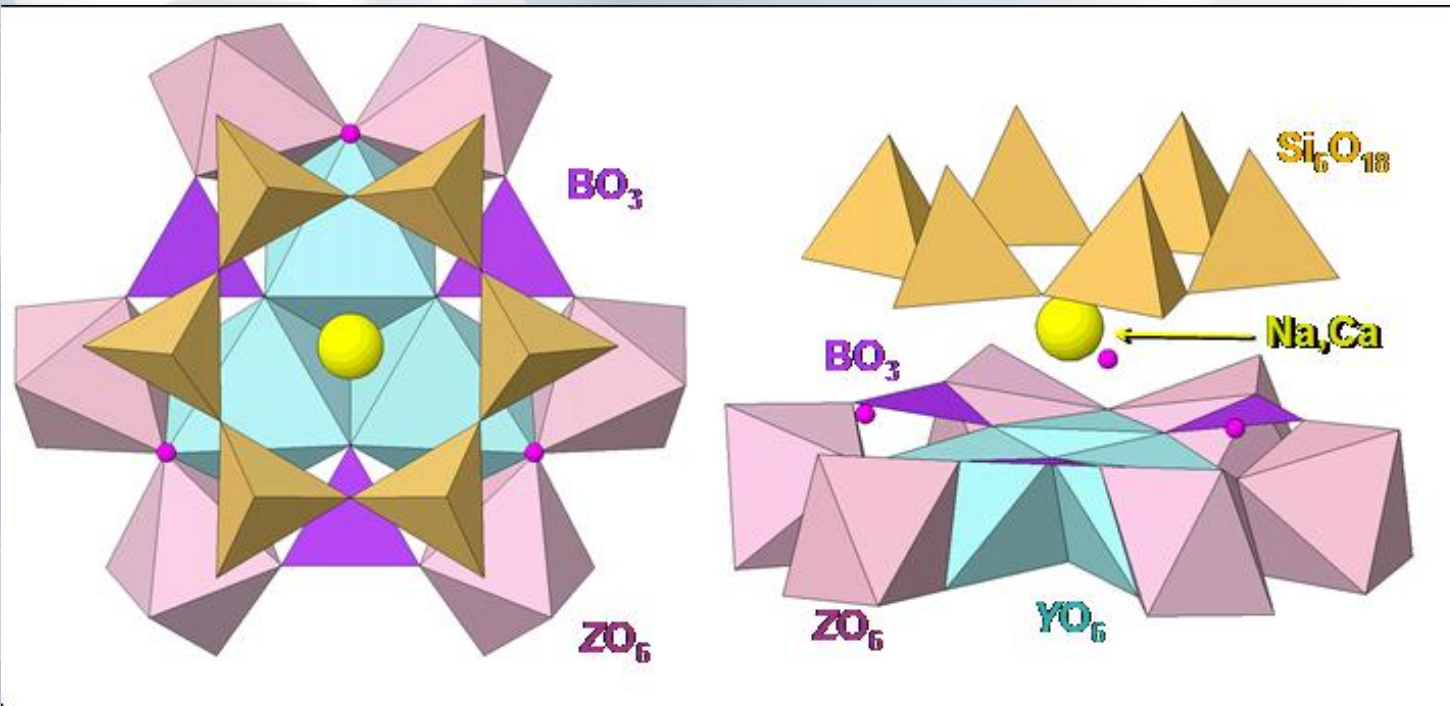


TURMALINAK: $(\text{Na,Ca})(\text{Li,Mg,Al})(\text{Al,Fe,Mn})_6(\text{BO}_3)_3(\text{Si}_6\text{O}_{18})(\text{OH})_4$



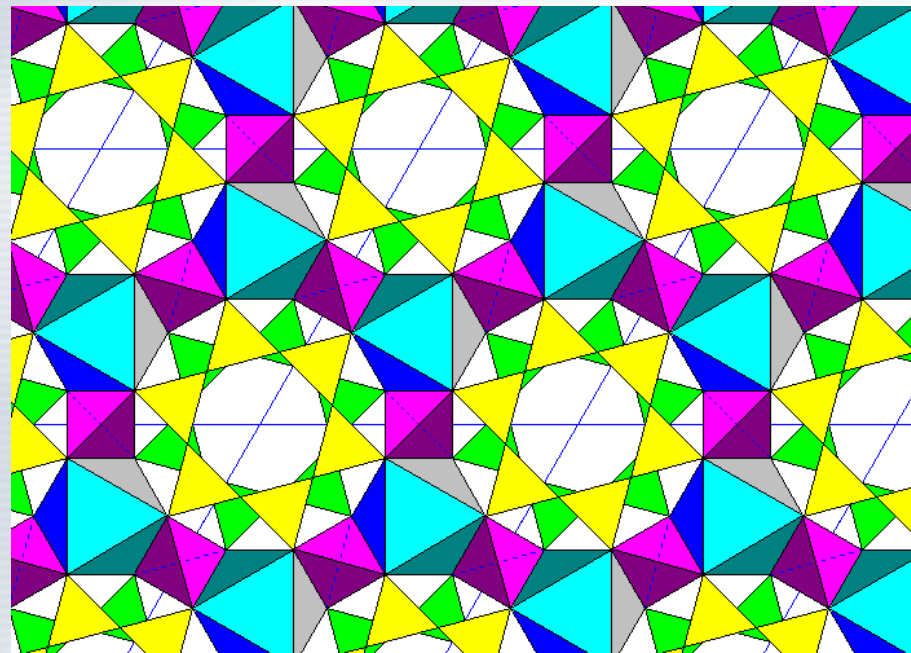
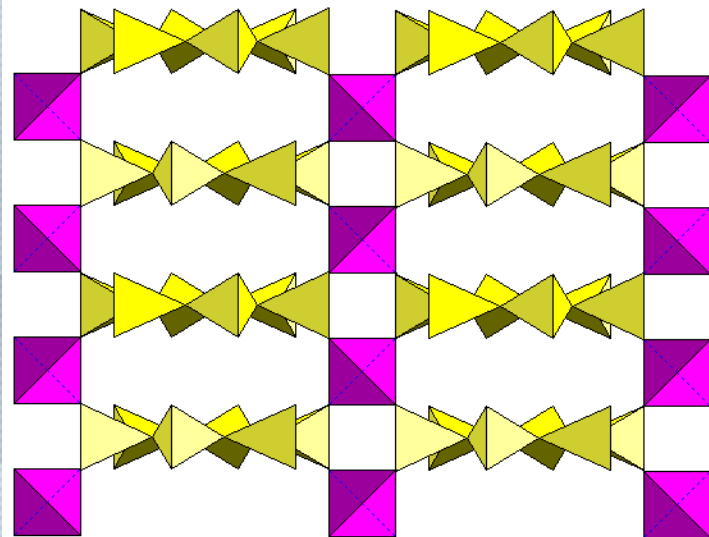
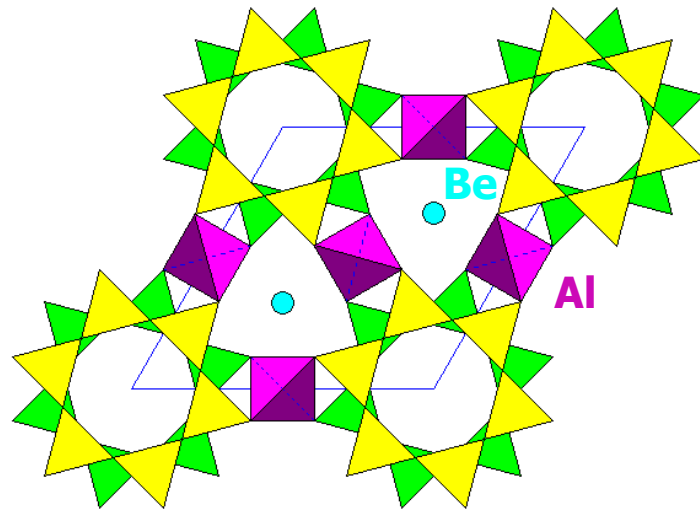
Structure of **tourmalines** (here shown in two projections) consists of six-membered rings of SiO_4 tetrahedra, clusters of edge-sharing octahedra and triangular borate anions, and large cations (usually **Na** or **Ca**) sandwiched between them. The two types of octahedra (YO_6 and ZO_6) can accommodate a wide range of elements (Fe, Al, Mg, Li, V, Cr, Mn and Ti, among others). These elements do not combine at random; in each specific case, their combination depends on size and charge constraints, as well as on the occupancy of other crystallographic sites



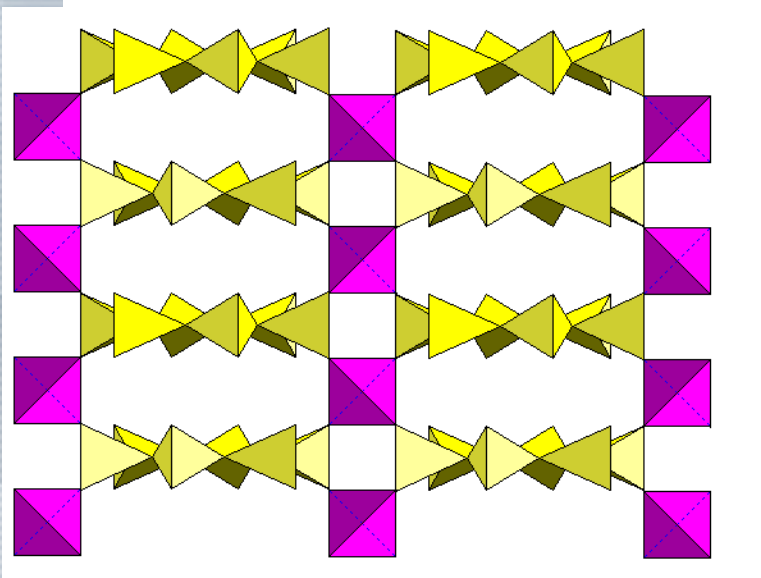
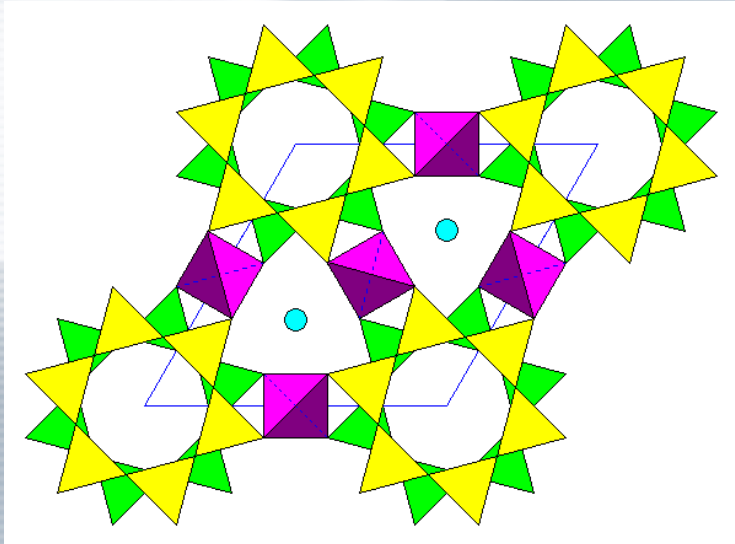
eman ta zabel zazu



BERILO: $\text{Be}_3\text{Al}_2(\text{SiO}_3)_6$



BERILO: $\text{Be}_3\text{Al}_2(\text{SiO}_3)_6$

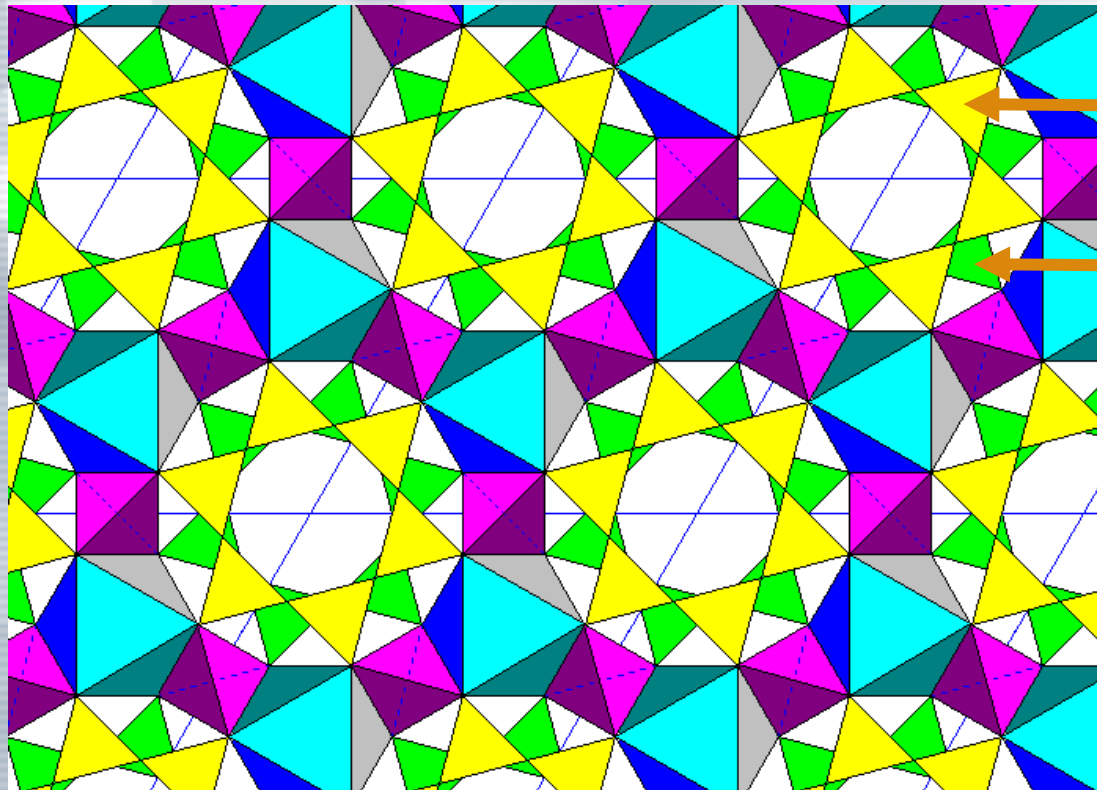


**Berilo berde:
esmeralda**



**Berilo urdina:
aguamarina**

CORDIERITA??: $(\text{Mg,Fe})_2\text{Al}_3(\text{AlSi}_5\text{O}_{18}) \cdot n\text{H}_2\text{O}$



Si/Al

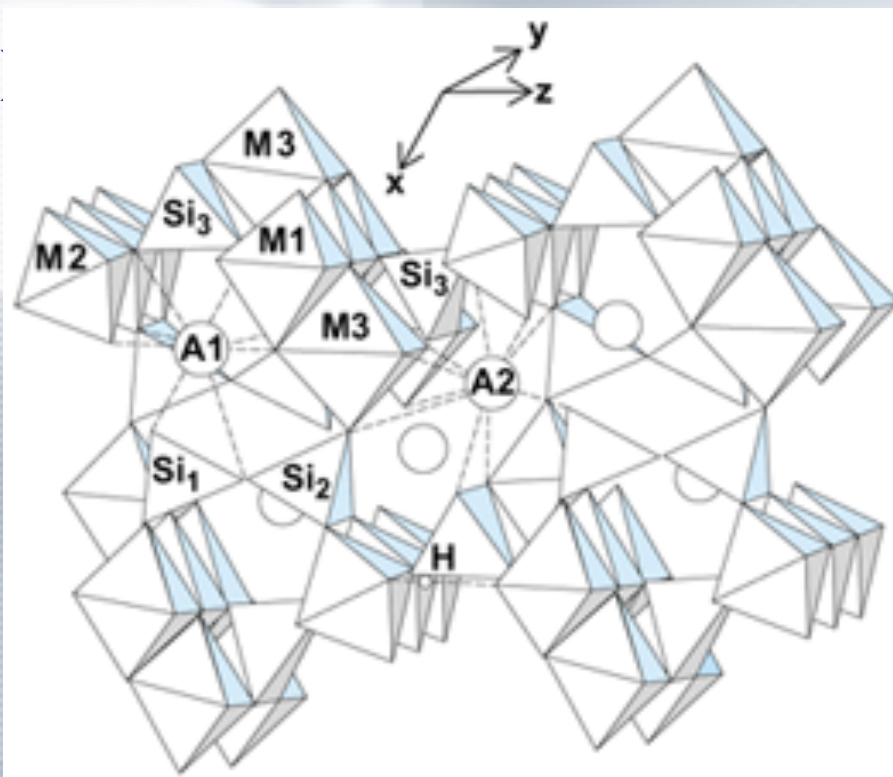
Al

Si/Al



ZIKLOSILIKATO
edo...?

EPIDOTAREN taldea: $\text{Ca}_2(\text{Fe}^{3+}, \text{Al}, \text{Mn}^{3+})\text{Al}_2\text{O}[\text{SiO}_4][\text{Si}_2\text{O}](\text{OH})$



Crystal structure of the epidote-group mineral clinozoisite. Si_3 represents the silicate group SiO_4 ; Si_1 and Si_2 represent the silicate group Si_2O_7 . M1, M2, and M3 are distinct kinds of octahedra. A1 and A2 are cavities in the framework structure. (After W. A. Deer, R. A. Howie, and J. Zussman, *An Introduction to the Rock-Forming Minerals*, Halsted Press, 1992)

Beste modu bat formula idazteko:



A: Ca, Sr, Pb^{II} , Ce^{III} , Y^{III} , La^{III} , Th^{III} (allanita), Fe, Mn, Mn.

B: Al (zoisita/klinozoisita), Fe (epidota), Mn, V, Ti (tribalenteak)

OLIBINOaren taldea:

Forsterita Fe_2SiO_4 – Fayalita Mg_2SiO_4

GRANATEen taldea:

PIrALSPita

Piropo $\text{Mg}_3\text{Al}_2(\text{SiO}_4)_3$ - *Almandino* $\text{Fe}_3\text{Al}_2(\text{SiO}_4)_3$ - *Espesartina* $\text{Mn}_3\text{Al}_2(\text{SiO}_4)_3$

UGRANDita

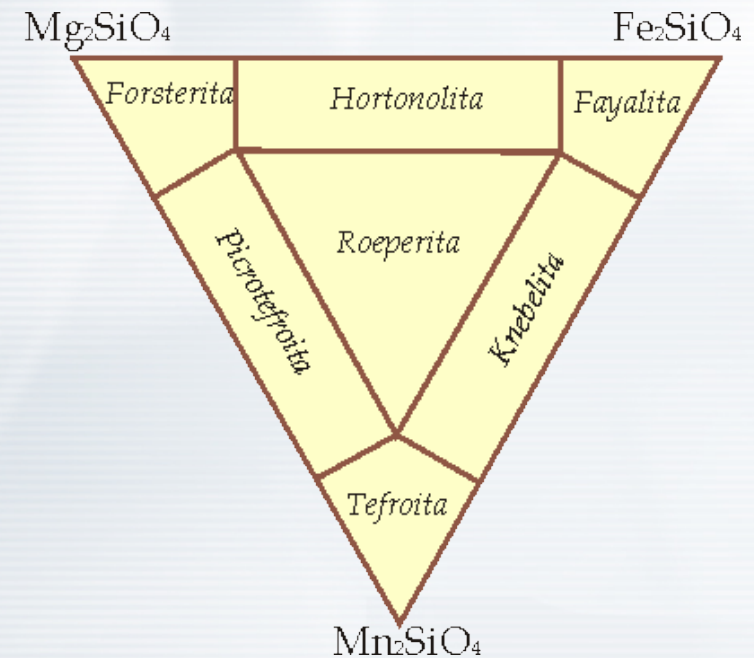
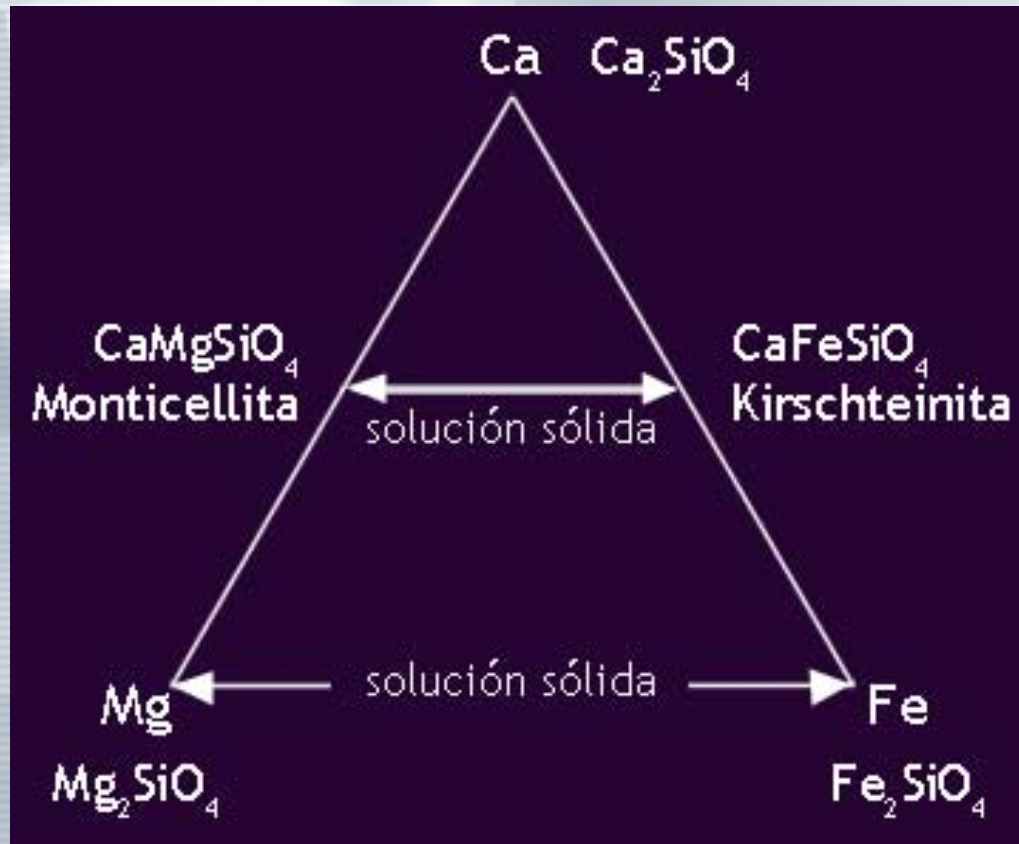
Uvarovita $\text{Ca}_3\text{Cr}_2(\text{SiO}_4)_3$ - *Grosularia* $\text{Ca}_3\text{Al}_2(\text{SiO}_4)_3$ - *Andradita* $\text{Ca}_3\text{Fe}_2(\text{SiO}_4)_3$

ALUMINOSILIKATOAK: Al_2SiO_5

Andaluzita-Sillimanita-Distena (zianita)

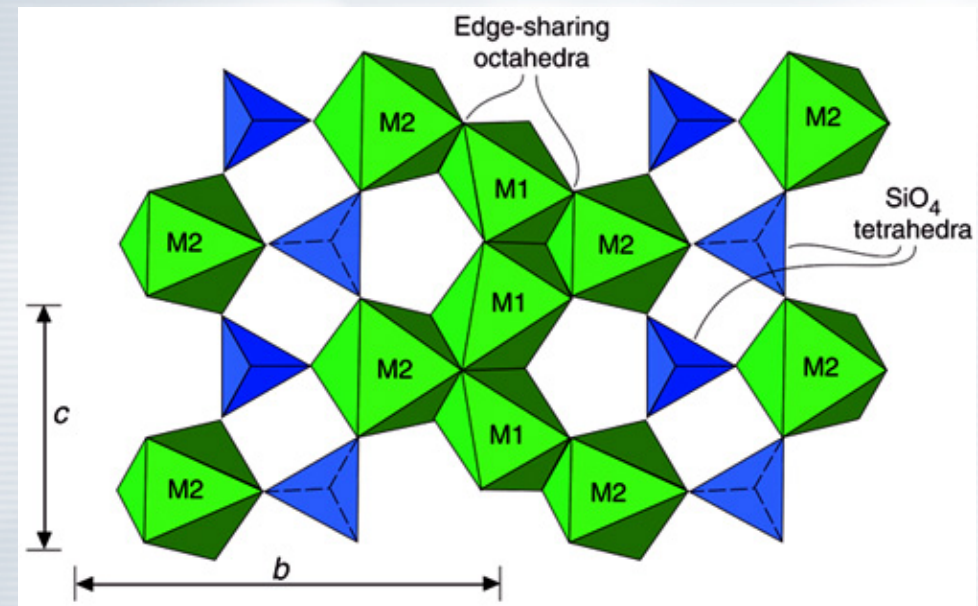
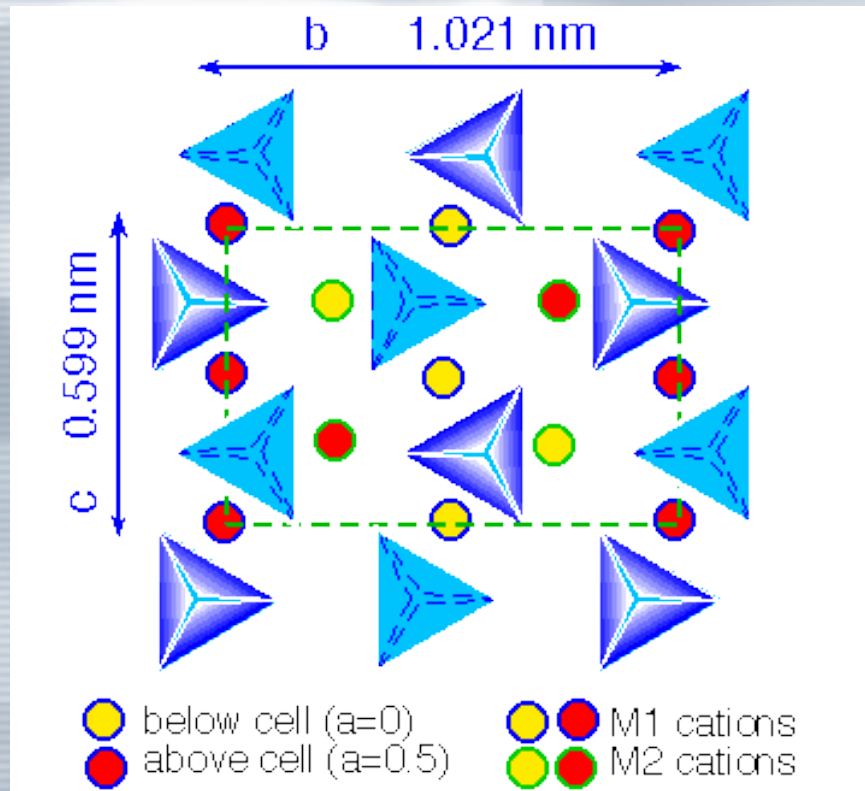
BESTE BATZUK:

ZIRKOIA $\text{Zr}(\text{SiO}_4)$, KLORITOIDE $(\text{Fe}, \text{Mg}, \text{Mn})\text{Al}_2\text{SiO}_5(\text{OH})_2$
eta ESTAUIROLITA $(\text{Fe}^{2+}, \text{Mg}, \text{Zn})_2\text{Al}_9(\text{Si}, \text{Al})_4\text{O}_{22}\text{OH}_2$

OLIBINO Fe_2SiO_4 - Mg_2SiO_4 

Alterazioak, hauetako zeintzuk??: serpentina, serizita, Fe-oxidoak, kaolinita, kuartzo, aktinolita, grosularia, klorita

OLIBINO Fe_2SiO_4 - Mg_2SiO_4



Ca egotekotan, M2 posizioetan sartzeko joera dauka. Zergatik?

OLIBINO Fe_2SiO_4 - Mg_2SiO_4

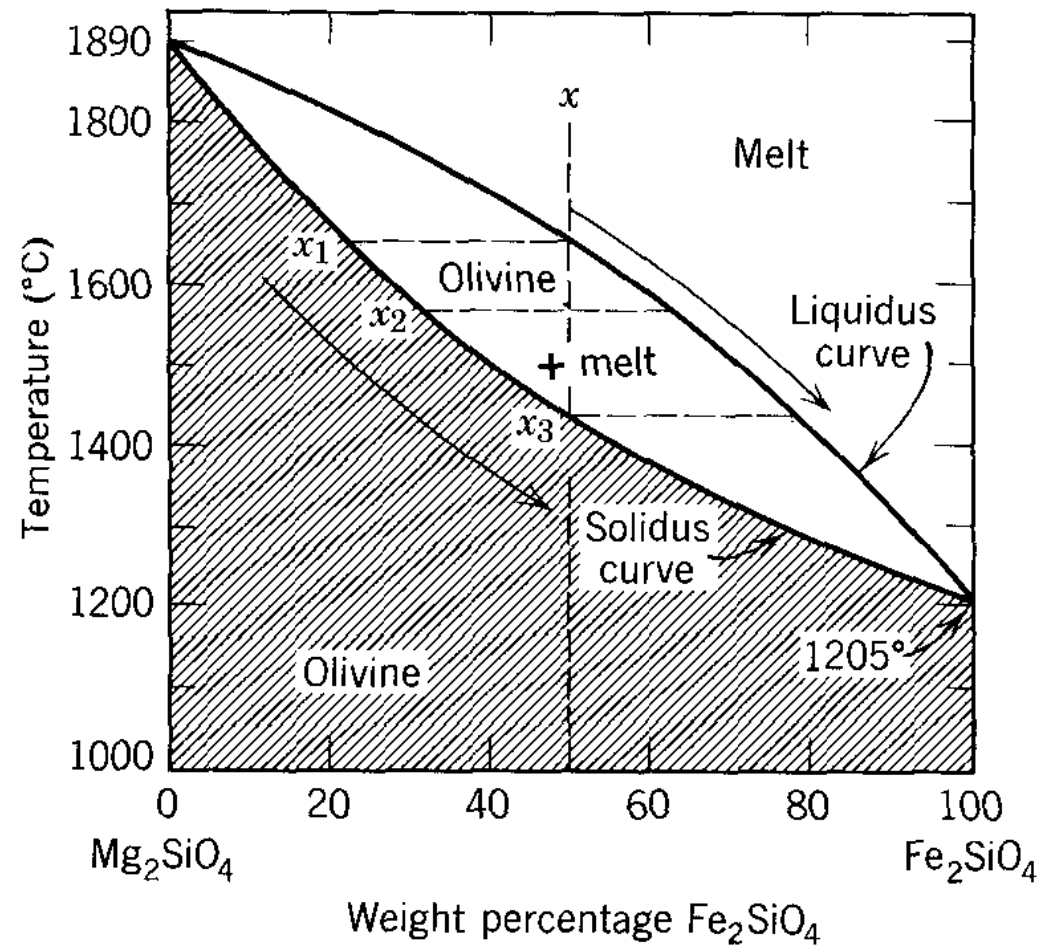
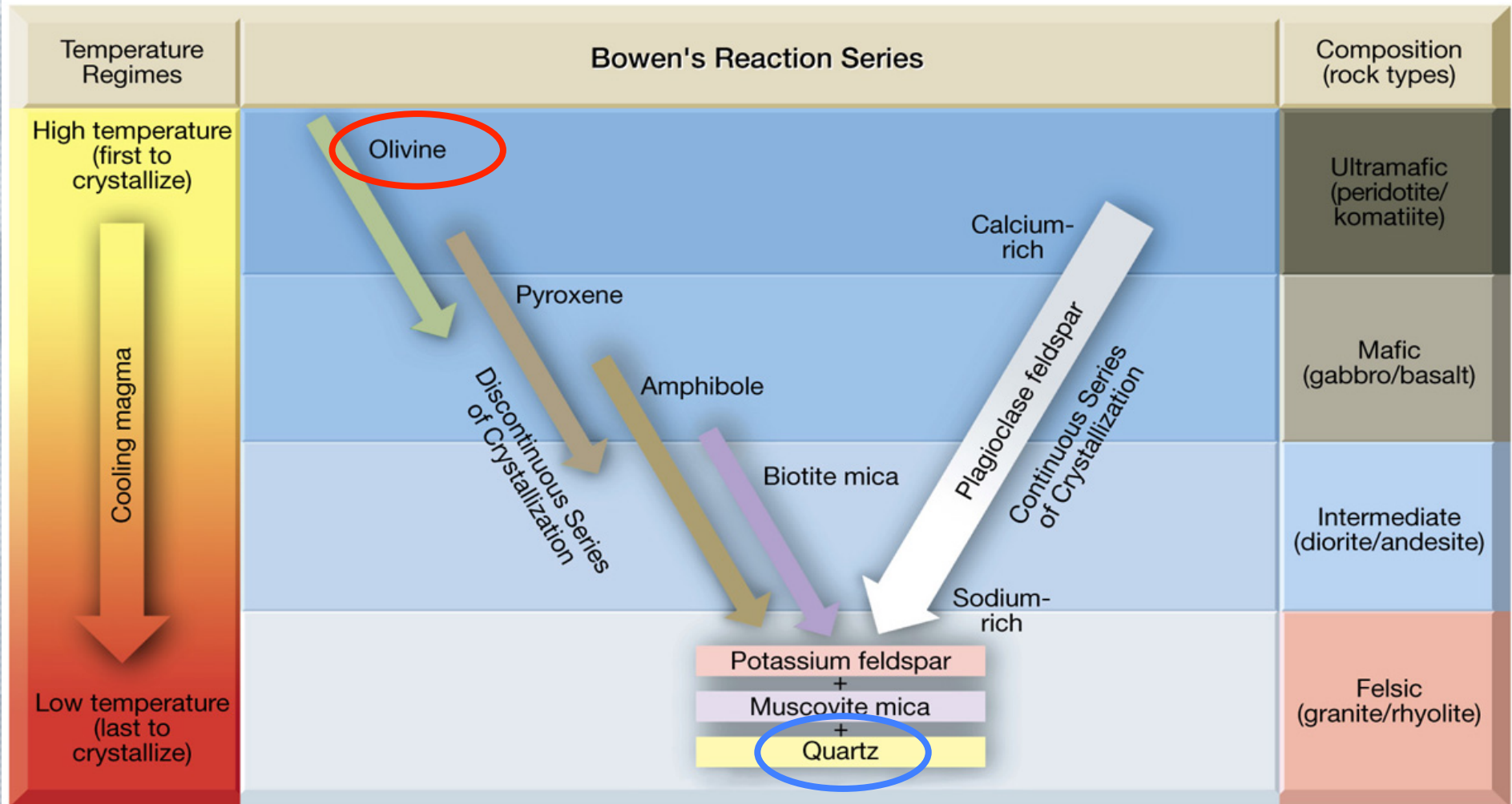
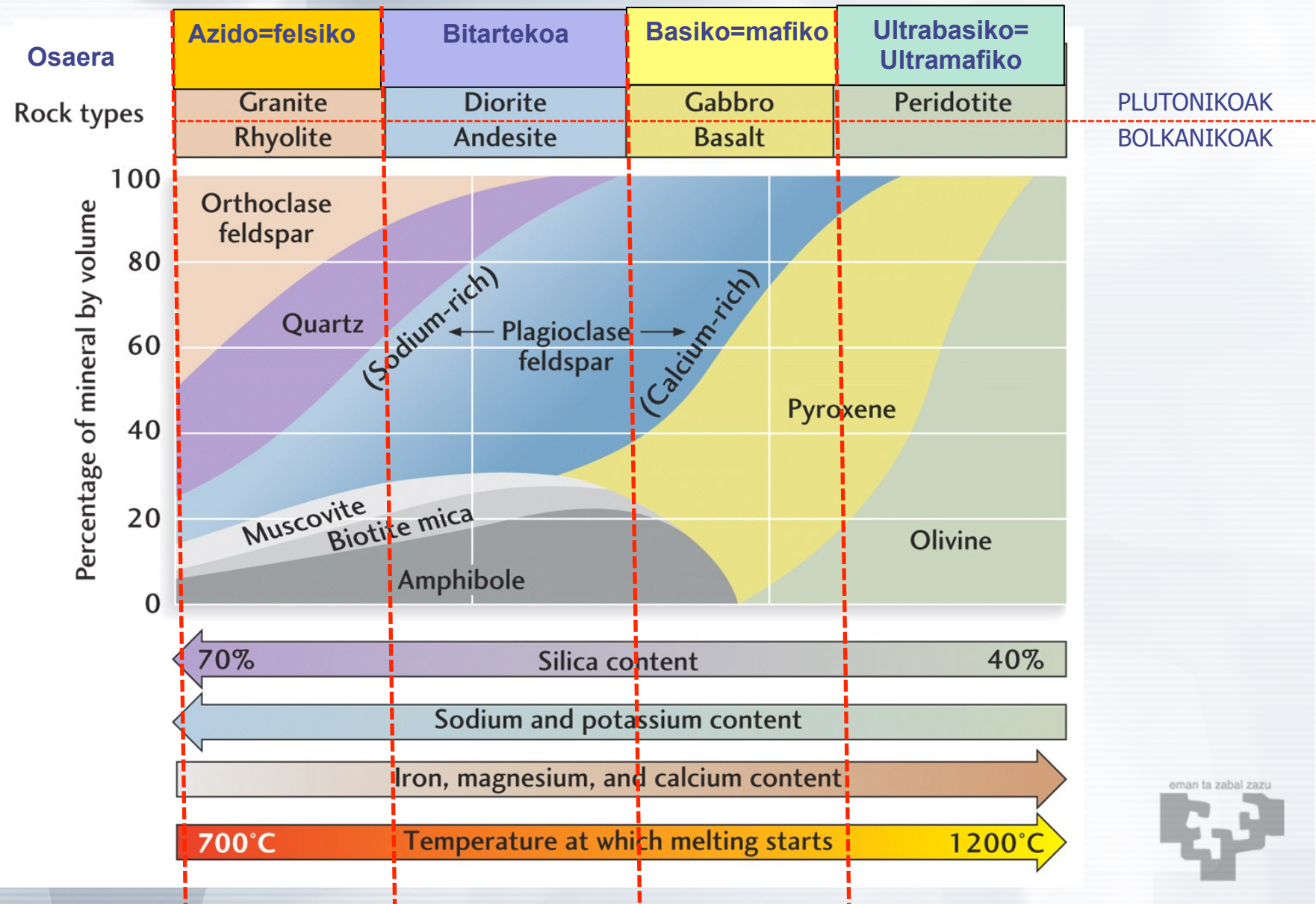


FIG. 10.7. Temperature-composition diagram for the system Mg_2SiO_4 - Fe_2SiO_4 at atmospheric pressure.

OLIBINO Fe_2SiO_4 - Mg_2SiO_4



PIROXENOAK-ANFIBOLAK



GRANATEAK: $A_3B_2(SiO_4)_3$ edo $A_3B_2(XO_4)_3 - x(OH)_{4x}$

A = Ca, Fe^{2+} , Mg, Mn^{2+}

B = Al, Cr^{3+} , Fe^{3+} , Mn^{3+} , Si, Ti, V^{3+} , Zr

X = Si, Al

PIrALSPita

Piropo $Mg_3Al_2(SiO_4)_3$

Almandino $Fe_3Al_2(SiO_4)_3$

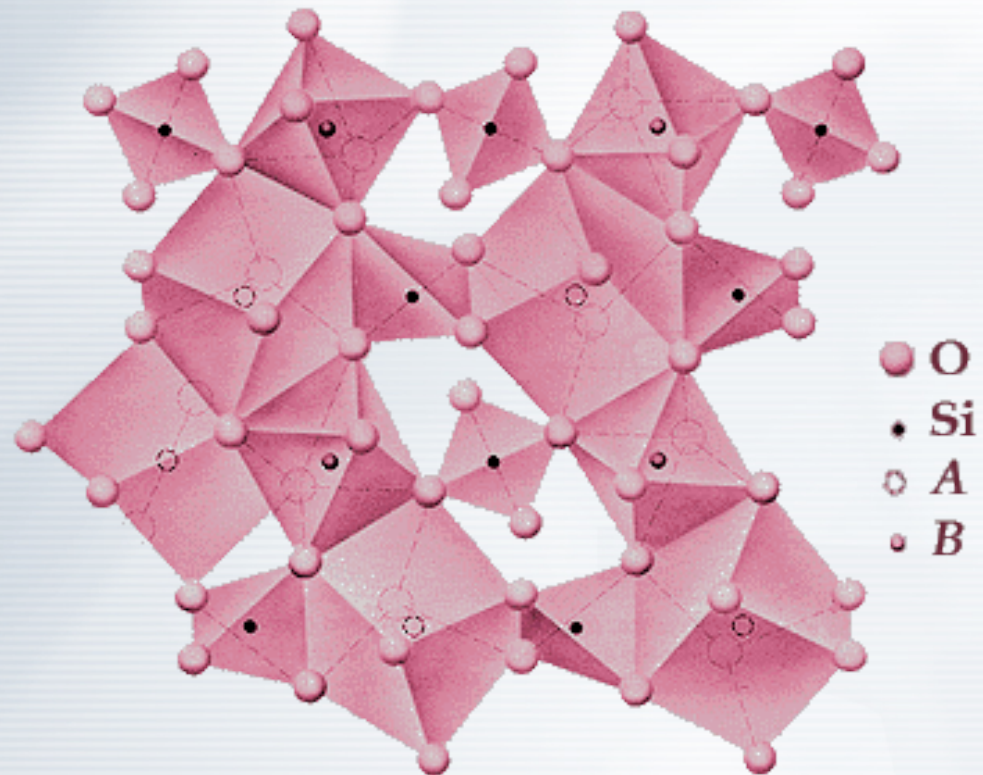
Espesartina $Mn_3Al_2(SiO_4)_3$

UGRANDita

Uvarovita $Ca_3Cr_2(SiO_4)_3$

Grosularia $Ca_3Al_2(SiO_4)_3$

Andradita $Ca_3Fe_2(SiO_4)_3$



GRANATEAK: $A_3B_2(SiO_4)_3$ edo $A_3B_2(XO_4)_3 - x(OH)_{4x}$

A = Ca, Fe^{2+} , Mg, Mn^{2+}

B = Al, Cr^{3+} , Fe^{3+} , Mn^{3+} , Si, Ti, V^{3+} , Zr

X = Si, Al

PIRALS Pita

Piropo $Mg_3Al_2(SiO_4)_3$

Almandino $Fe_3Al_2(SiO_4)_3$

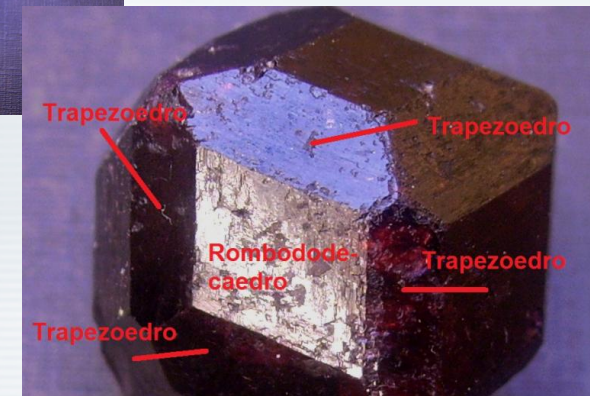
Espesartina $Mn_3Al_2(SiO_4)_3$

UGRANDita

Uvarovita $Ca_3Cr_2(SiO_4)_3$

Grosularia $Ca_3Al_2(SiO_4)_3$

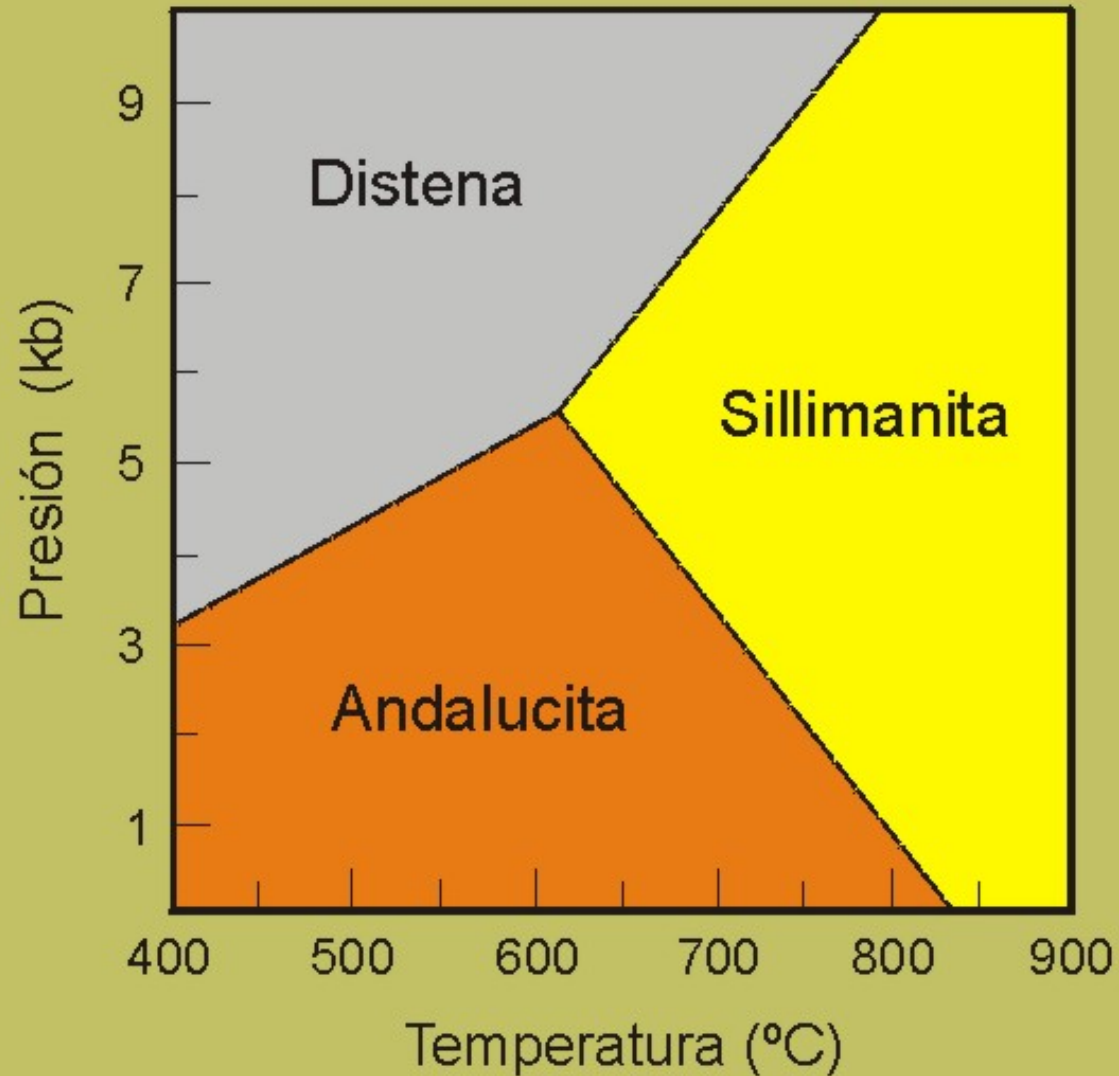
Andradita $Ca_3Fe_2(SiO_4)_3$



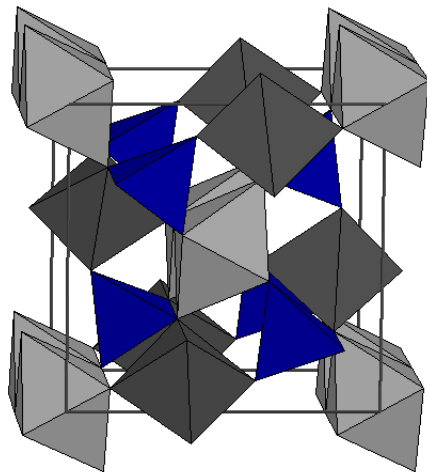
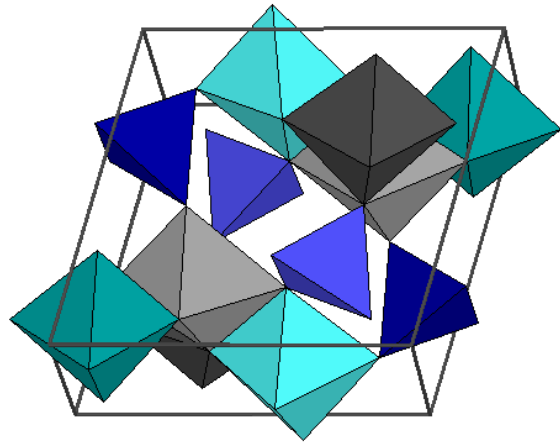
Hauetako zeintzuk aurki daitezke skarn, kareharria, arbela, marmol, gneiss edo kuartzita batean?



ALUMINIO-SILIKATOAK $\text{Al}_2\text{SiO}_5 = \text{Al}_2\text{O}_3\text{SiO}_4$



ALUMINIO-SILIKATOAK $\text{Al}_2\text{SiO}_5 = \text{Al}_2\text{OSiO}_4$



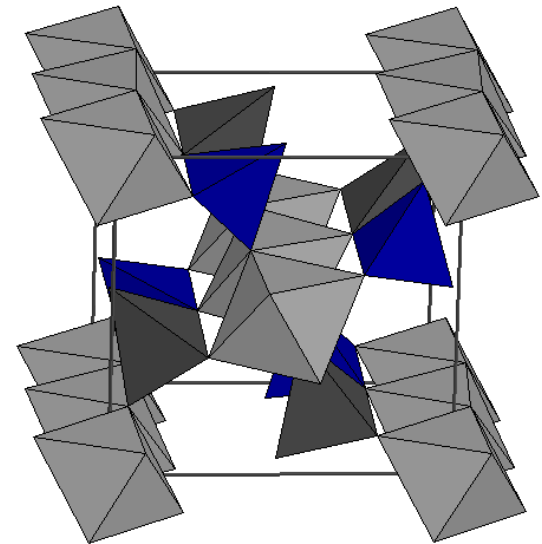
Distena

Sillimanita

Andalucita

500 600 700 800 900

Temperatura (°C)

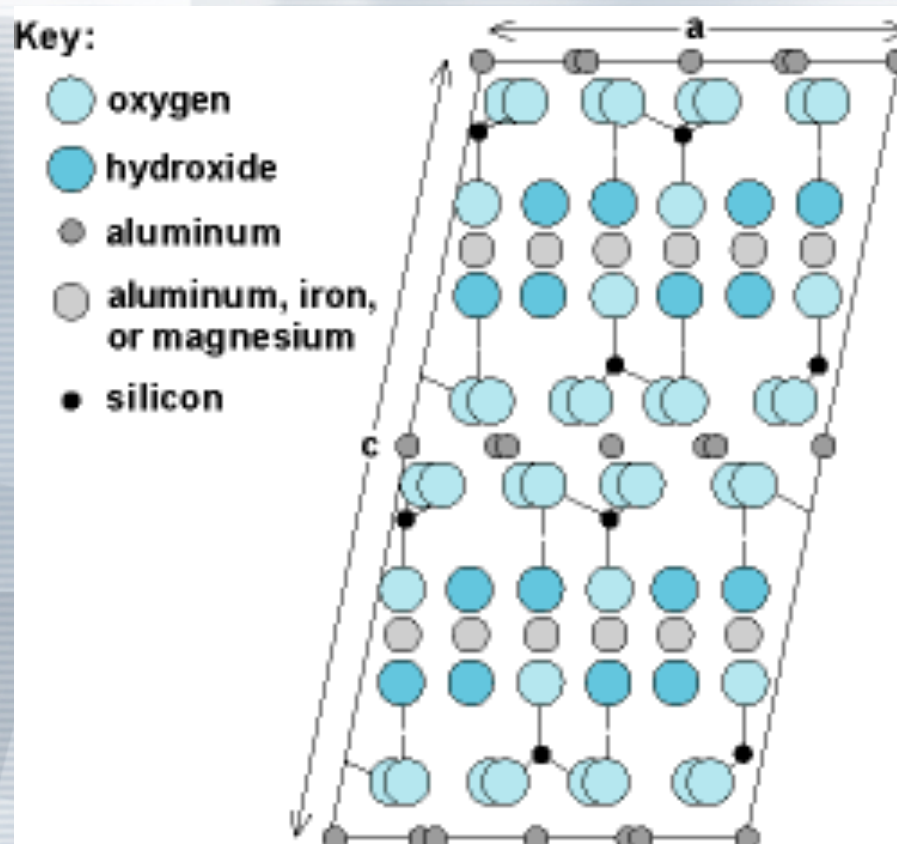


ZIRKOIA $\text{Zr}(\text{SiO}_4)$

Zirkonita= aldarte artifiziala

Sarritan metamiktikoa

KLORITOIDE $(\text{Fe}, \text{Mg}, \text{Mn})\text{Al}_2\text{SiO}_5(\text{OH})_2$



Orri oktaedrikoa

Tetredroak (elkarrekin lotu barik)

ZIRKOIA $\text{Zr}(\text{SiO}_4)$

Zirkonita= aldarte artifiziala

Sarritan metamiktikoa

KLORITOIDE $(\text{Fe}, \text{Mg}, \text{Mn})\text{Al}_2\text{SiO}_5(\text{OH})_2$

ESTAUROLITA $(\text{Fe}^{2+}, \text{Mg}, \text{Zn})_2\text{Al}_9(\text{Si}, \text{Al})_4\text{O}_{22}(\text{OH})_2$



A. metamorfiko MOTAK:

Arroka buztintsua + Presio konpresiboak + T

