



**Centurion**  
**UNIVERSITY**

*Shaping Lives...  
Empowering Communities...*

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

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

**Dr. Bishnuprasad Dash**

**SOIL SCIENCE AND AGRICULTURAL CHEMISTRY  
M.S.SWAMINATHAN SCHOOL OF AGRICULTURE,CUTM,  
PARLAKHEMUNDI**

**Topic**

**Soil colloids**

## **Concepts Covered:**

- Soil colloids and their types**
- Silicate clays**
- Basic structure of silicate clays**
- Types of crystalline silicate clays**

# Soil colloids

- ❑ **Colloid** – a two phase system where one finely divided phase is dispersed in another phase
- ❑ **Example:** solid in liquid – clay in water  
liquid in gas – clouds in atmosphere
- ❑ Soil particles < **2 $\mu$ m** are called soil colloids
- ❑ Includes the combined clay and humus fraction
- ❑ **Chemically active** and greatly impact ecosystem functions

# Properties of soil colloids

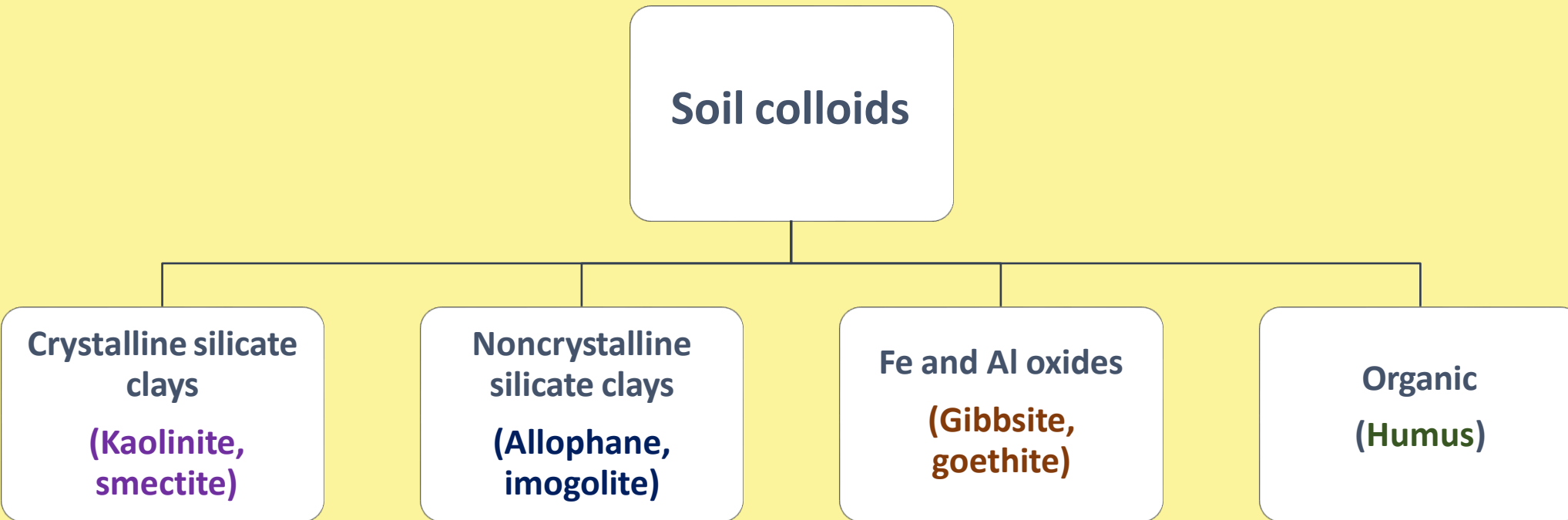
- Extremely small size
- Very high surface area
- Have charges (predominantly negative charge)
- Adsorption of cations and anions

colloids form an ionic double layer – an inner anionic(or cationic) layer with adsorbed outer cationic (or anionic) layer

- Adsorption of water

causes 'shrinking and swelling' of clay

# Types of soil colloids



# Crystalline silicate clays

- ❑ Has a layered structure with two to four sheets per layer
- ❑ Predominantly 'negative charged'
- ❑ Have diverse properties



Kaolinite

# Noncrystalline silicate clays

- ❑ Do not have an ordered, crystalline structure
- ❑ Have high amounts of both positive and negative charge
- ❑ High water holding capacities and low stickiness



Allophane

# Iron and aluminium oxides

- ❑ Found usually in highly weathered soils
- ❑ May be crystalline or amorphous
- ❑ Low plasticity and stickiness



goethite



gibbsite

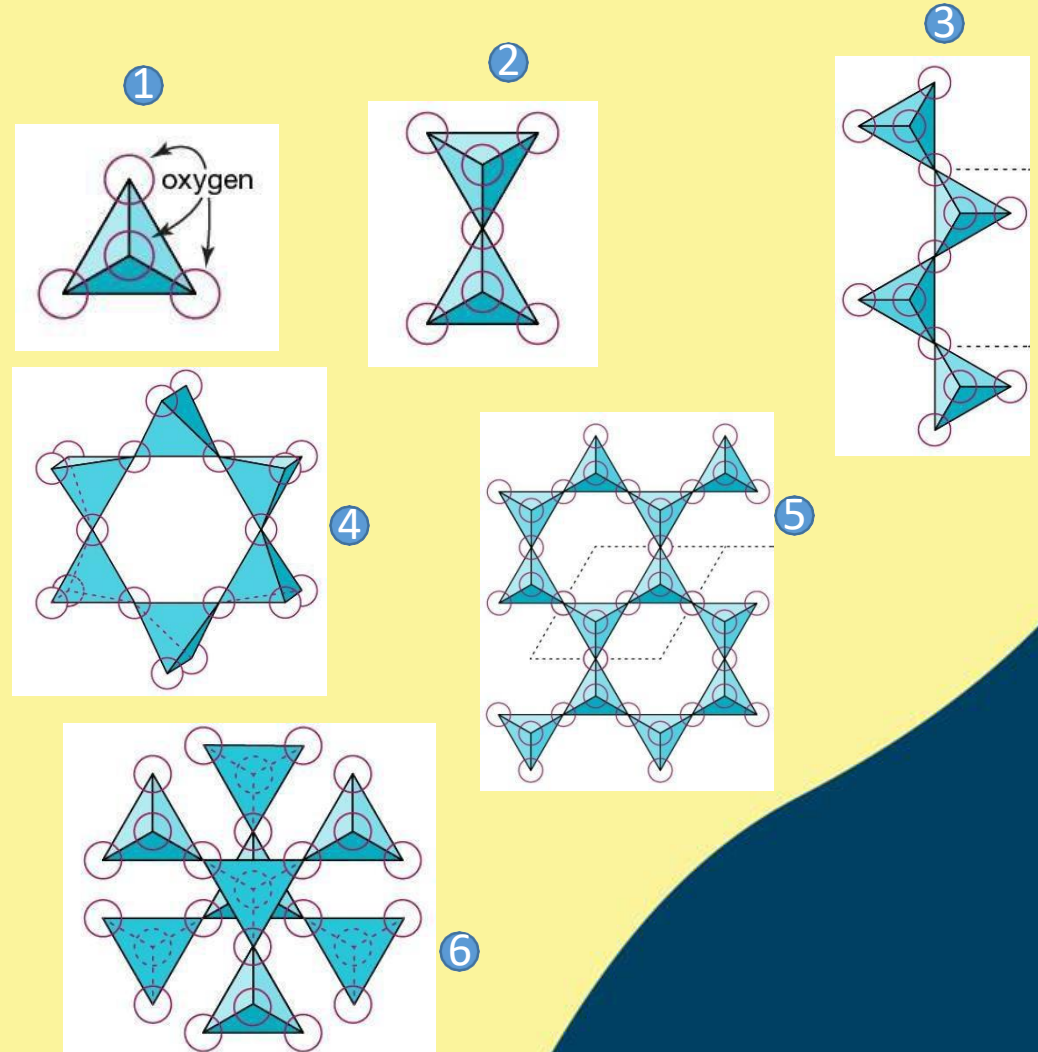


# Organic(humus)

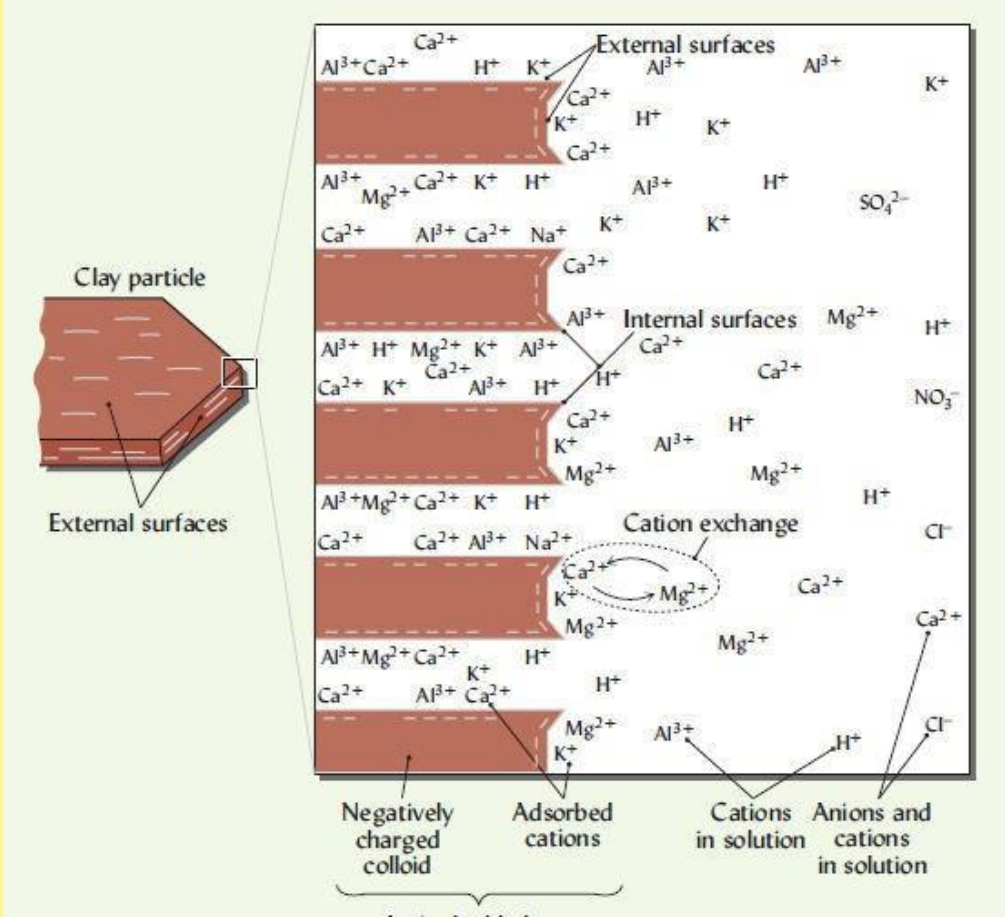
- ❑ Smallest of all soil colloids
- ❑ Made up of partially decomposed cell walls and biomolecules
- ❑ Very high water adsorbing capacity
- ❑ Net charge of humus is always negative

# Silicate clays

1. Nesosilicates—Separate  $\text{SiO}_4$  tetrahedra
2. Sorosilicates—Two or more linked tetrahedra ( $\text{Si}_2\text{O}_7$ ,  $\text{Si}_5\text{O}_{16}$ )
3. Inosilicates—Single or double chains of tetrahedra ( $\text{SiO}_3$ ,  $\text{Si}_4\text{O}_{11}$ )
4. Cyclosilicates—Closed rings or double rings of tetrahedra ( $\text{SiO}_3$ ,  $\text{Si}_2\text{O}_5$ )
5. Phyllosilicates—Sheets of tetrahedra ( $\text{Si}_2\text{O}_5$ )
6. Tectosilicates—Framework of tetrahedra ( $\text{SiO}_2$ )

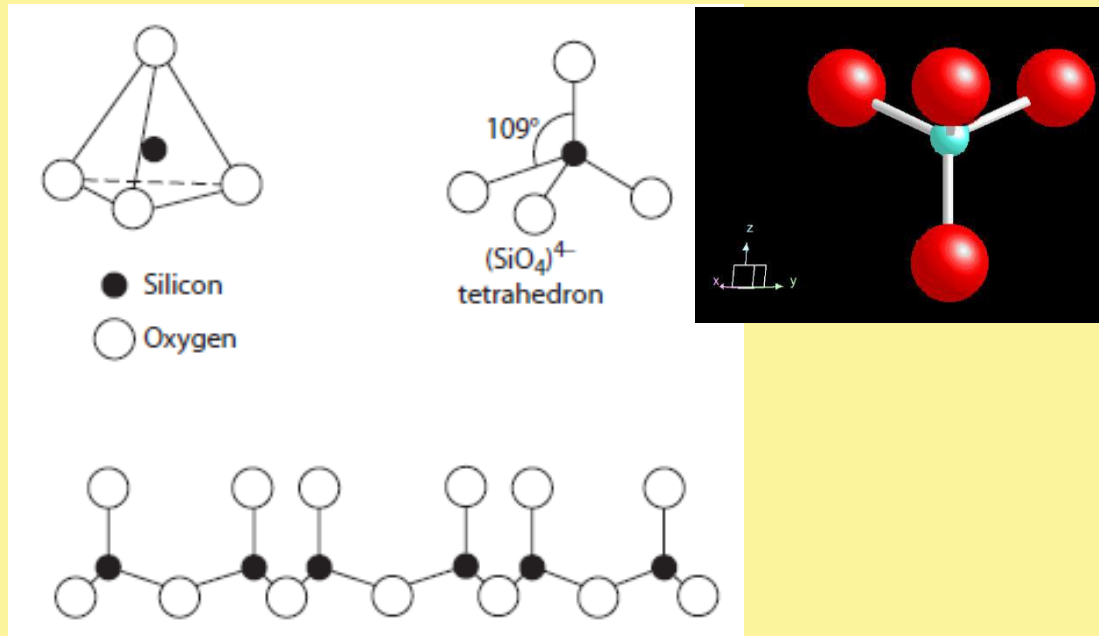


# A silicate clay crystal

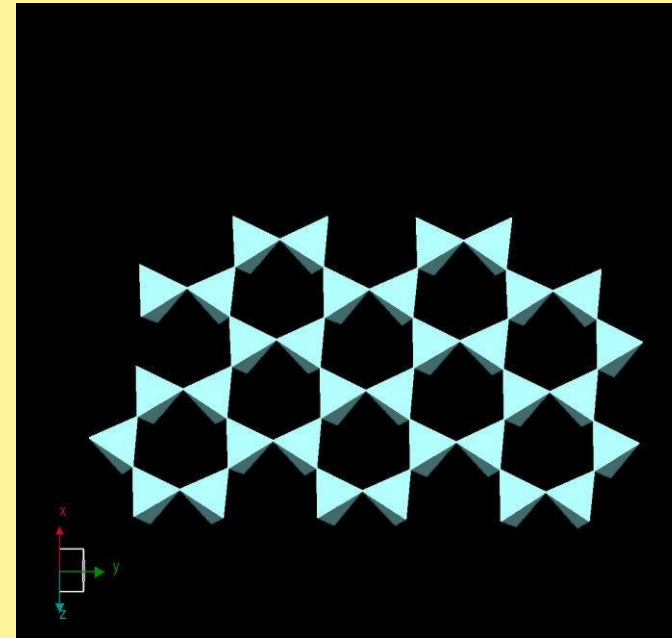


# Basic structure of silicate clays

## Silica tetrahedron

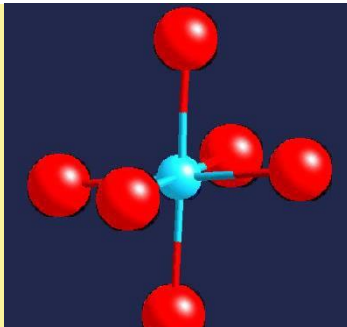
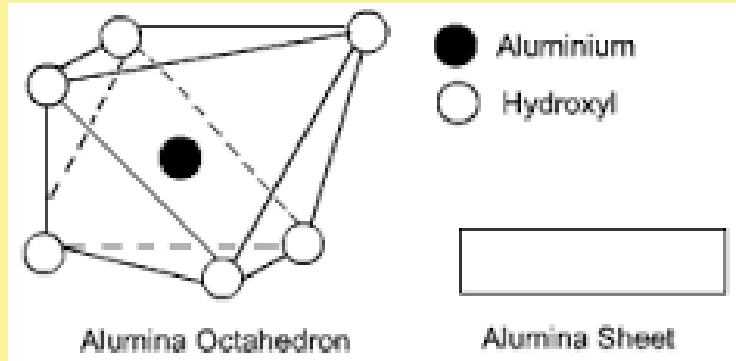


## Tetrahedral sheet

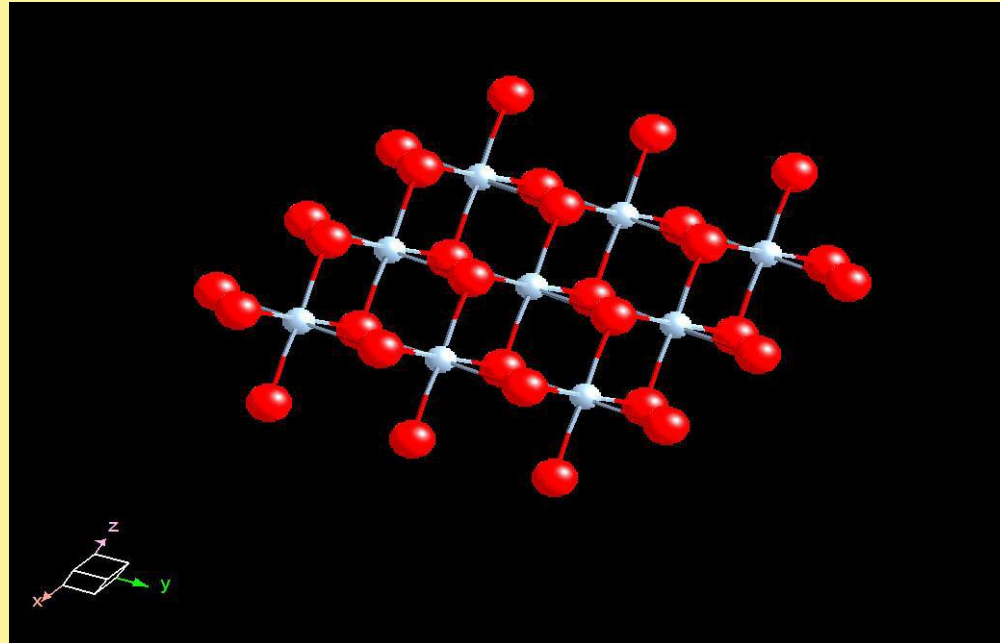


# Basic structure of silicate clays

## Alumina octahedron

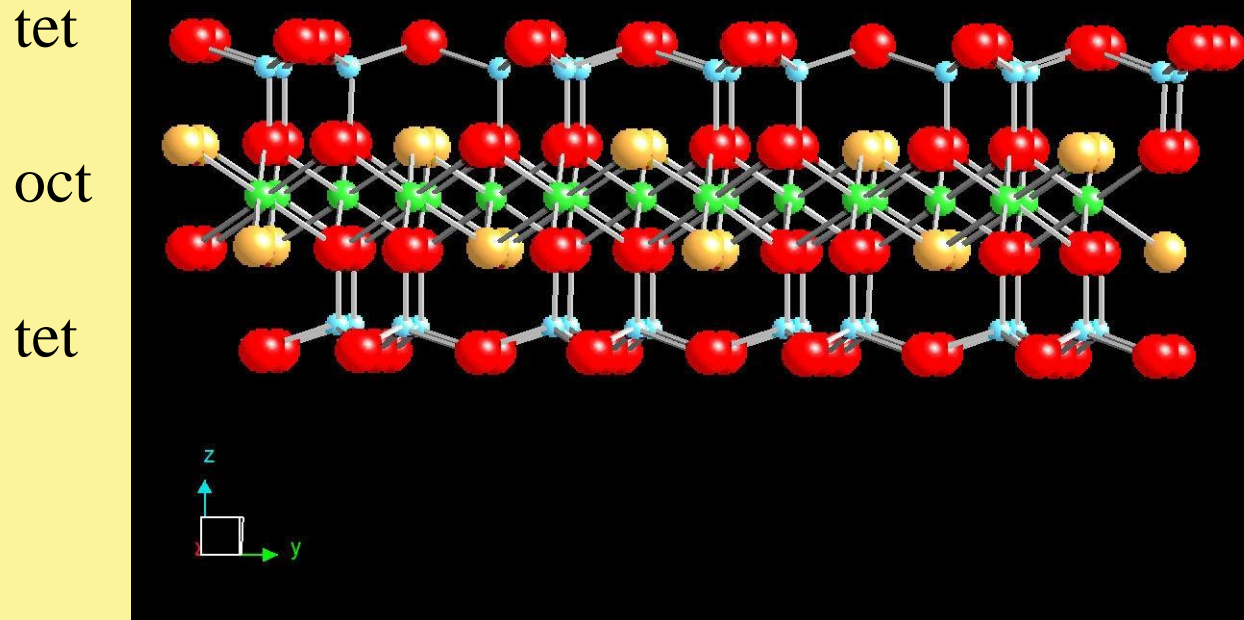


## Octahedral sheet



# Octahedral-tetrahedral linkage

Talc (2:1 trioctahedral mineral)



Shorthand notation



# Classification

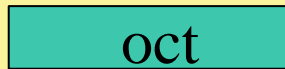
T:O

(class)

octahedra

trioctahedral

dioctahedral



brucite

gibbsite

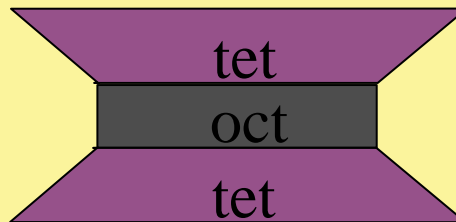
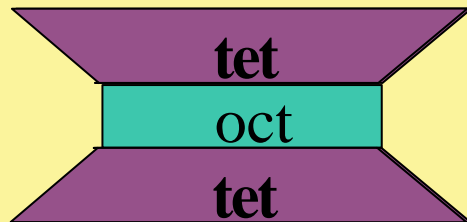
1:1



serpentine

kaolinite

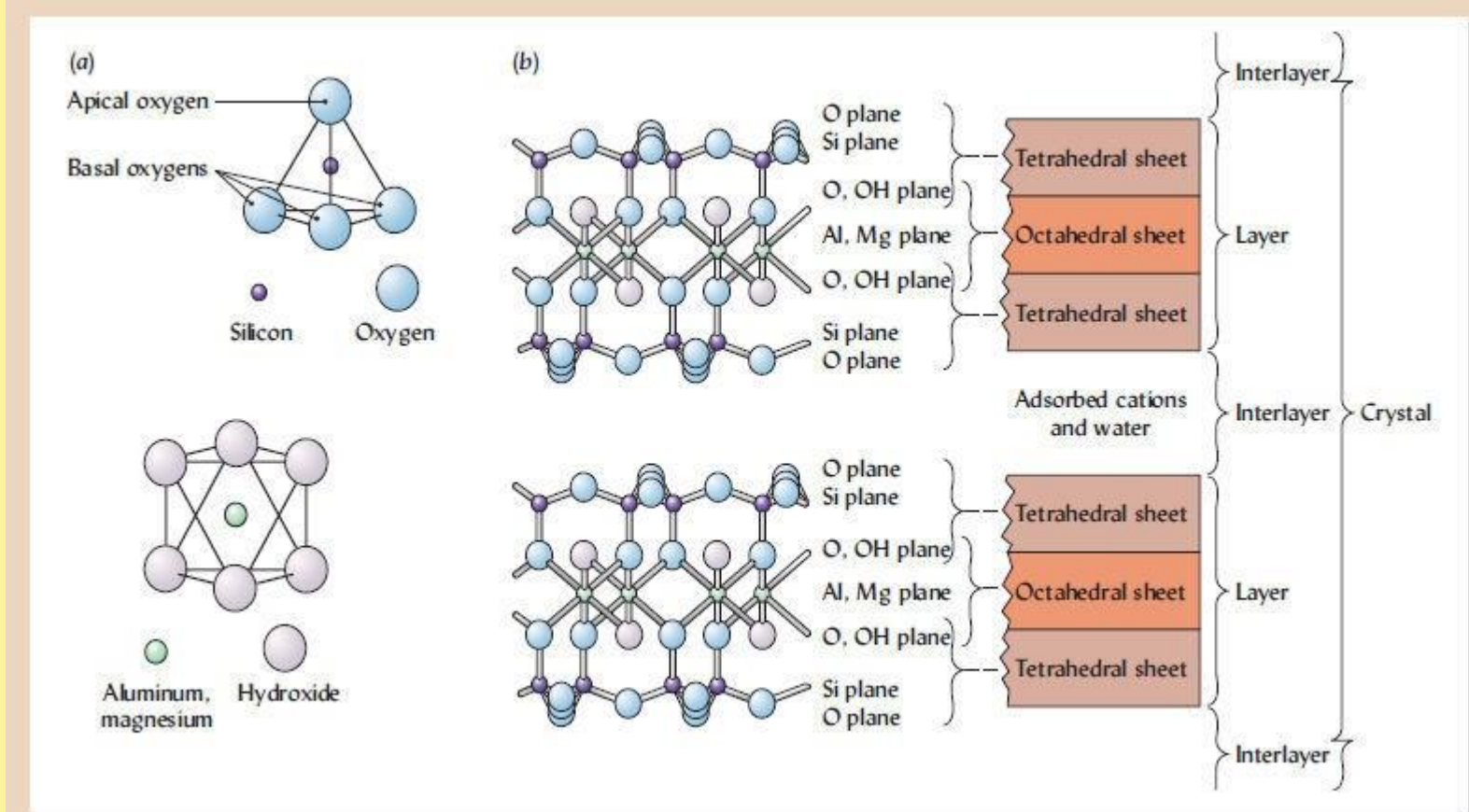
2:1



pyrophyllite

talc

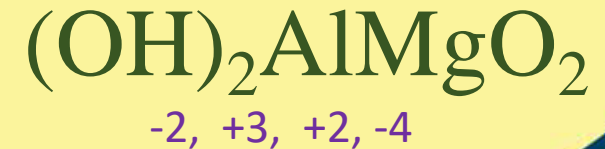
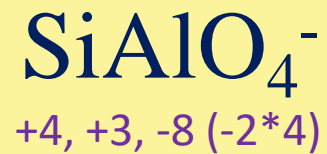
# Relationship between planes, sheets and layers





# Sources of charges

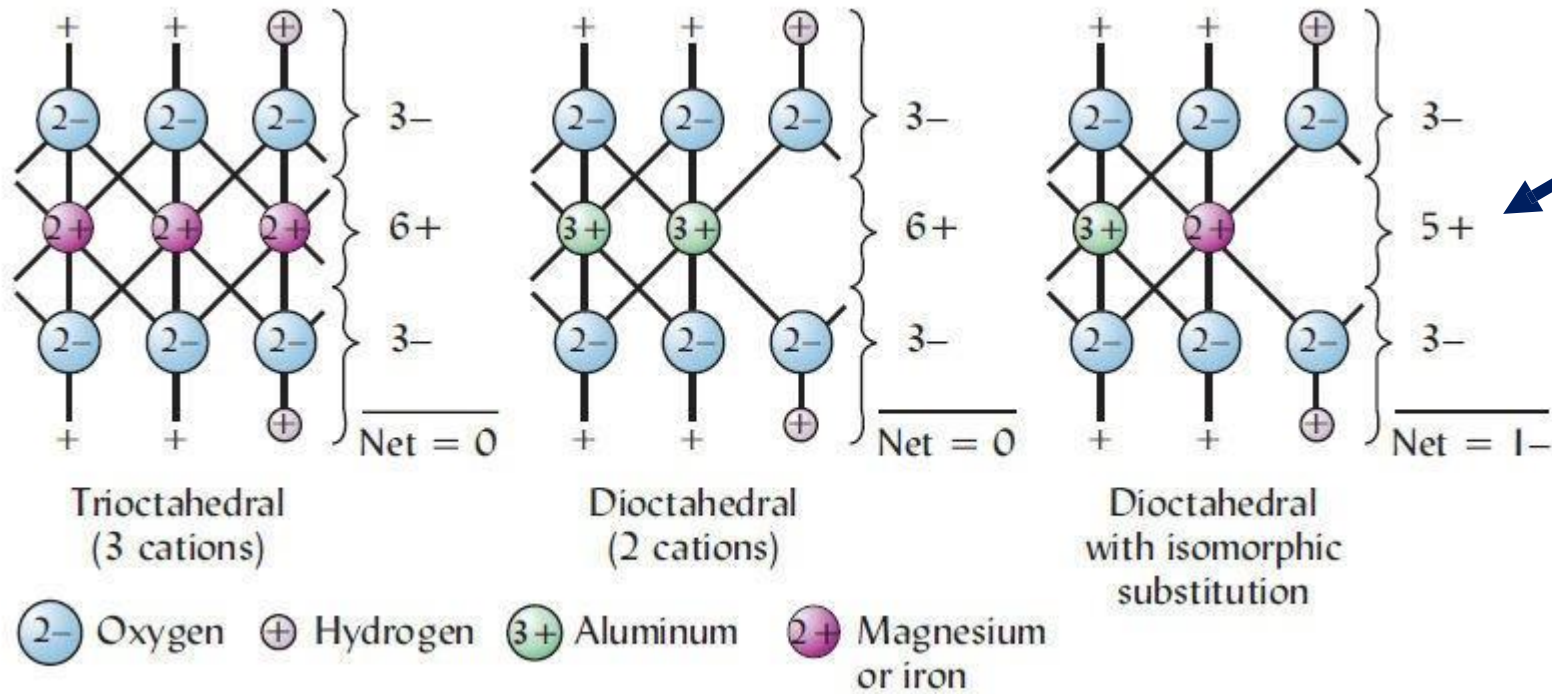
- Isomorphous substitution
- One element fills the position of another element having similar size



Tetrahedral

Octahedral

# Sources of charges



| Ion              | Radius, nm ( $10^{-9}$ m) | Found in                     |
|------------------|---------------------------|------------------------------|
| Si <sup>4+</sup> | 0.042                     | Tetrahedral sheet            |
| Al <sup>3+</sup> | 0.051                     |                              |
| Fe <sup>3+</sup> | 0.064                     | Octahedral sheet             |
| Mg <sup>2+</sup> | 0.066                     |                              |
| Zn <sup>2+</sup> | 0.074                     | Exchange or interlayer sites |
| Fe <sup>2+</sup> | 0.076                     |                              |
| Na <sup>+</sup>  | 0.095                     |                              |
| Ca <sup>2+</sup> | 0.099                     | Both sheets                  |
| K <sup>+</sup>   | 0.133                     |                              |
| O <sup>2-</sup>  | 0.140                     |                              |
| OH <sup>-</sup>  | 0.155                     |                              |

# Mineralogical organization of silicate clays

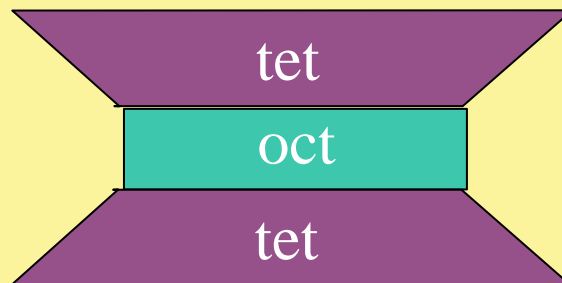
## □ Two main groups of crystalline clays

### ▪ 1:1 silicate clays

1 octahedral 1 tetrahedral

### ▪ 2:1 silicate clays

1 octahedral sandwiched between 2 tetrahedral



**THANK YOU**