

Experiments with Weathering, Erosion and Deposition for the Earth Science Regents Course

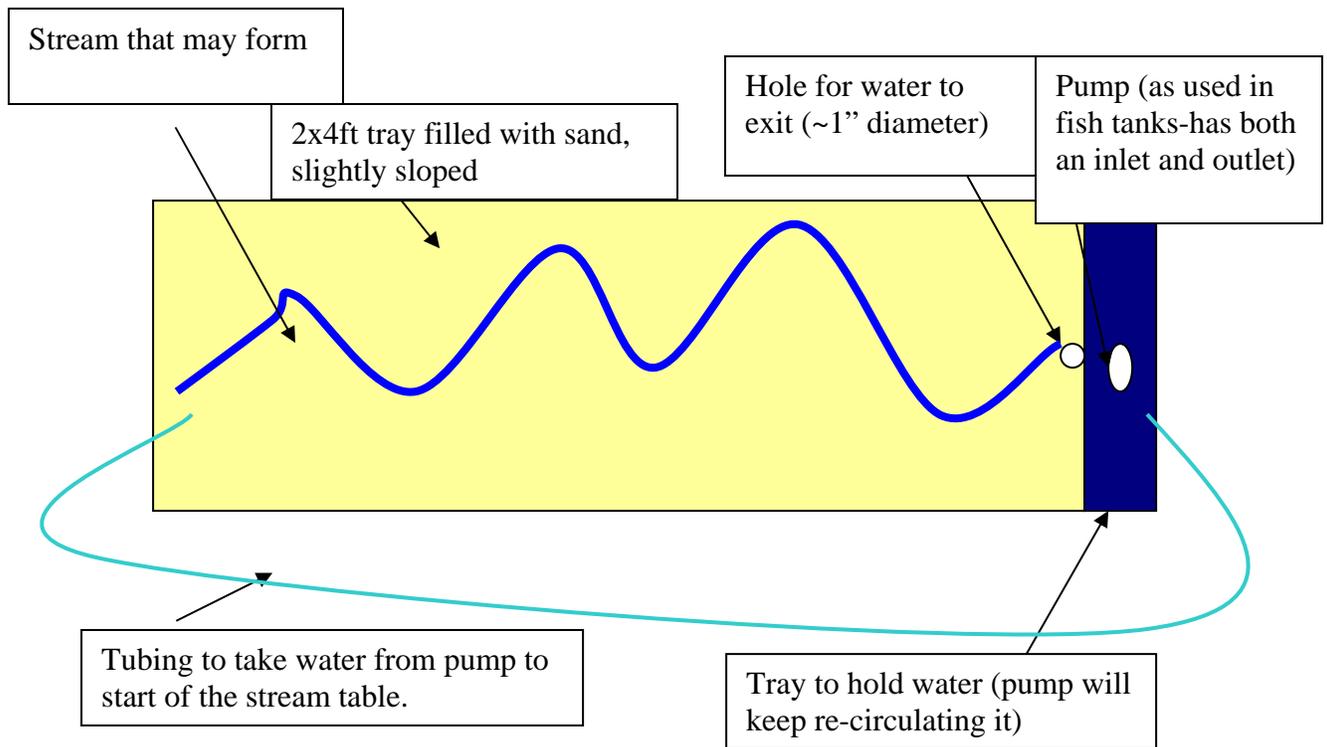
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For Teachers

1. Overview

The first three lab activities in this series will assist students in the visualization of how streams form, where erosion and deposition occur in a watershed due to streams (“big picture”), and where erosion and deposition occur within a stream itself (micro-setting). The last activity of the series will help students explore and understand how surface area relates to the rate of weathering of minerals and rocks. These activities complement an Earth Science curriculum that deals with weathering, erosion and deposition. Its main focus is on water as the driving force of these processes and does not deal with glaciers or wind. These activities are in the form of short-term experiments, exposing students on how to carry-out an experiment. If all of the activities in this series are done, it will serve to connect the three processes of weathering, erosion and deposition, which is not always expressed in textbooks.

These activities require a stream table with an automatic pump. The table should be at least 2 feet x 4 feet. They can be ordered online from Science Kit & Boreal Laboratories and also WARD’s Natural Science. The following is a diagram of what one should include.



Even though weathering is usually covered before erosion and deposition, we found it useful to present it after. In order to perform an experiment well, students must have practice in making observations. The stream table is very helpful in this regards. Also, since it is not practical to have 20+ students designing their own experiments around one stream table, we found it useful to use the stream table experiments (Activities 2&3) first as a teaching tool on how to design an experiment. Therefore, we did the stream table experiments with more guidance (the teacher designs the experiment and the students carry it out) which is very useful in an inquiry setting. More guidance at first when they are first learning about experimenting and then more freedom when it comes to the more simple weathering experiment was found to be very productive.

2. Subject

Earth Science. Based on: Callister, Jeffrey, 2002. Brief Review in Earth Science: The Physical Setting. Prentice-Hall, Inc., NJ.

3. Audience

9-12th grade

4. Time required

One lab period

5. Background

In order to use these activities, students should have covered units on rocks and minerals previously. It may be helpful also if they are aware of the different forces that can cause weathering, mainly chemical vs. physical. It may also be helpful if they are aware of other different forces of erosion already, mainly streams, glaciers, waves and wind. However, the class that this was piloted used these activities as an introduction to weathering, erosion and deposition. Their homework consisted reading of the relevant

chapters in their text the day before that experiment was to be done, so that they had the relevant background information. These activities are not meant to define important terms. They are meant to supplement the text so that the students can see those terms “in action.”

6. Learning and Behavioral Objectives

The students will learn the following concepts:

- Importance of particle size and the role of surface area in weathering
- Water erosion and the different parts of a stream (meander, tributary, stream bank, flood plain, mouth, delta, etc)
- The processes of erosion and deposition in a stream, including where they occur on both a large and small scale.
- How stream velocity relates to the rate of erosion and deposition
- The sorting of sediment in streams and how that can relate to velocity.

They will also learn to:

- Make good observations
- Learn the different parts of the Scientific Method
- Learn to design a simple experiment with provided materials.

7. National Science Education Standards Addressed

Science Content Standards 9-12

- Content Standard A:
 - Abilities necessary to do scientific inquiry
 - Understandings about scientific inquiry
- Content Standard D:
 - Geochemical Cycles
 - Evolution of the Earth System

8. Assessment Strategy

Follow-up questions are provided at the end of each activity, including questions related to hypothesis testing.

9. Teaching Tips/Potential Problems

- Completed labs are included at the end of this document.
- For the Activity 3, velocity of a stream and particle transport, the set-up may need to be altered on the stream table. For this activity, a long plastic tray was placed on top of the sand in the stream table. This is because the “particles” were prone to being buried in the sand of the stream table. We used beads of different sizes and had a lot of success with that set-up.
- Note, in using SweeTARTS™ in the weathering activity, it was found helpful if they used the same colored candy for each treatment. It was found out that a good way to measure how much the SweeTARTS™ had dissolved was by looking at the color of the water that resulted. Also it is important to note that the candy will not dissolve completely, so one of the independent variables should be a set time. Between 5 and 10 minutes was found to be appropriate enough to determine their results.

Activity 2. Stream Velocity and Erosion

Objectives:

- To observe how much erosion and deposition can be caused by a stream, depending on how fast or slow the stream is flowing.
- To learn how to conduct an experiment.

Background: Sediment is eroded from the top of a watershed by a stream and its tributaries. That sediment is then deposited at the mouth of the stream, located in the bottom portion of a watershed. The amount of erosion and deposition that occurs can be determined by measuring how large the stream's delta grows overtime.

List of materials:

Stream table with running pump that can pump at least 3 different speeds

Stop watch

A defined stream (same size and shape for each trial - Why?!)

A means to measure delta formation (ruler)

Pencil

Calculator

Procedure:

1. Examine the **Question** found below and develop a hypothesis from it.
2. Under **Methods**, design an experiment that could test your hypothesis. Your design should include at least the following:
 - Conduct at least three trials with the same stream shape each time at a slow, medium and fast pump speed
 - Conduct each trial for the same amount of time (Why?!)
 - Measure the “volume” of the delta after each trial in centimeters (length x width x height)
 - Record data
 - Return the sediments to the top of the watershed after each trial (Why?!)
3. Construct your defined stream on the stream table (straight and narrow works well)
4. Assign the needed roles in your group (these should stay the same through the whole experiment to keep data collection consistent):
 - Pump operator
 - Time keepers
 - Delta measurer
 - Data recorder
 - Engineer to keep the same stream size and shape and to redistribute the sediments
5. Carry out the Experiment that you designed under the **Methods** section.
6. Determine if your hypothesis was correct.
7. Answer follow-up questions.

Question: How does the velocity of a stream affect how much erosion and ultimately deposition occurs?

What is your **hypothesis**?

My hypothesis is that the faster the water flows, the more erosion will occur and the larger the delta will grow.

Methods: Explain how you will test your hypothesis. What are your **controls**? What are your **independent and dependent variables**?

We will construct one sized and shaped stream to run 3 trials because the shape of a stream (straight vs. meander) can affect its velocity and how long it is can change the amount of erosion– CONTROL

We will have three trials; one slow, one medium and one fast speed - INDEPENDENT VARIABLE

Each trial will be for the same amount of time; One minute – CONTROL

The volume of the delta will be measured in centimeters and recorded after each trial – DEPENDENT VARIABLE

The “sediments” will be returned to the top of the “watershed”, so that there is the same amount of sand present for each trial - CONTROL

Observations: Record what happens. Provide any **measurements** in a table.

Trial #	Volume of Delta
#1 (slow)	
#2 (medium)	
#3 (fast)	

Results/Conclusion: Was your **hypothesis** correct? Explain.

Yes – the faster the speed, the larger the delta

Follow-up questions

1) What do you think would happen if we increased or decreased this stream’s slope (make it steeper or flatter) instead of the speed of the pump?

Increasing the slope would cause more erosion, too.

2) What events in nature did the speed of the pump represent in this experiment? Hint: Think about weather and climate.

Rainfall and snowmelt

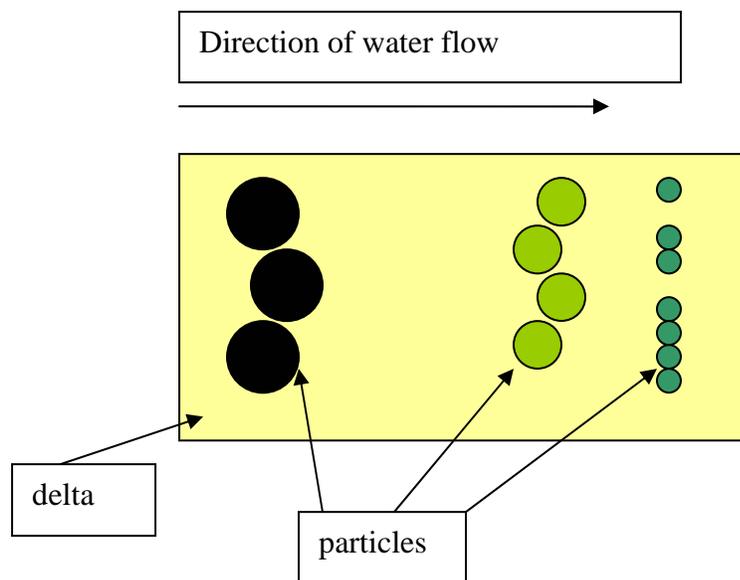
3) How do people try to control rivers and streams in “real life?” How would engineers keep a real stream from changing its size or course? Dams and levees

Activity 3. Stream Velocity and Deposition

Objectives:

- To measure how far different particle sizes will travel by increasing or decreasing the stream's velocity.
- To observe sorted deposition.
- To learn how to conduct an experiment.

Background: The size of a particle will determine if it will be able to be carried by a stream. The greater the velocity of a stream, the larger the particles it will be able to transport. When a stream hits the delta, the sediments will be deposited and sorted based on their size, if shape and density are relatively the same. The larger particles will settle out first, followed by smaller and smaller sediments. This is called horizontal sorting and looks like this:



List of materials:

Stream table with running pump that can pump at least 2 different speeds

Stop watch

Pencil

A defined stream – a plastic tray placed on top of the sand works best for this activity (same size and shape for each trial – Why?!)

Different particle sizes with the same shape, same type of material, such as beads or bean seeds – Why?!

A ruler (optional)

Procedure:

1. Examine the **Question** found below and develop a hypothesis from it.
2. Under **Methods**, design an experiment that could test your hypothesis. Your design should include at least the following:
 - Conduct at least two trials with the same stream shape each time with a slow and fast speed
 - Conduct each trial for the same amount of time (Why?!)
 - Use at least 3 different particle sizes and at least 5 particles for each size
 - Start with the particles lined up at the head of the stream for each trial, without placing any in front of any others
 - Draw an illustration of what happens during each trial
 - Take distance measurements (optional)
3. Construct your defined stream on the stream table (a plastic tray works well)
4. Assign the needed roles in your group (these should stay the same through the whole experiment to keep data collection consistent):
 - Pump operator
 - Time keepers
 - Distance measurer (optional)
 - Data recorder (everyone should draw their own sketch)
 - Engineer to maintain the stream and to line up the sediments for each trial
5. Carry out the Experiment that you designed under the **Methods** section.
6. Determine if your hypothesis was correct
7. Answer follow-up questions

Question: How does the velocity of a stream affect the distance particles of different sizes can travel?

What is your **hypothesis**?

The smaller particles will travel the farthest. The slow velocity will have trouble moving the largest particles.

Methods: Explain how you will test your hypothesis. What are your **controls**? What are your **independent and dependent variables**?

We will construct one sized and shaped stream to run 2 trials because the shape of a stream (straight vs. meander) can affect its velocity– CONTROL

We will have two trials; one slow and one fast speed - INDEPENDENT VARIABLE

Each trial will be for the same amount of time; 30 seconds – CONTROL

There will be 3 different particles sizes (INDEPENDENT VARIABLE) made of the same shape and material since density and shape can affect how far a particle travels and we are only examining size - CONTROL

A sketch of where each particle ends up will be made for each trial – DEPENDENT VARIABLE

Observations: Record what happens. Provide an illustration.

In both trials, the smaller particles traveled further. The faster velocity could move the largest particles, where the slower velocity could not. **Students should provide a sketch also.**

Results/Conclusion: Was your **hypothesis** correct? Explain.

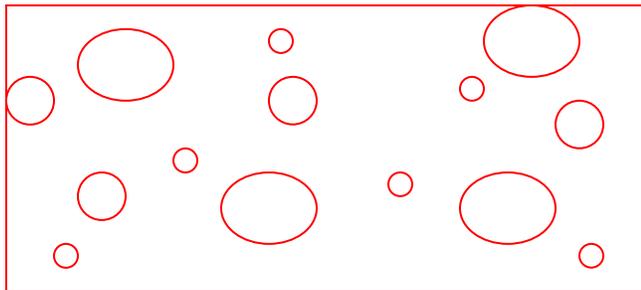
Yes – the greater the speed, the further the particles traveled and at greater speed, the largest particles were transported also.

Follow-up questions

1) How would the distance traveled by dissolved substances like the chemicals found in a leaking oil storage tank compare to how far pebbles would travel in a stream? What does that tell you about how far pollution can travel in a stream?

Dissolved substances can travel very far. This means that pollution can travel very far from where the spill occurred.

2) Streams typically cause sorted deposition. Glaciers, another form of erosion, cause unsorted deposition. Draw an illustration of what unsorted deposition might look like.



Activity 4. Weathering and Surface Area

Objectives:

- To understand the importance of surface area when it comes to weathering of rocks and minerals.
- To learn how to design your own independent experiment.

Background: There are two types of weathering; mechanical and chemical. Mechanical, or physical, weathering is the breakdown into smaller pieces, while chemical weathering breaks a rock or mineral down by altering a rock or mineral's chemical composition. Weathering can be affected by several forces, including exposure, particle size, mineral composition, and climate. This activity will look at the role of particle size and how fast a material can be weathered. See Figure 9-2

FIGURE 9-2 – as found in Student Handouts

List of materials:

- Acid solution (dilute vinegar)
- SweeTARTS™ (the same color)
- Hammer
- Stop watch
- Clear cups or beakers
- Safety goggles (if stronger acid)

Procedure:

1. Break into groups of 3 or 4.
2. Develop a question based on your previous knowledge of weathering of rocks and minerals and Figure 9-2.
3. Turn that question into a hypothesis.
4. Design an experiment that could test that hypothesis with the materials provided to you.
5. Carry out your experiment.
6. Determine if your hypothesis was correct
7. Answer follow-up questions

Question: Which dissolves faster – a solid SweeTARTS™ or a SweeTARTS™ that is broken up into smaller pieces?

What is your **hypothesis**?

The smaller the particle size, the faster it will dissolve.

Methods: Explain how you will test your hypothesis. What are your **controls**? What are your **independent and dependent variables**? Provide a sketch of your set-up.

We will have two cups of acid – CONTROL

A whole piece of candy will be put into one cup and a piece of candy smashed with a hammer will be put in the other – INDEPENDENT VARIABLE

They will both stay in the acid for 10 minutes – CONTROL

After 10 minutes, will we examine the amount of candy left and the color of the water to determine which “weathered” faster – DEPENDENT VARIABLE

Observations: Record what happens. Provide any **measurements** in a table.

The smaller particle size (the broken candy) dissolved faster.

Results/Conclusion: Was your **hypothesis** correct? Explain.

Yes – the SweeTARTS™ that was broken up into smaller pieces dissolved the most

Follow-up questions

1) Based on the results of your experiment, predict which of these would weather the fastest - a smooth round pebble or a jagged piece of rock. Why?

The jagged piece of rock has more surface area and can be weathered faster.

2) Explain how water could be a form of both mechanical and chemical weathering.

Water can continually wash over rock, breaking it down over time like waves hitting the shore (physical), or water can be acidic and dissolve particles like limestone chemically.