will design and conduct an experiment comparing the rate of erosion in different biomes. This activity not only allows students to learn about weathering and erosion, but also illustrates how scientists often use the results of one experiment to inspire another and/or use initial observations to inform a hypothesis.

Lesson concepts:

- As a result of this lesson, students will be able to:
- Describe some mechanisms of chemical and mechanical weathering
- Describe how chemical weathering differs from mechanical weathering
- Design, conduct, and communicate an experiment that compares the rates of weathering and erosion in two different biomes
- Explain how scientists use observations and/or results from experiments to inform and inspire additional tests
- Explain that science is an ongoing process

Grade span: 4–6

Materials:

- Small pan (an 8x8 baking dish works well)
- 2 Large pans (turkey roasting pans or large shallow plastic tubs work well)
- A thick layer of clay (about the length and width of a brick)
- A brick (1 brick for every 2 pairs of students)
- Small plastic bowls (1 per student pair)
- Gravel (2 handfuls per student pair)
- Water
- Sand (enough to fill the shallow pans for each student pair, to make a small "beach" on one side the large pan, and another handful for each pair)
- Dirt (enough to fill the large pans)
- 2-3 textbooks
- Sandpaper (a 50 grain or similarly coarse sandpaper will work best for this) (1 small piece per student pair)
- Rough samples of a soft stone such as calcite, limestone, dolomite, fluorite, rhyolite or similar stone with a hardness of about 3–4 on the Mohs hardness scale. (at least 2 different samples for each student pair)
- Sugar cubes (approximately 5–7 per student pair)
- One baby food jar or canning jar with lid
- Super-fine iron wool (1 clump per student pair) (this can be found in paint or hardware stores; the steel wool you find in grocery stores is usually stainless steel and will resist rust)
- Tape and 3 markers to label beakers with
- 2 pieces of chalk per student pair
- A mortar and pestle
- Vinegar (about ¾–1 cup per student pair)
- Small beakers (three per student pair + 3 additional beakers)
- Two small beakers with a pouring lip/spout
- 2 Alka-Seltzer or other brand antacid tablets per student pair
- A timer or clock

- 2 copper pennies (before the year 1981 works the best) per student pair
- 1 tsp. of salt per student pair
- One clear plastic cup per student pair
- A teaspoon
- Garbage bags, buckets, large bowls, or other place for students to dispose of wet sand, dirt, gravel and rocks at some lab stations.
- Lab Station Instructions
- Teacher Station List
- Student Lab Notebooks

Advance preparation: Prepare for this lab by making sure you have all the materials ready to go for each station listed on the Teacher's Station List. Print out the student instructions for each lab station and have them ready for students to use at that lab station. You will need access to a freezer to prepare some materials for Day 1 and again to freeze some of the student's experiments on Days 2 and 3. It does not necessarily need to be in the classroom.

Time: 4–6 periods

Grouping: Pairs

Teacher background: Weathering refers to the forces that change the physical and chemical character of rock near the earth's surface. Mechanical weathering is the breaking down of rocks into smaller pieces with little to no chemical change. Examples of mechanical weathering include frost action, abrasion, and pressure release. Chemical weathering is the decomposition of rock from exposure to water and atmospheric gases such as carbon dioxide and oxygen. As chemical weathering decomposes rock new chemical compounds are formed. Acid rain, caused by water combining with emissions of ammonium, nitrogen, sulfur, and carbon, is also a way of chemically eroding rock. Examples of chemical weathering include: rusting, acid breakdown, and solution weathering.

Erosion, in contrast, is the physical removal of rock particles by an agent such as streams or glaciers. Weathering helps break down a solid rock into loose particles that are easily eroded. Most eroded rock particles are at least partially weathered, but rock can be eroded before it has weathered at all.

Student prerequisites: Students should be familiar with terrestrial biomes and rock types prior to beginning this activity.

Procedures:

Day 1

1) Pass around sand, gravel, sea glass, and smooth rocks. Ask the students where sand and pebbles come from? How are they made? Ask them to look at the samples passed around carefully and think of some answers. Give them time to think before asking for responses. Students will probably say that sand and pebbles come from larger rocks that have been broken down into smaller pieces.
2) After students come to this conclusion ask them how the rocks broke down into sand or pebbles. Write down their answers on the board and ask questions, if necessary, to lead them to various types of mechanical weathering. If they do not come up with chemical weathering mechanisms offer a few ideas to add to the list from these categories. You should mention and explain acid rain (its cause and formation) so that they will be prepared to explore this in one of the lab stations.
3) Looking over the list, first ask students if they can divide up the various ideas into categories. This may be difficult for students depending on their level, but you should ask to stimulate their thinking on it. Write down the terms mechanical and chemical weathering as well as erosion and as a group try to come up with definitions for each one based on the initial thoughts. Then have students help you put their ideas on how rocks break down into categories. After categorizing, review the meaning of all of the terms.
4) Ask students if there is any way they could model and test their definitions of mechanical and chemical weathering and erosion. Together come up with some ideas for ways to test each of these ideas in the classroom. Gently guide them towards some of the lab stations you know you will be using.

5) Tell students that they will be testing their definitions of chemical and mechanical weathering and erosion, as well as the categorization of different mechanisms for each, at a series of eleven lab stations. At each station they should follow the instructions given on the Lab Station Instruction sheets, and determine whether chemical or mechanical weathering or erosion is being demonstrated. They should record their choice and justification in their notebooks. Most stations should be able to be completed in 10–15 minutes (total time of 110–165 minutes). For some stations, they can set up the experiment in 10–15 minutes, but will need to wait until Day 2 to see results. Make sure they label their materials at each lab station if they need to return on Day 2 to make additional observations. If you need to, spread this over two days or jigsaw this and have each pair of students do a small collection of stations and then share their observations on Day Two. Depending on the level of your students, you may want to quickly demonstrate the procedure for each station. The Lab Station Instructions for students includes basic instructions for each station. You may choose to modify it to include more or less instruction depending on the level of your students and to include additional materials if there are any you'd like to add.

Day 2

1) Allow students to look at any experiments from the previous day that were left unfinished and record their answers.
2) Give them a few minutes to review their notes from Day 1, and then ask them to share their thoughts about each station. In a class discussion, ask if they were able to confirm their thoughts about the mechanisms for each type of weathering. Make sure you confirm the correct answer and spend a little time explaining why/how each experiment represents chemical or mechanical weathering or erosion. In the end, write down final definitions for chemical and mechanical weathering and erosion and correctly categorize all the various mechanisms to make sure the class has a solid grasp on this.
3) Now that they've modeled, tested, and explored weathering and erosion, ask students what kinds of problems they could answer with that information. Explain that scientists don't usually stop after exploring just one idea. Can you imagine if Benjamin Franklin, after exploring lightning and testing his initial ideas about electricity, had simply stopped experimenting? Often explorations, modeling, and testing like they did yesterday lead to new ideas. What other kinds of experiments could they do that build on the information gathered yesterday? Generate a list of ideas on the board.
4) At some point if students don't suggest this, lead them toward the idea of the factors that might change the rate at which erosion or weathering occurs in different places. Ask students "With what you know now about erosion and weathering, what are some factors that might change the rate of erosion or weathering in different environments?" List the variables on the board and assist them by asking leading questions. Examples of answers would be moisture levels, different temperatures, wind strength, etc. Make sure you also help them explore the idea that rocks may be of different sizes or types in different environments.
5) After some thoughtful discussions about this idea, suggest that the class continue their scientific process by taking the knowledge they gained from Day 1's explorations to tackle this new problem "What factors control the rate of erosion and weathering?" Tell students that in pairs they will need to design an experiment that investigates the different rates of erosion in two different terrestrial biomes. For example, they might explore the difference in rates of mechanical weathering in a desert biome versus a tropical rainforest biome. Emphasize that they will need to focus on one variable. It may help to go through planning a sample experiment on the board as a whole class.
6) After explaining the challenge, give students time to brainstorm and plan. Allow them to use any of the materials from the previous day's lab stations and encourage them to use their new knowledge about erosion and weathering. Make sure they finish, either in class or for homework, writing up their question, a hypothesis that includes some explanation (an example of a good hypothesis might be "I think that a tin can will rust more quickly in the tropics than in the desert because rusting usually takes place in a moist environment and there is higher humidity in the tropics"), and a description of their planned procedure and materials.

Day 3

1) Begin the class by checking students' plans and then allow them to proceed with their experiments. They may take the entire class period to finish and some students may need to return to their experiment the following day to make some closing observations or finish up.

2) As homework, students should prepare a brief presentation of their experiments, including their hypotheses, procedure, data, and conclusions. Additionally they should include a description of what they discovered in the first day's explorations and how they built upon that in their second experiment.

Day 4

1) Some students may need to finish up experiments from the previous day. If so, you will need to give them time in class to do this and time to prepare their write-up and presentation. This may mean postponing presentations until Day Five.

2) When students are ready to present, have each pair briefly describe their experiments and results. During presentations, all students should take notes on how the presenting pair's results differ from their own. When everyone has finished, have a class discussion about how results help to answer the question "What factors control the rate of erosion and weathering?" Be sure to make a final list of the factors each group has discovered that may impact the rate of weathering and erosion in different environments. Discuss how different pairs' results differed and why. Ask students how they would change their experiments if they were able to repeat them to make them more accurate. Emphasize that if they had the time, making these revisions and/or moving on to other related experiments is what real scientists do. and what they did by linking up the work form Day 1 to the experiment done on Day 3. Initial explorations and observations are used to inform future experiments. Hypotheses represent informed predictions about what may happen in future experiments and why. They are not just guesses. If time permits, ask students to offer up some potential hypotheses for future experiments that reflect their new knowledge gained from the two sets of experiments they've done so far.