LABORATORY 3
SOIL ANALYSIS

OBJECTIVE

This lab will obtain four key soil parameters from the samples collected from Shawnee Gowan's Grizzly Glacier project relevés. This information will later be used in the ordination and other analyses of the vegetation. The variables include: Gravimetric soil moisture, soil color, soil pH, and soil texture.

Soil Moisture

Soil moisture and bulk density: The wet soils from the relevés were weighed in a soil can, and then oven dried at 105˚C and reweighed in the cans. The difference in the weight of the wet and dry soils is the weight of the water in the soil. Determine the following:

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.

Bulk density: The dry weight of the soil divided by the volume of the soil (= volume of the collection can). Several of the soils were not collected using cans of a known volume, so we won't determine this parameter.

Soil Color Determination

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.

	Dry color				Moist color			
Releve Nr.	Hue	Value	Chroma	Written color	Hue	Value	Chroma	Written color

Soil pH-measurement

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 saturated-paste method.

Equipment

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

Methodology

1. Place a few grams of each soil in cubicles of an ice-cube tray.
2. Add few drops of distilled water to a cubicle while stirring the soil with a glass rod.
3. Stir each cube with a glass rod until the soil and water are thoroughly mixed. As you pull the glass rod upward out of the cubicle, the soil should stick slightly, but the paste should fall off the glass rod, as it is removed further. There should be no standing water on the surface of the soil.
4. Rinse the rod thoroughly before inserting in another cube.
5. Use the pH meter to measure the pH.
6. Calibrate the electrode by first placing the electrode in prepared pH 4 and pH 7 buffer solutions and adjusting the pH calibration.
7. Measure pH of sample by placing electrode and temperature probe into the wetted soil. Press "=" to start measuring. Once reading is stable press "=" again to freeze measurement.
8. Rinse the electrode thoroughly with distilled water between measurements.

Relevé Nr.	pH (paste method

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

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

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 baffles
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 alcohol

Sources

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

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, otherwise 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 that 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 subtract 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

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

		40 sec			2 hrs						
Releve Nr.	**Weight (g)**	**H_{r40}**	**T (°F)**	**H_{c40}**	**H_{r2}**	**T (°F)**	**H_{c2}**	**Si+Cl %**	**Clay %**	**Silt %**	**Sand %**

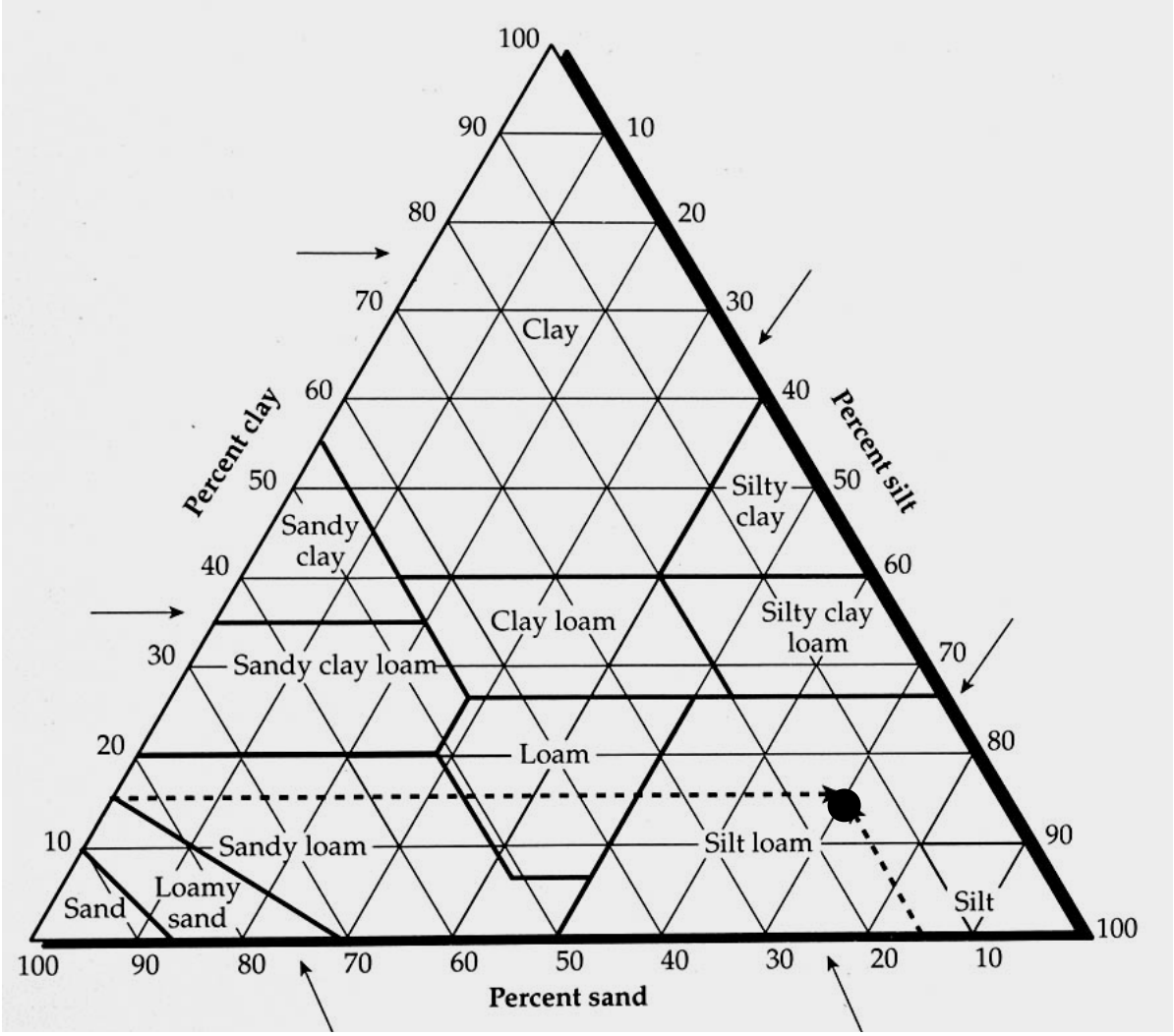

Figure 1. Soil texture triangle. The example point is 15% sand, 15% clay, and 70% silt. The texture class is 'silt loam'.