LABORATORY 6
SOIL ANALYSIS

OBJECTIVE

This lab will obtain several key soil parameters from the samples collected from the relevés in the Bicycle Bumps study area. This information will later be used in the ordination and other analyses of the vegetation.

Definition of soil variables to be determined.

Soil color: This will be determined using a Munsell Color Book.

> ***Hue*** *(page in Munsell color book):* The dominant color, (e.g. 10 R is red; 2.5YR has some yellow, 7.5YR are tans and browns, 2.5 Y is yellow, G is green). As soils age they oxidize and change from yellow to brown to red (e.g., 2.5Y to 10YR to 7.5YR to 5 YR to 10R).
>
> ***Value*** *(rows on each page):* The relative darkness or lightness of the hue from 1 (dark) to 8 (light). The value is often a function of the amount of humic organic material in the soil. Darker soils have more organic material. Very black horizons may be buried charcoal or accumulations of MnO_2. Whiter horizons may be the result of leaching as in an E horizon, or the accumulation of carbonate or gypsum.
>
> ***Chroma*** *(columns on each page):* The strength or intensity of the color from 0 (least with none of the hue) to 8 (most vivid). This is indicative of the amount pigmenting material present, but it is strongly influenced by the texture of the soil.
>
> **Example**: a soil with color 10YR5/6 is 10YR hue, 5 value, and 6 chroma, a yellowish brown in the U.S. system of color names.

Soil moisture and bulk density: These variables have already been determined and are posted on the web page. The wet soils from the relevés were weighed in their plastic bags, and then oven dried at 105˚C and reweighed. The average weight of the plastic bags (tare weight) was determined to be 8g.

> ***Bulk density:*** The dry weight of the soil divided by the volume of the soil (= volume of the collection can).
>
> ***Gravimetric soil moisture:*** The weight of soil water divided by the dry weight of the soil.
>
> ***Volumetric soil moisture:*** The volume of soil water divided by the volume of the soil. In our case the volume of the collection can was 180 cm^3. Remember that unique property of water : its volume in cm^3 is equal to its weight in grams.

Soil pH: The soil pH is the log of the hydrogen ion concentration and a measure of the acidity or alkalinity of the soil. We will use the *water-saturation percentage preparation* method (see hand out in lab). Patrick Kuss will demonstrate the method.

Soil Texture: The relative proportion of sand, silt, and clay in a soil. The size classes for these categories are: gravel >2 mm; sand, 2 - 0.05 mm; silt, 0.05 - 0.002 mm; clay, <0.002 mm. We will determine the percentage of sand silt and clay in our samples using the *Bouyoucos hydrometer method* (see handout in the lab). A soil texture triangle will then be used to determine the texture category. We will use three variables in the ordination analysis: sand (%), silt (%), Clay (%), and soil texture (from the texture

triangle). Patrick Kuss will provide an overview of the method.

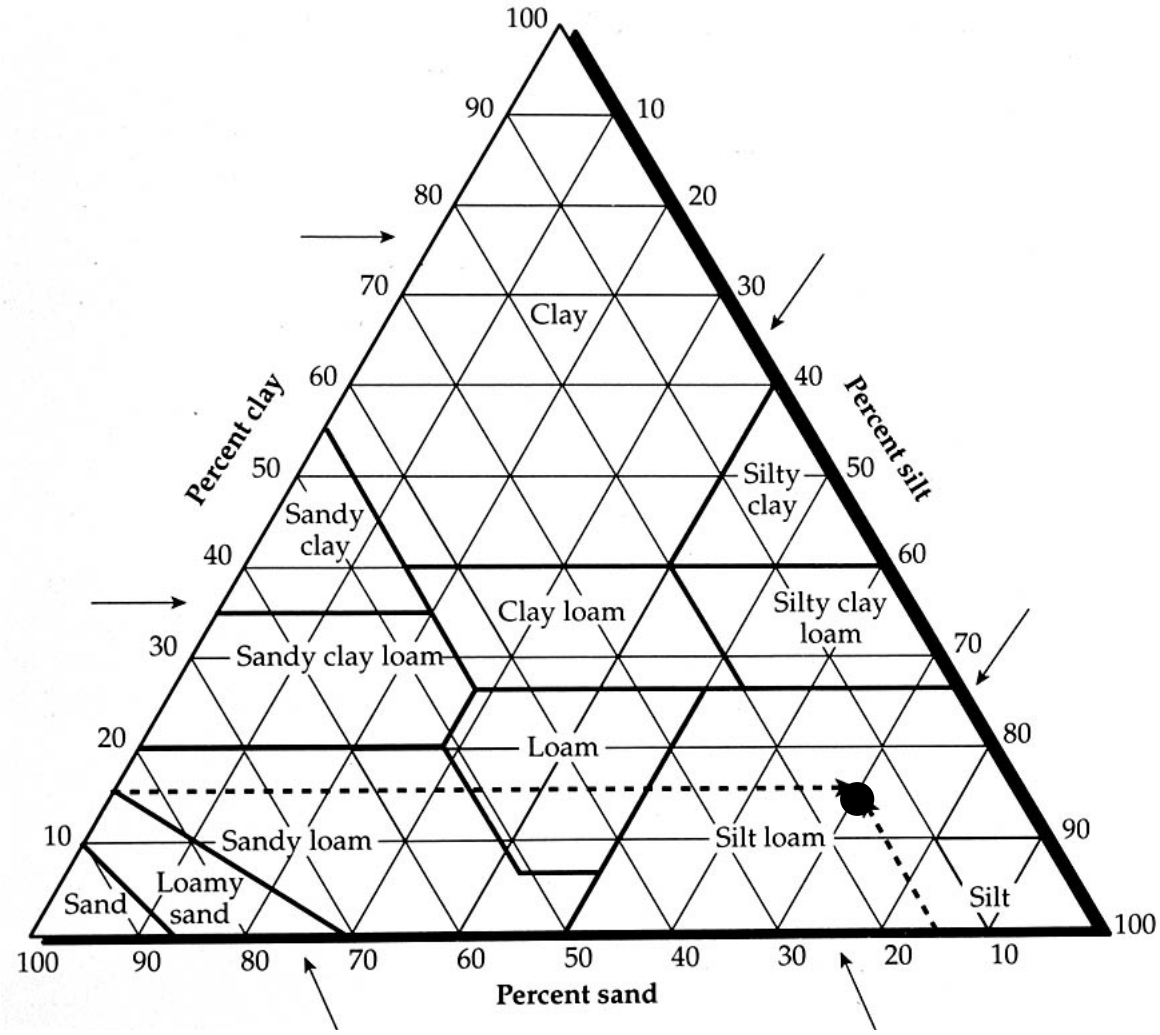

Figure 1. Soil texture triangle. The example point is 15% silt, 15% clay, and 70% sand. The texture class is 'silt loam'.

Soil texture analysis (percentages of Sand, Silt and Clay)

The Bouyoucos hydrometer method is suggested for particle size determination of forst soils. However, it should be recognized that the hydrometer method is not exact and for accurate particle size determination the pipette mehtod should be followed. The hydrometer method has the advantage of being rapid and if the details are properly followed the results are comparable.

Methodology

1. **Sieve** dried soil sample through 2 mm mesh sieve.
2. **Weigh** out 50 g of sieved sample.

If soil sample contains a considerable amount of organic material continue with step 3, otherwis continue with step 4.

3. Put sieved sample into a 1 liter Erlenmeyer flask. Add 15 ml hydrogen peroxide (30%) to destroy organic matter. If organic matter is high more peroxide may be added. Let stand until foaming ceases or overnight. Because of the odor, place samples under the hood.
4. Transfer sample into **milk shake mixer cup** and dilute to within 1 ½ inches of the top with distilled water.
5. **Add 10 ml sodium pyrophosphate** solution
6. Stir in the **milk shake mixer** (sandy soils ~ 5 min, loess soils ~ 10 min, clay soils ~ 25 min).
7. Pour and wash the dispersed **sample into a 1 liter graduated cylinder** and fill the cylinder to the 1000 ml mark with distilled water.
8. Cover top of cylinder with Parafilm® and vigorously **mix the solution**, placing your hand over the top and inverting the cylinder completely about 8 times. After mixing, immediately place cylinder on the table and **note the time** using a stopwatch. If the sample is foamy after being mixed and shaken so thet the hydrometer would be difficult to read, add 1 or 2 drops of amyl alcohol to the suspension before adding the hydrometer.

DO NOT MOVE THE CYLINDER FOR THE NEXT 2 HOURS

9. After ~ 10 sec. begin inserting the hydrometer slowly, without unnecessary mixing, so that a **hydrometer reading** may be taken **after 40 sec**.
10. Measure the **temperature** of the solution using a Fahrenheit thermometer.
11. After **2 hours**, take another **hydrometer and temperature reading**.

Calculations

Temperature corrections

For each degree Fahrenheit above or below 67°, apply a temperature correction of 0.2 gradations onto the hydrometer reading. For temperatures above 67°F, add the correction, for temperatures below 67°F substract the correction.

Abbreviations

H_{r40s} = Hydrometer reading raw after 40 sec.
H_{c40s} = Hydrometer reading temperature corrected after 40 sec
T_{40s} = Temperature in °F after 40 sec
H_{r2h} = Hydrometer reading raw after 2 hrs
H_{c2h} = Hydrometer reading temperature corrected after 2 hrs
T_{2h} = Temperature in °F after 2 hrs

Si+Cl = Silt + Clay

Calclulations

Si+Cl (%) = (B_{c40s}/Weight) * 100
Clay (%) = (B_{c2h}/Weight) * 100
Sand (%) = 100 – Si+Cl
Silt (%) = Si+Cl – Clay

		40 sec			2 hrs						
Releve	**Weight (g)**	**H_{r40}**	**T (°F)**	**H_{c40}**	**H_{r2}**	**T (°F)**	**H_{c2}**	**Si+Cl %**	**Clay %**	**Silt %**	**Sand %**
1											
2											
3											
4											
5											
6											
7											
8											
9											
10											
11											
12											

Equipment

1. Sieve with 2 mm mesh size
2. Weighing scale, plastic trays, spoons
3. Soil dispersing equipment
    a. Milkshake stirrer with soil dispersing paddle
    b. Dispersing cups with baffels
4. Standard Bouyoucos soils colloids hydrometer, range: -2 to 60 g/liter
5. Fahrenheit thermometer to read within 1 degree of 60 – 80 °F
6. 1000 ml graduated cylinders
7. Parafilm®, scissors
8. Stopwatch

Solutions

1. Sodium pyrophosphate: 0.02 N in Na^+ solution of $Na_4P_2O_7$
    a. 1.33 g $Na_4P_2O_6$ to a liter DDW **OR**
    b. 2.23 g $Na_4P_2O_7*10H_2O$to a liter DDW
2. Hydrogen peroxide (30 %)
3. Amyl acohol

Sources

Forest Soils Laoratory Notebook, revised 2005, by L. Oliver, UAF – Natural Resources

Soil pH-measurement

The soil pH is the logarithm of the hydrogen ion concentration and a measure of the acidity or alkalinity of the soil. We will use the *water-saturation percentage preparation* method to obtain pH-values for our soil samples from the relevé sites.

Methodology

1. Fill approx. ½ of single ice cube tray compartment with dried and sieved soil
2. Add DDW to the soil in increments without stirring the soil until water just wets the entire soil mass, then add a few drops more until surface glistens slightly
3. After this moisture content has been attained, the soil is stirred with a glass rod.
4. Measure pH by placing electrode and temperature probe into the wetted soil.Press "=" to start measuring. Once reading is stable press "=" again to freeze measurement.

Relevé	pH
1	
2	
3	
4	
5	
6	
7	
8	
9	
10	
11	
12	

Epuipment

1. pH-meter (Corning pH meter 140) with pH-electrode
2. Buffer solutions (pH 4 and pH 7)
3. Distilled water (DDW) in plastic bottles
4. Ice cube trays
5. Paper cleanex
6. Large beaker for cleaning of electrode