Clay Basics

A horizon

- Zone were parent materials weather
  - Original rocks and minerals break down into smaller and smaller pieces
  - Eventually dissolve

A horizon

- Zone were new materials form
  - New clays are formed as weathering products of original minerals
  - Different clays have different properties
  - Different clays are characteristic of different stages of weathering

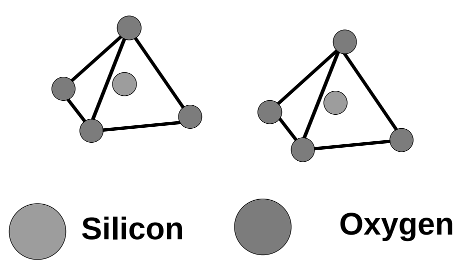
Clay formation

- Tends to be accompanied with accumulation of certain elements (Al, Fe, Si)
  - (In secondary clays)
- Loss of other elements (Ca, Mg, K)
  - (Leached from the soil)

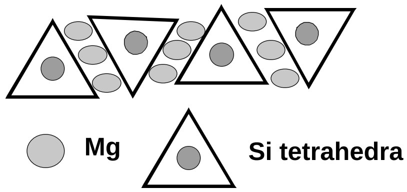
Phyllosilicates
phyllon = leaves

- Just like phyllo dough pastries, they are composed of repeating layers of sheets

Silica tetrahedra
tetra = 4

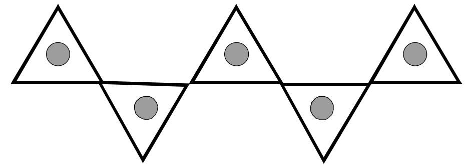


How to build a mineral
Single tetraheda



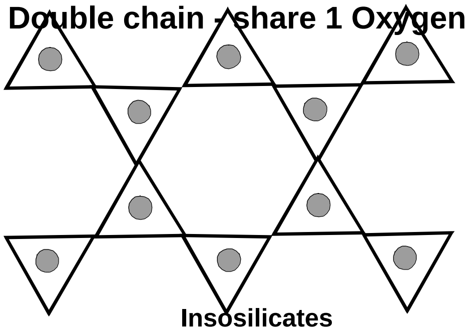
Nesosilicates
(Olivine)

How to build a mineral
Single chain - share 1 Oxygen



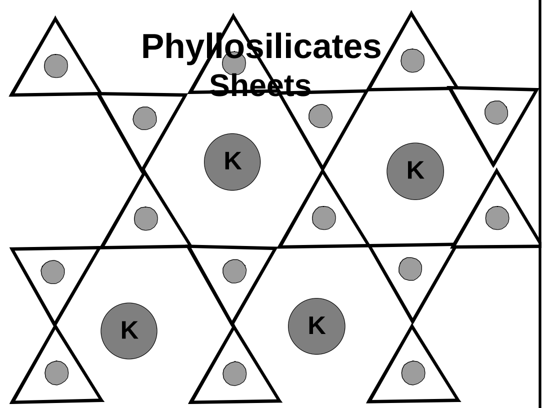
Insosilicates - chains

How to build a mineral
Double chain - share 1 Oxygen

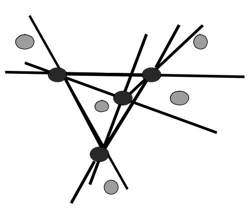


Insosilicates

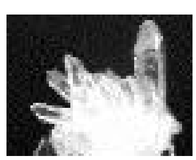
Phyllosilicates
Sheets



Tectosilicates



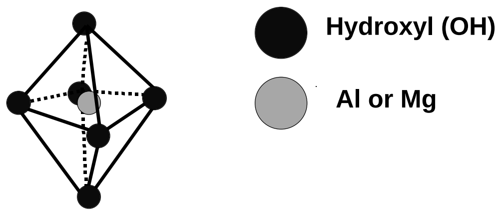
3 dimensional array
All Oxygen shared
eg Quartz : SiO_2



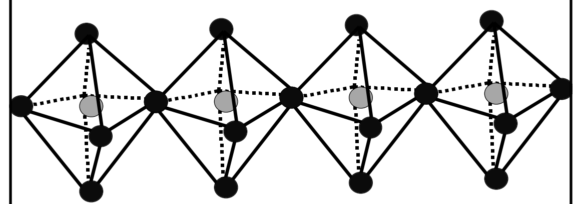
Silicate minerals

- **Less oxygens shared, easier it is to break down**
- **Nesosolicates easiest to weather**
- **Quartz (tectosilicates) very resistant to weathering**

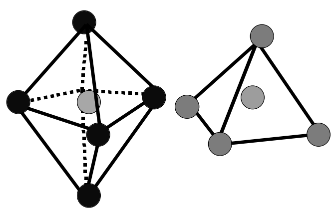
Aluminum Octahedra
Octa = 8



Aluminum Octahedra
Sheets

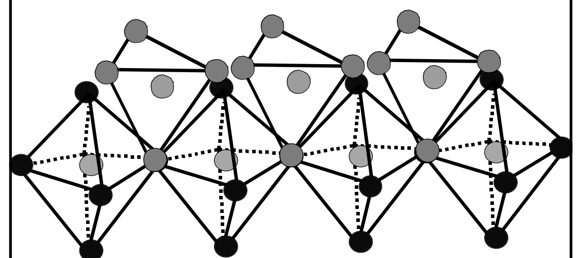


Then you take an octahedra sheet and a tetrahedra sheet



keep in mind that occasionally other elements will substitute for Al and Si

and you stack them together

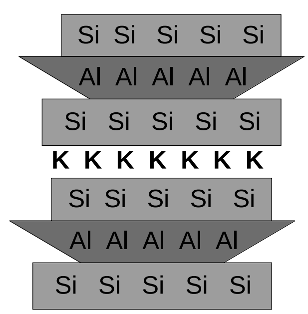


The way that they are stacked

- **The numbers of alternating sheets**
- **The forces holding the sheets together**
- **The amount of substitution for Al and Si**

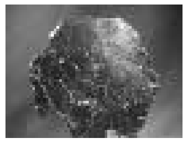
Determine the nature of the clay mineral

Clay minerals
Mica: 2:1 clay

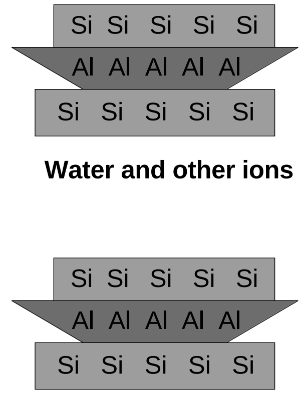


Mica

- K in the interlayer holds sheets together tightly
- Non expanding mineral
- Size 0.2 -2 μm
- External surface
  - 70-100 m^2/g
- Internal surface
  - -
- Net charge
  - 15-40 cmol/g

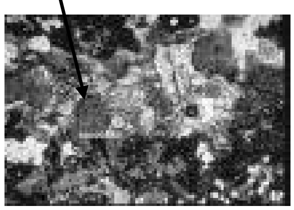


Smectite 2:1 clay

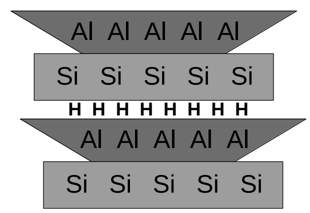


Smectite

- Very active
- Size 0.1-1 μm
- External surface
  - 70-120 m^2/g
- Internal surface
  - 550-650 m^2/g
- Net charge
  - 80-120 cmol/g

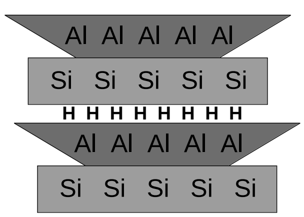


Kaolinite 1:1 (Si:Al) mineral



Hydrogen bonding holds this together

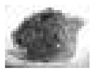
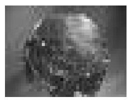
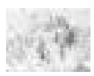
- Kaolinite 1:1 (Si:Al) mineral



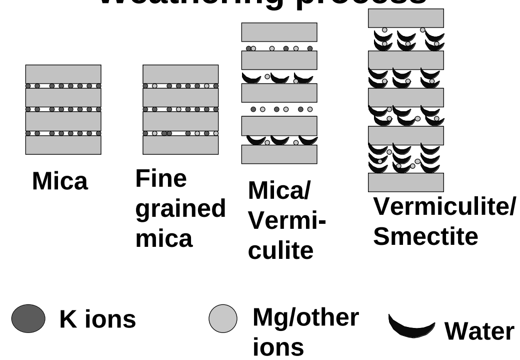
Kaolinite

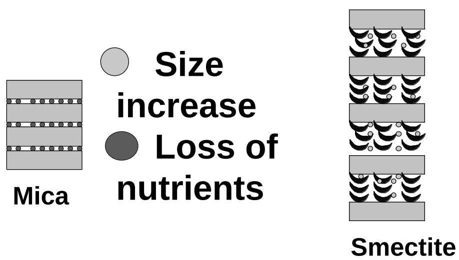
- Very inert
- Size 0.5-5 μm
- External surface
  - 10-30 m^2/g
- Internal surface
  - -
- Net charge
  - 2-5 cmol/g

Weathering

- Chlorite 
- Mica 
- Montmorillonite 

Weathering process



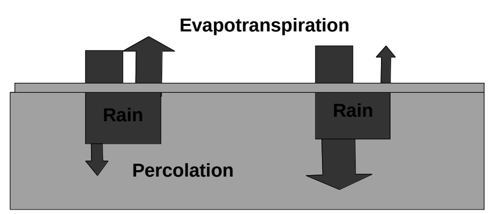


Weathering products

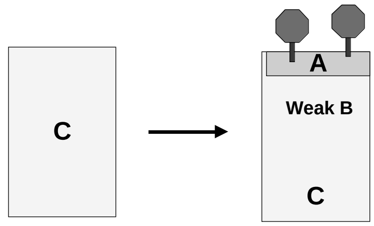
- Quartz → not weatherable, will form small sand particles
- Mica (high base status soil) → Vermiculite
- Smectite (neutral to acid soil) → Al oxide mineral

- High Si parent material (not pure quartz) → Kaolinite, gibbsite
  Si and other bases will weather out of soil
- High Fe minerals → Fe oxide clays like goetite and hematite
- Volcanic ash → allophane and imogolite (weathering product of allophane)

Which is hotter?
Where will soil form faster?

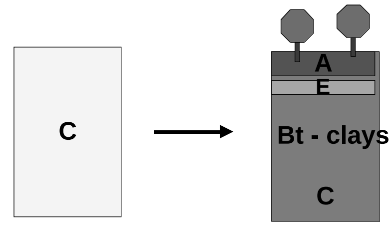


How weatherable minerals will affect soil formation



Coarse sand parent material

Sandy parent materials with a mix of weatherable minerals



Alfisol from sandstone and a range of weatherable minerals

- High Smectite
- Near neutral pH
- Clay films, skins
- High nutrient holding capacity

Entisol from sandy glacial till

- Highly acidic
- Some red color
- No clay films
- Low nutrient holding capacity