Soils Laboratory 2

Soil Texture

What are my goals for today's laboratory?

1. To define soil texture

2. To determine soil texture qualitatively by the ribbon method

3. To understand the basis for determining soil texture quantitatively by mechanical analysis

4. To determine soil texture by mechanical analysis

Introduction

Soil texture is one of the most important physical properties of soils. Soil texture is related to a number of important soil characteristics such as water holding capacity, soil drainage, and soil fertility. As we will discuss in lecture, soil texture is simply the relative proportion of sand, silt, and clay in a given soil. The U.S. Department of Agriculture (USDA) has defined 12 standard texture classes. These classes are typically displayed in what is known as the USDA texture triangle, as illustrated below. Each of the texture classes is associated with a specific composition of sand, silt, and clay.

USDA Texture Triangle
Using the Soil Texture Chart
To determine the texture class of a soil, you will first determine the % sand, silt, and clay in the sample. Using these values you consult the chart above to determine the official USDA texture class. To read the triangular chart draw lines from points on each axes that correspond to the values you obtained from mechanical analysis. Please consult with your instructor to determine the correct angles to draw the lines. The texture class in which the lines intersect is the texture class of your soil.

How do we determine soil texture?
Soil texture may be determined in a qualitative fashion or a quantitative fashion. A qualitative determination of texture gives us an estimate of texture. A quantitative determination of texture gives us a precise measurement of the % sand, % silt, and % clay in a sample. This allows us to use the USDA texture triangle to assign the soil to one of the twelve official classes of soil texture. In today’s laboratory, you will begin by determining the soil texture of your sample in a qualitative fashion using a test known popularly as the ribbon test.

Determining Soil Texture by the Ribbon Method

Materials

1. Soil sample(s)
2. Tap water

Method

1. Follow the directions illustrated in the chart on the following page to determine soil texture by the ribbon method.

2. Record your finding in the data table provided at the end of the lab.
Using the Ribbon Test to Estimate Soil Texture

Step 1
Collect a small amount of dry soil in your palm, approximately enough to make a small ball of soil about 3/4 inch in diameter when wetted.

Step 2
Add water drop wise to the dry soil until it takes on the consistency of modeling clay.

Step 3
Form the soil sample into a ball, about ½ - ¾ inch in diameter. If you are unable to form a ball, that is if the soil is not 'sticky' enough to form a ball, the texture of your sample is sand. Record this in the data table at the end of lab and stop the procedure. If you can form a ball, continue the procedure.

Step 4
Place the ball of soil between your thumb and forefinger, and begin to gently knead the ball into a relatively flat ribbon shape. As the ribbon develops, let it extend over your forefinger until it breaks from its own weight. If the soil sample does not form any ribbon, the texture of your sample is loamy sand texture. Record this in the data table at the end of lab and stop the procedure. If it does form a ribbon, continue the procedure.

Step 5
If you are able to form a ribbon that is less than 1 inch and the soil has a gritty feel to it, you have a sandy loam texture. Record this in the data table at the end of lab and stop the procedure. Otherwise continue the procedure.

Step 6
If you are able to form a ribbon that is less than 1 inch and the soil has a smooth feel to it, you have a silty loam texture. Record this in the data table at the end of lab and stop the procedure. Otherwise continue the procedure.
Step 7

If you are able to form a ribbon that is less than 1 inch and there is not either a noticeable gritty or smooth feel you have a **loam texture**. Record this in the data table at the end of lab and stop the procedure. Otherwise continue the procedure.

Step 8

If you are able to form a ribbon that is between 1-2 inches long and the soil has a noticeable gritty feel to it, you have a **sandy clay loam texture**. Record this in the data table at the end of lab and stop the procedure. Otherwise continue the procedure.

Step 9

If you are able to form a ribbon that is between 1-2 inches long and the soil has a noticeable smooth feel to it, you have a **silty clay loam texture**. Record this in the data table at the end of lab and stop the procedure. Otherwise continue the procedure.

Step 10

If you are able to form a ribbon that is between 1-2 inches long and the soil does not have either a noticeable gritty or smooth feel to it, you have a **clay loam texture**. Record this in the data table at the end of lab and stop the procedure. Otherwise continue the procedure.

Step 11

If you are able to form a ribbon that is more than 2 inches long and the soil has a noticeable gritty feel to it, you have a **sandy clay texture**. Record this in the data table at the end of lab and stop the procedure. Otherwise continue the procedure.

Step 12

If you are able to form a ribbon that is more than 2 inches long and the soil has a noticeable smooth feel to it, you have a **silty clay texture**. Record this in the data table at the end of lab and stop the procedure. Otherwise continue the procedure.
Step 13

If you are able to form a ribbon that is more than 2 inches long and the soil does not have either a noticeable gritty or smooth feel to it, you have a **clay texture**. Record this in the data table at the end of lab and stop the procedure.

Determining Soil Texture by Mechanical Analysis

The method for determining soil texture quantitatively is known as the **mechanical analysis method**. Mechanical analysis of texture takes advantage of the fact that particles of different sizes will fall out of suspension at different speeds. In mechanical analysis of texture we shake soil and water together in a large glass cylinder to form a suspension of particles. We then place the cylinder on the lab bench and allow the particles of soil to begin to gradually settle to the bottom of the cylinder.

Stokes law describes the speed at which particles of different sizes settle out of a suspension. Particles of sand are much larger in diameter than particles of silt and clay. Silt particles are larger in diameter than clay particles. Stokes Law tells us, in essence, that the larger the particle, the more quickly the particle will settle out of suspension. In other words, as the particles settle out of suspension, the sand fraction of the soil will accumulate on the bottom as a fairly discrete layer, followed by the silt and the clay particles. Typically, most of the sand particles in the soil will settle to the bottom in about 40 seconds. The silt and clay particles will take quite a bit longer, perhaps as long as 2 hours.

The way we measure the quantity of particles in a suspension is by using a hydrometer.

**Mechanical Analysis of Soil Texture**

**Materials**

1. Sedimentation Cylinders (1000 ml graduate cylinders)
2. Blender or mixer
3. Balances
4. Hydrometers
Note: You should use the same hydrometer throughout the procedure.

5. Watches / Stopwatch

6. 8% Calgon solution

7. Large rubber stoppers to fit 1000 ml graduate cylinders

Procedure

1. Using the sieve shaker, sieve the air-dry or oven dry soil sample provided by the instructor through a 2 mm sieve.

2. Weigh 50.0 grams of the sieved soil and transfer soil into the blender cup provided.

3. Add 5 ml of a dilute Calgon solution which will be supplied by your instructor. The purpose of the Calgon is to help disperse the soil particles so that they can fall independently of each other. This is necessary because this is an assumption of Stokes law.

4. Fill the blender cup with distilled water so the top of the suspension is about 10 cm from the top. Place the top on the blender and blend for about 5 minutes. This step is designed to thoroughly disperse the soil particles.

5. Quantitatively (i.e. use a squirt bottle with distilled water if necessary) transfer the sample (now dispersed) into a 1000 ml sedimentation cylinder.

6. Using distilled water, bring the volume of the mixture to 1000 ml

7. Place a rubber stopper over the end of the cylinder and resuspend the mixture by turning the cylinder end to end several times vigorously. Then set the cylinder back down and record the exact time (to the second).

8. Immediately after setting the cylinder down, carefully insert the hydrometer into the suspension. Exactly 40 seconds after the cylinder was set down record the hydrometer reading (and all subsequent hydrometer readings) in the table provided. See the figure below to see how to read the hydrometer.

Note: Recall that the hydrometer tells you how many grams/liter of particles are in the suspension and that you have a volume of 1 liter. Thus, the 40 second reading gives the grams of silt and clay still suspended after the sand particles have settled. Since you started with 50 grams of soil, by subtracting
the weight of the silt+clay from 50 grams you will know how many grams of sand were in your original soil sample.

10. At your instructor's discretion, you may need to calibrate the hydrometer by placing it into a sedimentation cylinder that contains 5 ml of the Calgon solution and 995 ml deionized water. The reason the hydrometers need to be calibrated is because not all of the hydrometers read 0 g/l when there is no soil particles in suspension. Subtract the calibration reading from the hydrometer readings you record if the calibration reading is greater than 0 and add this value to the hydrometer readings if the calibration reading is less than 0.

11. Let the suspension sit undisturbed for 20 minutes. At this time, place the hydrometer in the suspension and record the reading in the table provided.

Note: This reading gives the grams of clay per liter still in suspension. Now you have all the information you need to calculate the % by weight of each of the three types of particles.

12. After calculating the % of each particle, use the USDA Texture Triangle to determine the texture class of your sample.

13. Pour the suspension into the waste container provided [NOT IN SINKS!] and clean the cylinder and leave to dry.
<table>
<thead>
<tr>
<th>Item</th>
<th>Your Data</th>
<th>Example Calculation</th>
</tr>
</thead>
<tbody>
<tr>
<td>40 second hydrometer reading [This equals the grams per liter of silt + clay still in suspension]</td>
<td>30 g / liter [which means you have 30 grams of silt + clay still in suspension]</td>
<td></td>
</tr>
<tr>
<td>20 minute hydrometer reading [This equals the grams per liter of clay still in suspension]</td>
<td>10 g / liter [which means you have 10 grams of clay still in suspension]</td>
<td></td>
</tr>
<tr>
<td>grams sand [ = 50 grams - 40 second reading]</td>
<td>50 - 30 = 20 g sand</td>
<td></td>
</tr>
<tr>
<td>grams clay [ = 20 minute hour reading]</td>
<td>10 g</td>
<td></td>
</tr>
<tr>
<td>grams silt [ = 50 grams - (g sand + g clay)]</td>
<td>50 - (20+10) = 20 g</td>
<td></td>
</tr>
<tr>
<td>% sand [ = (g sand / 50 g soil) X 100]</td>
<td>20 / 50 X 100 = 40%</td>
<td></td>
</tr>
<tr>
<td>% clay [ = (g clay / 50 g soil) X 100]</td>
<td>10/50 X 100 = 20%</td>
<td></td>
</tr>
<tr>
<td>% silt [ = (g silt / 50 g soil) X 100]</td>
<td>20/50 X 100 = 40%</td>
<td></td>
</tr>
</tbody>
</table>
Pre-Test
Soil Texture

1. What is soil texture?

2. What is the importance of soil texture?

3. What is the rationale behind the ribbon test for soil texture?

4. What is the rationale behind mechanical analysis of texture?

By my signature I affirm that I have read the laboratory, completed the above pre-test, and have a reasonable understanding of the procedures involved in this laboratory.

________________________________________  _________________________________________
Students Signature & Date                    Instructors Signature & Date
Soil Texture
Final Results & Interpretation

<table>
<thead>
<tr>
<th>Results</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ribbon Test Texture Class =</td>
</tr>
<tr>
<td>% Sand =</td>
</tr>
<tr>
<td>% Silt =</td>
</tr>
<tr>
<td>% Clay =</td>
</tr>
<tr>
<td>USDA Soil Texture Class =</td>
</tr>
</tbody>
</table>

**Interpretation of Results**

In the interpretation column of your final lab report, you are to indicate the likely drainage properties of your soil, based on texture. As you will learn in lecture, a coarser textured soil (sandy textures) generally has higher drainage rates than a finer textured soil (silty, clayey textures). Use the information below as a guide to what you will put in your final lab report.

<table>
<thead>
<tr>
<th>Texture Class</th>
<th>Drainage Rate</th>
</tr>
</thead>
<tbody>
<tr>
<td>Clay, Sandy Clay, Silty Clay, Silty Clay Loam</td>
<td>Slow-Moderate</td>
</tr>
<tr>
<td>Silt, Silt Loam, Loam, Sandy Clay Loam, Clay Loam</td>
<td>Moderate</td>
</tr>
<tr>
<td>Sandy Loam, Loamy Sand, Sand</td>
<td>Rapid</td>
</tr>
</tbody>
</table>

By my signature I affirm that I have completed this laboratory, calculated and recorded the results above, and have checked the results with the lab instructor. I have also consulted with the lab instructor with regard to the above interpretation of the results.

<table>
<thead>
<tr>
<th>Students Signature &amp; Date</th>
<th>Instructors Signature &amp; Date</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
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