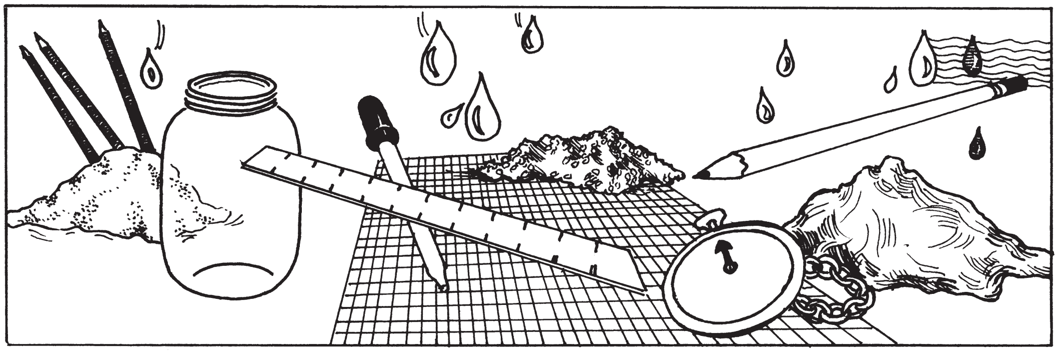


Activity #3: Determining the Percolation Rate of Soil

Adapted from "The Percolation Rate of a Soil," CurriculumResources for Earth Science Teachers, Maine Department of Conservation.

Objectives:

To understand how water moves through different types of soils

Time:

Two 55-minute class periods

Background:

As water enters and moves through a soil, it becomes available to the plants and animals which exist in the soil. The speed at which the water passes through the soil determines how long it is available and how much is present for use by the soil organisms. The percolation rate of a soil is the rate at which the water enters and moves through a soil.

In this activity, students will test the soil sample you provided for them to use in activity #2, and the various sizes of soil that they separated out during activity #2. This will help the students understand how the composition of grain sizes (percentage of coarse sand/fine sand/clay/silt) in any given soil sample affects the movement of water through that soil.

Materials:

Students should work in groups of four. Each group will need four half-gallon paper milk cartons, a nail, three 400 ml beakers, a water supply, a graduated cylinder, a stopwatch or clock with a second hand, a ruler, a grease pencil, and soil sample from Activity 2: Determining Soil Particle Size.

Procedure:

The students will test a soil sample using the same soil you provided for Activity 2. They will also test three of their soil portions from Activity 2 - coarse sand, silt, and clay. You may need to supplement their soil portions if there is not enough to cover the milk carton to a depth of one inch. The students will poke a hole in one corner of their milk carton with the nail. Use a nail size that will allow water to exit the carton, but which will keep the soil inside the carton. If necessary, you can cover the hole with layers of cheesecloth. After this activity, dry and save the soil particles for later use.

Answers to student questions:

1. In the "ocean" that Justine and Marc built with their Dad, in the Geology reading, they lined the hole with plastic. What was the purpose of the plastic?

    The soil they were building in was too porous to hold water. The plastic served as an artificial "hardpan."

2. What sediment size would you expect to find at the bottom of a natural body of water, such as the marsh area of the Tijuana Estuary? Explain your answer.

    You would be most likely to find smaller grain sizes, such as clay, that could hold water. Also, the sand and silt sizes would have been eroded by the water moving through the estuary.

3. Justine tells Marc that water soaks into the soil until it hits hardpan. What soil size(s) would you expect to find in hardpan? Why? What would happen to the land if no hardpan existed?

    You would expect to find clay sizes because they are most likely to prevent water infiltration. If no hardpan existed, water would continue moving through the soil and the land would dry out, such as you would find on an ocean beach.

4. Which sediment size(s) are you most likely to find on the beach at the Tijuana Estuary? Where did the sediment come from? Which sediment sizes would you be least likely to find on the beach? Why?

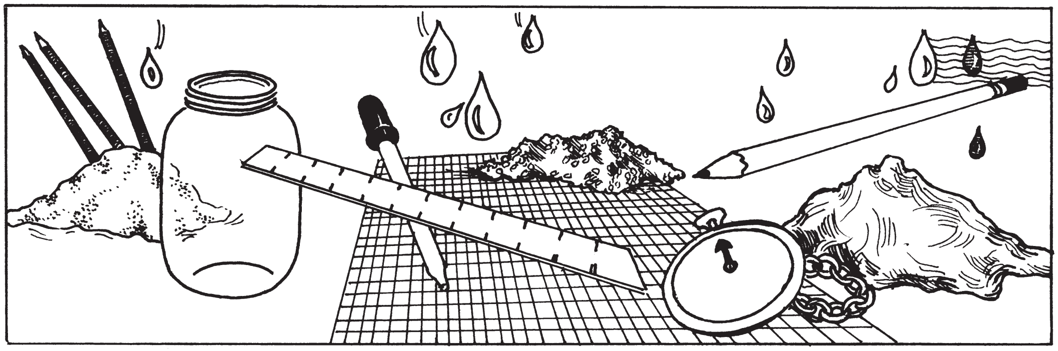
    Beach sediments are usually made up of coarse sands, with some fine sands and possibly some silts. You are least likely to find clay-sized particles on a beach because they get washed out into the ocean the easiest due to their smaller size. The sediments come from the mountains where rocks are broken into small pieces which are carried to the sea by the rivers. During river transport, the pieces of rock are tumbled and broken into smaller and smaller pieces. As the speed of the moving water slows down due to the flatness of the land, larger particles settle out of the water. The smallest particles remain in suspension in the water the longest.

5. Plant roots serve two main functions - they absorb water and nutrients from the soil and they provide an anchor for the plant against wind and water movement. Which sediment size(s) or combination of sizes would be least likely to support plant life? Do you think you would find large trees and bushes growing in clay soil? Why or why not?

Clay-sized sediments would be least likely to support plant life because they restrict the movement of water, but coarse sands by themselves are also unlikely to support plant life because water moves through them too fast for the plants to absorb. Students should understand that plants do best in soils that are combinations of particle sizes. Large trees and bushes probably wouldn't be found in clay soil because their roots would have a difficult time penetrating the hard-packed clay, giving the tree little support. There are, however, plants that have adapted to clay soils.

6. Plants get their nutrients from minerals dissolved in the water in which their roots are growing. Why are you least likely to find plants growing on a beach?

Since beaches are composed mainly of coarse sands, water would move through the sediments too fast to be available to the roots of the plant.



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INTRODUCTION:

As water enters and moves through a soil, it becomes available to the plants and animals which exist in the soil. The speed at which the water passes through the soil determines how long it is available and how much is present for use by the soil organisms. The percolation rate of a soil is the rate at which the water enters and moves through a soil.

Soils in an estuary tend to be mostly sands, silts, and clays. Water enters and moves through sand quickly because the shape of the sand particles is very irregular. This irregular shape leaves spaces between the particles where water can flow, providing a "filter" that can trap larger materials, and serving as a gas exchange for carbon dioxide and oxygen. Water enters and moves through clay very slowly, if at all, because the clay particles are extremely small and flat, and there is little space between the particles for the water to move. Without the movement of water, there is little gas exchange in clay soils. These two micro-environments provide different habitats for organisms, react to storms and floods differently, and serve unique purposes within the estuary.

This activity will give you an opportunity to determine the percolation rate of the soil sample, and the soil portions from Activity 2.

MATERIALS:

Each group of four students will need the following:

- Four milk-carton bottoms, approximately 6 inches high
- One nail
- Four 400-ml glass beakers
- One graduated cylinder
- Two stopwatches
- A grease pencil and ruler
- A sample of soil
- Soil portions of coarse sand, silt, and clay

PROCEDURE:

1. Cut off the top of the milk carton, leaving about 6 inches remaining.

2. Using the nail, poke a hole through one corner of each carton bottom from the inside.

3. With the cartons sitting upright on the table, place about 1 inch of the soil sample in one carton, 1 inch of coarse sand in another carton, 1 inch of silt in the third carton, and 1 inch of clay in the fourth carton.

4. Place each carton on top of a 400 ml beaker with the drain hole pointing down into the beaker.

5. With the grease pencil, mark each of the catch beakers 1 inch above the bottom.

6. Slowly pour 250 ml of water into each carton and start the stopwatch.

7. Allow the water to filter through the sample. Record the time when the water fills the catch beaker to the one inch line.

8. Allow the water to run until no more flows, or until it is dripping so slowly it appears to have stopped flowing.

9. Measure and record the volume of the water in the catch beaker.

	TIME 1” REACHED	VOLUME WATER RETURNED (ml)
soil sample		
coarse sand		
silt		
clay		

10. Calculate the percolation rate in inches/hour by dividing 60 minutes by the time it took to reach 1 inch. For instance, if it took 3 minutes to reach 1 inch, divide 60 by 3, for a percolation rate of 20 inches per hour. Record below.

Soil sample ______________________

Coarse sand______________________

Silt_____________________________

Clay____________________________

11. The standard percolation rate scale is as follows:

Very slow	<0.20 inches/hour
Slow	0.20 to 0.62 inches/hour
Moderate	0.63 to 2.00 inches/hour
Rapid	2.01 to 6.30 inches/hour
Very Rapid	>6.31 inches/hour

How do the rates for your samples compare to those of the scale?

12. When all of the water has seeped through, you should notice that all 250 ml. has not returned. Calculate the volume not returned by subtracting column 3 from 250 ml and record below.

Water Retained By Sample

Soil Sample _________________

Coarse Sand_________________

Silt_________________________

Clay________________________

The water not returned is a physical function of the material itself and varies among soil types. The water retained in the sample is adhering to the surfaces of the sample particles as well as being trapped in the spaces between the particles. This can be used as a measure of the water-holding capacity of the soil.

When finished, do not discard your soil samples. They should be dried and saved to use in another activity.

QUESTIONS:

1. In the "ocean" that Justine and Marc built with their Dad, in the Geology reading, they lined the hole with plastic. What was the purpose of the plastic?

2. What sediment size would you expect to find at the bottom of a natural body of water, such as the marsh area of the Tijuana Estuary? Explain your answer.

3. Justine tells Marc that water soaks into the soil until it hits hardpan. What soil size(s) would you expect to find in hardpan? Why? What would happen to the land if no hardpan existed?

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