Sediment Tubes

Background

1. Stream Science in Antarctica: During the 2001-02 summer season, the streams in Taylor Valley had the highest flow in recorded history. Before the high flow, lots of green algae was observed, but the next year there was none. Why would that be? (Scoured from the rocks by the fast moving water? Covered by sediment?) Wolman Pebble Counts were taken at each stream. 100 random pebbles were measured both across their longest and shortest sides to determine an average of the streambed characteristics. Scientists are looking for a relationship between the streambed and the algae that grows there.

2. Parcticle settling is governed by Stoke's Law, which says that settling is linearly dependent on parcticle density and quadratically dependent on diameter. In other words settling is proportional to the square of the diameter of the parcticle and directly proportional to parcticle density.

3. The parcticles will be carried laterally by water currents and will settle depending on their size and density. Some of the parcticles that settle out along the way will stay permanently on the bottom, but sediments can be reintroduced into the water by turbulence. This resuspension tends to occur when there are strong currents and also in shallower areas when wind mixes grains from the banks and causes additional turbulence on the surface. Sediment deposits tend to form in low energy, or slow moving water areas such as pools or on the inside bends of meandering streams.

3. Agricultural Run-off: As rain hits fields, smaller grains of sediment and soil are mixed with the water and the run-off brings it to the stream. The stream becomes full of sediment. Too much sediment can change the stream eco-system functions. It can cover the natural bottom sediment and the invertebrate habitats. Invertebrates feed the fish, so they are also impacted. The water column becomes murky and not enough light can penetrate allowing photosynthesis of algae to occur. In many agricultural streams, Riparian Buffer strips have been planted, a row of trees and grasses along a bank to slow the run-off as it approaches the stream. The grasses slow the water movement, and the sediment falls out before entering the stream.

Resources and Reference Materials

http://earthobservatory.nasa.gov/Newsroom/NewImages/images.php3?img_id=7272 (nice images of the Dry Valleys)

You might want to take a look at some of my Antarctic journal entries and images:
../../huffman/1.11.2003.html

../../huffman/1.10.2003.html

Sediment Tubes: Teacher Information

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Activity adapted from "Sediment Tubes" by Wayne Wittenberg, teacher, Glen Ellyn, IL

Overview

Students will observe how different density soils and rocks behave in wind and in water. They will make predictions and careful observations as they learn about sediment transport and sediment rates in streams and rivers.

Grade Level/Discipline

Students in grades 4-8 will use this activity to develop science process skills while learning about sediment rates. Upper junior high and high school science classes can extend the activity to include environmental discussions of agricultural run-off, turbidity measurements, and/or colloids in solutions that never settle out. (see "extensions")

National Standards

Content Standard A: scientific inquiry

Content Standard B: properties and changes in properties of matter; motions and forces; interactions of energy and matter

Content Standard D: energy in the earth system

Pre-activity set-up

1. Have materials ready for distribution to each group

Materials

For each group you will need the following supplies:

1 Tube (18" clear plastic water-tight tube with PVC caps on both ends, OR a clear plastic tennis ball can

4 film canisters: diatomaceous earth, sand, soil, pebbles

Hand lenses--1 for each student

Water to fill tube

Large Ziploc bag

Straw

Time Frame

The sediment tube activity can be discussed and set-up in one 40 minute class, but short periods of observation should be set aside over the next few days.

Engagement and Exploration (Student Inquiry Activity)
Explanation (Discussing)
Elaboration (Polar Applications)

1. Pass out groups' materials

2. Give time for students to examine the four materials with a hand lens

3. If the wind was to blow across these four materials, which would move in the lightest winds? Which would need a greater force?

4. Lay the Ziploc bag on the table. One partner holds it open, forming a "cave." Place 1/4 of each canister inside the lip of the bag. Use the straw to blow across the piles to see which move in the wind the easiest. Which take more force? Share ideas with the whole group. Is there agreement, or do some groups have differing ideas?

5. Ask the "Activator Question": Rivers and streams carry large amounts of sediment as they move. What happens when rushing waters of a river meet larger bodies of water and slow down? Let students discuss this in groups and share ideas with the larger group.

6. If all four materials are mixed in water, what will happen? Let students share their ideas. (Some possible suggestions: Mix and stay mixed? Mix and then separate into distinct layers? Which materials will fall out first? Then what? Some mixing, some layering? How long will it take until the water is clear? How long would it take for it to clear enough for fish to live in it? Other thoughts?)

7. Show pictures of streambeds. Would they change their prediction or leave it the same? Have small groups share their ideas with the larger group.

8. Draw a model of the group's prediction on the student worksheet.

9. Pour all materials from the canisters and from the Ziploc bag into the large tube.

10. Fill tube with water.

11. Place caps securely on the ends.

12. Shake the tube to mix all materials.

13. Set it on a flat surface and let it stand without any more disturbance.

12. Make observations over time. Compare to prediction.

Exchange (Students Draw Conclusions)

Students draw what their tube looks like after three days of settling has occurred. Write a paragraph drawing a conclusion about the four different materials and how they settled out of the water. Were the results surprising or as they expected?

EXTENSIONS:

1. Diane McKnight's stream science in Antarctica--go to http://huey.colorado.edu and then follow the links to research projects and stream science

2. Discuss agricultural run-off (see "Background Information")

3. Sediment rates are measured in many different ways. Turbidity is the measure of suspended parcticles in the water. Take random river samples and measure this with a turbidity kit. (Available from Hach, Vernier, and other sources.) Turbidity could be graphed over hours and days.

4. Have students think of "stuff" that is less dense than water and would never settle. (Styrofoam, sticks, leaves, etc.) How would these additions affect the eco-system?

5. What if bones were thrown in? Which layers would be best for preserving fossils?

6. Add powdered milk to the sediment tube. It will form a solution with parcticles so small they will never settle out. The powder would look like clay but would turn to milk and stay forever cloudy. You could add this to a few tubes and watch them over several days until they realize that some parcticles never settle out. Introduce the new term "colloid."

Evaluation (Assessing Student Performance)

Have the students write a paragraph discussing how this model is like the sediment rates in a real river? How is it different?

From the student's paragraphs, the teacher will be able to determine the depth of understanding the students have about sediment rates and sediment transport.

Sediment Tubes: Lab Instructions

Materials

Each group needs the following supplies:

- 1 Tube (18" clear plastic water-tight tube with PVC caps on both ends, OR a clear plastic tennis ball can
- 4 film canisters: diatomaceous earth, sand, soil, pebbles
- Hand lenses--1 for each student
- Water to fill tube Large Ziploc bag or large grocery bag
- Straw
- Student worksheets

Procedure

1. Pour about a teaspoon of each of the materials in the film canisters in separate piles a piece of paper. Examine the four materials with a hand lens. Discuss with your group how they are alike and how they are different.
2. If the wind was to blow across these four materials, which would move in the lightest winds? Which would need a greater force?
3. Lay the Ziploc bag on the table. One partner holds it open, forming a "cave." Place about 1/4 of the materials from each film canister in a separate pile inside the lip of the bag.
4. Use the straw to blow across the piles to see which moves in the wind the easiest. Which takes more force? Share your group's ideas with the whole group. Is there agreement, or do some groups have differing ideas?
5. Rivers and streams carry large amounts of sediment as they move. What happens when rushing waters of a river meet larger bodies of water and slow down? Discuss this with your group and share your ideas with the larger group.
6. If all four materials are mixed in water, what will happen? Share your ideas in your small group.
7. Draw a model of your group's prediction on the student worksheet.
8. Pour all materials from the canisters, the Ziploc bag, and the paper on which you first observed the materials into the large tube.
9. Fill tube with water.
10. Place caps securely on the ends.
11. Shake the tube to mix all materials.
12. Set it on a flat surface and let it stand without any more disturbance.
13. Make observations over the next ten minutes. Discuss how the materials are acting in the water. How is it changing? Compare your prediction to how the tube looks at the end of the period. Draw your observation. Make notes and labels to explain what you observe.
14. Take five minutes during each of the next three days to make a new observation. Record how the sediments in the tube have changed.

Discussions Questions/Extensions ......

Write a paragraph explaining what you have observed in the sediment tube activity. Relate your observations to how sediments in streams and rivers act. Describe how this model is like real rivers and streams. How is it different?