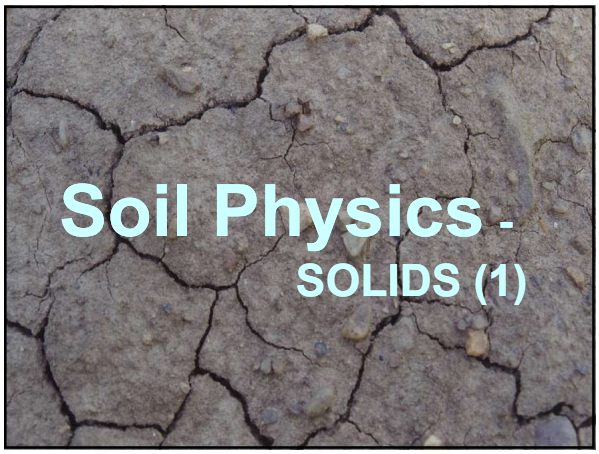


Soil Physics - SOLIDS (1)

Soil physics is the branch of soil science that deals with the state and transport of matter and transformations of energy in the soil

Lecture outline

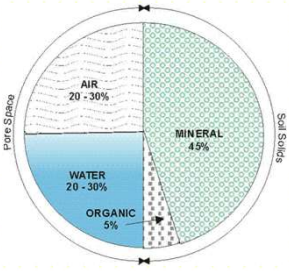
A. Soil as a 3-phase system

B. Mass and volume relationships of soil constituents

C. Soil particles and soil texture

Soil as a three-phase system

Soil consists of three phases



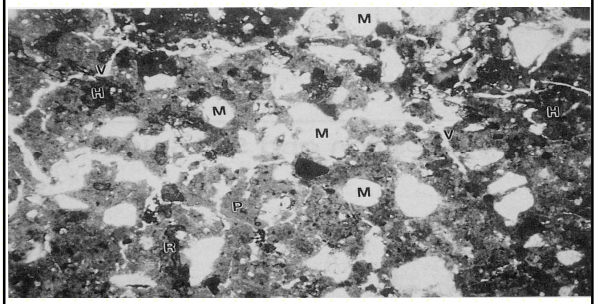
Volume composition of a loam surface soil

1) Solid (mineral and organic material)

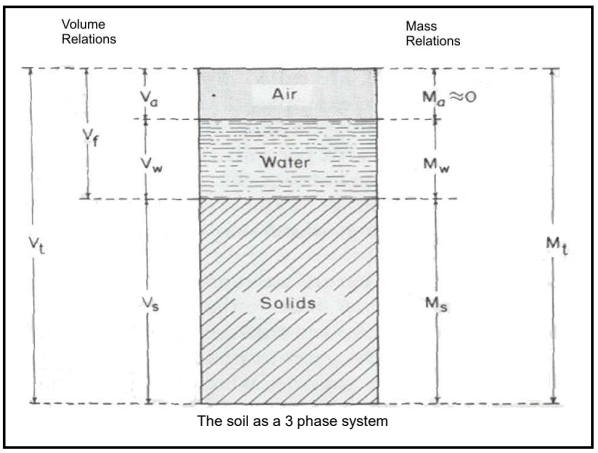
2) Liquid (water and solutes such as ions, organic compounds, gases)

3) Gas (various gases such as O_2, CO_2, N_2)

Soil matrix



M=primary minerals H=humus (organic matter) P=plasma (clay)
V=voids (pores) R=root fragments (organic matter)



The soil as a 3 phase system

Density of solids or particle density (ρ_s)

- In most mineral soils particle density is ~ 2600 to 2700 kg/m^3 (or 2.6 to 2.7 g/cm^3)
- Density of **organic matter** is ~ 1300 kg/m^3
- Density of **water** is ~ 1000 kg/m^3
- Density of **air** is negligibly small

$$\rho_s = \frac{M_s}{V_s}$$

M_s = mass of solids
V_s = volume of solids

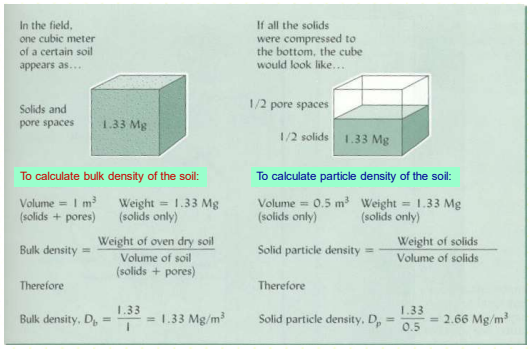
Bulk density (ρ_b)

- In most mineral soils bulk density is about 1300-1350 kg/m^3

$$\rho_b = \frac{M_s}{V_t} = \frac{M_s}{V_a + V_w + V_s}$$

M_s = mass of solids
V_t = total soil volume

Bulk density vs. particle density



Porosity (*f*)

- In most mineral soils porosity is about 0.3-0.6 (30-60%)

$$f = \frac{V_f}{V_t} = \frac{V_a + V_w}{V_a + V_w + V_s}$$

V_f = volume of pores
V_t = total soil volume

Soil water content on a volume basis (θ_v)

$$\theta = \frac{V_w}{V_t}$$

V_w = volume of water
V_t = total soil volume

$$\theta = \frac{V_w}{(V_s + V_f)}$$

V_w = volume of water
V_s = volume of solids
V_f = volume of pores

Soil water content on a mass basis (θ_m)

$$\theta_m = \frac{Mw\ (g)}{Ms\ (g)}$$

M_w = mas of water
M_s = mass solids

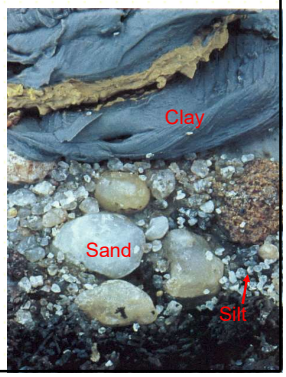
Convert from gravimetric to volumetric soil water content:

$$\theta_V = \frac{\theta_m \times \rho_b}{\rho_{water}}$$

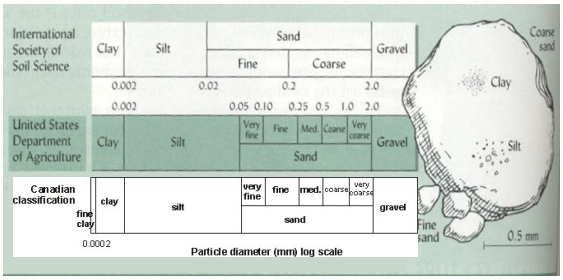
2 mm - "Magic" number in soil science

Size of soil mineral constituents

- **Fine earth (primary) particles** (sand, silt, and clay) have diameter smaller than 2 mm
- **Coarse fragments** (stones, cobbles, and gravel) have diameter larger than 2 mm

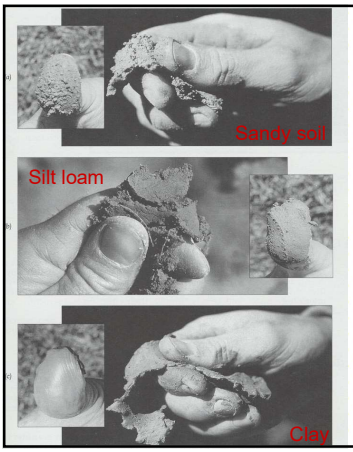


Classification of soil particles according to their size



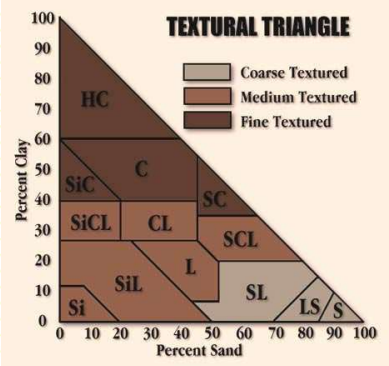
Soil texture

– refers to the relative proportions of sand, silt, and clay in a soil



Hand-texturing ("feel") method

Soil textural classes



C = Clay
L = Loam
Si = Silt
S = Sand

What other soil properties are affected by soil texture?