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## **ASAC 1101 : FUNDAMENTALS OF SOIL SCIENCE (2+1)**

**Level : B.Sc (Ag), I semester**

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**SOIL SCIENCE AND AGRICULTURAL CHEMISTRY  
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**Topic**

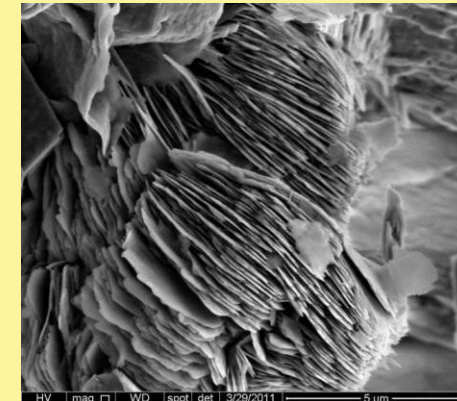
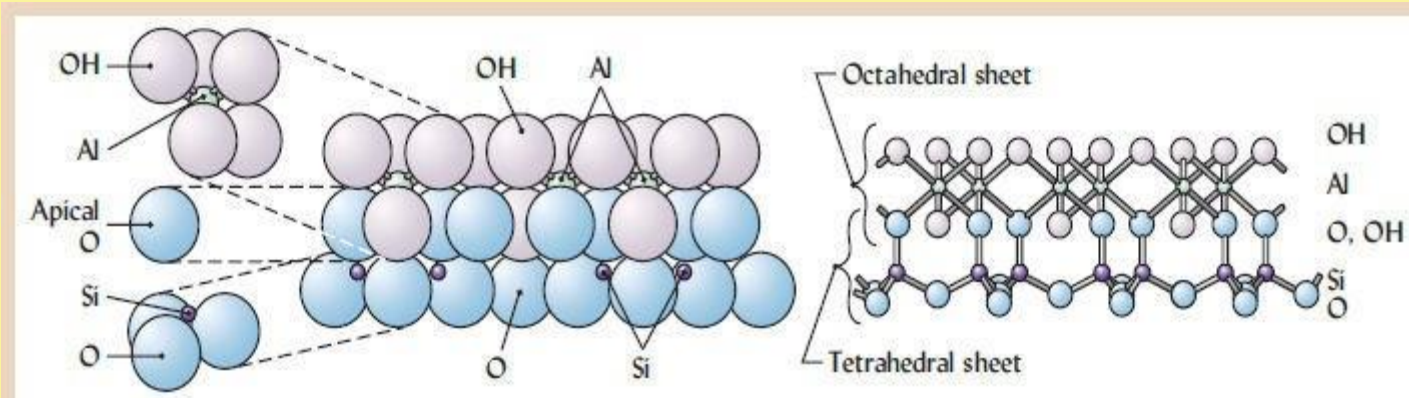
**Silicate clay minerals**

## **Concepts Covered:**

- Types of crystalline silicate clay**
- Properties of silicate clay**

# 1:1 silicate clay

- Layer consists of 1 tetrahedral and 1 octahedral sheet held together by apical oxygen atom
- **Kaolinite** – most common 1:1 silicate clay
- Synthesized under equal concentrations of  $\text{Al}^{3+}$  and  $\text{Si}^{4+}$



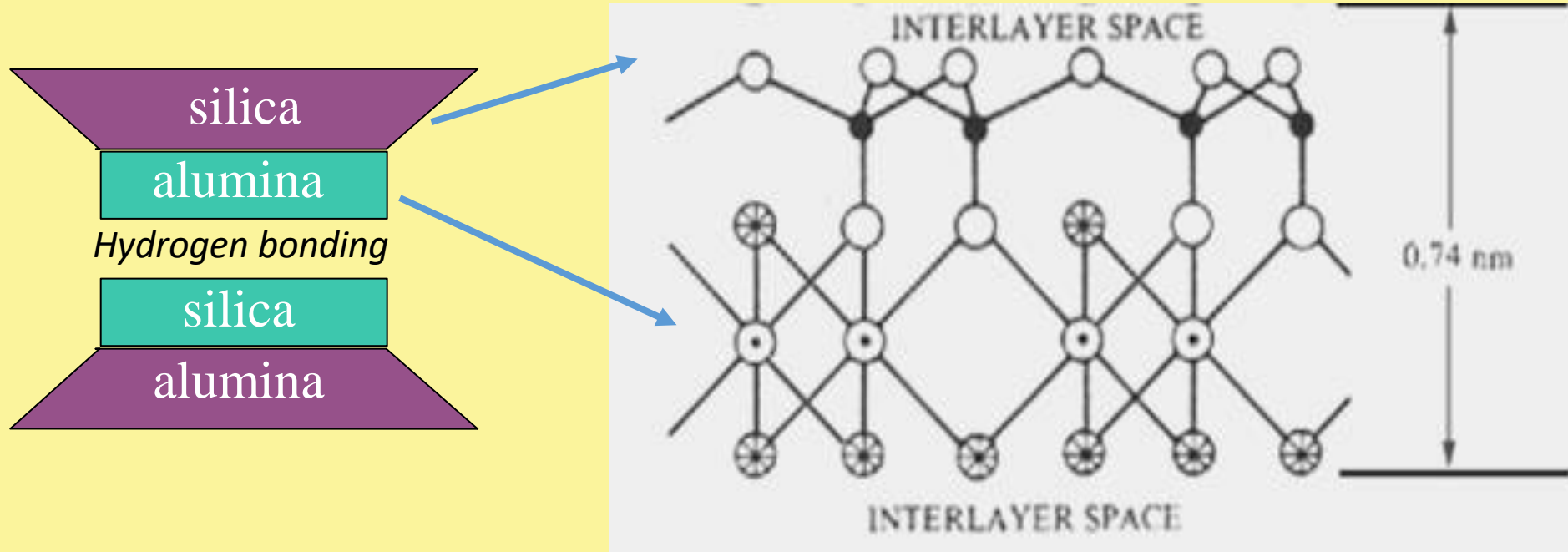
kaolinite

# Kaolinite

- ❑ 1:1 clay
- ❑ Little or no isomorphous substitution
- ❑ **'Nutrient poor'**
- ❑ No 'shrink swell' because of hydrogen bonding between adjacent layers
- ❑ A product of acid weathering



# Kaolinite



Less cation exchange capacity owing to hydrogen bonding  
Relatively less plasticity, stickiness and cohesion

## 2:1 clays

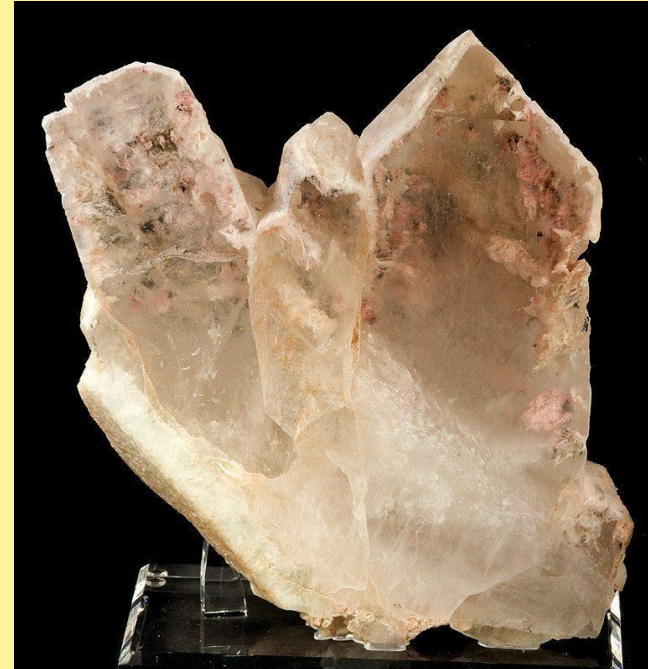
- Two silica tetrahedral sheets linked to one octahedral sheet
- Four major groups of 2:1 clays
  - Expanding clay
    - Smectite
    - Vermiculite
  - Non expanding clay
    - Fine grained mica
    - Chlorite

# Smectite

- ❑ Have high isomorphous substitution
- ❑ Mostly negatively charged
- ❑ Subject to **shrinking and swelling** (owing to loosely bound oxygen-oxygen or oxygen-cation bonding)
- ❑ High plasticity, stickiness and cohesion (owing to high expansion)

# Montmorillonite(a 2:1 smectite)

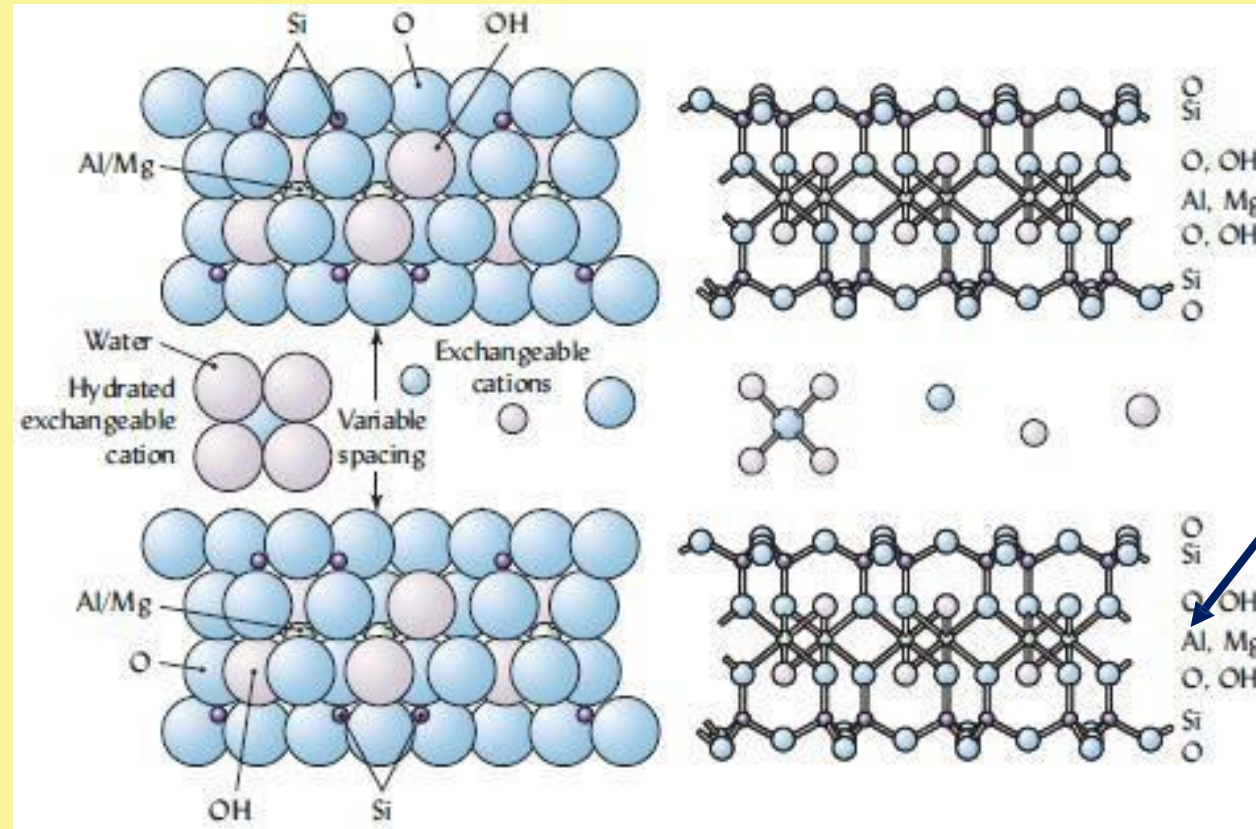
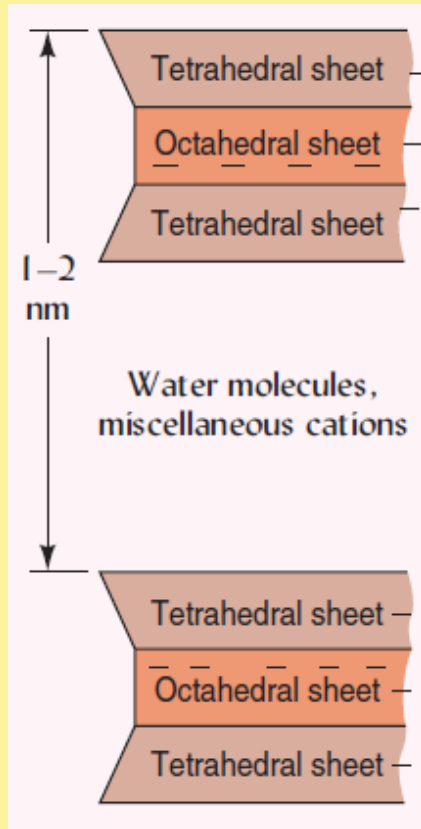
- ❑ Layer charge originates from the substitution of  $Mg^{2+}$  for  $Al^{3+}$  in the octahedral sheet
- ❑ 'nutrient rich'
- ❑ Very high shrink-swell capacity
- ❑ Unstable under low pH and high moisture



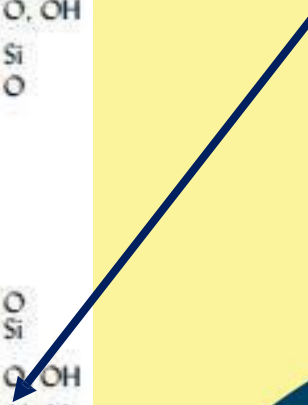
Rob Lavinsky



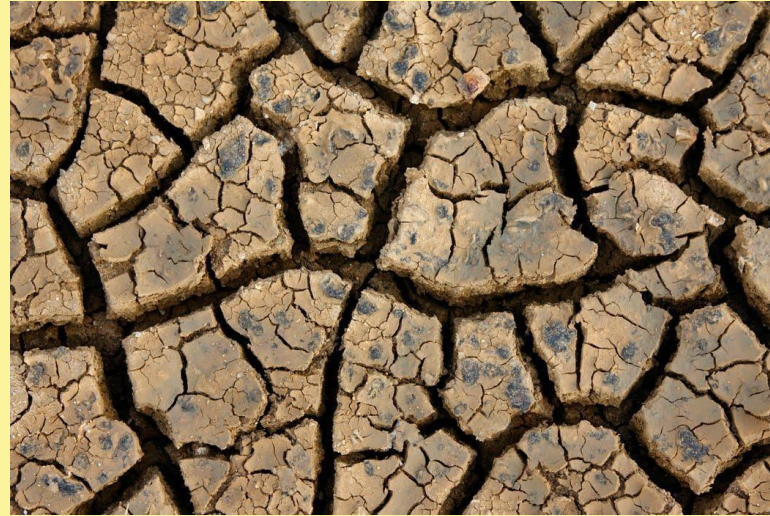
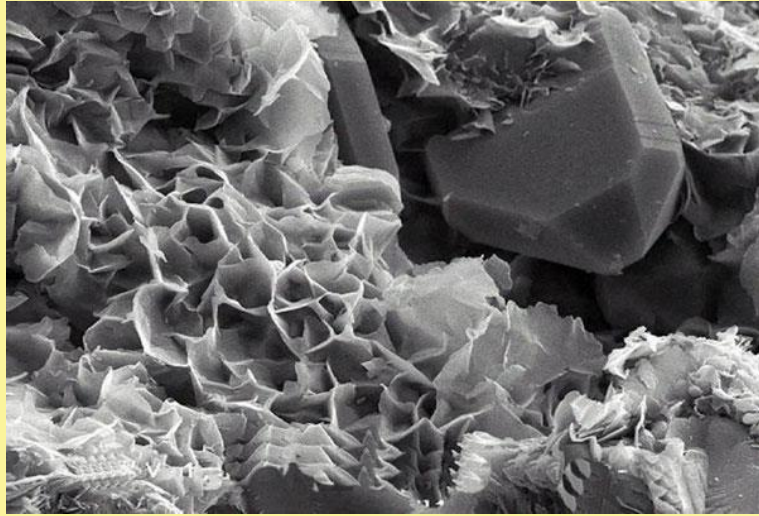
# Structure of montmorillonite



Isomorphous substitution occurs here



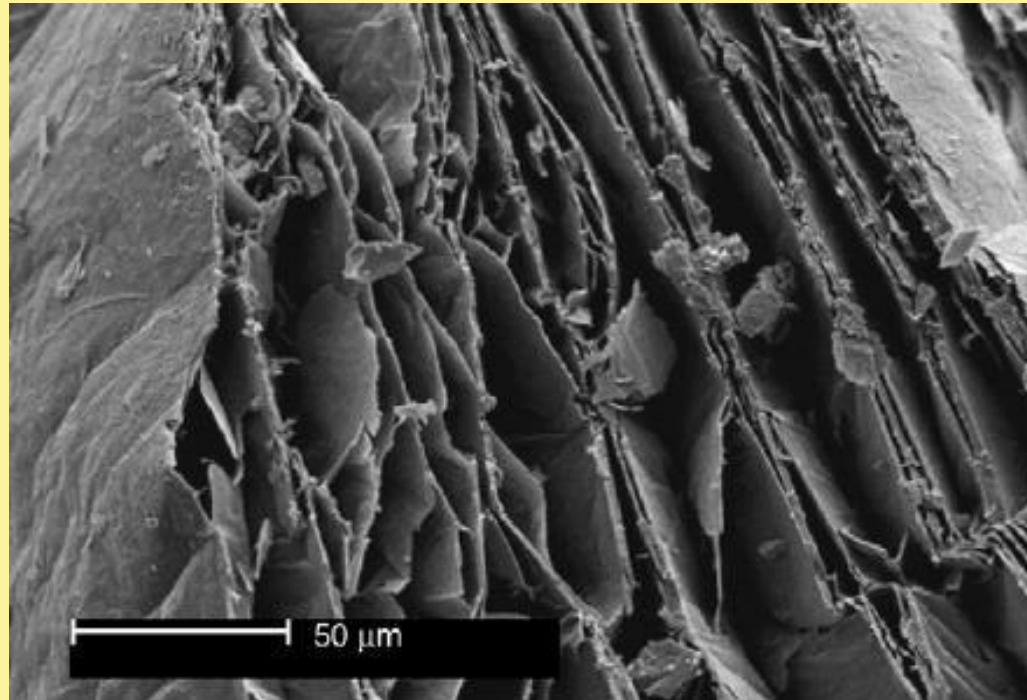
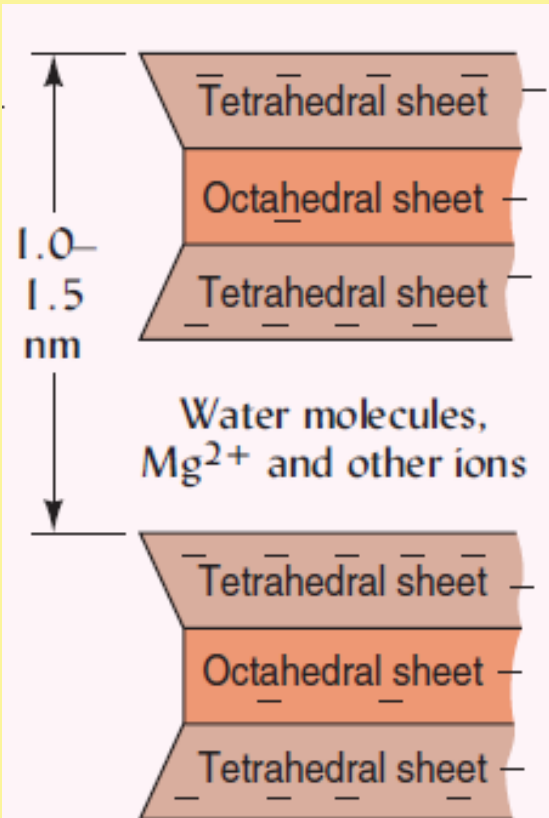
# Montmorillonite



# Vermiculite

- Weathered mica products where the  $K^+$  ions between the molecular sheets are replaced by  $Mg^{2+}$  ions
- Have the **highest Cation Exchange Capacity (CEC)** of all clays
- Less swelling capacity than smectites but more than kaolinite
- 'nutrient rich'
- Stable under low pH

# Structure of a vermiculite





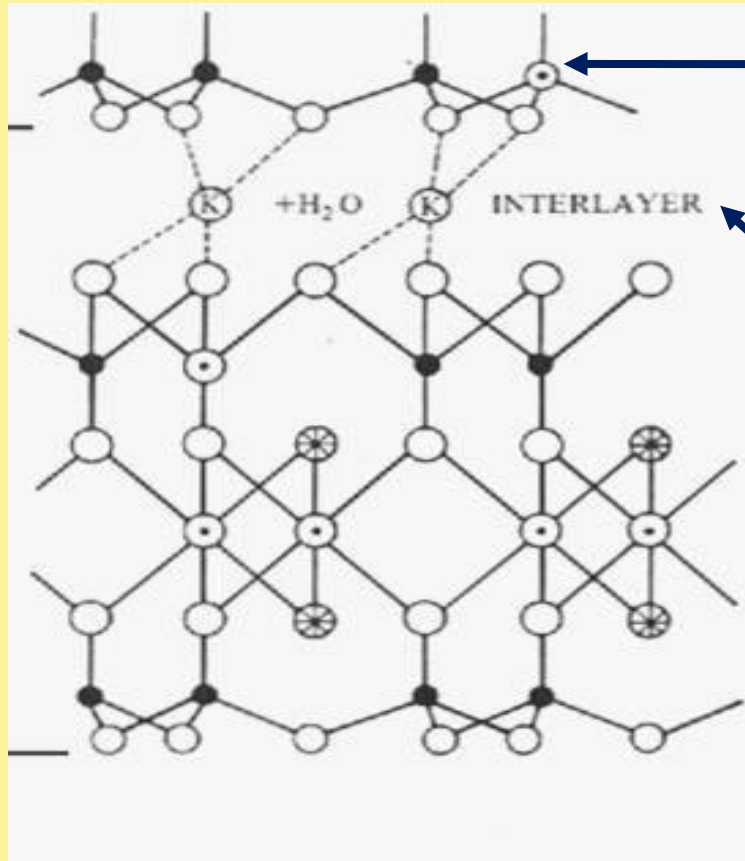
# Mica group

- $\text{Si}^{4+}$  in tetrahedral is replaced by  $\text{Al}^{3+}$
- High net negative charge
- $\text{K}^+$  ions adsorbed in interlayer
- Non-expansive
- Fairly 'nutrient poor'



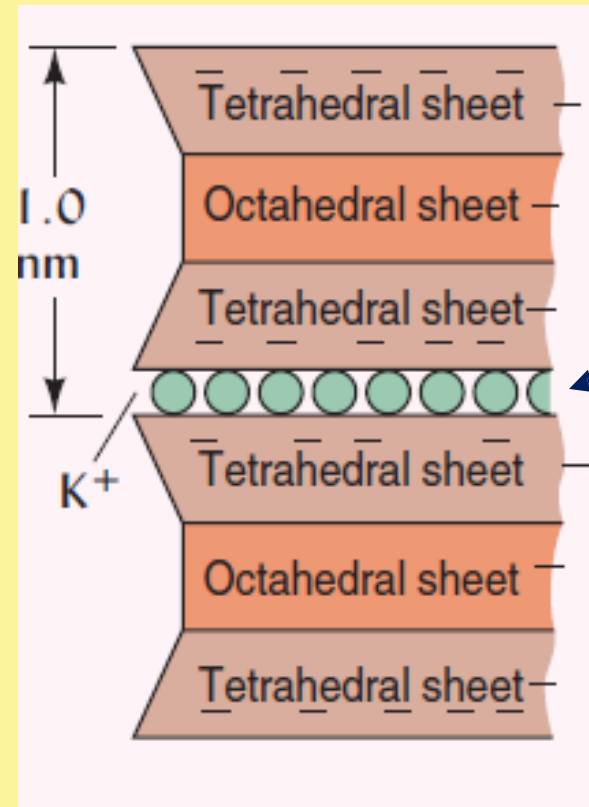
Illite

# Illite (2:1, fine grained mica)



Isomorphous substitution

K<sup>+</sup> in interlayer

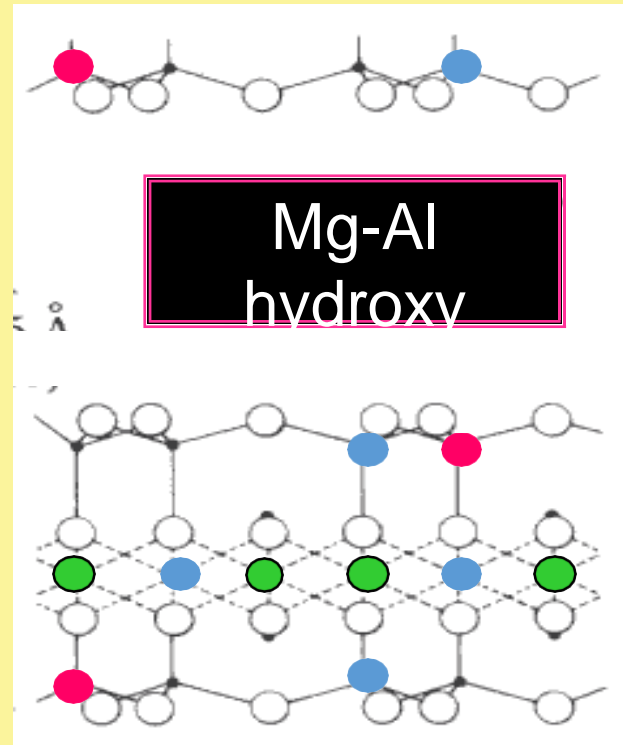
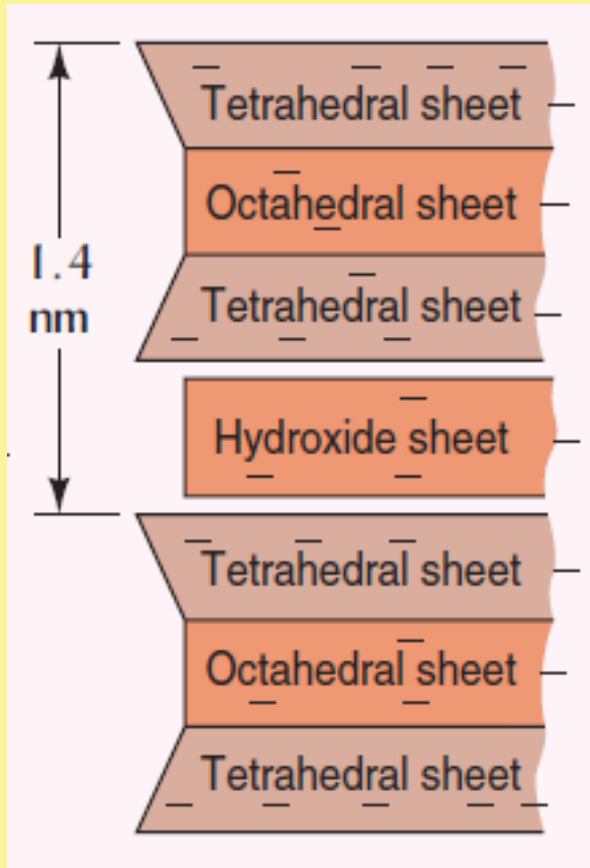


K<sup>+</sup> tightly bound

# Chlorite

- ❑ Iron or magnesium occupy the octahedral sheets
- ❑ **Hydroxy octahedral sheet** in the interlayer space
- ❑ Restricted swelling (due to locked interlayer structure)
- ❑ 'Nutrient poor'
- ❑ Common in sedimentary rocks and the soils derived from them

# Chlorite (2:1:1 clay)

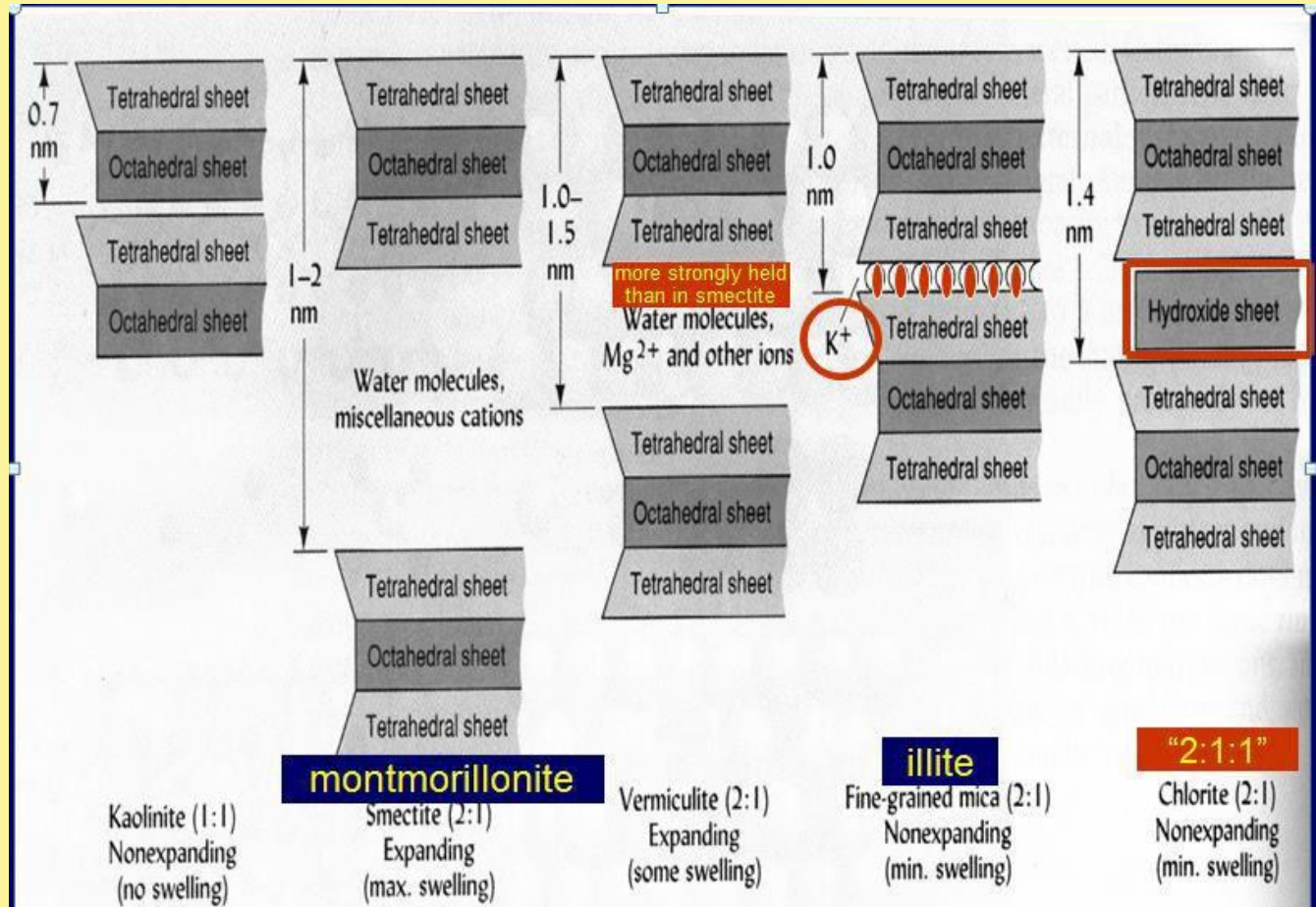


● = Al    ● = Fe    ● = Mg

Locked structure  
Low nutrient capacity



# Visual comparison





**THANK YOU**