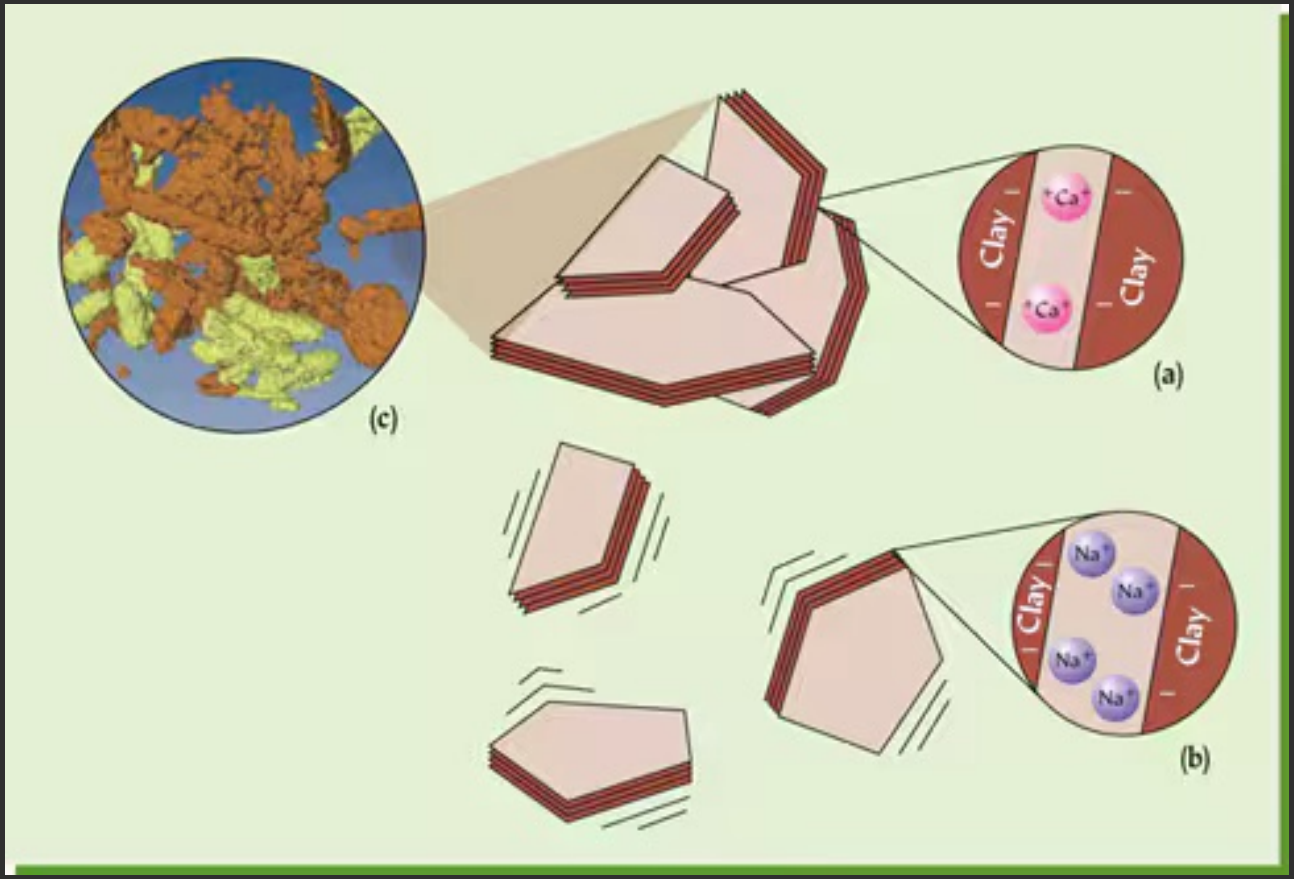
Flocculation of Clay

- Negative charges of clay attract positive charges creating "stacks" of clay particles
- Clay plates or layers

Multivariate charges , Ca^{2+}, Fe^{2+}, Al^{3+} = complex compunds with organics that flocculate with fine silt. - Microaggregates

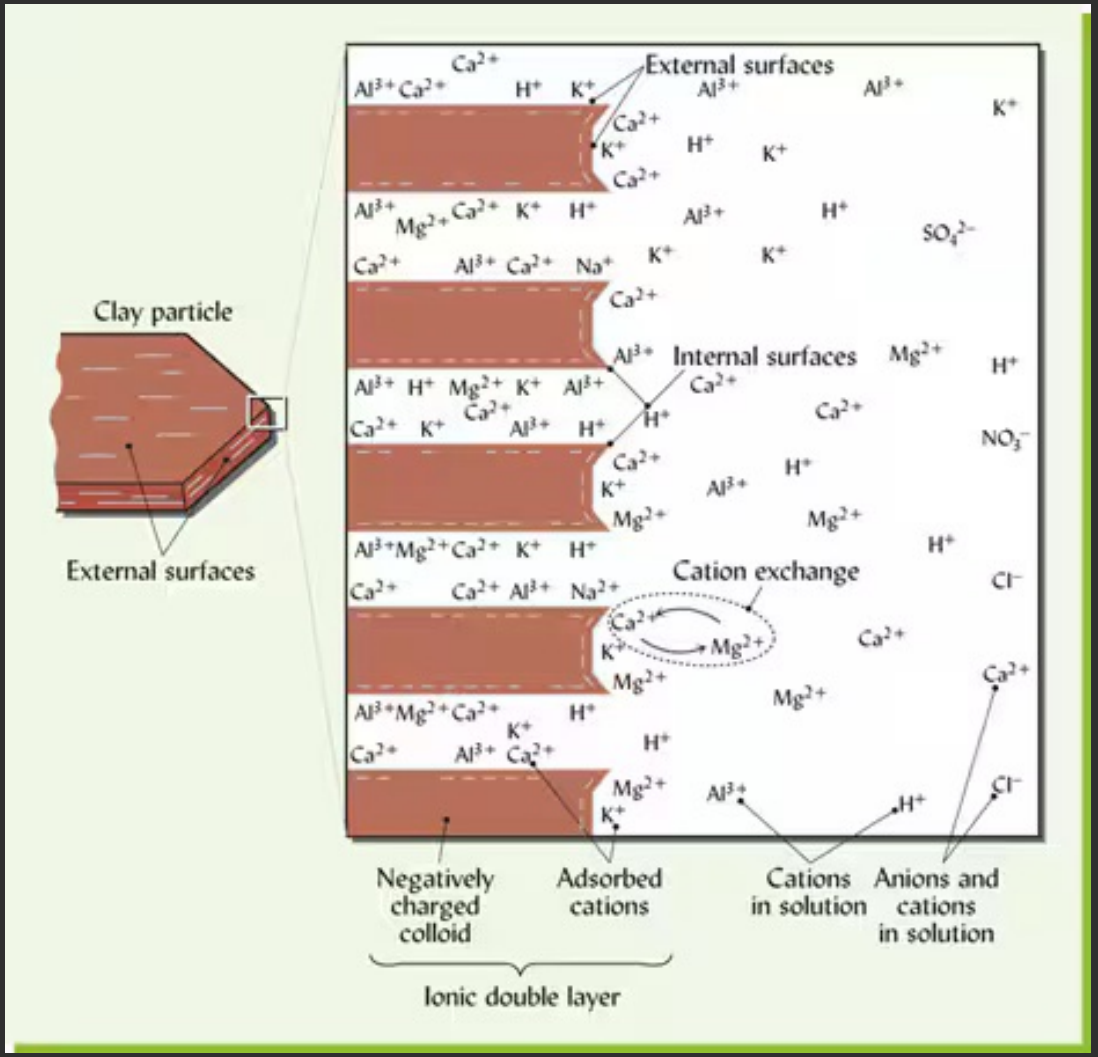
Impervious to water


Clay
$^{+}Ca^{+}$
$^{+}Ca^{+}$
Clay
(a)
(c)
Clay
Na+
Na+
Na+
Na+
Clay
(b)

Colloids and surface area

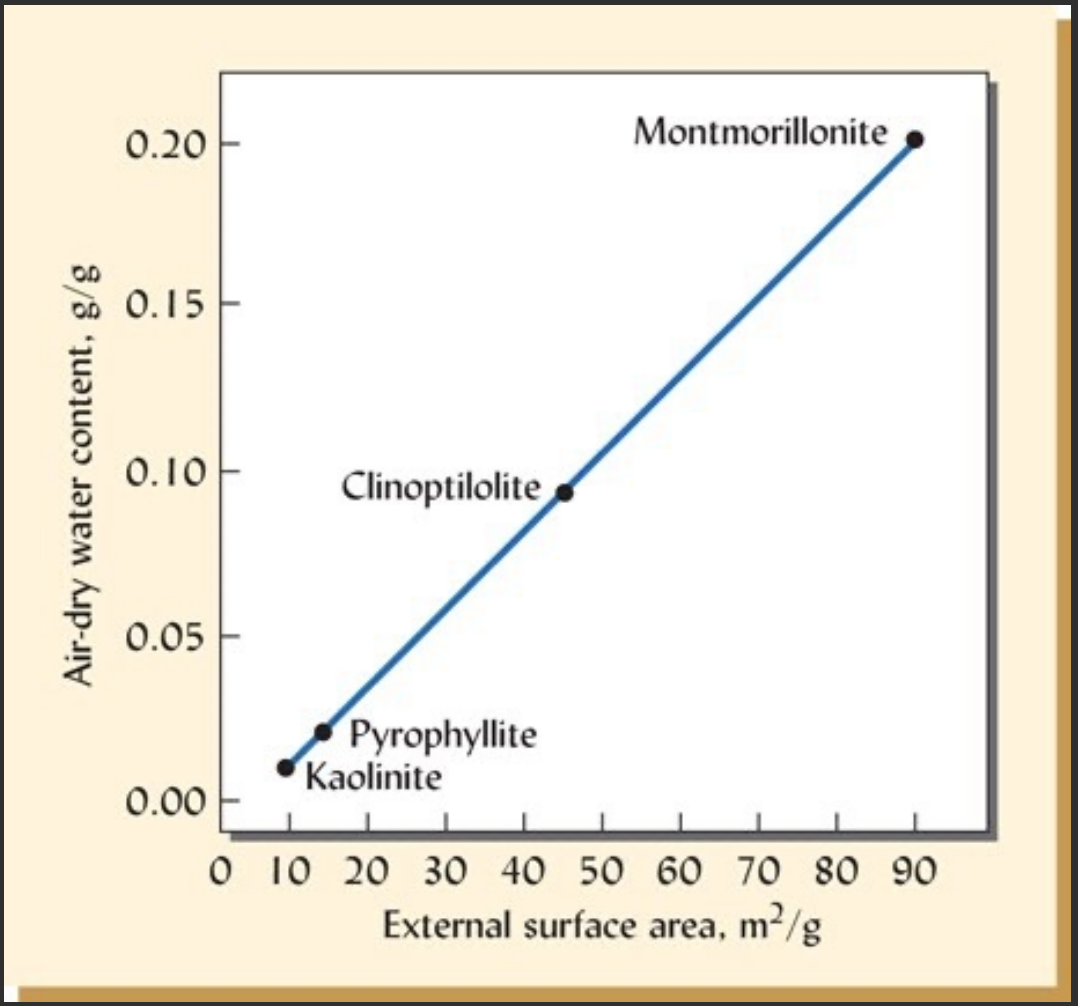
- Net charge the of colloid can attract both cations and anions
- - Small soil collids can have 1000 x SA per unit mass
- -- Each negatively charged colloid can attract 1000s of cations
- ---hydrated cations swarm near colloids

Cation exchange -
A cation bonded to soil particle surface is exchanged with a cation in solution in soil water



Water absorption in soil is the result of charges on soil colloid attracting opposite charges in water molecules

-- This can happen between clay particles. which will seperate apart the clay molecules


Montmorillonite
Clinoptilolite
Pyrophyllite
Kaolinite
0.20
0.15
0.10
0.05
0.00
Air-dry water content, g/g
0 10 20 30 40 50 60 70 80 90
External surface area, m²/g

Crystalline Silicate Clays

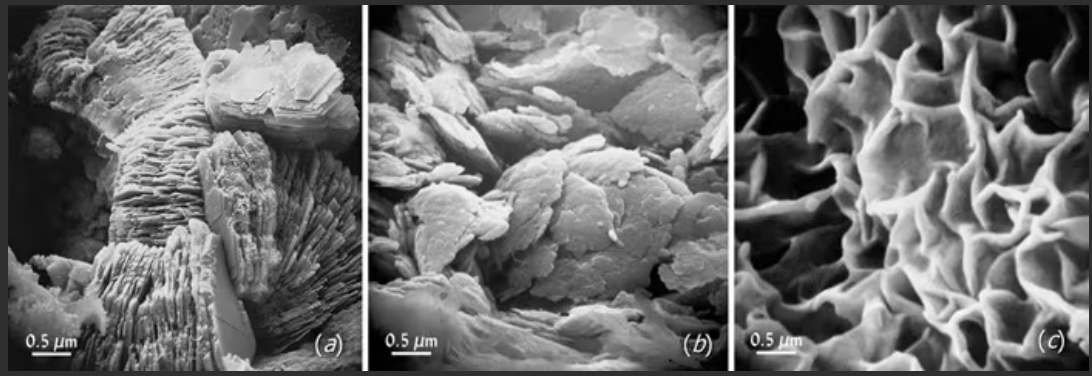
- Kalonite
- Smectite (Montmonrillonmite)

- Layered sheets of Al, Si, O

- These tend to have neutral to very negative charges

Kalonite

Mont.



Non-crysalline sillicate clays

- Al, Si, O

- Allophine
- Imogolite
- -- Volcanic ash; tend to have positive charges
- Do not form cyrstalline sheets

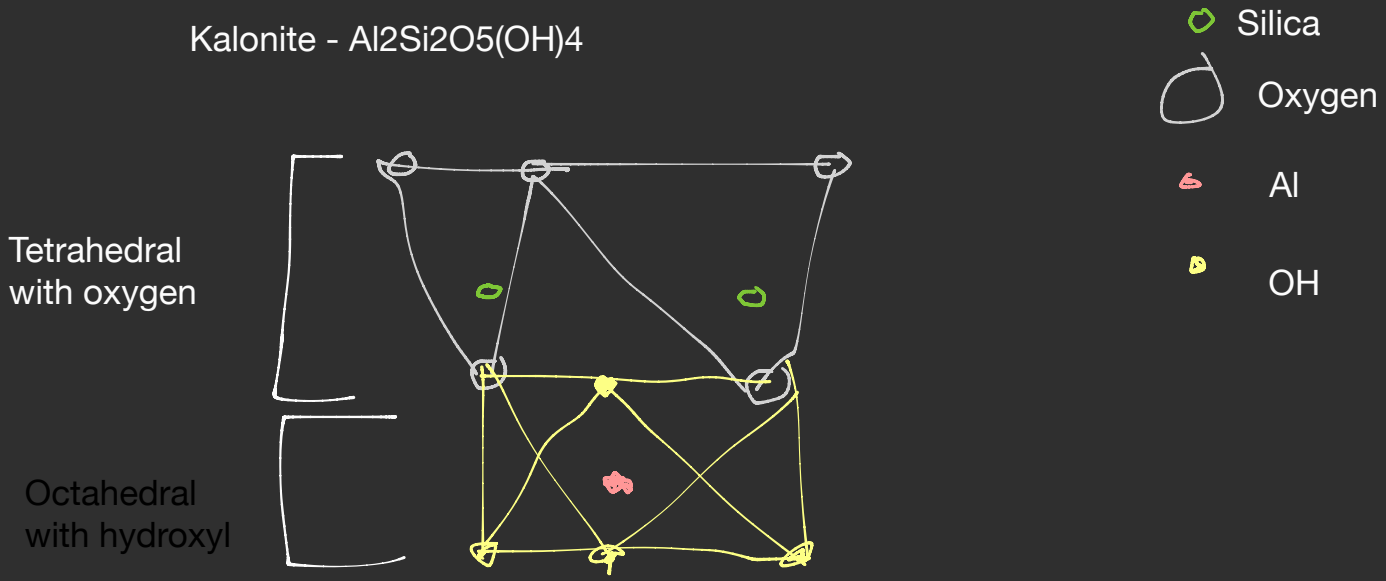
Iron and Al Oxides; positive and negative charges

- Gibbsite - Al oxide clay
- Geothite - Fe oxide clay

Humus (organic colloid)

- not mineral based or cystalline
- partially decompoised cell walls and biological molecules
- Carbon chains, H, O, N
- Smallest of soil colloids
- A strong negative charge - high water and cation absorbing capacity
- -- Low cohesion

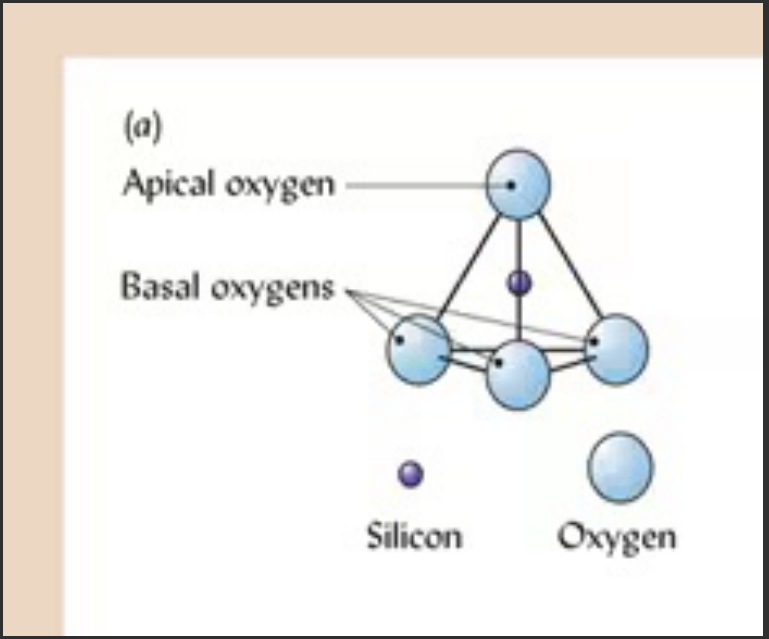
Kalonite - $Al_2Si_2O_5(OH)_4$



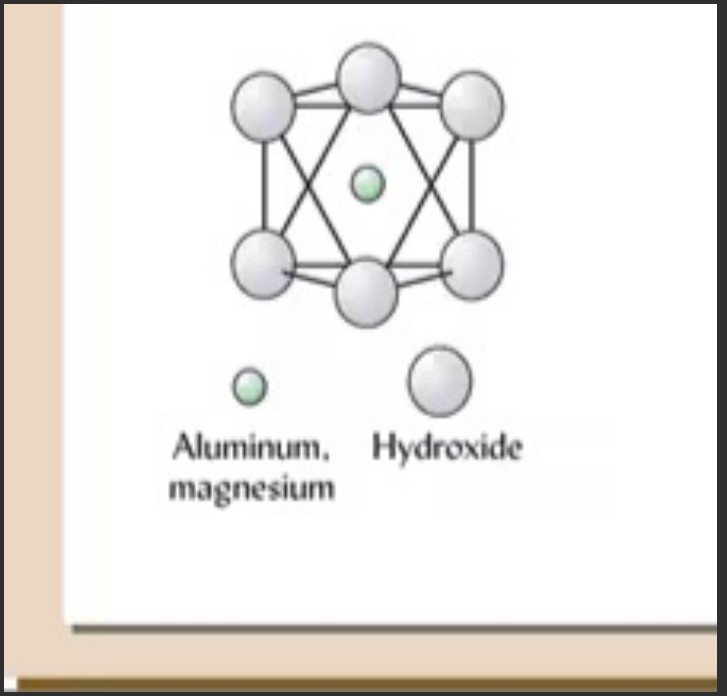
Kalonite is a 1:1 Silicate clay - 1 silicon tetrahedral : 1 Al octahedral

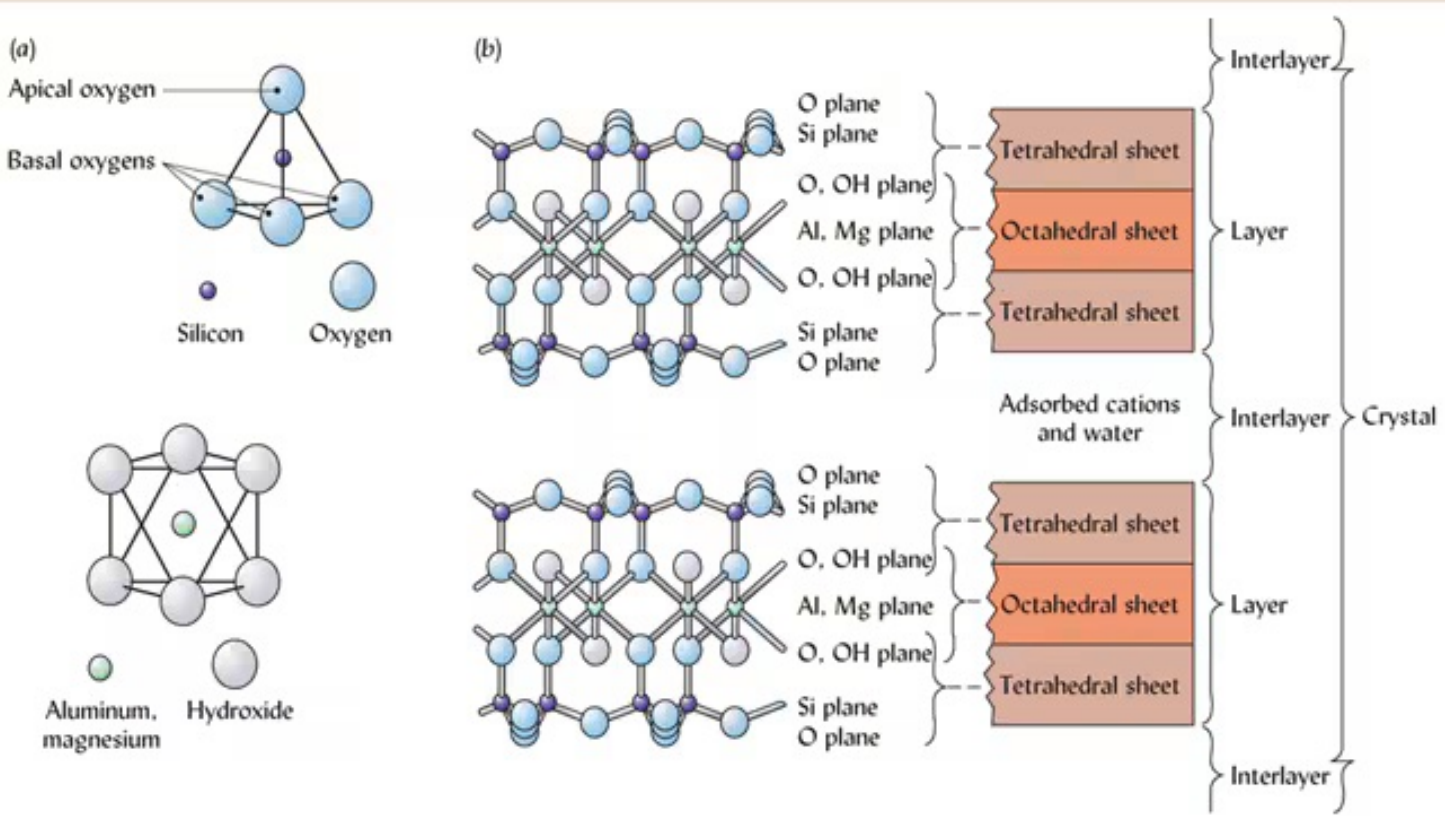
- Apex ocygen of the tetrahedral is H bonded to the apex hydorxyl group in the octahedral
- - Because the clay are tightly bonded and hard to seprate, Kaonite has low water absorbing capacity

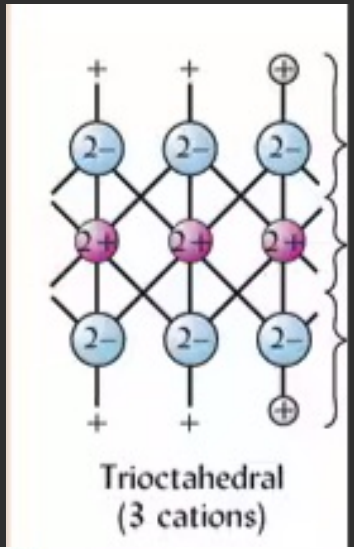
Tetrahedral



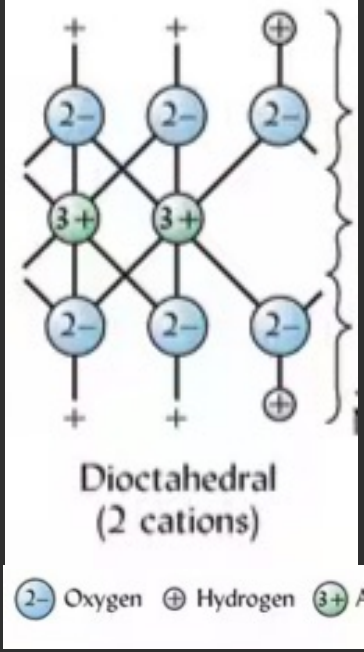
Octahedral




(a)
Apical oxygen
Basal oxygens
Silicon
Oxygen
Aluminum, magnesium
Hydroxide
(b)
O plane
Si plane
O, OH plane
Al, Mg plane
O, OH plane
Si plane
O plane
Tetrahedral sheet
Octahedral sheet
Tetrahedral sheet
Adsorbed cations and water
Interlayer
Layer
Interlayer
Crystal
Layer
Interlayer



Total net charge = 0



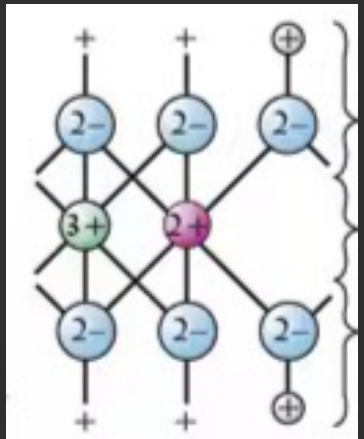
-3

+6

-3

Net charge of 0

Isomorphic substitution = Cation or molecule with same or similar share and size substitutes with another molecule



-3

+5

-3

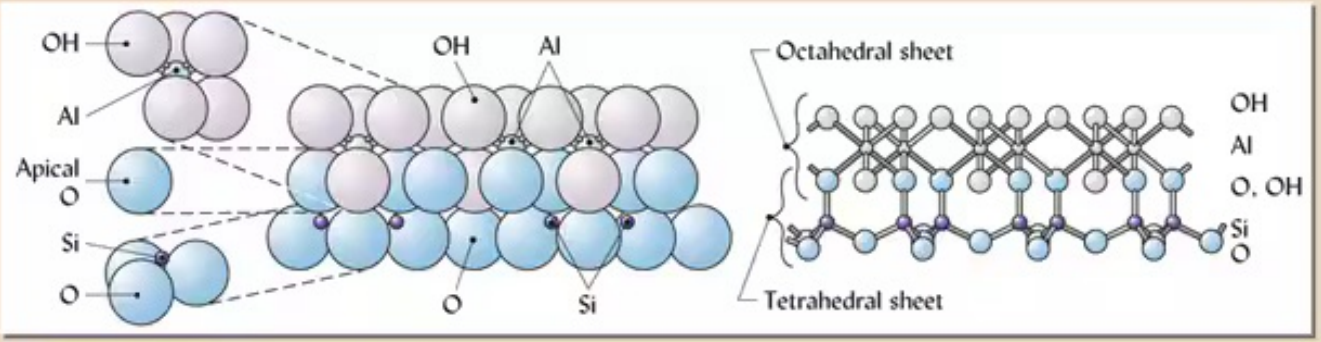
Dioctahedral with isomorphic substitution

Total net charge: -1

2– Oxygen ⊕ Hydrogen 3+ Aluminum 2+ Magnesium or iron

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

Particles within 0.02 nm can substitute


OH
Al
Apical O
Si
O
OH
Al
O
Si
Octahedral sheet
Tetrahedral sheet
OH
Al
O, OH
Si
O

2: 1Silicate clays

2 tetrahedral sheets : 1 octahedral sheet

Strong negative charges from isomorphic substitution;

Repelling of negatice charge in one tetrahedral from another to give rise to a large interspace between clay sheets -

Vermiculites and Smectites (shrink-swell, water abosrbing clays)

- High cation abosorbing capacity