Activity 1
Pore Space Testing
Lab activity, 45-60 minutes

Objectives

Students will demonstrate the correct procedure for determining how much pore space is present in a soil sample. Pore space is defined as the percentage of a soil that is composed of air.

Students will employ a graduated cylinder to determine the volume of both a powder and a liquid.

Materials needed for each group (2-4 students)

Dry soil
Water
100 ml graduated cylinder
250-500 ml beaker or glass jar
Paper and pencils for calculations

Step-by-step procedures

1. Pour 100 ml of dry soil into the graduated cylinder. Do not pack the soil down.
2. Once exactly 100ml of soil has been measured, transfer the soil into the empty beaker or glass jar.
3. Gently tilt the beaker and orient the dry soil so that it is sloped against one side of the beaker and the bottom of the beaker is visible.
4. Rinse your graduated cylinder three times to remove all dust contamination. Fill the cylinder with EXACTLY 100ml of water.
5. Slowly and carefully add water to the soil in the beaker, taking care to pour at the point where the soil is shallowest in the beaker.
6. CAUTION: This is the hardest part! Continue adding water very gradually until the soil has completely soaked up as much water as it will hold. This sometimes takes ten minutes! Verify there is no dry soil remaining by looking at the soil through the bottom and the sides of the beaker.
7. Observe how much of the original 100ml of water is remaining. Subtract this amount from 100ml to determine how many milliliters of water your soil sample absorbed. This number tells you your pore space percentage!

EXAMPLE:

100ml of water to start
-46ml left in the graduated cylinder

=54ml was absorbed by the soil

8. Record your answer on the judging form. Repeat the process for any other samples you may have. Be sure to rinse all lab ware before beginning again!
9. Save your soil for activity #2. (It is recommended that you complete steps 1-5 of activity #2 before you clean up.)

Activity 2
Introduction to Soil Texture: Sedimentation Bottle
Lab or classroom activity, 45 minutes

Objectives

Students will observe the diversity of particles that make up soil by mixing soil and water in a two-liter bottle and then observing the layering of soil particles as they settle to the bottom of the bottle.

Students will become aware that soil is composed of particles that are different sizes and shapes.

Students will learn that these particles are called sand, silt and clay, and they are classified by particle size.

Materials

Used soil from activity one
Clear one-liter or two-liter bottle with lid
Water
Soil Separates Text (downloadable)
Pencils
Drawing or notebook paper

Step-by-step procedures

1. Remove the label from your bottle. Fill the bottle half full with water.
2. Add the 200ml of soil that was left over from activity #1. It may take some effort to add the muddy soil through the narrow neck of the bottle. Using your fingers to guide the soil seems to be the best method.
3. Cap the bottle and shake it vigorously for one minute.
4. Set the bottle someplace where you can watch it settle. Some particles will settle immediately, others may take a day or two.
5. After all particles have settled (we recommend waiting at least one day), look carefully at the layers at the bottom of the bottle. The layers of different sized particles you observe are called soil separates. Normally, these particles are mixed together within soil and difficult to see individually. The sedimentation bottle demonstration allows see them more easily
6. Draw a cross-section (show all of the layers as they look from the side) and label the layers of particles you observe in the bottle. Use the soil separates table to help you

label the parts of your cross section. Try to identify and label the layers of sand, silt and clay that are present.

7. Save your bottle and soil for Activity 3

Activity 3
Using the Texture Triangle
Classroom activity, 45 minutes

Objectives

Students will apply understanding of soil texture and soil separates (see activity 2) to classify soils by name using the textural triangle.

Materials

Texture Triangle handouts (downloadable)
Chalkboard or overhead for sample problems
Sediment bottle from Activity 2
Pencil

Step-by-step procedures

1. Students refer to their sedimentation bottles and are reminded that soil particles (called separates) are classified into three main groups by size: Sand, Silt and Clay.
2. Notice that the layers are not all the same thickness; this is because the soil separates exist within soil in different percentages. It is by measuring these percentages that soil scientists can exactly determine a soil's texture.
3. The tool scientists use to determine he soil's texture exactly is called the texture triangle. Note that this triangle has each side labeled with the name of each kind of separate: Sand, Silt and Clay.
4. The texture triangle also has on each of it's sides the numbers 0-100 and lines that correspond to each number. These numbers and lines will help you determine a soil's texture exactly.
5. Imagine a soil sample like the one in your bottle. All of the soil in the bottle represents 100% of the sample. But if you measure the percent represented by each of the three separates, you might get 50% sand, 30% silt and 20% clay. Note that the percentages must ALWAYS total 100%.
6. Start with the percentage for sand (50%). Locate the sand side of the triangle. VERY IMPORTANT: Note the numbers on the sand side of the triangle are *SLANTED.* This slant will show you what line you should use when determining your soil sample texture. Note that next to the 50% sand number there are two lines radiating outward, however only one of the lines is oriented so that the number 50 would sit upon it if the line were extended.
7. Trace over the top of the 50% sand line with a pencil, extending all the way over to the clay side of the triangle.

8. Now take the clay percentage (20%). Determine the correct line by observing how the number 20 is positioned, and trace over this line all the way over to the silt side of the triangle.
9. Next take the silt number (30%), locate the 30% line for silt (remember the *slant* of the number) and trace this line.
10. Find the intersection of the three lines. This intersection falls in the area of the triangle labeled "loam" This name precisely classifies a soil sample with the separate percentages of 50% sand, 20% clay and 30% silt.
11. (a) Practice with these sample problems and use the texture triangle to determine the correct textural classification of each:

- 20% sand, 50% silt, 30% clay
- 80% sand, 10% silt, 10% clay
- 40% sand, 40% silt, 20% clay
- 90% sand, 5% silt, 5% clay

11. (b) Use the texture triangle to determine the lowest clay percentage (%) allowed for a soil texture to be classified as:

- clay
- silt loam
- loam
- clay loam
- sandy clay
- silty clay loam

Activity #4
Classifying Soil Samples Using "Field" Methods
Lab or outdoor activity
45 minutes

Objectives

Students will determine the sand, silt and clay texture percentages of a soil sample by utilizing "field" test methods of soil texture analysis.

Students will use the textural triangle to correctly name their soil by texture percentage

Materials

Soil samples
Water
Water squeeze bottles
Texture triangle
Paper towels for cleanup

Step-by-step procedures

NOTE TO TEACHERS: As part of the MESA Day Soils Contest, students are required to determine the textural classification of two soils samples by using "field" methods. The techniques described below serve as the basis for "educated estimates", which is really what a soil scientist working in the field would employ when classifying soil without lab equipment. The best tool for student success in this part of the curriculum is an understanding of the relative size and appearance of soil separates, and the ability to assign a percentage for each separate that is truly relative to the soil sample. Remember: all soil that students test will have ALL THREE separates; the tricky part is determining the relative percentages of each separate!

Test A: Soil texture by feel

1. Place approximately two tablespoons of soil in your hand
2. Moisten soil gradually with small amounts of water until it is completely moistened and putty-like. Don't use too much water!
3. When all of the soil is moist, try forming a ball. If the soil feels **sticky**, you have a significant percentage of **clay** in your soil.
4. Smooth out your soil ball using your thumb. Feel the flattened ball with your thumb. If it feels **grainy** and/or if you can **see** individual sand grains, you have a significant percentage of **sand** in your soil.

5. Make a "ribbon" out of your soil. This is done by flattening the soil to the thickness of 2-3 quarters (U.S. 25-cent coins), maintaining the width of a quarter as well. Squeezing the soil between your thumb and forefinger is the easiest way to make the ribbon. How long your ribbon gets before it breaks will give you a clue about the soil separates contained within.

    - If your ribbon is less than 1" or won't form a ribbon, you have a significant percentage of **sand**.

    - If your ribbon is between 1" and 2" before breaking, you have equal parts **silt** and **clay** in your sample.

    - If your ribbon is 2" long or longer, you have a significant percentage of **clay** in your sample.

Test B: Soil texture by the runoff method

1. Place approximately two tablespoons of soil in your hand.
2. Use the water squeeze bottle to saturate (completely wet) the soil.
3. Tilt your hand and allow any excess water to run off. Notice the color of this runoff. If it appears "dirty", then soil sediment is contained within the water.
4. Rinse the soil again and look at the runoff. Rinse as many times as you need to before the water becomes clear.
5. Count the number of times that the runoff contained sediment (appeared dirty). Multiply this number times 3%.
6. Example: If the water contained sediment (appeared dirty) ten times before it ran clear, you would multiply 10 x 3% = 30%. This number represents the **combined percentage** of **silt** and **clay** in your sample. The sample contains approximately 15% **each** (30% total) of silt and clay.
7. In this example, the sand percentage would be approximately 70%, silt would be 15% and clay would be 15%. Using the texture triangle, we would classify this soil sample as Sandy Loam. (70% sand, 15% silt, 15% clay)

When using any field technique, it's best to ROUND OFF to the nearest 5%. Remember, your three percentages (sand %, silt %, clay %) are based upon an EDUCATED ESTIMATE.