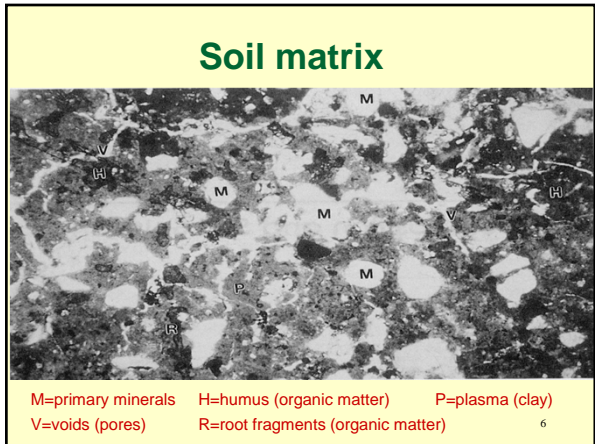
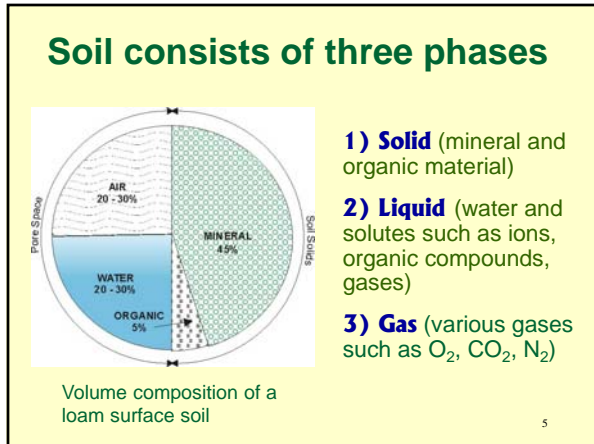




Soil physics is the branch of soil science that deals with the state and transport of matter and transformations of energy in the soil

- Lecture outline**
- Soil as a 3-phase system
 - Mass and volume relationships of soil constituents
 - Soil particles and soil texture



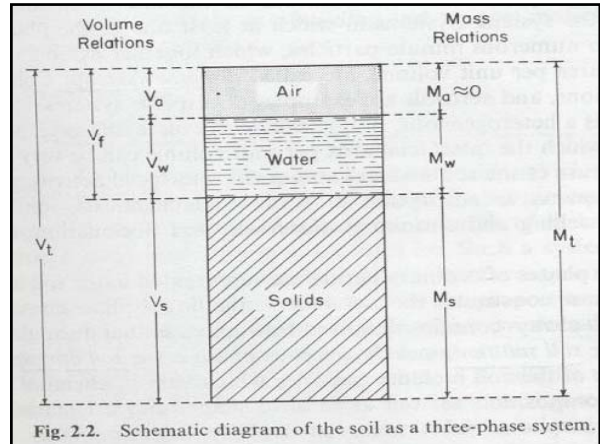
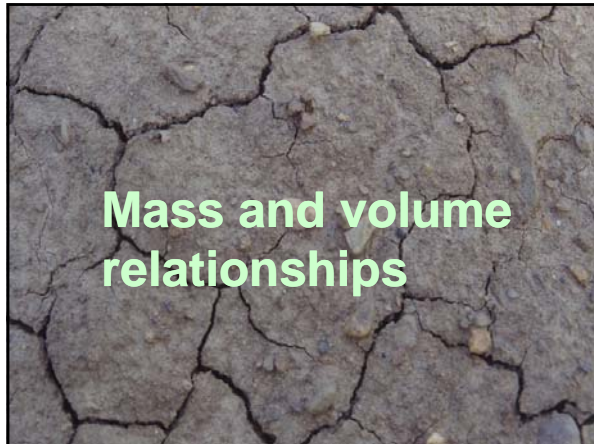


Fig. 2.2. Schematic diagram of the soil as a three-phase system.

Density of solids or particle density (ρ_s)

- In most mineral soils particle density is ~ 2600 to 2700 kg/m³ (or 2.6 to 2.7 g/cm³)
- Density of **organic matter** is ~ 1300 kg/m³
- Density of **water** is ~ 1000 kg/m³
- Density of **air** is negligibly small

$$\rho_s = \frac{M_s}{V_s} \quad \begin{array}{l} M_s = \text{mass of solids} \\ V_s = \text{volume of solids} \end{array}$$

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
Bulk density (ρ_b)

- In most mineral soils bulk density is about 1300-1350 kg/m³

$$\rho_b = \frac{M_s}{V_t} = \frac{M_s}{V_a + V_w + V_s} \quad \begin{array}{l} M_s = \text{mass of solids} \\ V_t = \text{total soil volume} \end{array}$$

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Bulk density vs. particle density

<p>In the field, one cubic meter of a certain soil appears as...</p>  <p>Solids and pore spaces 1.33 Mg</p> <p>To calculate bulk density of the soil:</p> <p>Volume = 1 m³ (solids + pores) Weight = 1.33 Mg (solids only)</p> <p>Bulk density = $\frac{\text{Weight of oven dry soil}}{\text{Volume of soil (solids + pores)}}$</p> <p>Therefore</p> <p>Bulk density, $D_b = \frac{1.33}{1} = 1.33 \text{ Mg/m}^3$</p>	<p>If all the solids were compressed to the bottom, the cube would look like...</p>  <p>1/2 pore spaces 1/2 solids 1.33 Mg</p> <p>To calculate particle density of the soil:</p> <p>Volume = 0.5 m³ (solids only) Weight = 1.33 Mg (solids only)</p> <p>Solid particle density = $\frac{\text{Weight of solids}}{\text{Volume of solids}}$</p> <p>Therefore</p> <p>Solid particle density, $D_p = \frac{1.33}{0.5} = 2.66 \text{ Mg/m}^3$</p>
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Porosity (f)

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

$$f = \frac{V_f}{V_t} = \frac{V_a + V_w}{V_a + V_w + V_s} \quad \begin{array}{l} V_f = \text{volume of pores} \\ V_t = \text{total soil volume} \end{array}$$

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Soil water content on a vol. basis (θ)

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

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

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Soil particles and soil texture

2 mm - “Magic” number in soil science



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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

International Society of Soil Science	Clay	Silt	Sand		Gravel		
			Fine	Coarse			
	0.002	0.02	0.2	2.0			
	0.002	0.05	0.10	0.25	0.5	2.0	
United States Department of Agriculture	Clay	Silt	Very fine	Fine	Med. coarse	Very coarse	Gravel
United States Public Roads Administration	Clay	Silt	Sand		Gravel		
				Fine		Coarse	
	0.005	0.05	0.25	2.0			

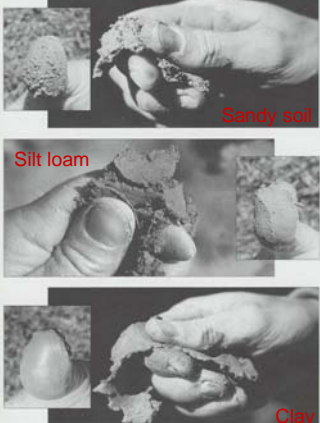
Particle diameter (mm, log scale)

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Soil texture

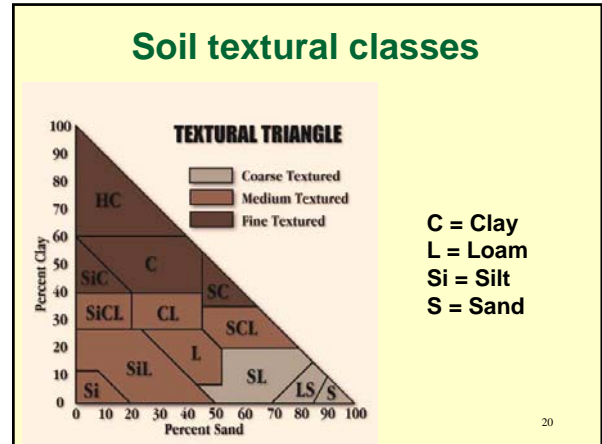

– refers to the relative proportions of sand, silt, and clay in a soil

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Hand-texturing (“feel”) method

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Why do we study soil texture?

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