Principles of Soil Science

Lecture -5-

Cation-exchange capacity (CEC)

Is the amount of exchangeable cations per unit weight of dry soil and is expressed in terms of milliequivalents of positively charged ions per 100 grams of soil

meq/100g soil

CEC Definition:

- The sum total of exchangeable cations that a soil can adsorb. This soil property is due to the negative electrical charge of the colloidal (both organic and inorganic) fraction of most soils.
- The negative charge is balanced by adsorbed cations so that the soil system as a whole is electrically neutral.
- The balancing cations represent a definite quantity referred to as the cation exchange capacity (CEC).”

Why Cation Exchange Capacity is important?

- Exchangeable K, Mg and Ca are important sources of plant K.
- The amount of lime required to neutralize a soil.
- Cation exchange sites slow losses by leaching.
- Cation exchange sites hold fertilizers and so reduce their mobility.
- Cation exchange sites adsorb many metals from wastewater, preventing them from entering the ground water.

Cation Exchange is vital for plant growth

- **Cation exchange :**

  = Process that allows plants to gain nutrients

  – Negatively charged soils hold cations (positively charged ions) of calcium, magnesium, and potassium

  – Roots donate hydrogen to soil in exchange for these nutrients

Cation Exchange is vital for plant growth

- **Cation exchange capacity:**

  = A soil's ability to hold cations

  – Cations that don't leach are more available to plants

  – A useful measure of soil fertility

  – Greatest in fine or organic soils

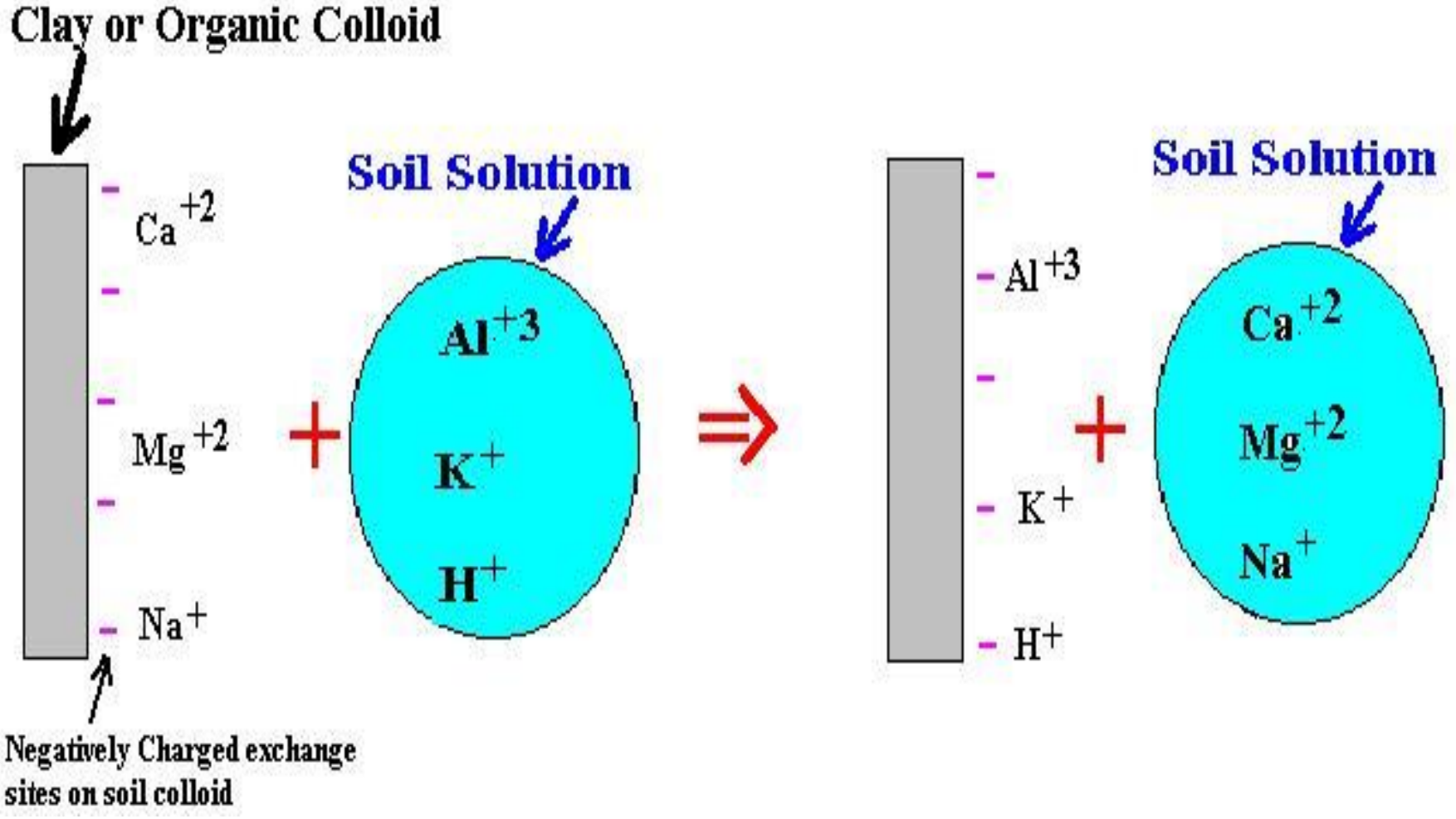
Colloids and cation exchange…

Cation exchange occurs at the surfaces of colloidal particles.

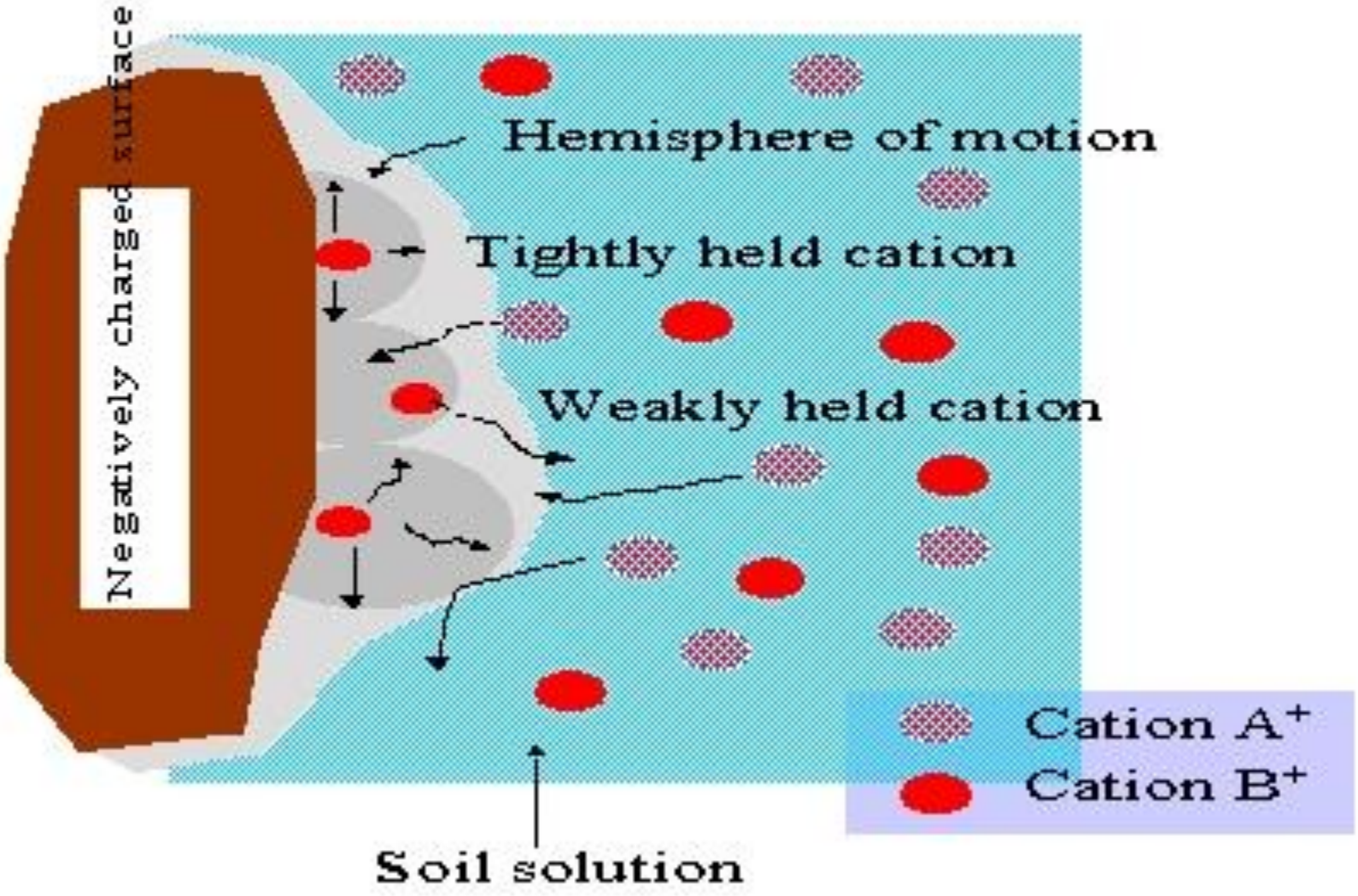
Cation exchange =

"The interchange between a cation in solution and another cation adsorbed on the surface of any surface - active material such as a clay colloid or organic colloid."

Cation Exchange Illustrated



Cation exchange process



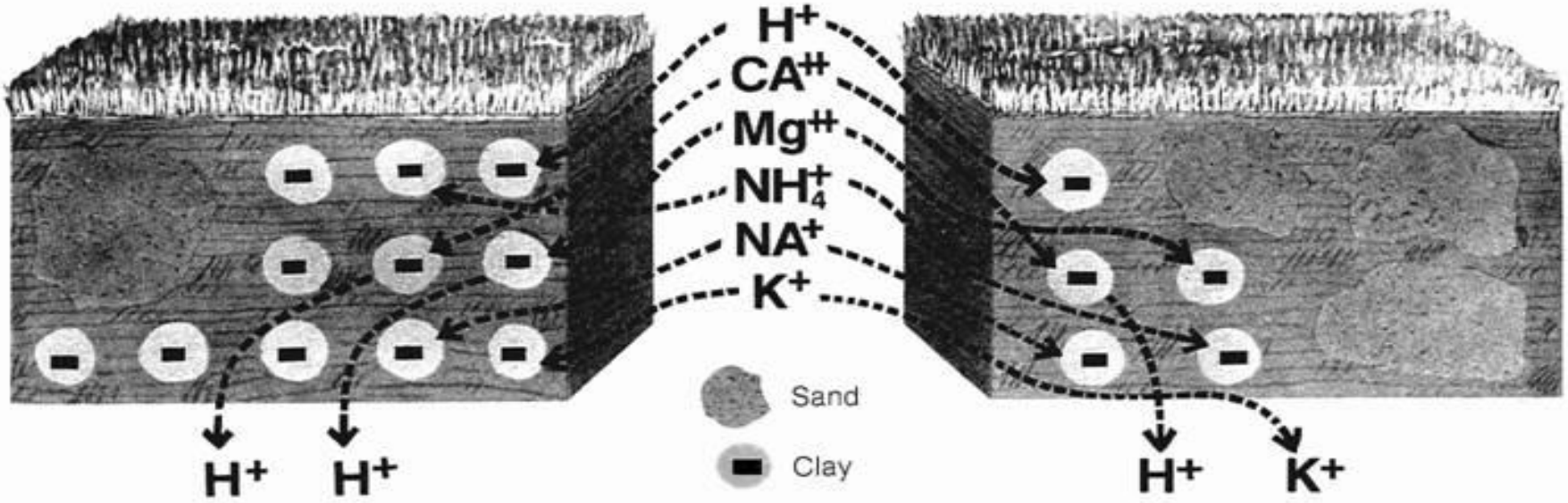
A SCHEMATIC LOOK AT CATION EXCHANGE

CEC 25

MORE CLAY, MORE POSITIONS TO HOLD CATIONS

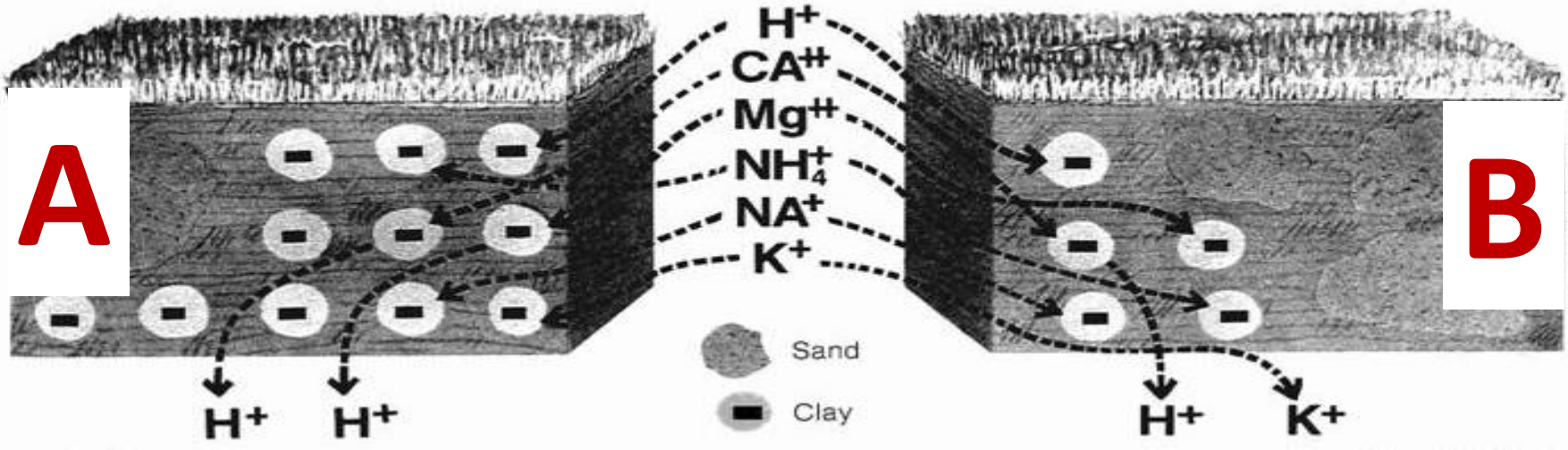
CEC 5

LOW CLAY CONTENT, FEWER POSITIONS TO HOLD CATIONS



50 CEC (Heavy Clay) ← **Common CEC Range** → **0 CEC** (Sand)

SOME PRACTICAL APPLICATIONS	
Soils with CEC 11-50 Range	Soils with CEC 1-10 Range
• High clay content • More lime required to correct a given pH • Greater capacity to hold nutrients in a given soil depth • Physical ramifications of a soil with a high clay content • High water-holding capacity	• High sand content • Nitrogen and potassium leaching more likely • Less lime required to correct a given pH • Physical ramifications of a soil with a high sand content • Low water-holding capacity



Q1/ Write the most important differences between A & B?

پ 1 / جیاوازی چی یە لە نێوان ئەم دوو وێنەیەی
بەرامبەرت ؟ بەتەواوی ڕوونی بکەوە هەریەکەیان
ئاماژە بەچی دەکەن ؟

CEC value of some clay minerals & Organic matter

Minerals	CEC meq /100g soil
Fe , Al oxides	0
Kaolinite	2-16
Illite	20-40
Chlorite	20-40
Montmorillonite	60-100
Fermeculite	100-150
Organic matter	**100- 800**

$$CEC_{Soil} = CEC_{Clay} * Clay_{\%} + CEC_{OM} * Organic\ matter_{\%}$$

Q* Assume the soil content of Montmorillonite **15 %** , **10 %** Chlorite and **3 %** organic matter , then explain the ability cohesion range of the soils?

Answer/

In the low level:

$$CEC_{Soil} = CEC_{Montmorillonite} * \%_{Montmorillonite} + CEC_{Chlorite} * \%_{Chlorite} + CEC_{OM} * \%_{Organic\ matter}$$

= (60 * 15 +20 * 10 +3 * 100) * 0.01

= 14 meq / 100 g soil

In the high level:

$$CEC_{Soil} = CEC_{Montmorillonite} * \%_{Montmorillonite} + CEC_{Chlorite} * \%_{Chlorite} + CEC_{OM} * \%_{Organic\ matter}$$

$$= (100*15 + 40*10 + 800*3)*0.01$$

$$= 43 \text{ meq / 100g soil}$$

Ability between 14- 43 meq / 100g soil