Earth Materials II

Review - Igneous Minerals

Quartz

Orthoclase

Plagioclase

Mica

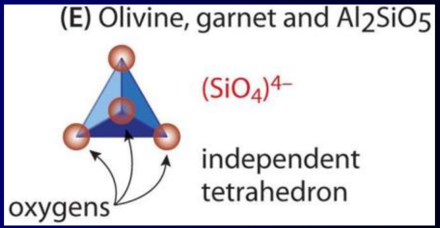
Amphibole

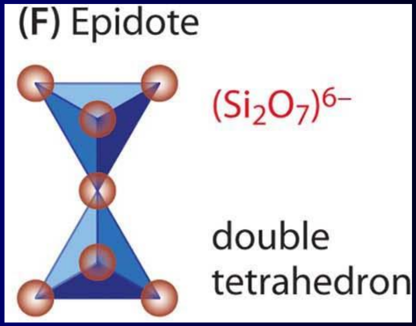
Pyroxene

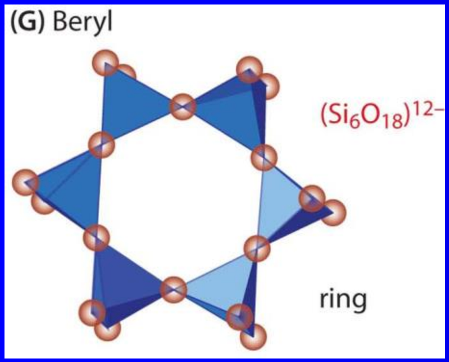
Olivine

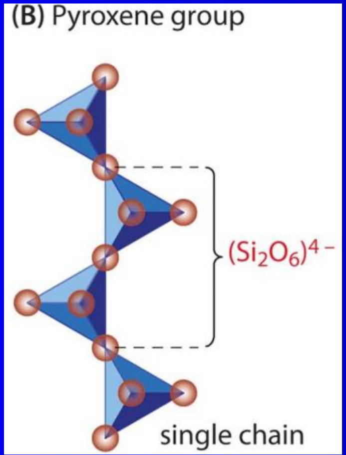
Table 7-4. Properties of the silicate crystal classes

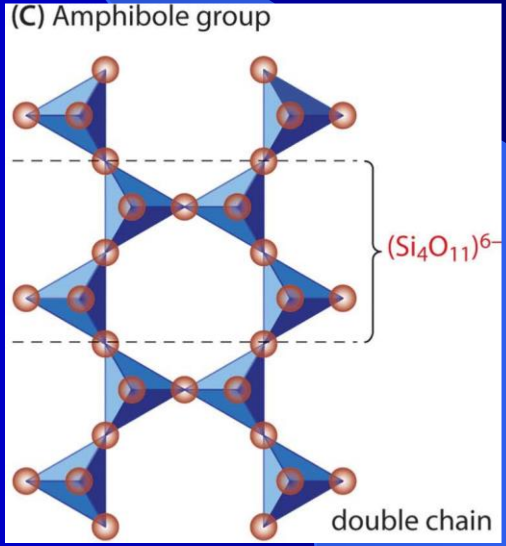
Class	Tetrahedral arrangement	# shared corners	Chemical unit	Si:O	Example
Nesosilicate	Independent tetrahedra	0	SiO_4^{4-}	1:4	Olivine
Sorosilicate	Two tetrahedra sharing a corner	1	$Si_2O_7^{6-}$	1:3.5	Melilite
Cyclosilicate	Three or more tetrahedra sharing two corners, forming a ring	2	SiO_3^{3-}	1:3	Beryl
Inosilicate	Single chain of tetrahedra sharing two corners	2	SiO_3^{3-}	1:3	Augite
	Double chain of tetrahedra alternately sharing two or three corners	2.5	$Si_4O_{11}^{6-}$	1:2.75	Hornblende
Phyllosilicate	Sheet of tetrahedra sharing three corners	3	$Si_2O_5^{2-}$	1:2.5	Kaolinite
Tektosilicate	Framework of tetrahedra sharing all four corners	4	SiO_2	1:2	K-feldspar

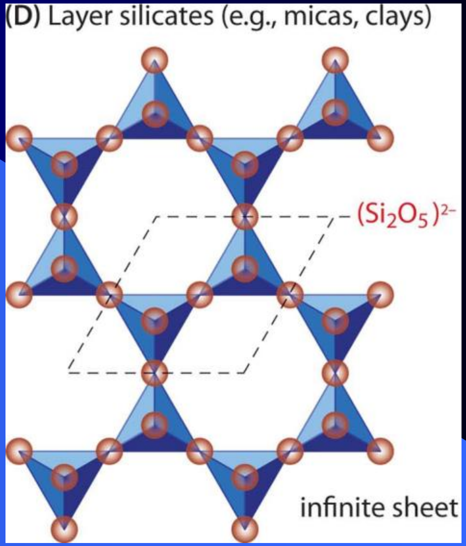






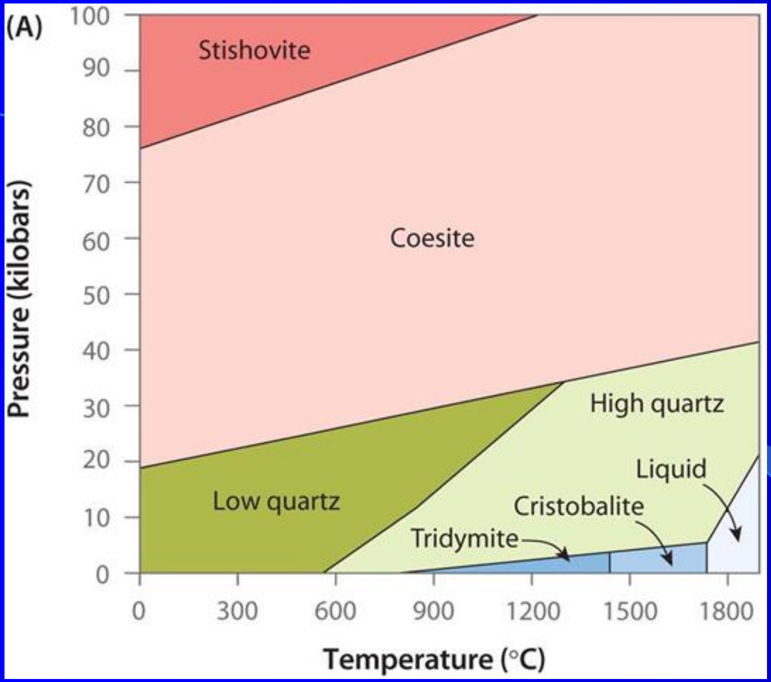






Quartz – SiO_2

P-T conditions and polymorphs

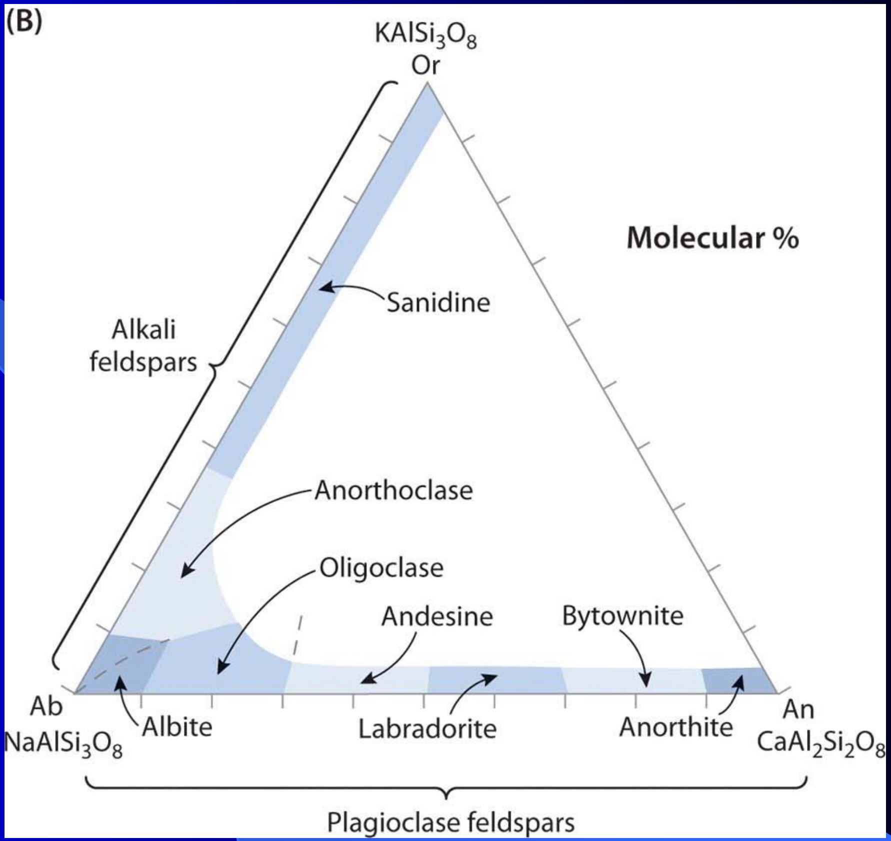


Feldspars

K-feldspar ($KAlSi_3O_8$)

Plagioclase ($NaAlSi_3O_8 \leftrightarrow CaAl_2Si_2O_8$)

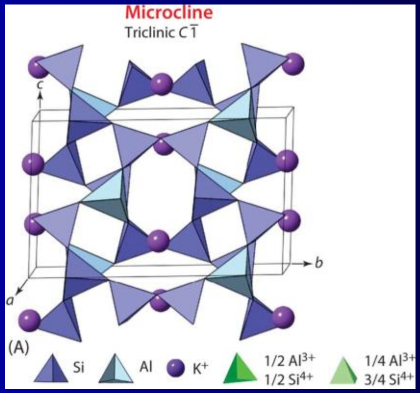
Coupled substitution: CaAl ↔ NaSi

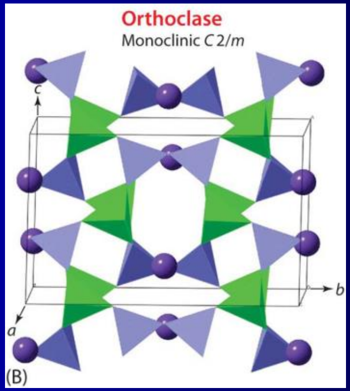


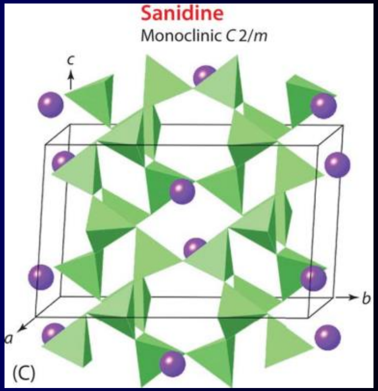
$KAlSi_3O_8$ polymorphs:

The distinction between the polymorphs is based on the ordering of Al in the tetrahedral sites.

- Microcline – low T polymorph – one in every four tetrahedral sites is filled with an Al. Total order
- Orthoclase – moderate T polymorph – Al is distributed over two equivalent tetrahedral sites. Partially ordered
- Sanidine – high T polymorph – equal probability of finding Al in any of the four tetrahedral sites. Completely disordered.

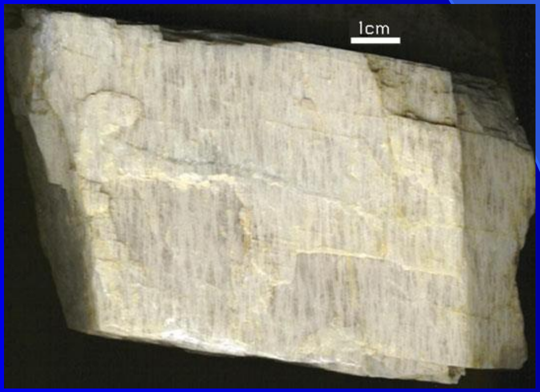






Perthite – albite exsolved from microcline or orthoclase.

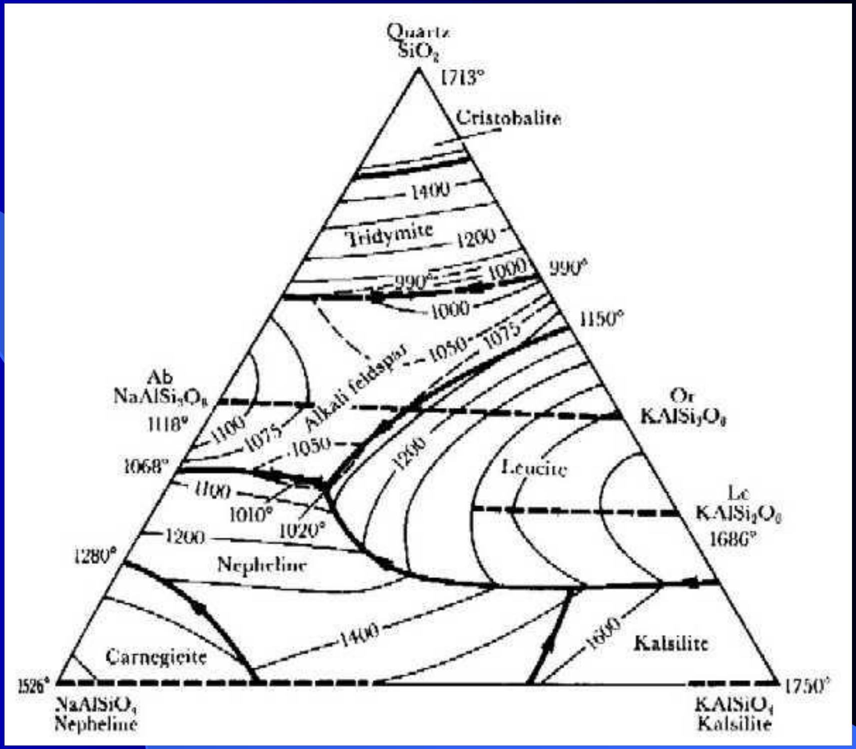
Antiperthite – orthoclase exsolved from albite.



Feldspathoids

- Leucite – $KAlSi_2O_6$
- Nepheline – $(Na,K)AlSiO_4$
- Sodalite – $Na_4Al_3Si_3O_{12}Cl$

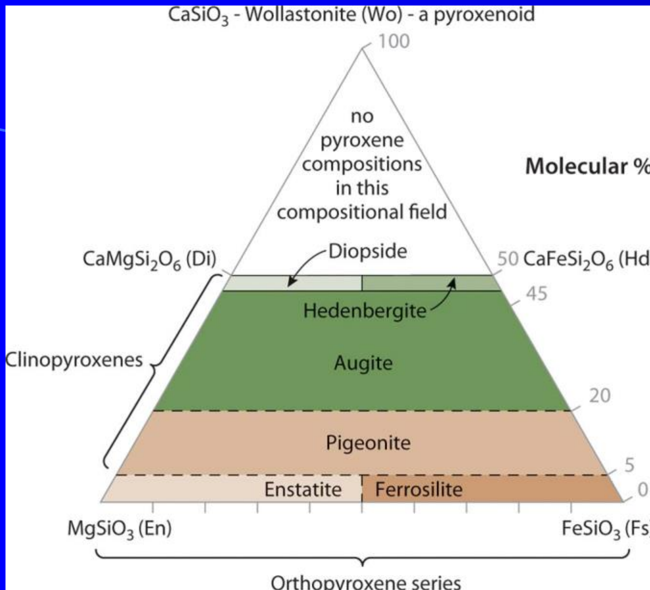
Feldspathoids are found in silica undersaturated igneous rocks. Silica deficient relative to the feldspars.

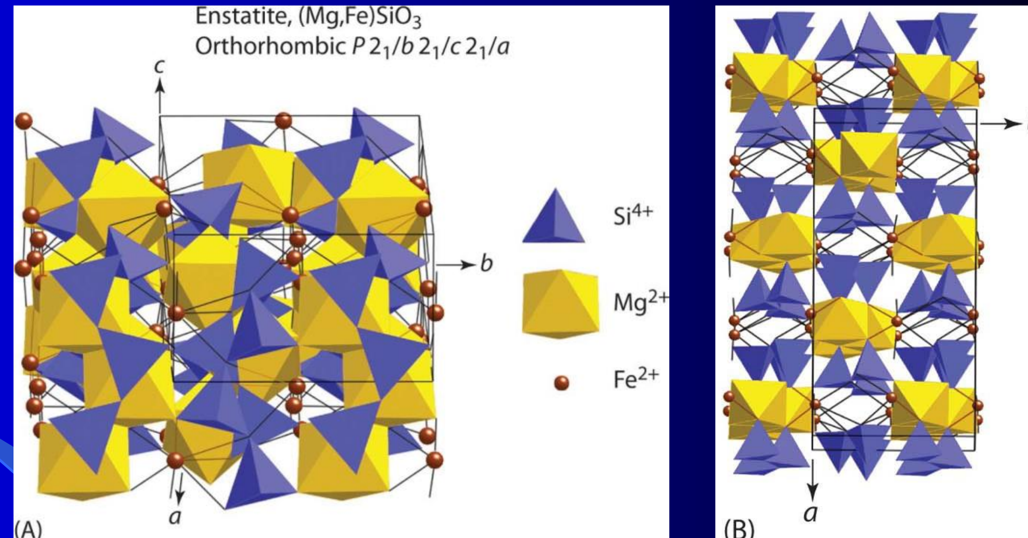


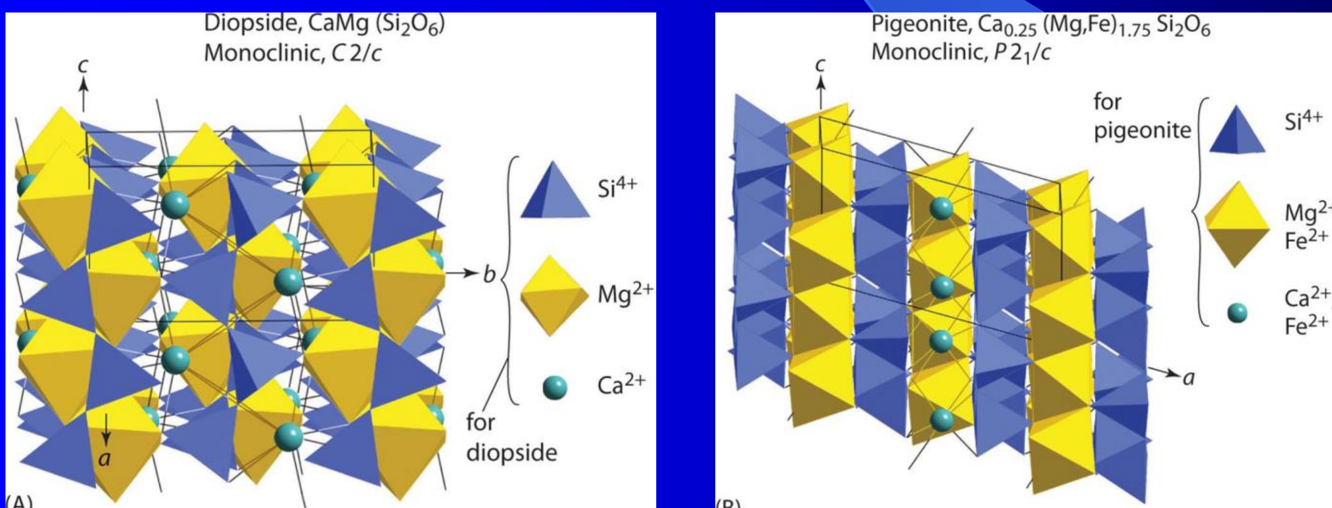
For example:

$$KAlSi_2O_6 + SiO_2 = KAlSi_3O_8$$

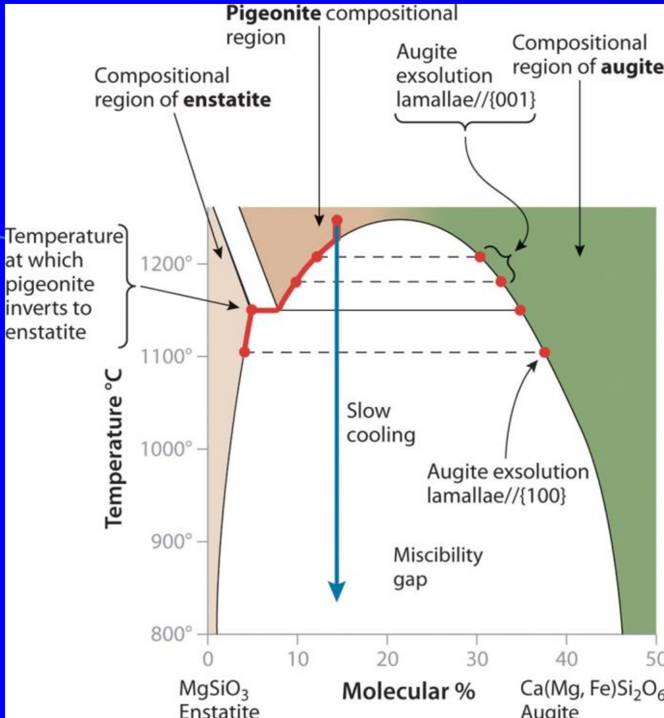
Single chain silicates - Pyroxenes

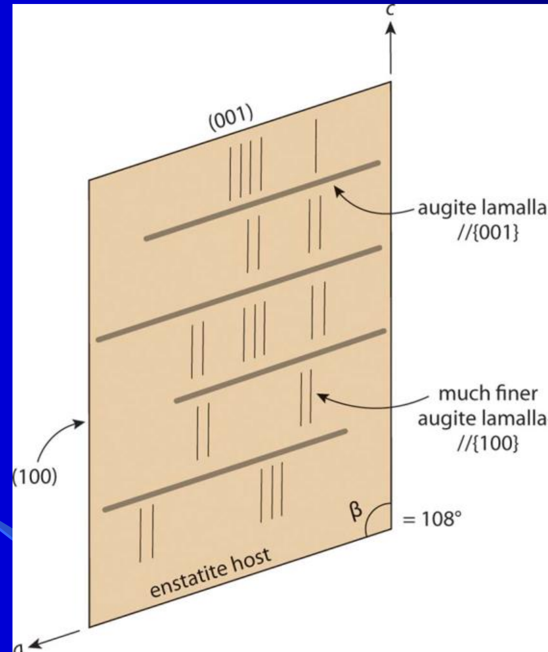






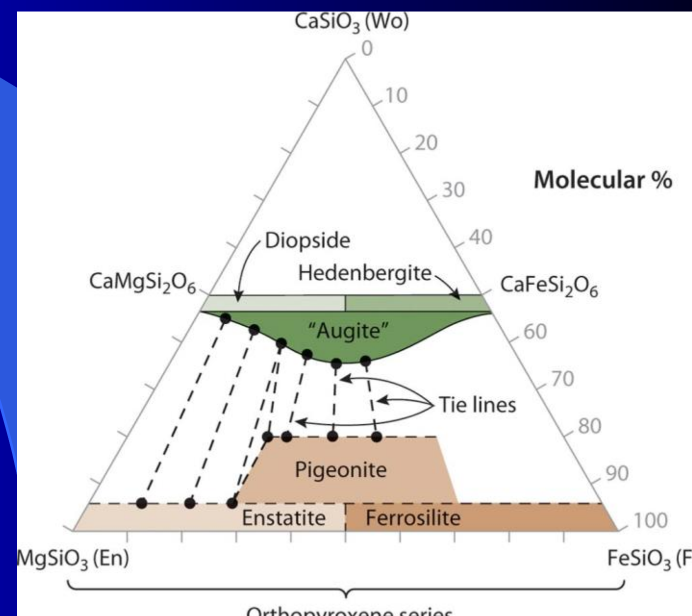
Enstatite: $MgSiO_3$ – $(Mg,Fe)SiO_3$
Pigeonite: $Ca_{0.25}(Mg,Fe)_{1.75}SiO_6$
Augite: $(Ca,Na)(Mg,Fe,Al)(Si,Al)O_2O_6$
Aegirine: $NaFe^{3+}Si_2O_6$



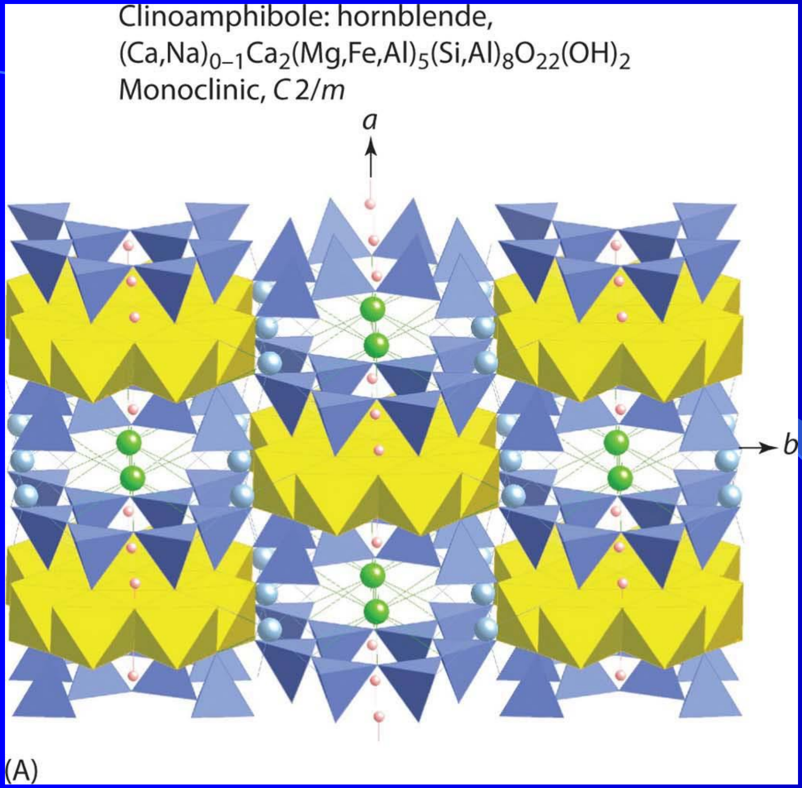


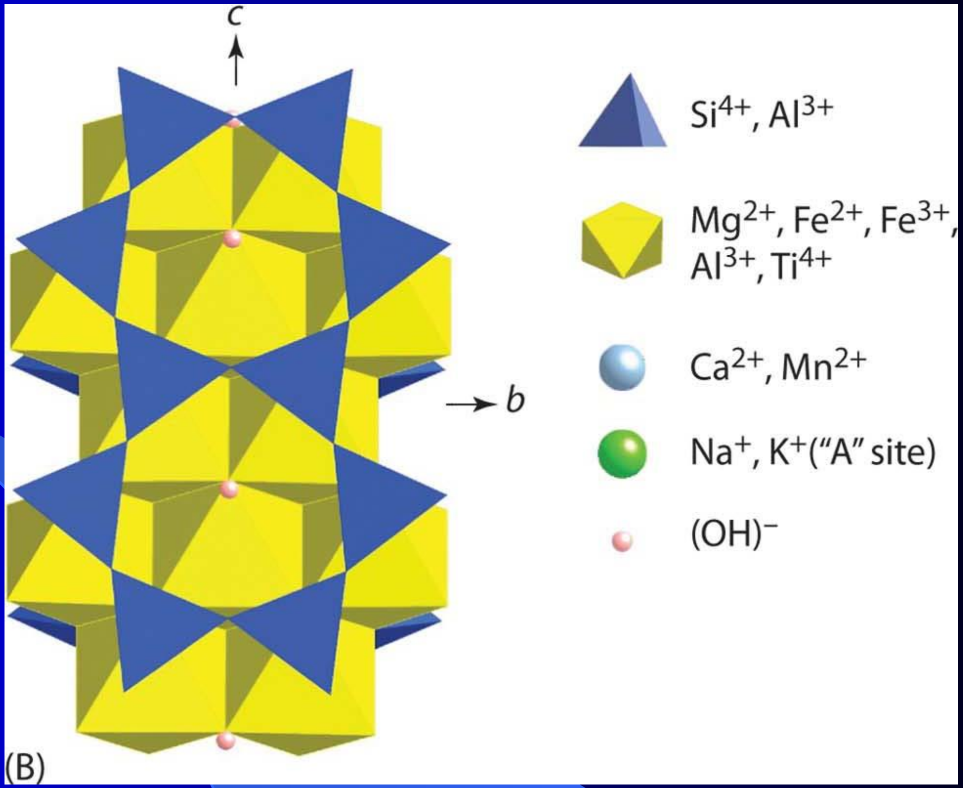
Exsolution of augite lamallae in enstatite host. Enstatite is orthorhombic but orientation of lamallae indicate that the original grain was pigeonite (monoclinic).

Alkali olivine basalts – one Ca-pyroxene. Tholeiites – two pyroxenes, one Ca-rich and the other Ca-poor. Composition of co-existing pyroxenes.



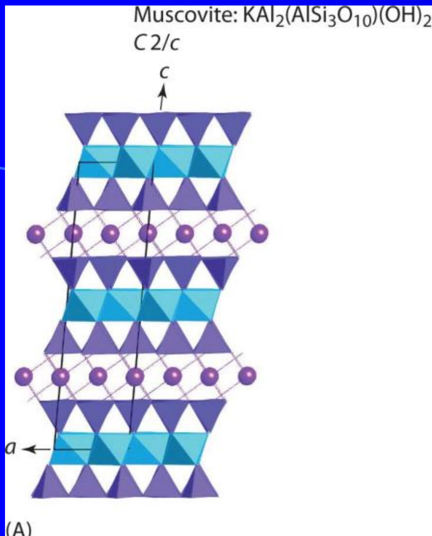
Double chain silicates - Amphiboles

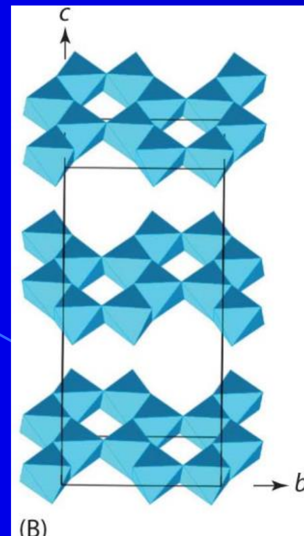


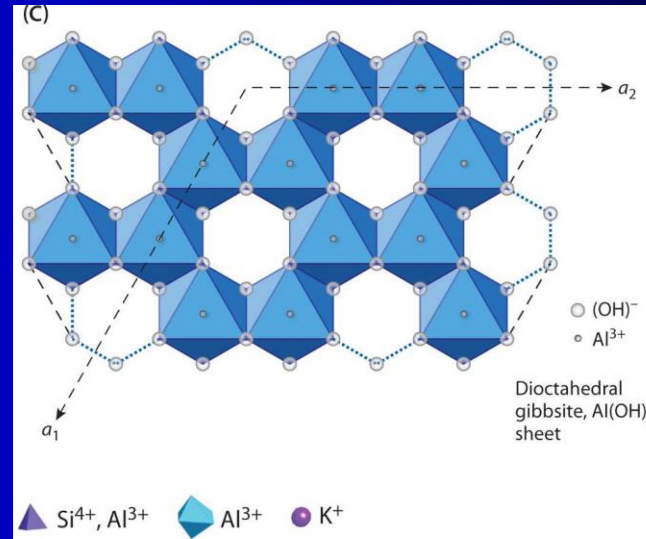


Hornblende: $(Na,K)_{0-1}Ca_2(Mg,Fe,Al)_5(Si,Al)_8O_{22}(OH)_2$

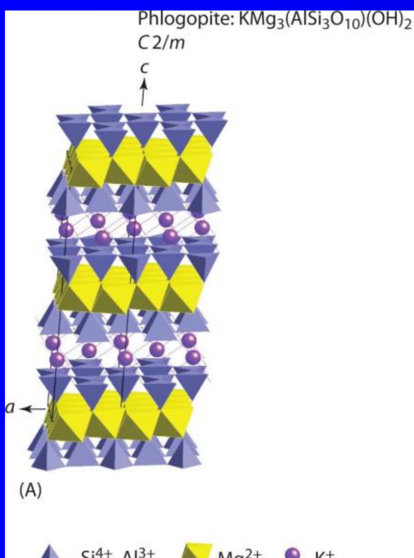
Sheet Silicates - micas

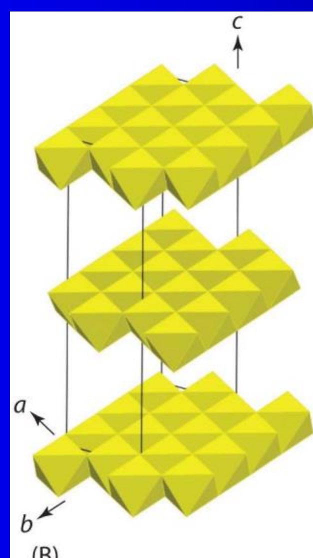


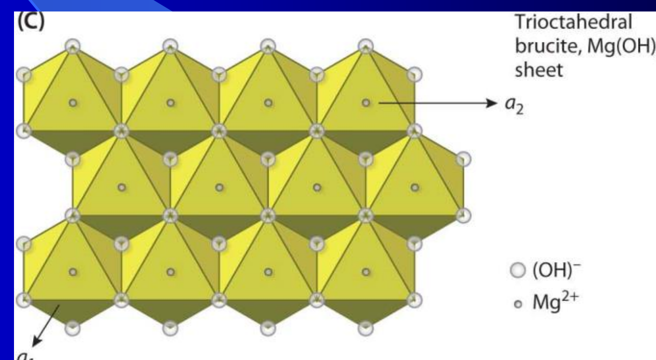




Biotite: $K(Mg, Fe)_3AlSi_3O_{10}(OH)_2$

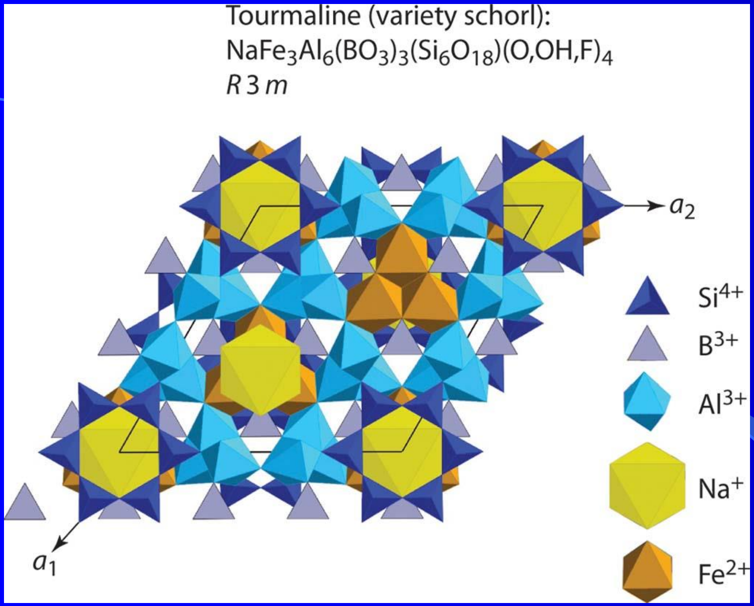




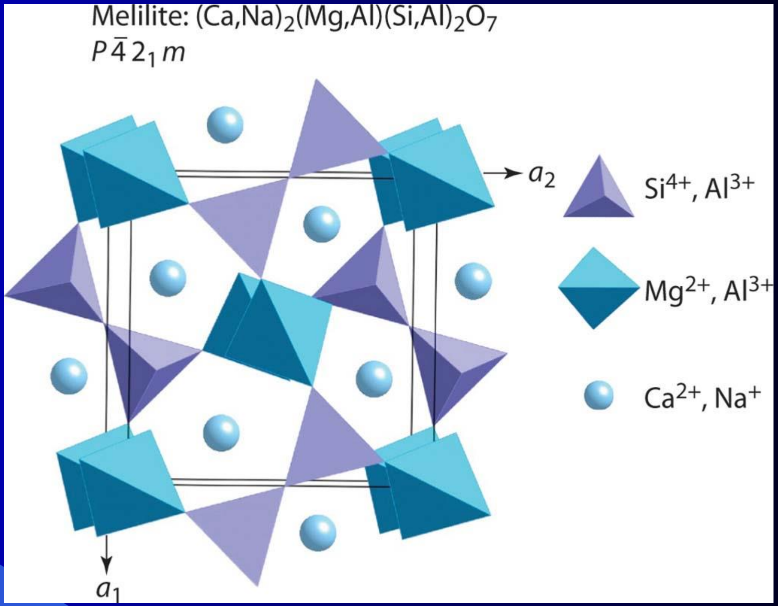


Dioctahedral gibbsite – $Al(OH)_3$
Trioctahedral brucite – $Mg(OH)_2$

Cyclosilicate

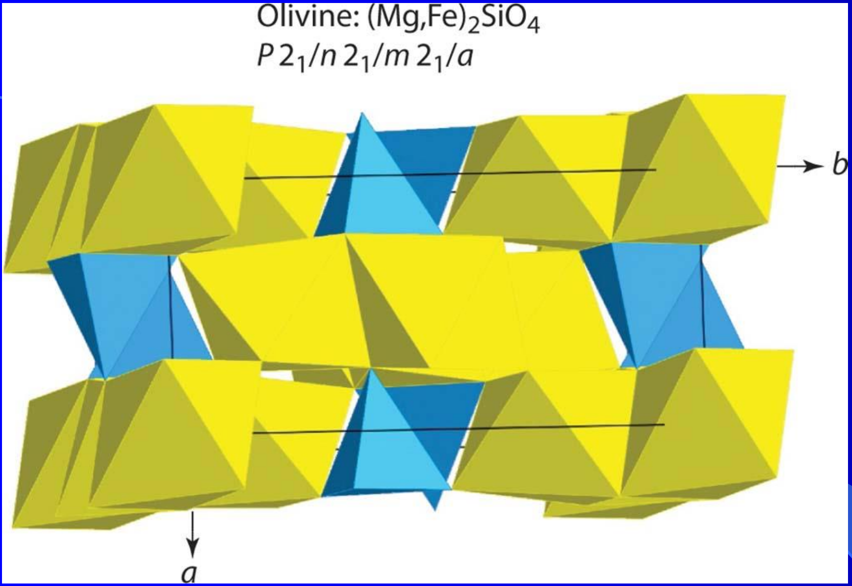


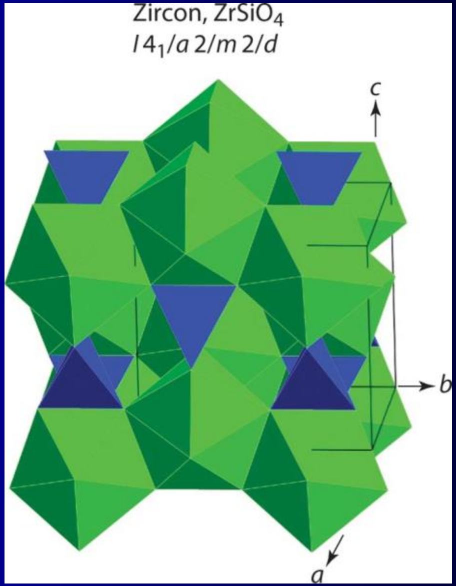
Sorosilicate



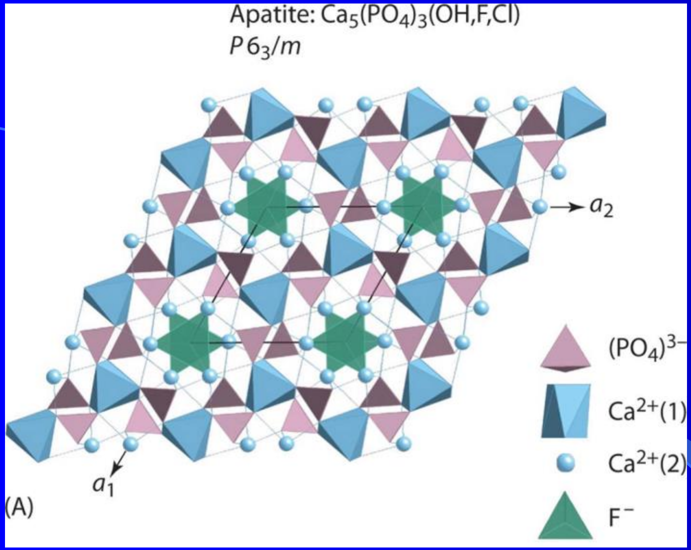
Gehlenite $[Ca_2Al(Al, Si)_2Si_7] \rightarrow$ Akermanite $[Ca_2MgSi_2O_7]$

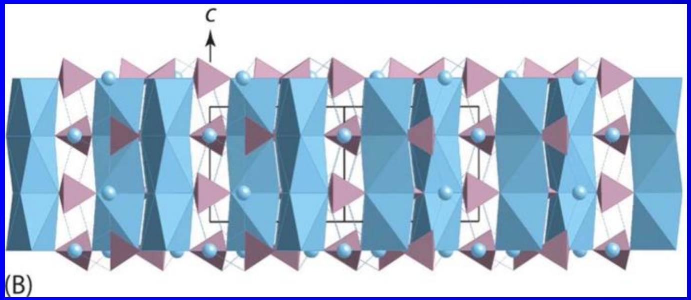
Nesosilicates





Apatite





Chlorapatite – Cl

Fluorapatite – F

Hydroxyapatite - OH

Other Minerals

Mineral	Formula
Oxides	
Chromite	$FeCr_2O_4$
Hematite	Fe_2O_3
Magnetite	Fe_3O_4
Ilmenite	$FeTiO_3$
Rutile	TiO_2
Sulfides	
Pyrite	FeS_2
Pyrrhotite	$Fe_{1-x}S$
Chalcopyrite	$CuFeS_2$