

Physical Landscapes and the Geosphere (ACNA 4007)

Soils: The ground beneath our feet

Activity Outline:

We have discussed that soils are varied in terms of their physical and chemical properties. Despite our perception of the world as driven by **photosynthesis**, virtually all net primary production ends up as soil organic matter and, because of its relatively long residence time, soils contain twice as much carbon as vegetation and more ecology occurs below than above-ground (Bardgett 2005).

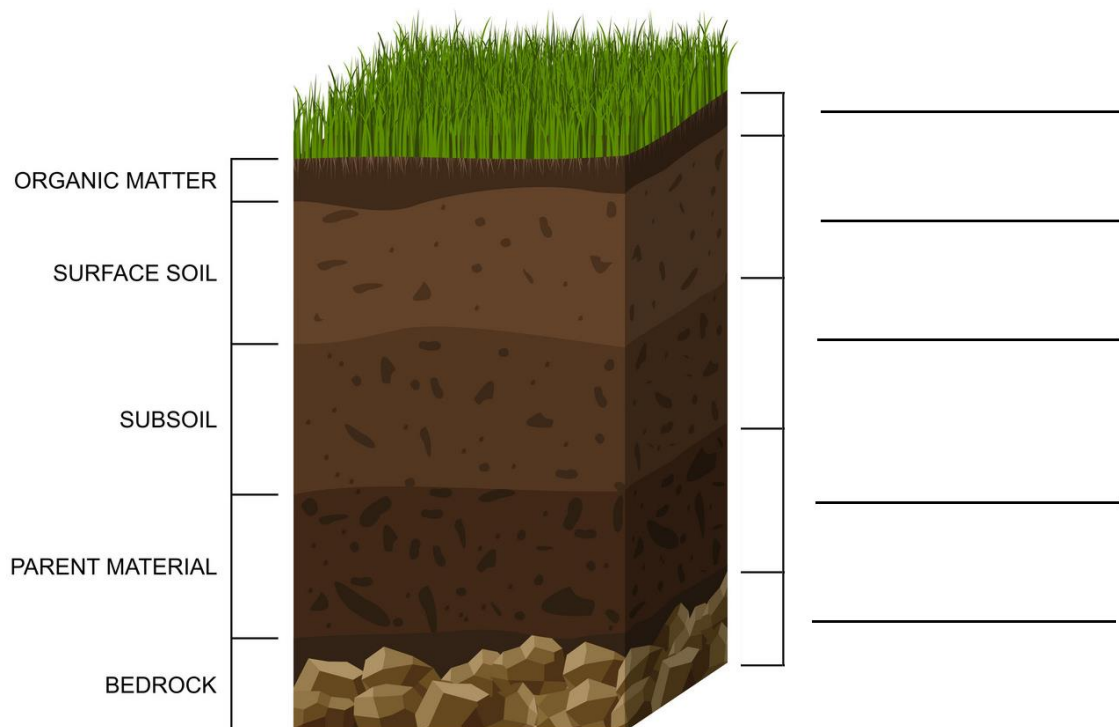


Figure 1. Diagram of typical soil layers. Blank lines should be filled in with the soil horizons (e.g. O, A horizons).

Aim

In this lab we will be describing and characterising soils. We will also undertake some basic soil description activities before conducting some simple soil testing (including measuring pH, nitrogen, phosphorus, and potash) using colour comparators.

Background

Soil classification is carried out in a wide range of environmental areas. Soils are commonly described in the field at natural exposures, or where bore holes are used to obtain samples from the subsurface. Typically, soils are described based on the **presence of soil horizons** and the **character of the boundaries** between horizons, the **texture** of the soil based on the **size** of the soil constituents, the **colour** of the soil material, the structure of the soil, the presence of organic matter and roots, and the hydraulic conductivity (White, 2024).

Other relevant characteristics include the geomorphic (landscape) location of the soil (including slope, elevation, aspect), and soil parent material. These characteristics are in turn used to classify soils which are classified into twelve soil orders (Table 1).

Table 1. Soil Orders and General Descriptions (from Plant and Soil Sciences eLibrary).			
Type	Description	Type	Description
Entisols	Little, if any horizon development	Inceptisols	Beginning of horizon development
Aridisols	Soils located in arid climates	Mollisols	Soft, grassland soils
Alfisols	Deciduous forest soils	Spodosols	Acidic, coniferous forest soils
Ultisols	Extensively weathered soils	Oxisols	Extremely weathered, tropical soils
Gelisols	Soils containing permafrost	Histosols	Soils formed in organic material
Andisols	Soil formed in volcanic material	Vertisols	Shrinking and swelling clay soils

Activity 1: Describing Soils

Task 1: Soil Texture

The texture you determine from feeling your soil is a subjective measurement. This means that another person might not think that the soil has the same texture as you do. The texture refers to the percentages of sand, silt, and clay present. The triangle shown in Figure # is known as a textural triangle and can be used to plot or determine the percentages of sand, silt and clay in your soil from the texture you have determined. A **particle size distribution** (like we carried out during the sedimentology lab) would be carried out to determine the actual percentages of sand, silt and clay in the soil.

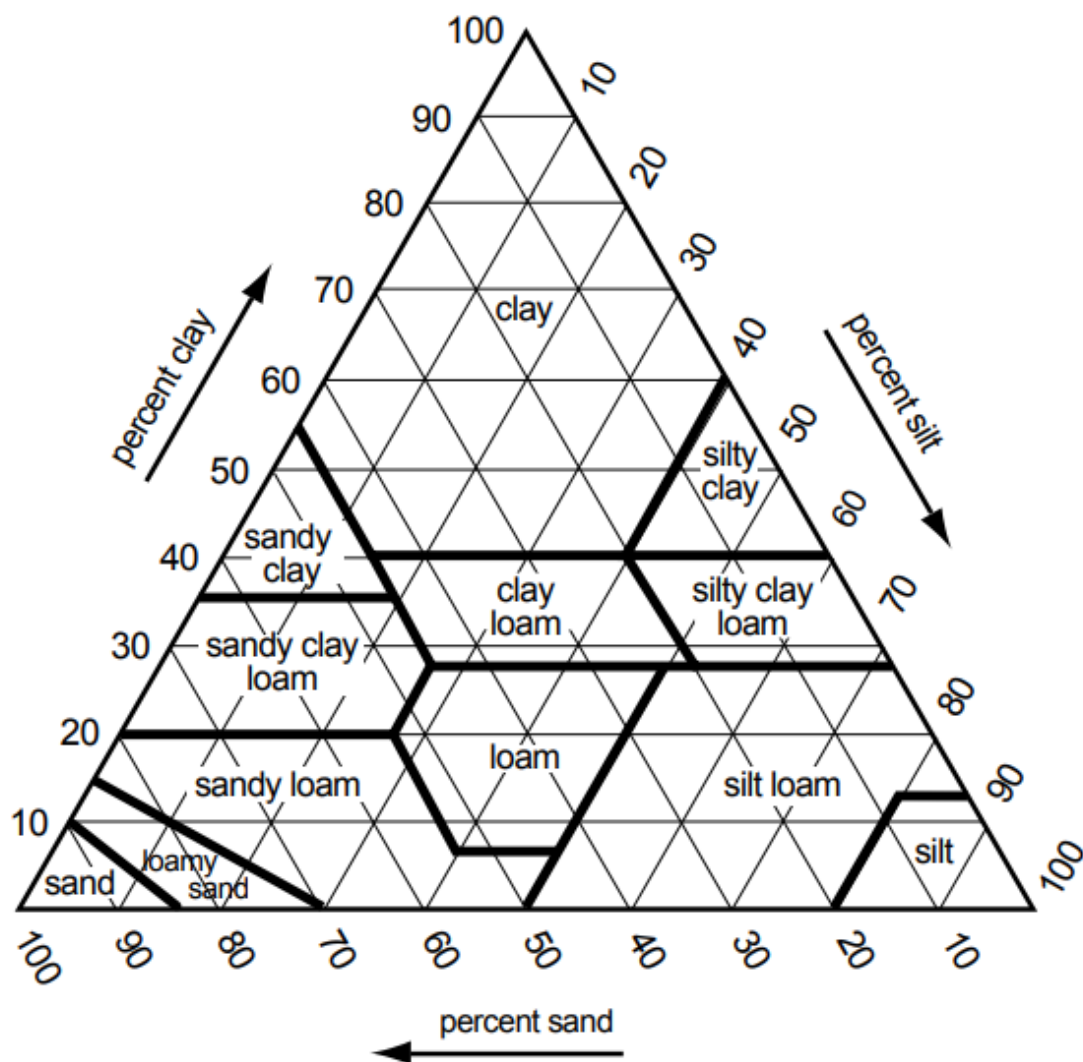


Figure 2. Soil textural triangle.

1) First, become familiar with how this graph works. Then, fill in the blanks to determine your texture, or % of clay, sand and silt.

	% Clay	% Sand	% Silt	Texture Name
a)	30	10	60	Silt Clay Loam
b)	60	30	10	—
c)	—	40	40	—
d)	10	—	—	Loamy Sand
e)	45	10	45	—
f)	5	35	—	—
g)	40	—	10	—

Task 2: Soil Texture Test

Next, we are going to undertake a more practical (and quick) assessment of soil texture. You have been given four samples of soil. Try to undertake a quick assessment of soil texture using the guidance below to identify your soil types. As a hint, the soil types you have are Chalk Soil, Clay Loam, Chalk Loam and Sandy Soil. **For each sample, you need to take a small sample of soil (about the size of a golf ball). Next, knead the soil, whilst adding a small amount of water until this soil feels like putty / play dough. After this, use the guide below to work out the appropriate soil texture description.**

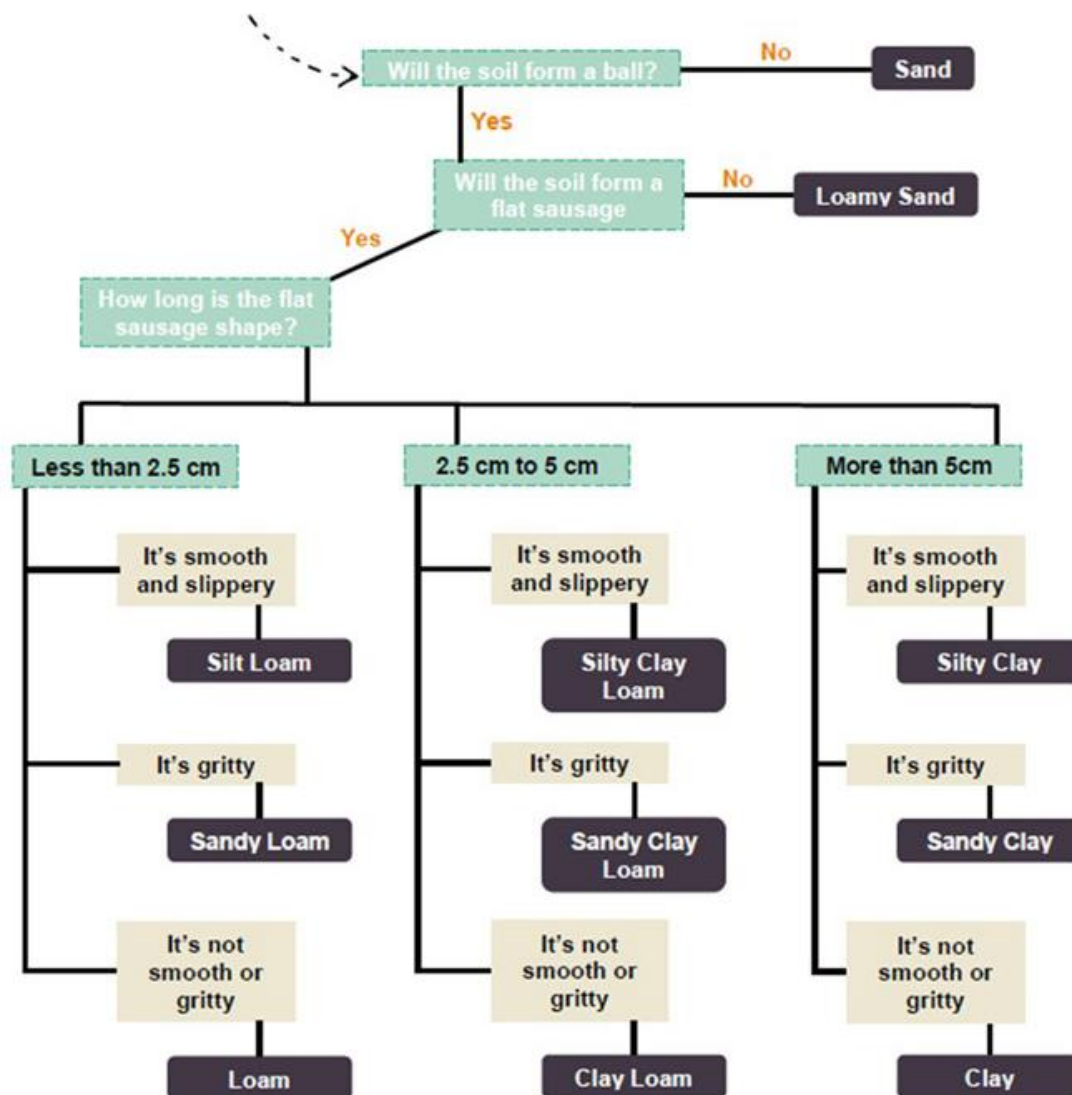


Figure 3. Flow diagram demonstrating a soil texture test (Modified from RHS, 2024).

2) Write down the soil texture for each soil:

A)

B)

C)

D)

Task 3: Soil Colour

Colour is important as it indicates potential processes occurring in the soil. Accumulations of material, redox reactions, and mineralogy impact observed colours. Since simple colour description works like “dark” or “red” won’t mean the same thing to different people, soil scientists use a standard notation to indicate a soil’s colour. The **Munsell soil colour** book is a tool used to standardize soil colour across locations.

Soil colour is formatted this way: **Page/Value/Chroma** (Example: 10YR 2/1).

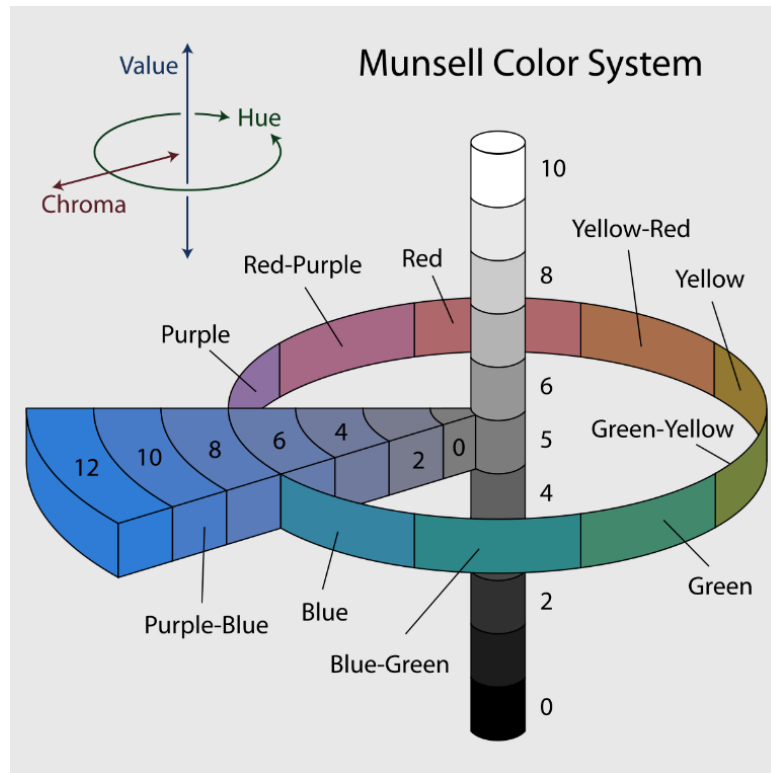


Figure 4. Munsell Colour System. From: [Soil color – Introduction to Soil Science \(pressbooks.pub\)](http://pressbooks.pub/soilcolor/).

Page (hue): mix of colours or hue

The hue is described by the first set of number and letter symbols in the Munsell system. Hue represents the position of the colour on the colour wheel (Y=Yellow, R=Red, G=Green, B=Blue, YR=Yellow Red, RY=Red Yellow).

Value: lightness or darkness

The value is the number before the slash in the Munsell system. Value indicates the lightness of a colour. The scale of value ranges from 0 for pure black to 10 for pure white. The chroma is the number after the slash in the Munsell system.

Chroma: intensity

Chroma describes the “intensity” of a colour. Colours of low chroma values are sometimes called weak, while those of high chroma are said to be highly saturated, strong, or vivid. The scale starts at zero, for neutral colours, but there is no arbitrary end to the scale.

3) Using the following samples, classify the soil colour using the Munsell colour system:

Sample Name	Page	Value	Chroma
Silt Soil 1			
Silt Soil 2			
Organic Soil			
Sandy Soil 1			
Sandy Soil 2			
Chalk A Horizon			
Horizon Chalk C			
Clay Soil 1			
Clay Soil 2			
Clay Soil – Gley			
Gravel Loam			
Rendzina			

Activity 2: Testing Soils

Soils are routinely tested as part of soil management practices across agriculture and environment. There are many tests carried out on soil. Today we are going to explore testing soils for pH, nitrates, phosphate, and potash (potassium), recording the results in the table below.

1) Testing pH

A pH value is a measure of hydrogen ion concentration. Simply put, it is a measure of the acidity and alkalinity of a material. Because hydrogen ion concentration varies over a wide range, a logarithmic scale (pH) is used: **for a pH decrease of 1, the acidity increases by a factor of 10**. Most plants do well when the soil pH is between 6.2 and 6.8. The pH range is 0 (extremely acid) to 14 (extremely alkaline) with 7 being neutral.

Soils can be classified according to their pH value:

- 6.5 to 7.5—neutral
- over 7.5—alkaline
- less than 6.5—acidic, and soils with pH less than 5.5 are considered strongly acidic (Figure 5).

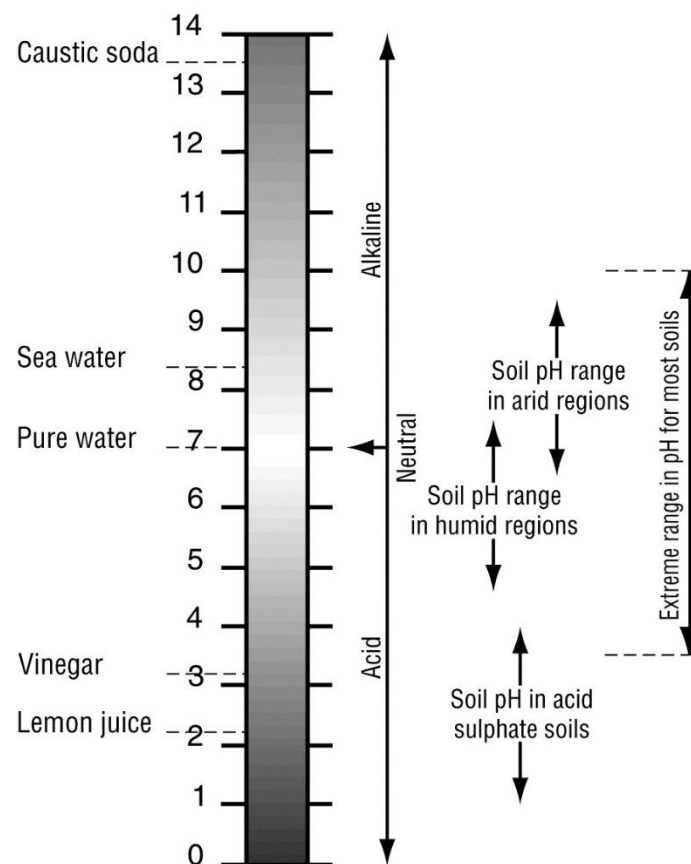


Figure 5. pH diagram.

4. Using the Rapitest soil test kit provided, test your 4 soil samples to determine their pH range and provide a description (e.g either neutral, alkaline, or acidic).

2) Testing Phosphorus

Soil phosphorus (P) provides an index of fertility of agricultural soils and Phosphorus in soil is second only to nitrogen in the amount needed by plants. Healthy levels of P in soil range from 25 to 50 ppm.

5. Using the Rapitest soil test kit provided, test your 4 soil samples to determine their phosphorus range and provide a description (e.g surplus, adequate, deficient).

3) Testing Nitrogen

Abundance of nitrogen is important for soil and plant health. The nitrogen cycle is a biogeochemical process through which nitrogen is converted into many forms, consecutively passing from the atmosphere to the soil to organism and back into the atmosphere. Nitrogen fertiliser is frequently added to soils to supplement nitrogen in soils (Figure 6). Nitrogen is vital because it is a major component of chlorophyll, the compound by which plants use sunlight energy to produce sugars from water and carbon dioxide (i.e., photosynthesis). It's also important because nitrogen is a: Major component of amino acids, the building blocks of proteins! Soil should contain an adequate supply (40 ppm) of nitrogen (N).

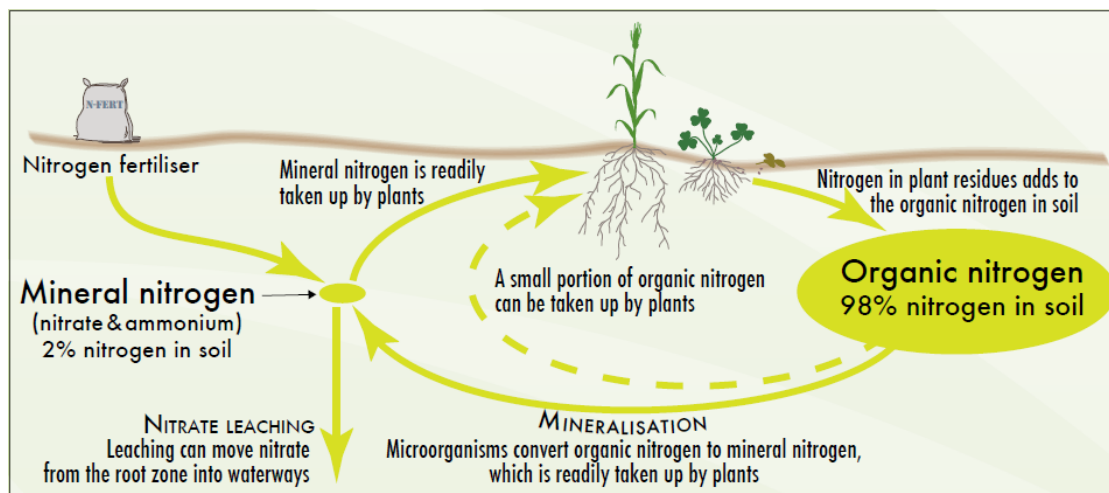


Figure 6. Application of nitrogen fertilizer to soils (From Soilquality.com.au).

6. Using the Rapitest soil test kit provided, test your 4 soil samples to determine their phosphorus range and provide a description (e.g surplus, adequate, deficient).

4) Testing Potash

Potash is the term commonly used for potassium. It's one of the three major nutrients that plants require for healthy growth and is represented by the chemical symbol 'K'. The other two major nutrients are Nitrogen (N) and Phosphorus (P). In many parts of the world, agricultural soils are gradually becoming depleted of potash. Some soils were high in potassium when they were first cultivated long ago. However, after many years of intensive cropping and repeated nutrient removal during harvest, many fields now require regular inputs of potash to maintain their productivity.

7. Using the Rapitest soil test kit provided, test your 4 soil samples to determine their phosphorus range and provide a description (e.g surplus, adequate, deficient).

Potassium is found in soil solution as the potassium ion, K^+ , the form that is taken up by plants. However, the potassium content of fertilisers is usually referred to and measured as 'potash' or K_2O . This is just a convention and 'potassium', 'potash', 'K' and ' K_2O ' are often used interchangeably when referring to fertilisers or application rates.

Record your results from the soil testing below:

Soil	Texture	Munsell Colour	pH	Nitrogen	Phosphorus	Potash
A						
B						
C						
D						

Bonus Questions

8) For your soils (A, B, C, D) estimate the percentage of clay, sand and silt (%) using the soil textural triangle (Figure 2).

Additional Materials

White, T., 2024. Soil Description and Classification. Accessed from: [Soil Description and Classification | Earth 530: The Critical Zone \(psu.edu\)](#) [last accessed 24/01/24].

[Soil Characterization Protocol \(globe.gov\)](#)

[The Twelve Orders of Soil Taxonomy | Natural Resources Conservation Service \(usda.gov\)](#)

Simplified soil key:

