

Dirt, what's in it?



Cheryl Turpin

Frank W. Cox High School

Virginia Beach, VA

Cheryl.turpin@vbschools.com

Soil Formation

Soils have formed at the earth's surface as the result of the interactions of many processes acting on some initial material exposed on the surface. The kind of soil that forms is determined by 5 different factors:

1. **Parent materials**: This is the bedrock that has been either slowly broken up at a site or transported there by water or other natural agents. Soil has developed from this material.
2. **Climate**: Rainwater makes the "softening" of rock and soil possible by the process of weathering. Soils have slowly changed color and density as the result of wetting and drying, warming and cooling, and freezing and thawing. Each climate zone has a characteristic pattern of soil.
3. **Living organisms**: plants (both above and below ground parts), bacteria, fungi, ants, gophers, and many other living organisms shape each small part of the soil. These plants and animals add humus and help speed up weathering of rock particles. Soil is a blend of weathering materials and humus mixed together by such forces as burrowing animals and well-felled trees.
4. **Topography**: The lay of the land. Hilly areas commonly have more different kinds of soils than very flat areas. This is primarily related directly or indirectly to the wider variation in soil moisture conditions in hilly areas.
5. **Time**: The age of soil is reckoned in terms of tens, hundreds, or thousands of years. For a few thousand years, soil develops to maturity and generally becomes a better medium for plant growth.

What soil does?

1. Medium for plant growth (food, feed, fiber...)
2. Mechanical support for living organisms and their structure.
3. Regulate water flow (run-off, infiltration, storage, and recharge)
4. Provides nutrients and cycles nutrients (organisms and decomposition of organic material)
5. Acts as a filter (physical, chemical and biological)

What are some important soil properties?

1. Physical properties

- a. Texture – proportion of sand (coarse), silt medium) and clay (fine) size particles
- b. Structure - arrangement of particles into various shaped units
- c. Consistence – how friable (firm) stickiness and plasticity
- d. Density – weight per volume
- e. Porosity – size and total volume of pores related to texture and structure
- f. Water relations – water holding and water movement

2. Chemical properties

- a. pH – acid, neutral or alkaline; most soil is between 4 – 8
- b. electrostatic charge – creation of cat ion exchange capacity
- c. fertility – plant nutrient content

3. Biological properties

- a. microorganisms – bacteria, fungi, algae (1 gram of soil may contain a billion bacteria)
- b. decomposition of organic material – (release of elements for plant uptake)
- c. burrowing of organisms and rooting of plants affect soil porosity.



"Here's some baby spinach—from my soil to your plate."

Today we will be testing for:

Test Physical	Soil A	Soil B	Soil C
Density	M	M	M
	V	V	V
	D	D	D
Texture by			
Ribbon	description	description	description
Bottle	total	total	total
	sand	sand	sand
	silt	silt	silt
	clay	clay	clay
% Composition	total	total	total
	sand	sand	sand
	silt	silt	silt
	clay	clay	clay
Porosity	Total soil	Total soil	Total soil
	Total water	Total water	Total water
	Porosity %	Porosity %	Porosity %
Test Chemical	Soil A	Soil B	Soil C
pH			
Potassium			
Phosphorus			
Nitrogen			

Testing Bulk Density of Soils

Experimental Procedure

1. Weigh out 35 grams of soils A, B, and C.
2. Pour into a 100 ml graduated cylinder. Tap gently on the table a few times to settle the particles.
3. Determine the volume in the cylinder.
4. Calculate the bulk density (mass divided by volume).

Testing Porosity of Soils

Experimental Procedure

5. Fill one measuring cup to the 100 ml mark with A.
6. Fill a graduated cylinder to the 100 ml mark with water.
7. Slowly and carefully pour the water into the first cup until the water just reaches the top of the sand.
8. Pour slowly so none will spill out of the measuring cup, as this will cause an error in the measurement.
9. Record exactly how much water was used.
10. Use the formula below to calculate the percent porosity for the sand.

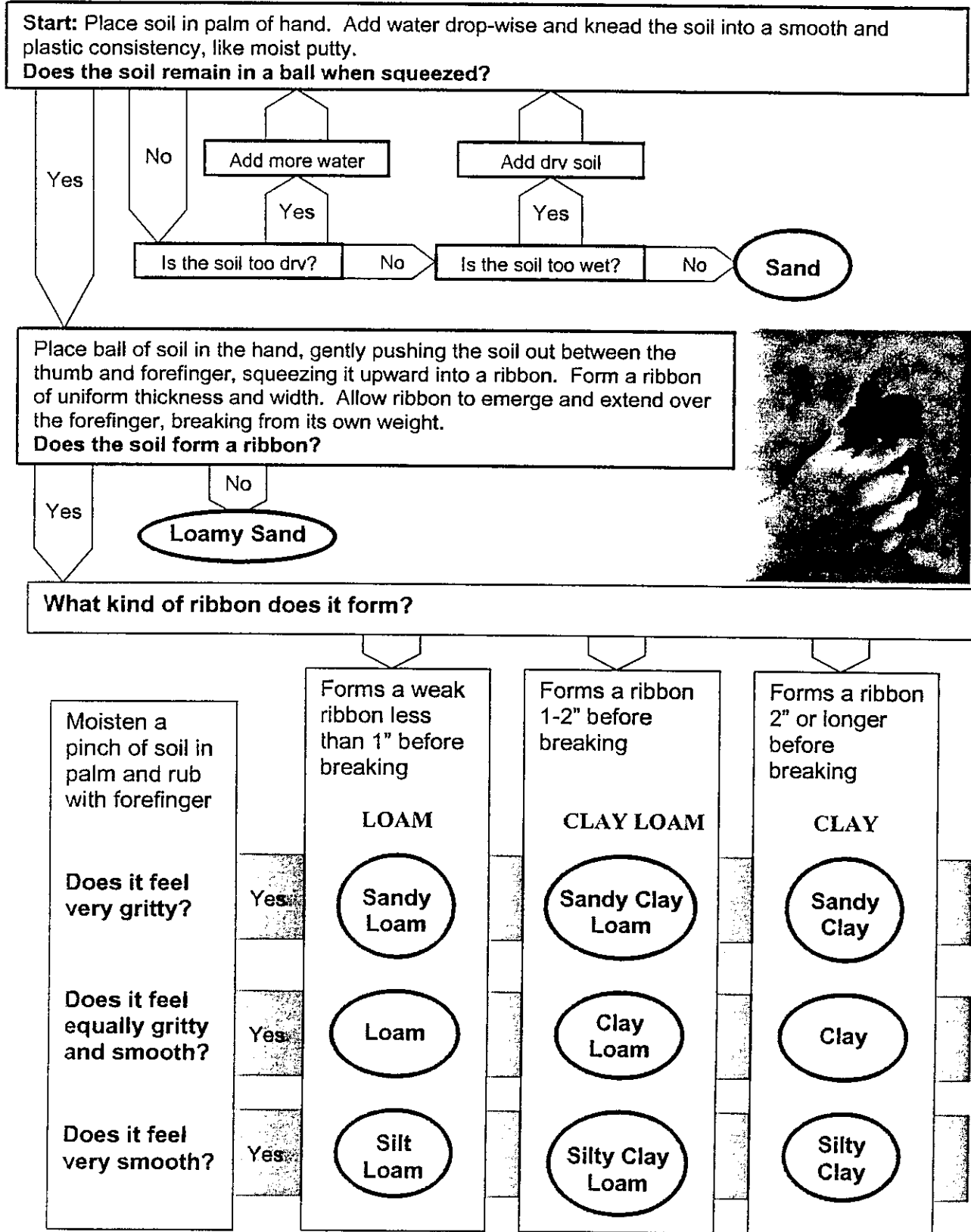
$$\text{Porosity} = (\text{Amount of water added to sample} \div \text{Total sample volume}) \times 100$$

11. Repeat the same procedure with the soils B and C.

Possible questions:

1. Which has the greatest density?
2. Which has the least density?
3. Which has the greatest total porosity? (Least density)
4. Which has the least total porosity? (Most dense)
5. Which can hold more water? (Least dense)
6. What is the relationship between texture (particle size) and porosity?
(The bigger the particle the more porosity)

Figure 4. Soil Texture by Feel



Soil Texture Triangle

The *soil texture triangle* gives names associated with various combinations of sand, silt and clay. A *course-textured* or *sandy* soil is one comprised primarily of medium to coarse size sand particles. A *fine-textured* or *clayey* soil is one dominated by tiny clay particles. Due to the strong physical properties of clay, a soil with only 20% clay particles behaves as sticky, gummy clayey soil. The term *loam* refers to a soil with a combination of sand, silt, and clay sized particles. For example, a soil with 30% clay, 50% sand, and 20% silt is called a *sandy clay loam*. [Figure 2]

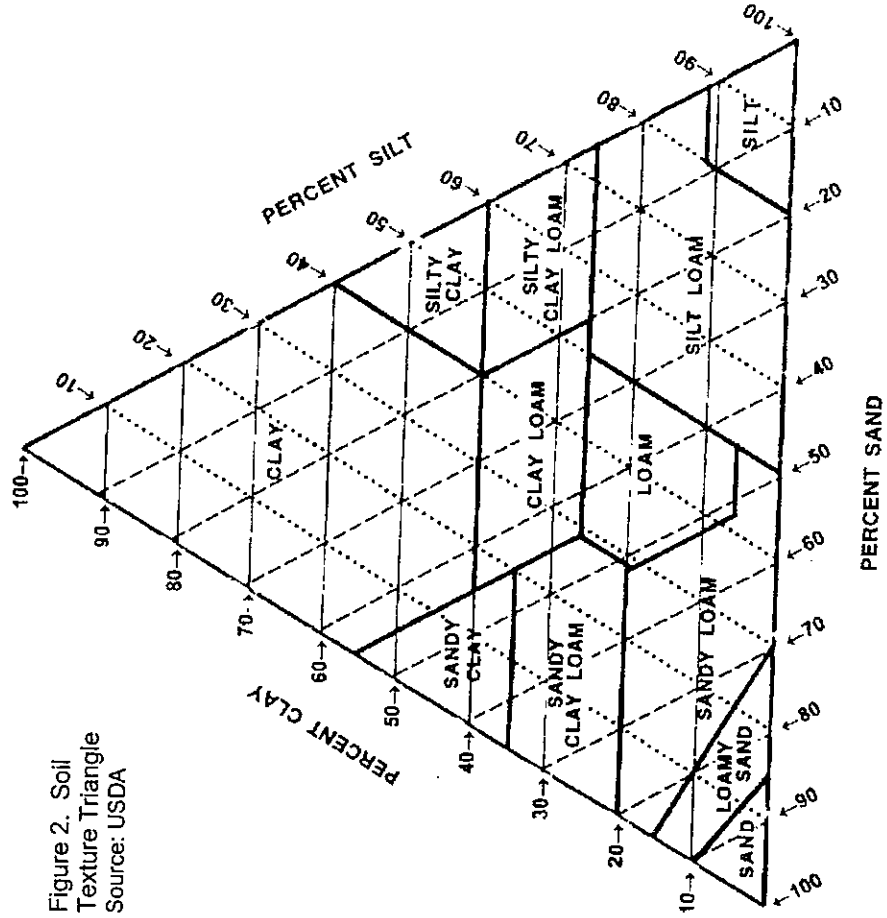
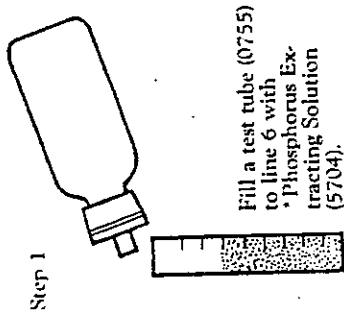


Figure 2. Soil Texture Triangle
Source: USDA

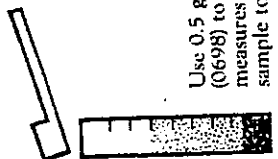
Phosphorus Test



Step 1

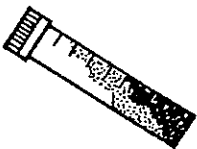
Fill a test tube (0755) to line 6 with *Phosphorus Extracting Solution (5704).

Step 2

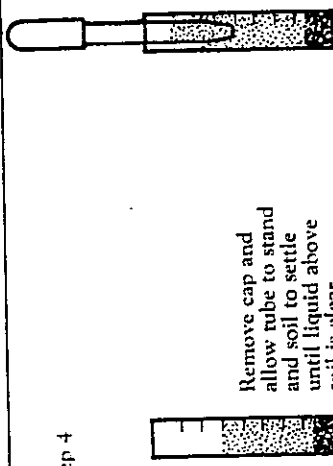


Use 0.5 g spoon (0698) to add three measures of soil sample to test tube.

Step 3



Cap tube and gently shake for one minute.



Step 4

Use one pipet (0364) to transfer the clear liquid to another clean test tube. To avoid agitation of soil, squeeze bulb of pipet before inserting tip into liquid. Release bulb slowly to draw clear liquid into pipet, do not pull up any soil. Fill second tube to line 3.

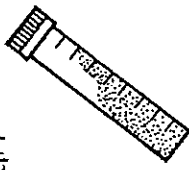
Remove cap and allow tube to stand and soil to settle until liquid above soil is clear.

Step 6



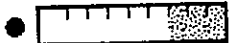
Add six drops of *Phosphorus Indicator Reagent (5705) to soil extract in second tube.

Step 7



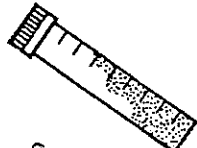
Cap tube and shake to mix contents.

Step 8



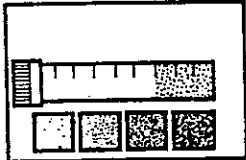
Add one *Phosphorus Test Tablet (5706) to test tube.

Step 9



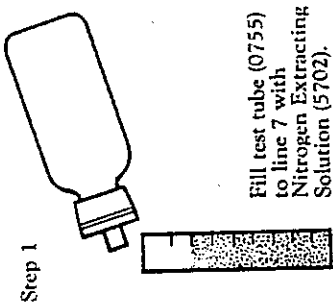
Cap tube and shake to dissolve tablet. A blue color will develop.

Step 10



Compare test color with Phosphorus Color Chart and record result.

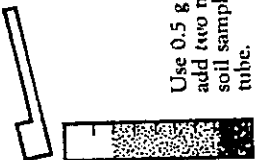
Nitrogen Test



Step 1

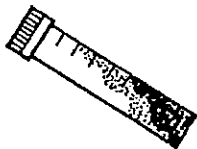
Fill test tube (0755) to line 7 with Nitrogen Extracting Solution (5702).

Step 2



Use 0.5 g spoon to add two measures of soil sample to test tube.

Step 3



Cap tube and gently shake for one minute.

Step 4



Remove cap and allow soil to settle.

Step 6



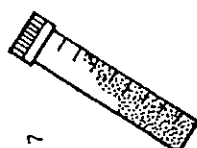
Use a clean pipet (0364) to transfer the clear liquid to another clean test tube. Be careful not to pull up any soil into pipet. Fill second tube to line 3 with liquid.

Step 5



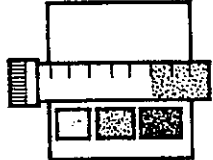
Use 0.25 g measuring spoon (0695) to add two measures of *Nitrogen Indicator Powder (5703) to soil extract in second tube.

Step 7



Cap tube and gently shake to mix.

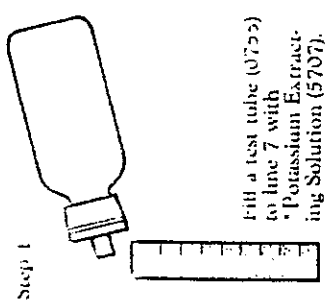
Step 8



Wait 5 minutes for pink color to develop above the powder. Compare test color with Nitrogen Color Chart and record result.

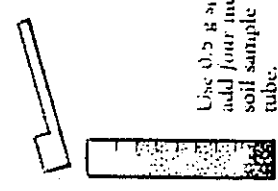
Potassium (Potash) Test

Step 1



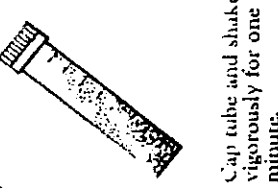
Fill a test tube (0752) to line 7 with Potassium Extracting Solution (5707).

Step 2



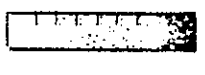
Use 0.5 g amount to add four measures of soil sample to test tube.

Step 3



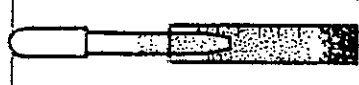
Cap tube and shake vigorously for one minute.

Step 4




Remove cap and allow soil to settle.

Step 5



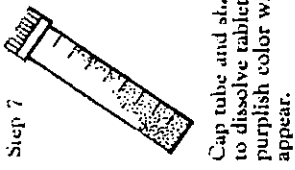
Use a clean pipet (0364) to transfer the clear liquid to another clean test tube. Be careful not to pull up any soil into pipet. Fill second tube to line 5 with liquid.

Step 6



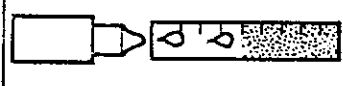
Add one Potassium Indicator Tablet (5708) to soil extract in second tube.

Step 7



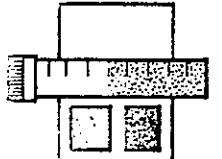
Cap tube and shake to dissolve tablet. A purplish color will appear.

Step 8



Add Potassium Test Solution (5709) two drops at a time, keep count. Swirl test tube after each addition to mix contents. Stop adding drops when color changes from Purplish to Blue.

Step 9



Use Potassium End Point Color Chart as a guide in reading this color change. Keep an accurate count of the number of drops added. Read test result from table.

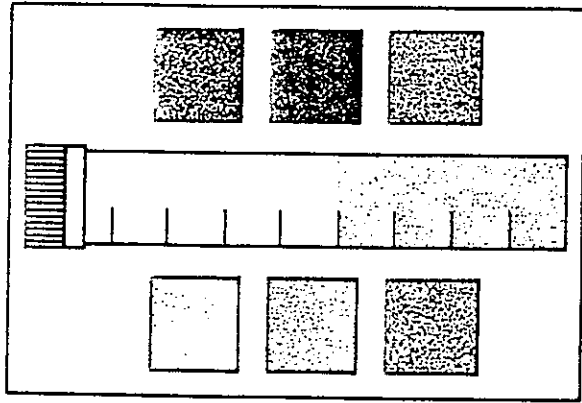
Step 10

Number Of Drops Added	Potassium (Potash) Level
0 - 8	Very High
10	High
12	Medium High
14	Medium
16	Medium Low
18	Low
20 or more	Very Low

Reading the Color Charts

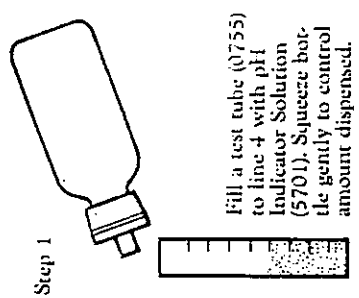
When comparing a test color with a color chart stand with the light source coming from behind and hold the test tube one-half inch away from the color chart.

If the color of a test reaction falls between two standard colors on a color chart, the mid-point between the two standard values is taken as the test result. For example, a pH test color reaction falling between the standard colors for pH 4.0 and pH 5.0 represents a test result of pH 4.5. In the other tests, color reactions may either match, fall between, or fall beyond the three standard colors representing "Low", "Medium", and "High". Therefore, seven different test results are possible: Very Low, Low, Medium Low, Medium, Medium High, High, and Very High.



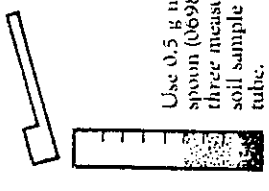
pH Test

Step 1



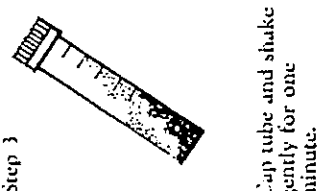
Fill a test tube (0755) to line 4 with pH Indicator Solution (5701). Squeeze bottle gently to control amount dispensed.

Step 2




Use 0.5 g measuring spoon (0698) to add three measures of soil sample to test tube.

Step 3



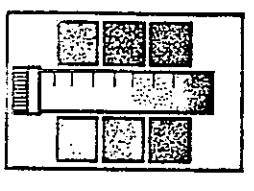
Cap tube and shake gently for one minute.

Step 4



Allow tube to stand for 10 minutes to let soil settle.

Step 5



Compare color reaction with pH Color Chart and record result.