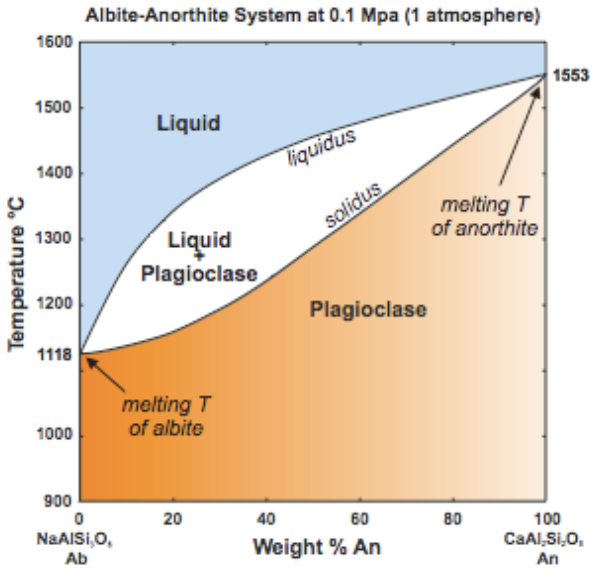
Equilibrio de fases III:
Sistemas binarios 2 y Ternarios

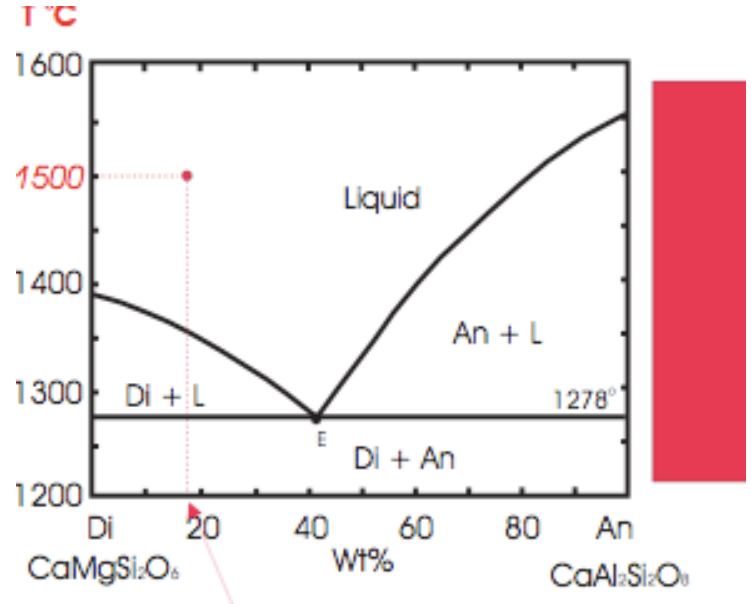
GL42A, Martes 26 de Abril, 2011

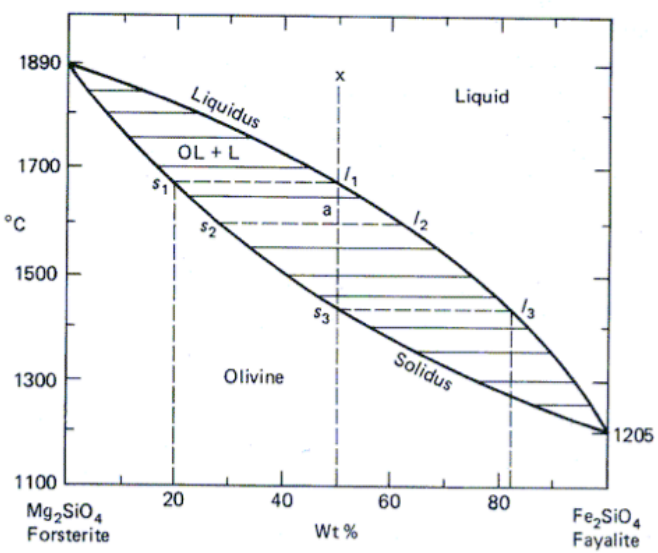
- Control 1: Martes 10 de mayo (mayoría)

- Materia: Módulo 1 del Curso
  - gases, leyes termodinámica
  - equilibrio de fases 1, 2 y 3 componentes
  - equillibrio redox

Sistemas binarios

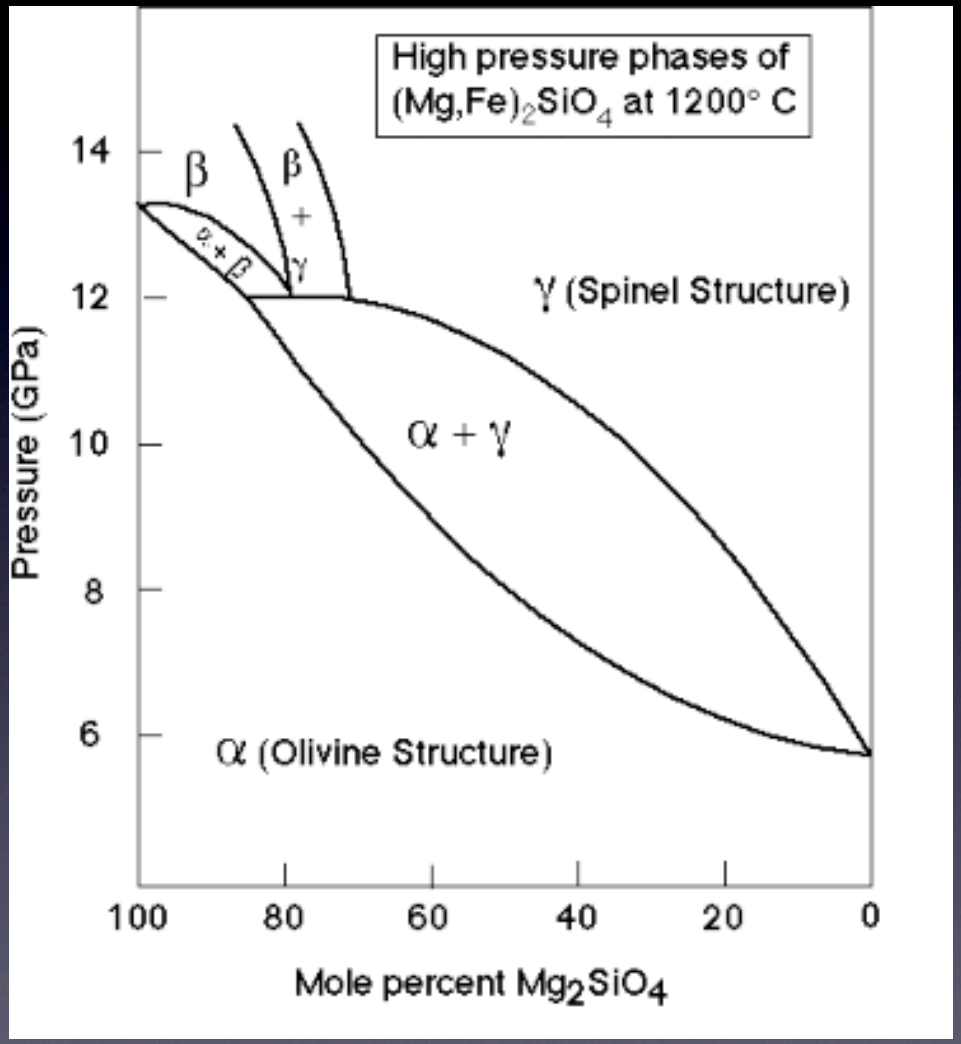


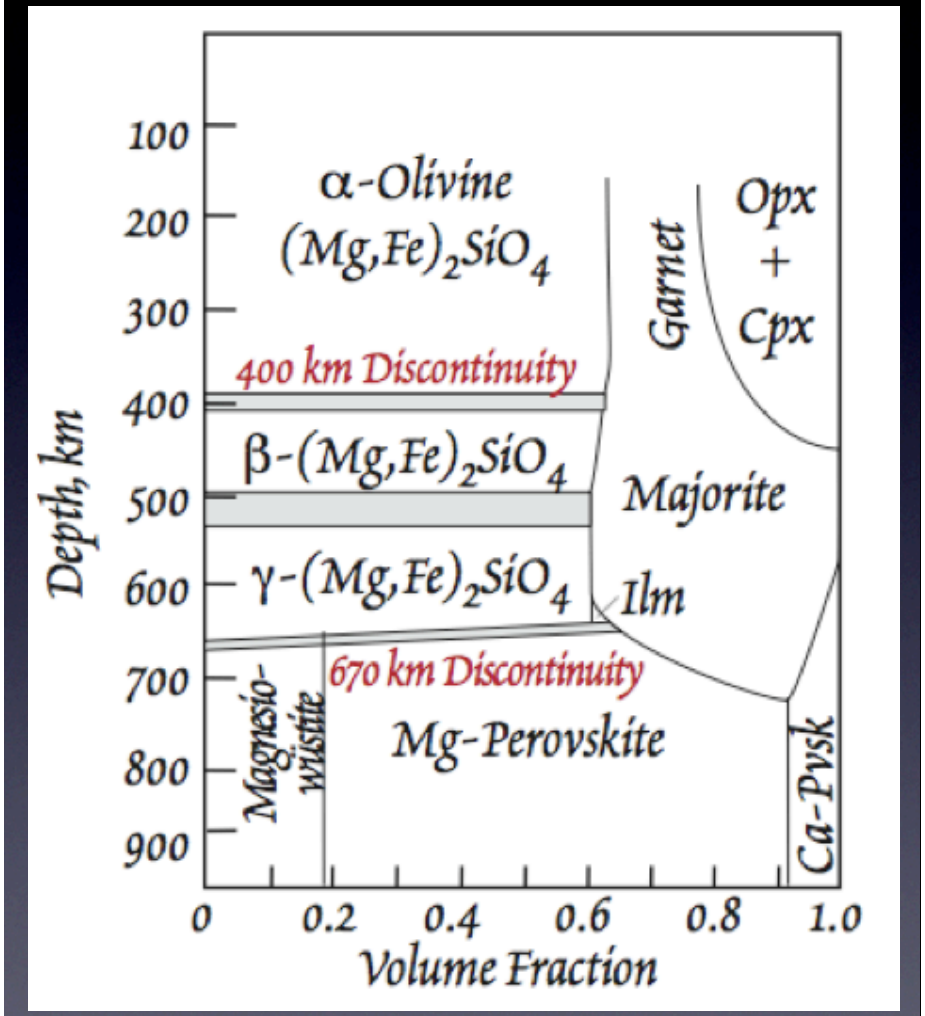




Evolución en equilibrio
Evolución fuera del equilibrio?

Sistemas binarios isotérmicos (T=cte)



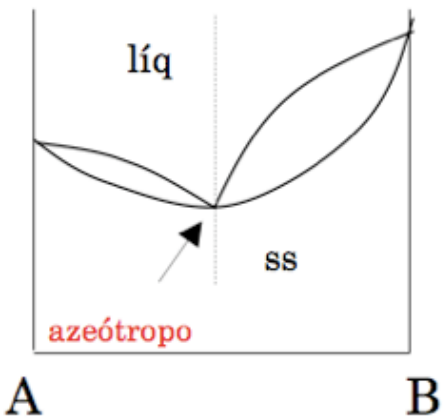


Solución sólida completa con máximo o mínimo térmico

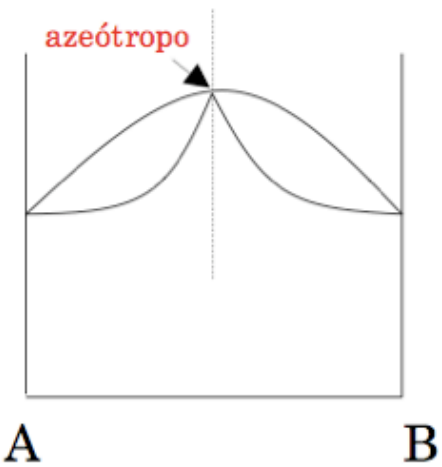
Corresponden a variaciones del sistema binario con solución sólida completa. La diferencia radica en la presencia de un **punto azeótropo**, que puede corresponder a un mínimo o máximo térmico según sea el caso:

En el azeótropo, la composición del líquido es igual a la del sólido.

Mínimo térmico

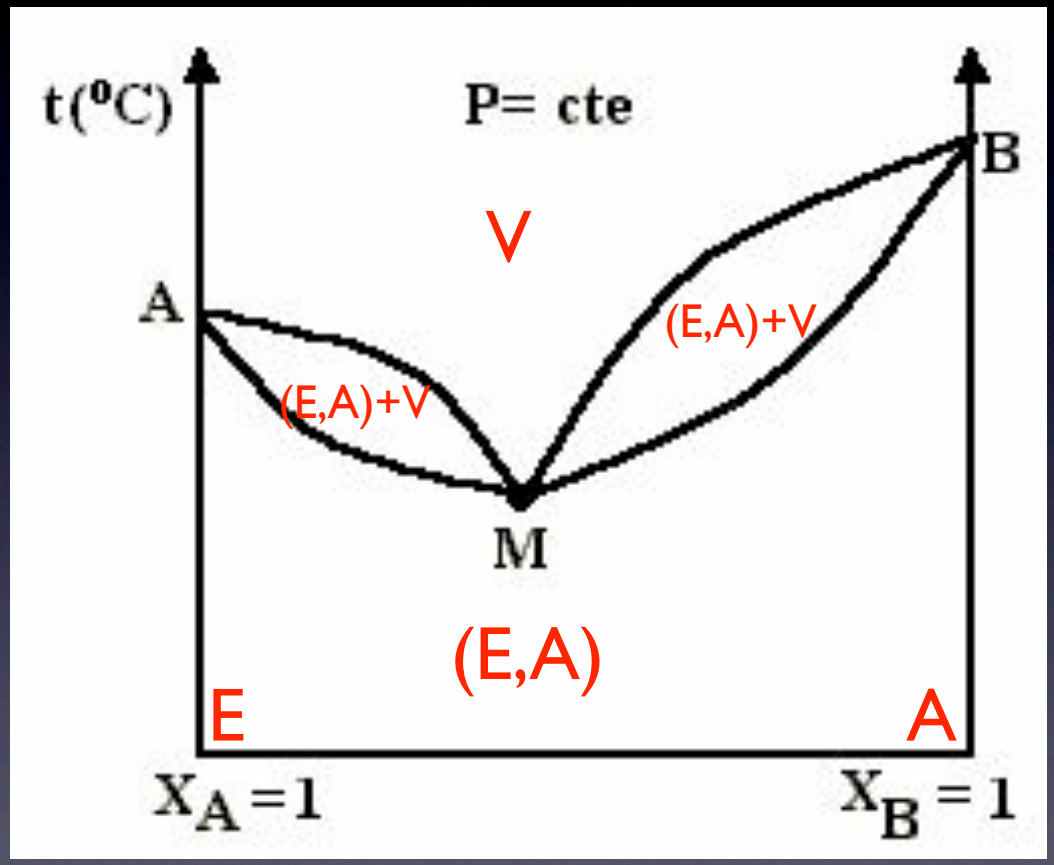


Máximo térmico



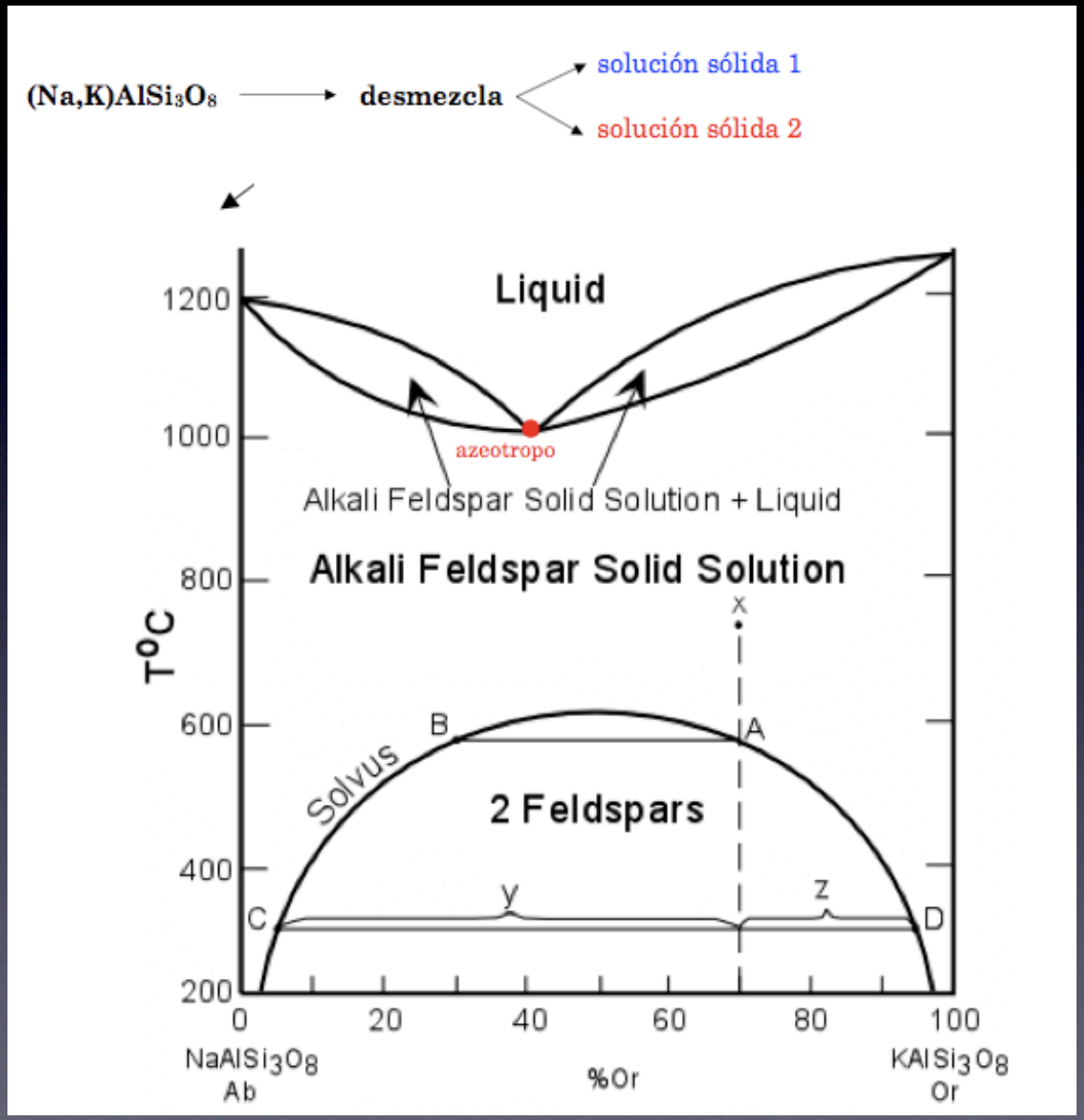
Los **azeótropos** (sean mínimo o máximos térmicos) no son puntos **eutécticos**

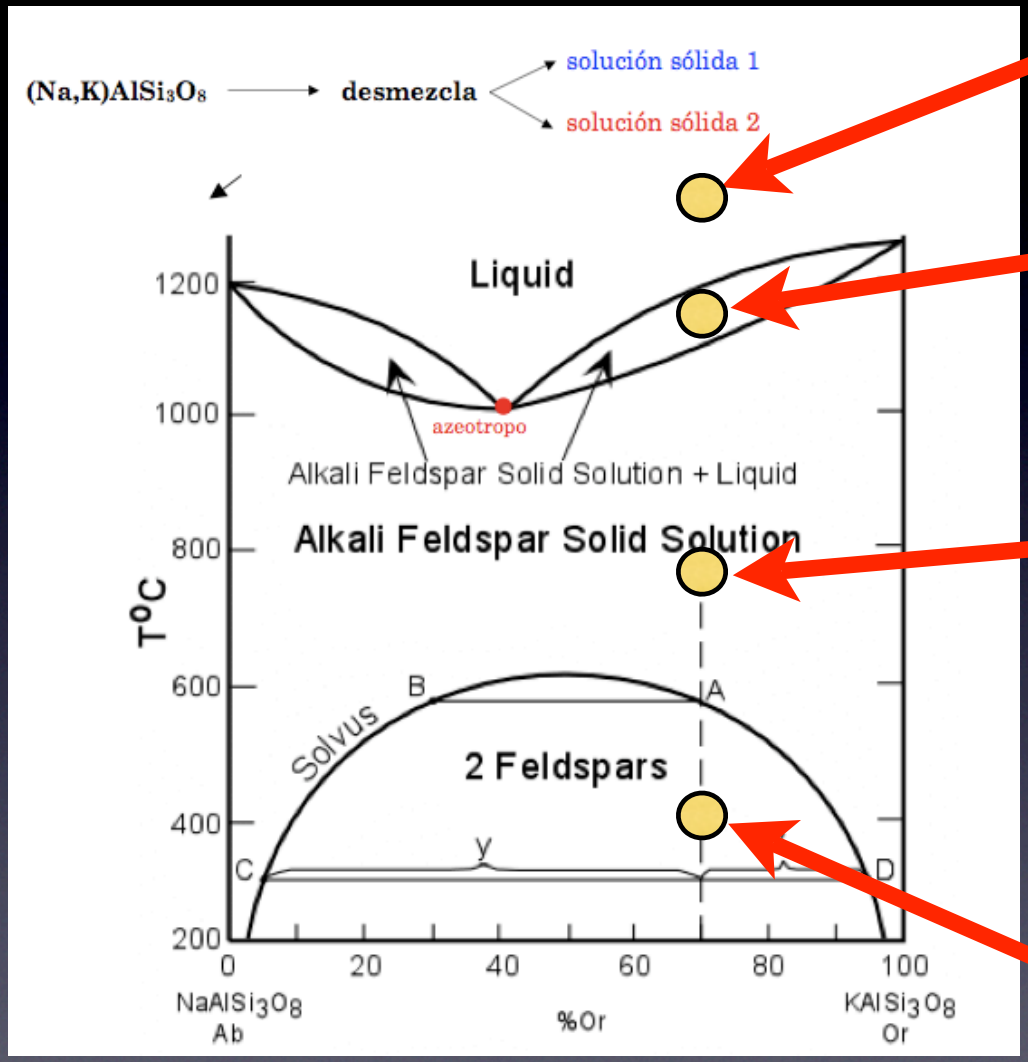
No hay mayores ejemplos geológicos de azeótropos en sistemas binarios

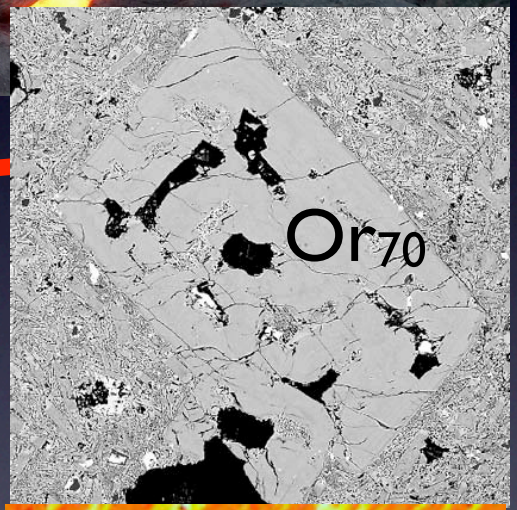


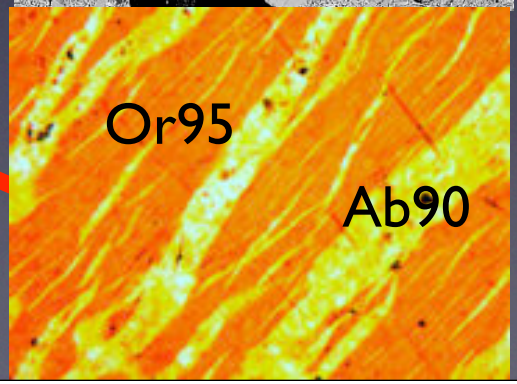
sistema etanol-agua

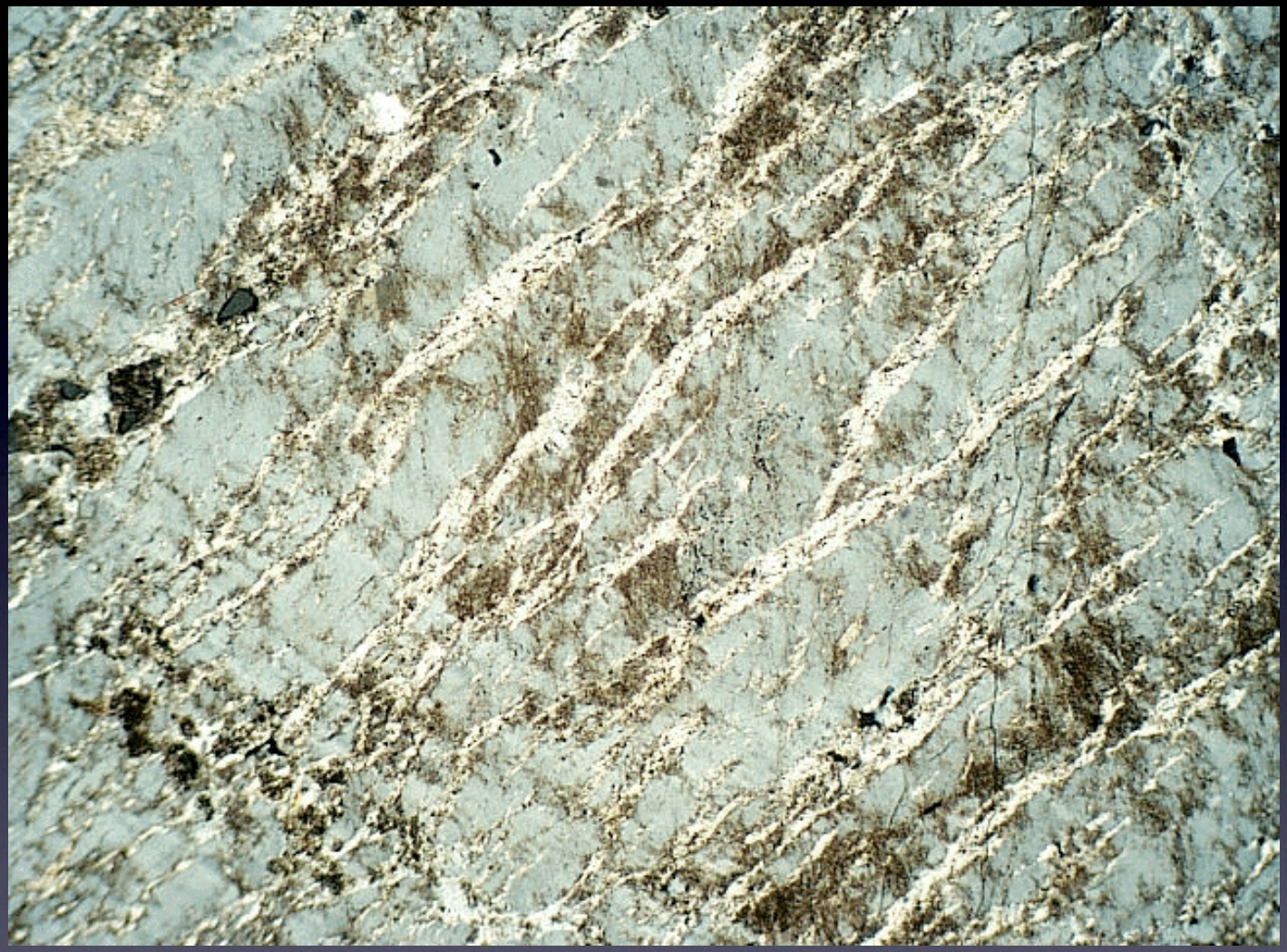
3. Sistemas con solución sólida parcial




(Na,K)AlSi3O8
desmezcla
solución sólida 1
solución sólida 2
Liquid
azeotropo
Alkali Feldspar Solid Solution + Liquid
Alkali Feldspar Solid Solution
2 Feldspars
Solvus
A
B
C
D
y
T°C
1200
1000
800
600
400
200
0
20
40
60
80
100
NaAlSi3O8
Ab
%Or
KAlSi3O8
Or


Or70

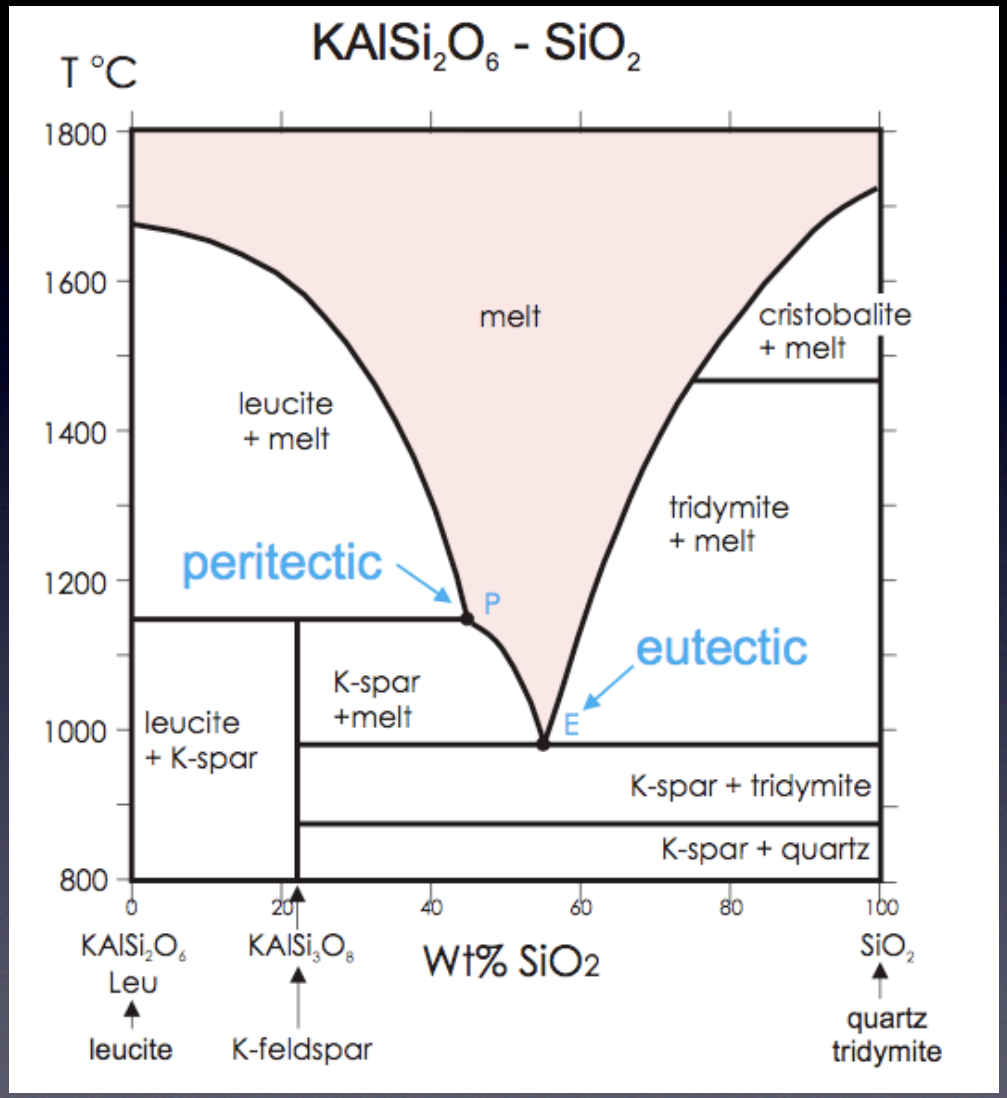

Or95
Ab90



pertitas (microscopía óptica)

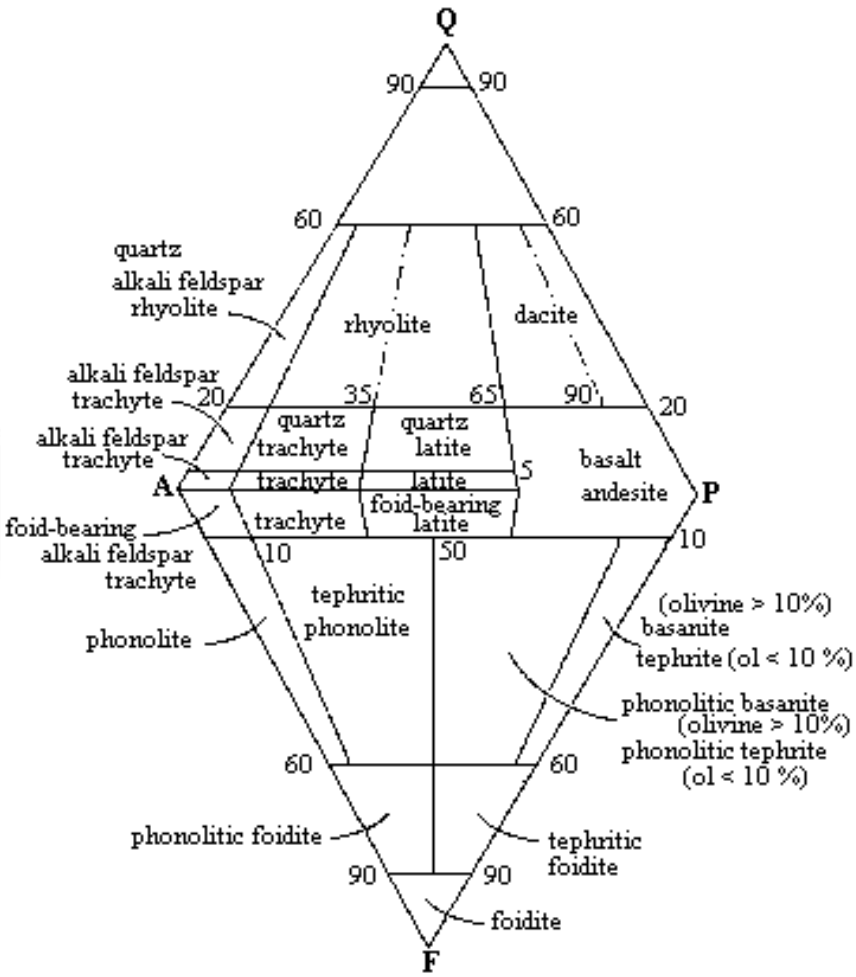
pdf animado
Sistema Ab-Or

4. Sistemas con reacción

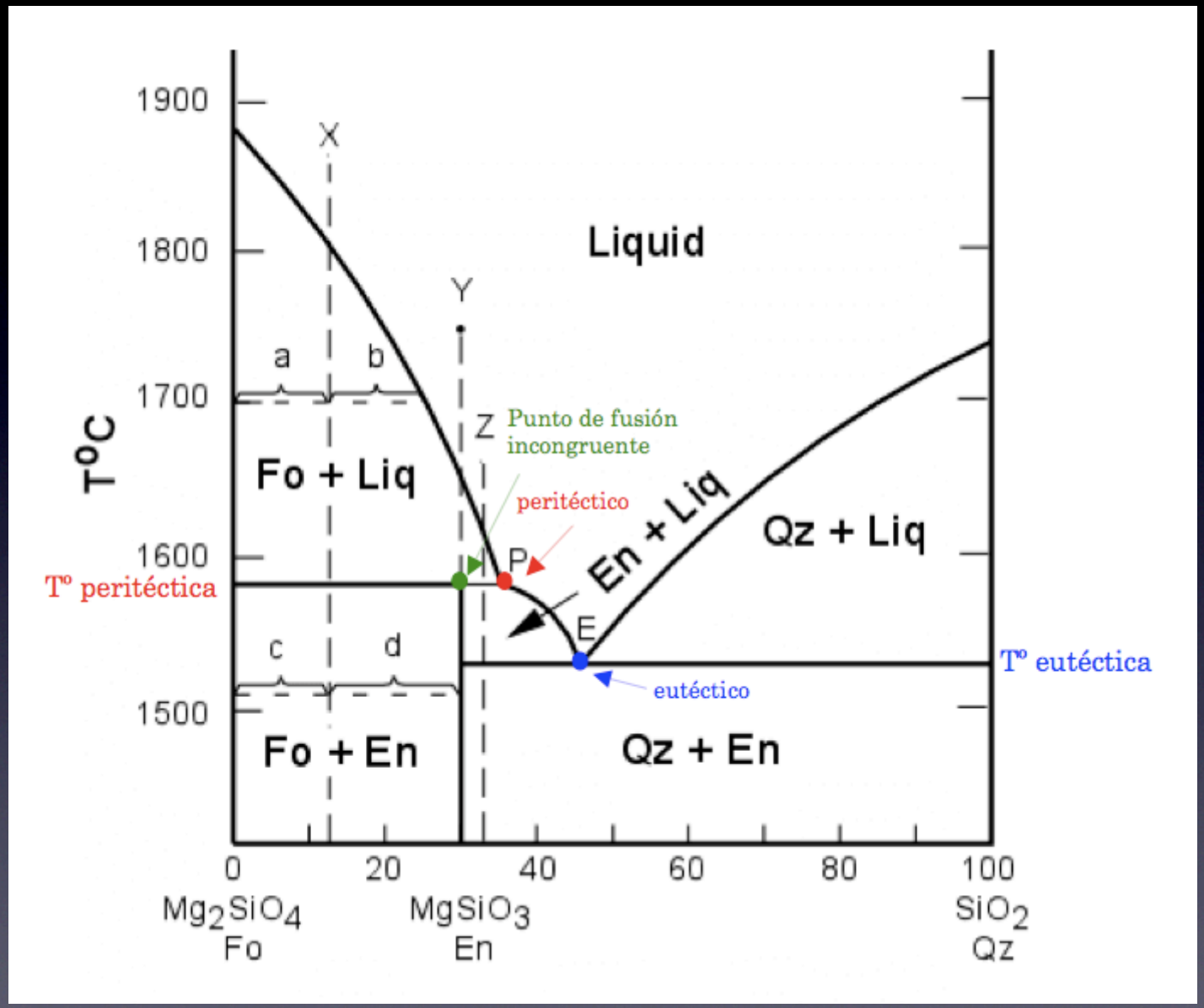


sistema nefelina-sílice

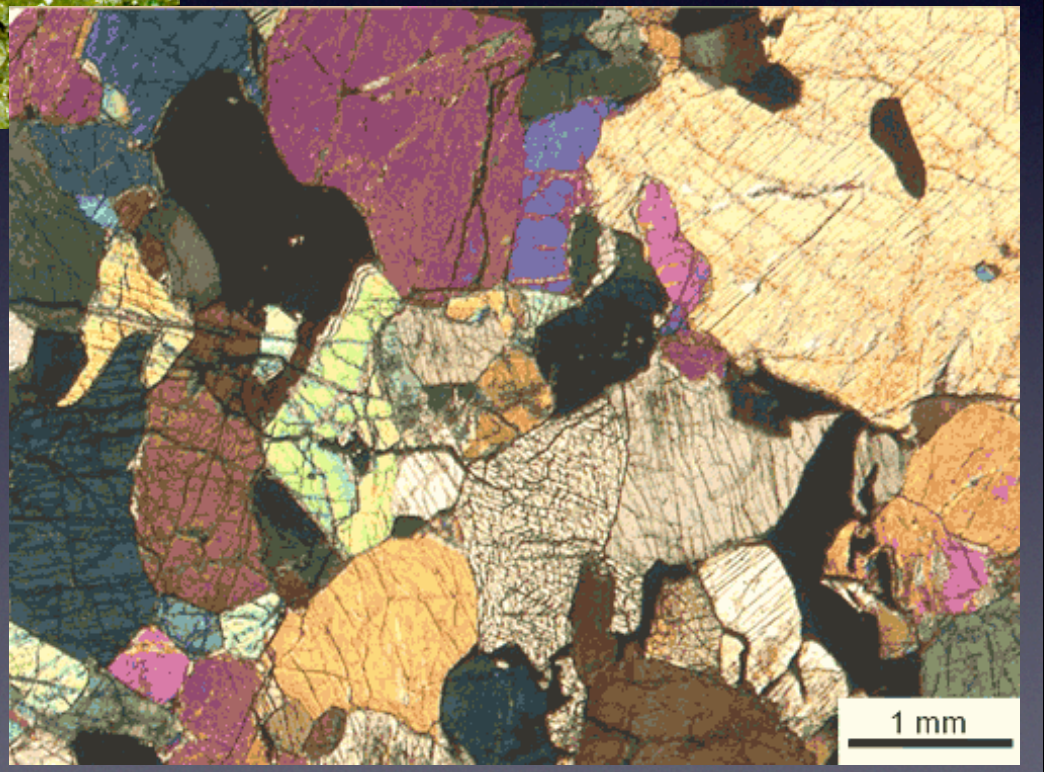
pdf animado
(Leu-qz)



rocas alcalinas c/ feldespatoides

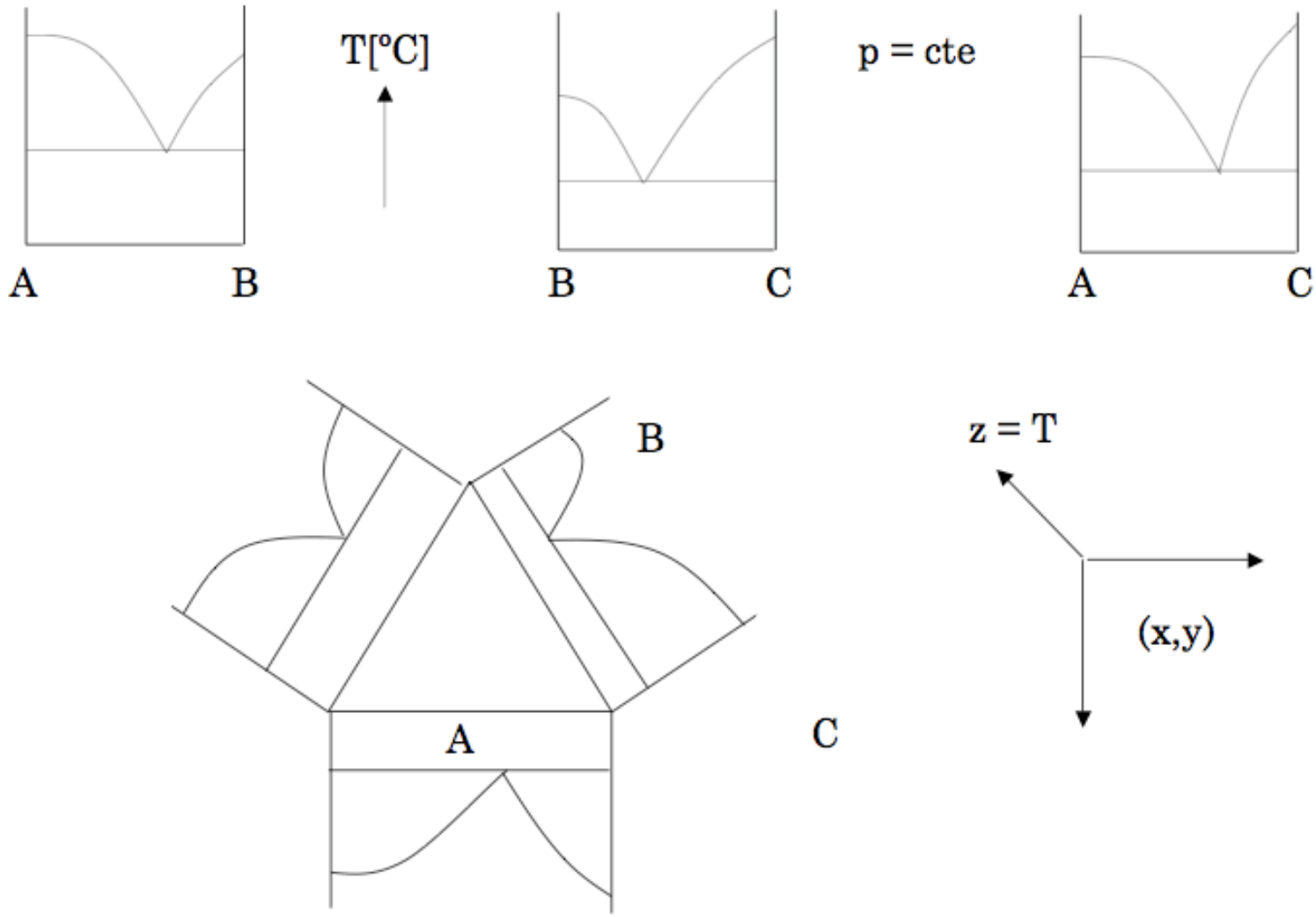


sistema forsterita-sílice



Ol+Opx

Sistemas Ternarios



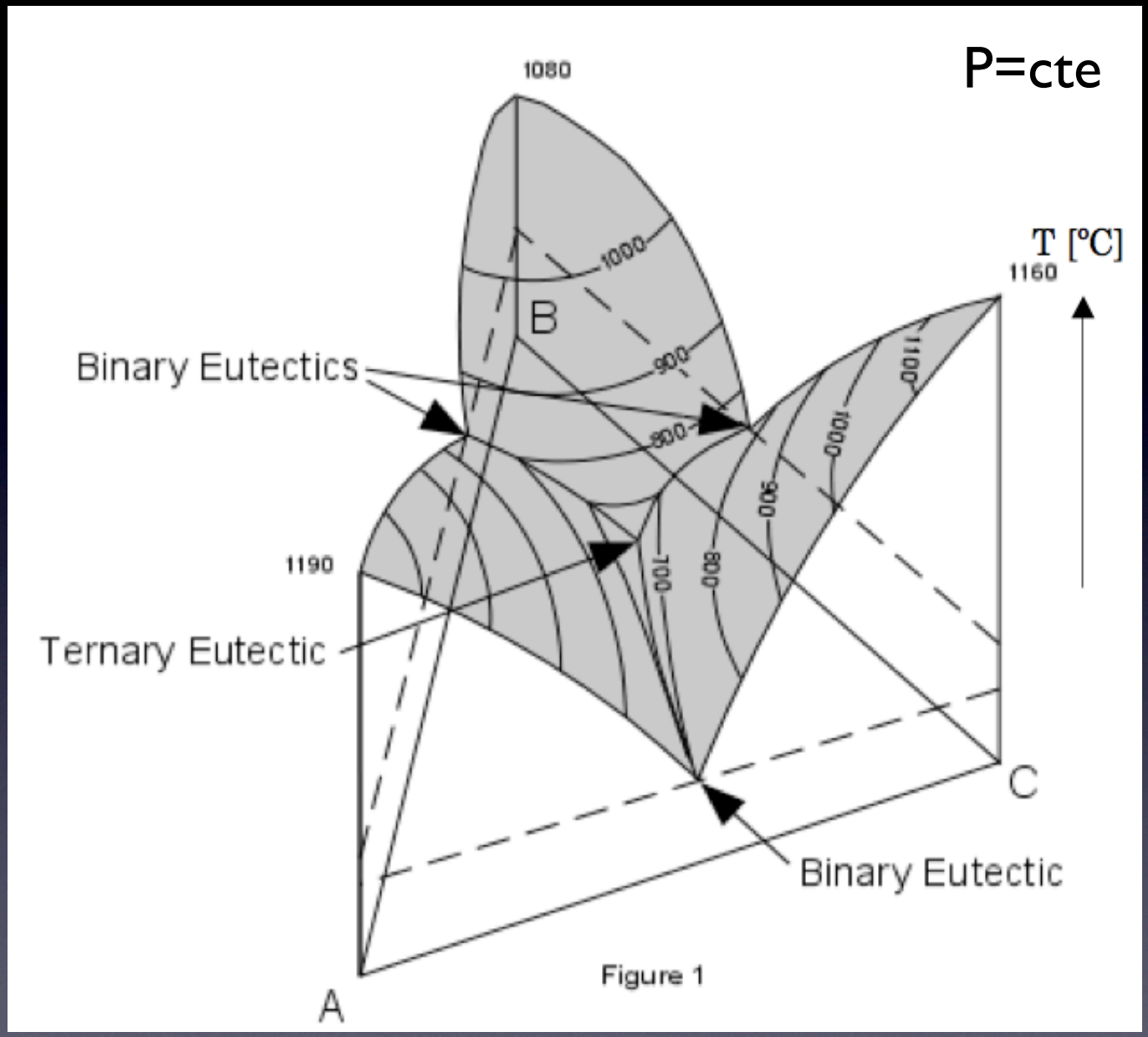
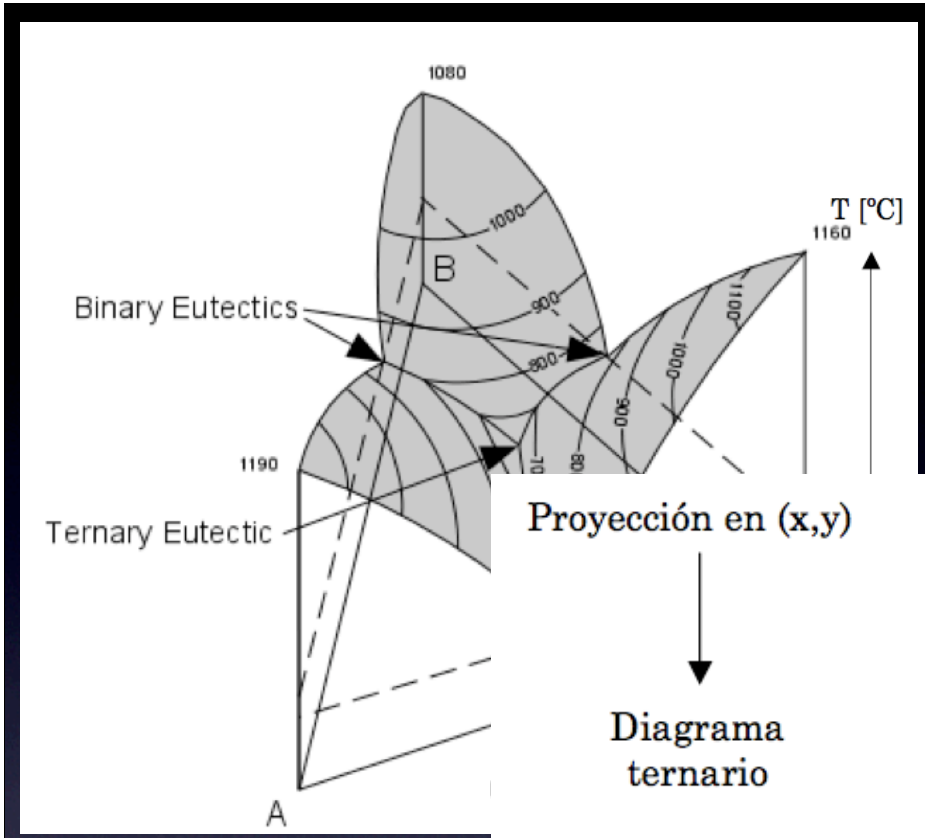


Figure 1

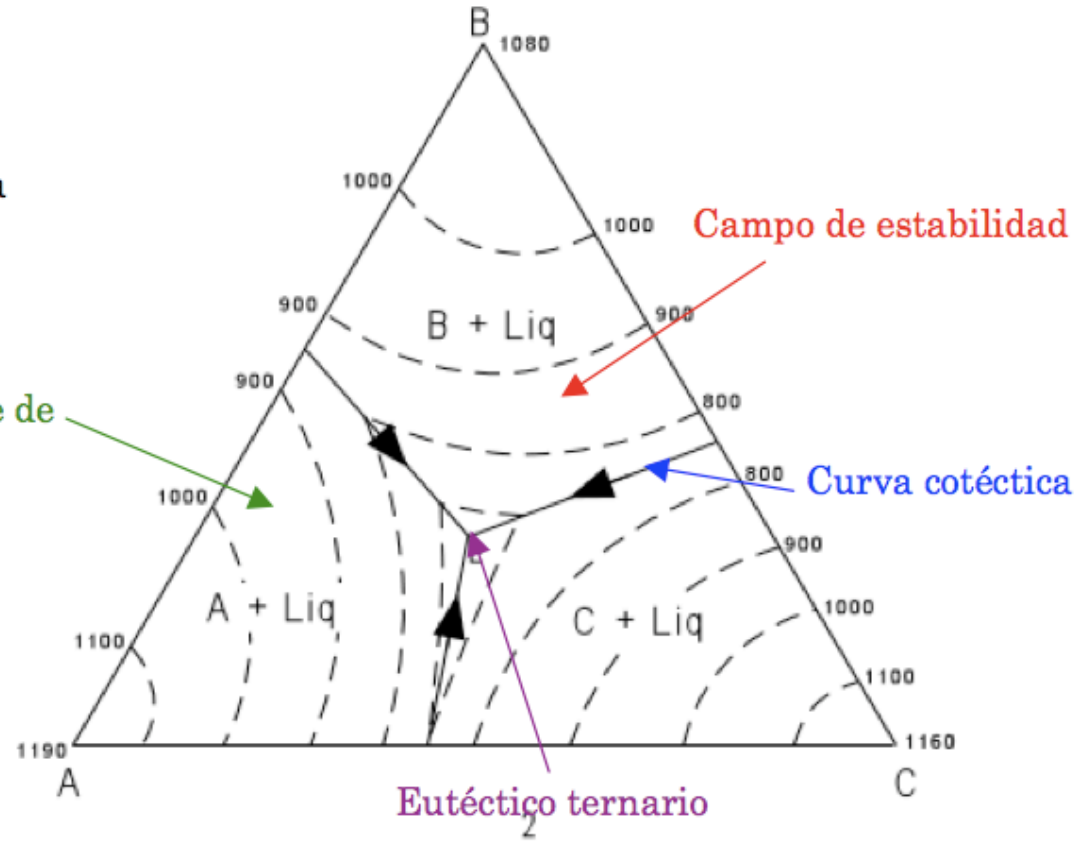
representación en 3D

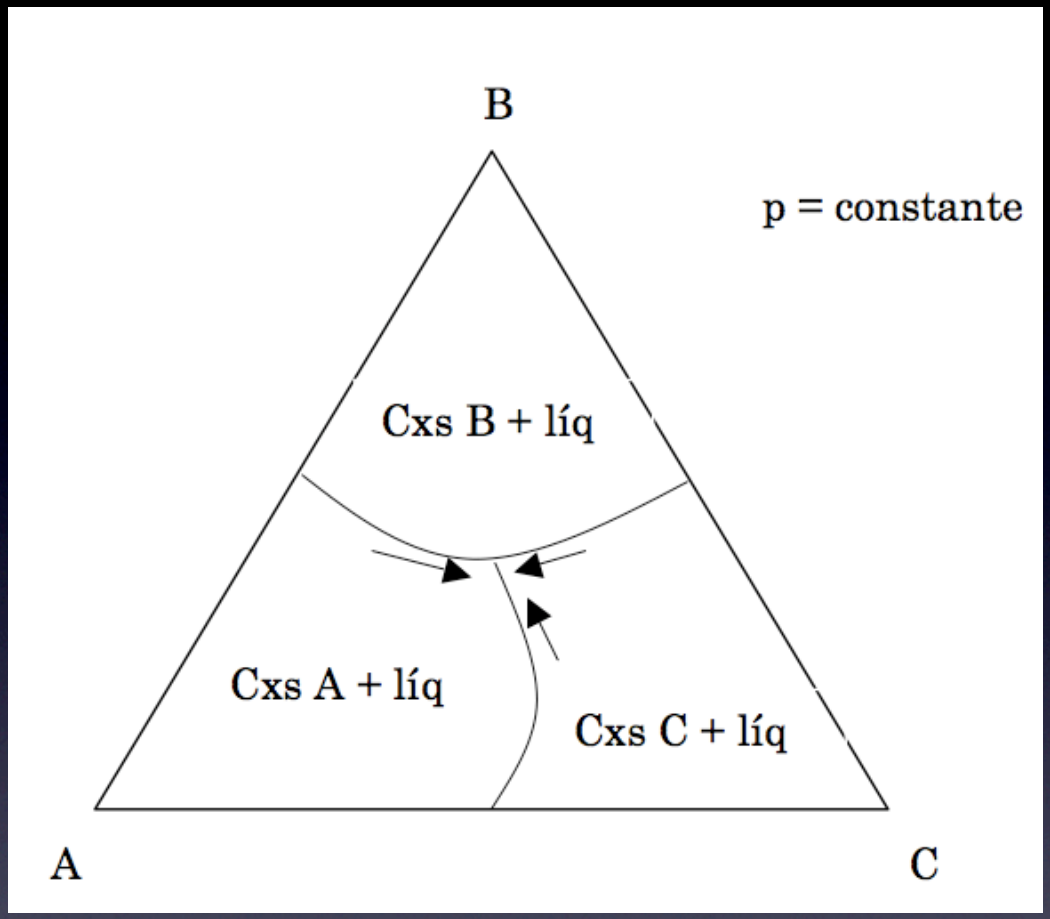


Proyección en (x,y)

Diagrama ternario

p = cte

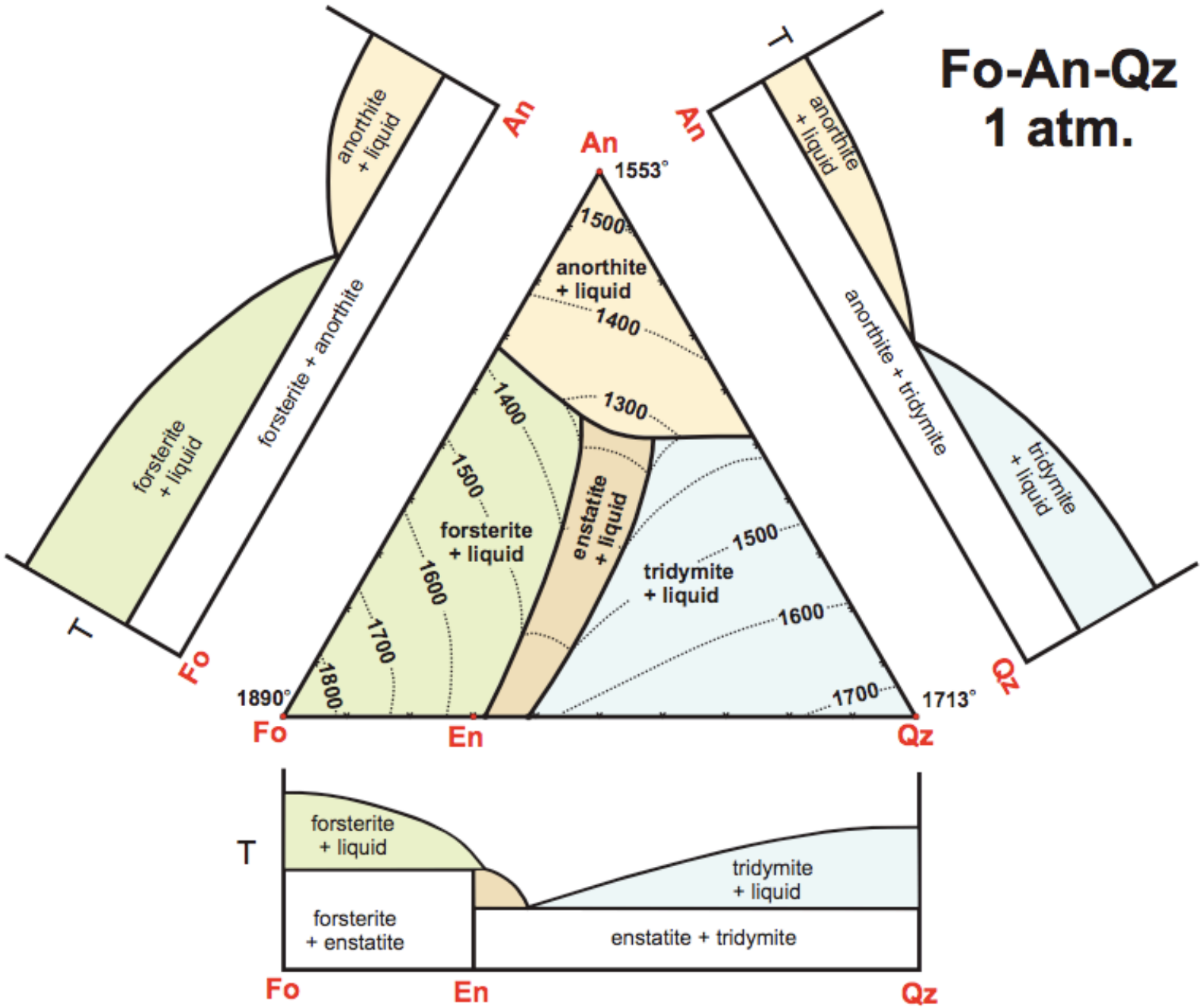


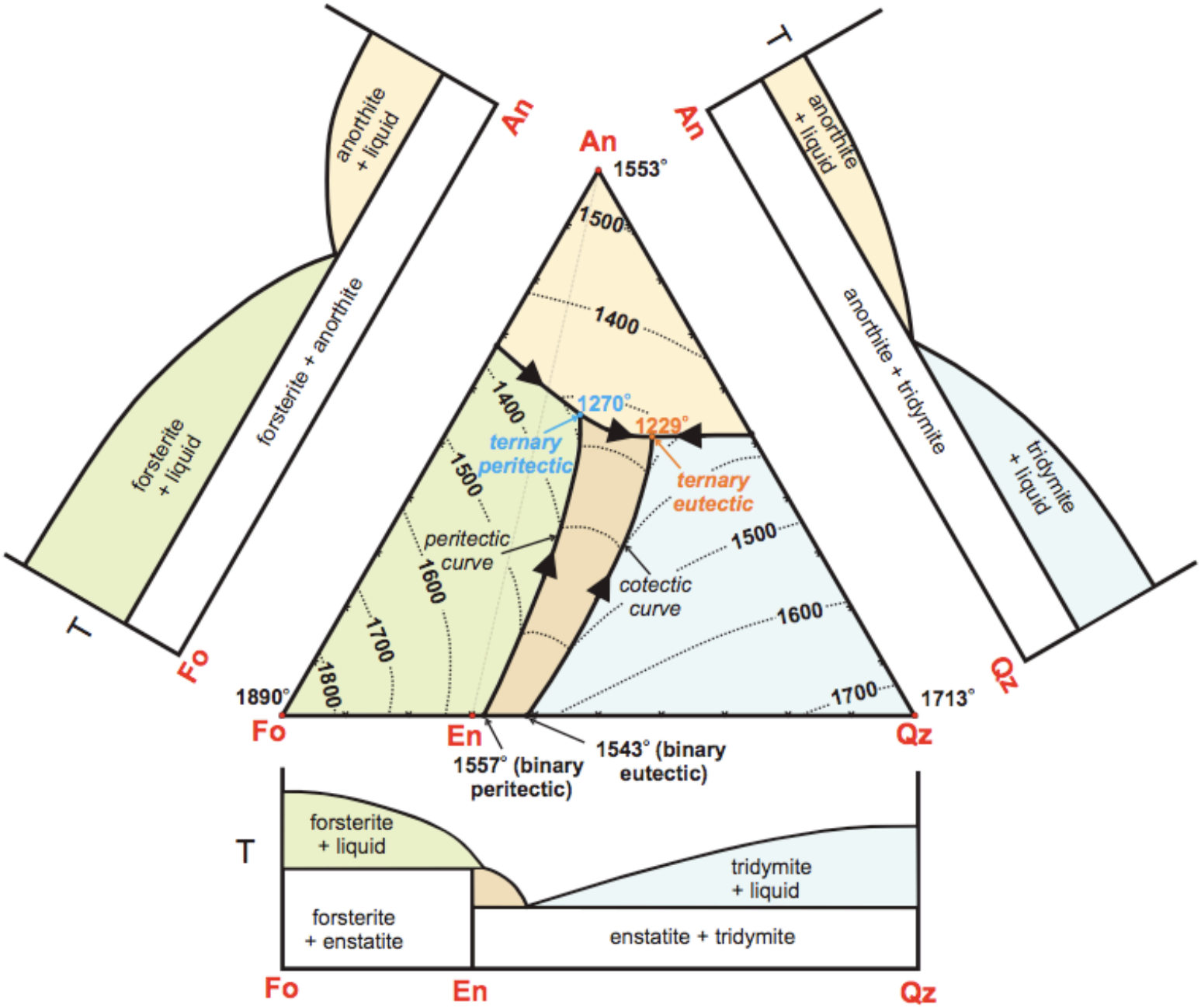


$$F + P = C + 1$$

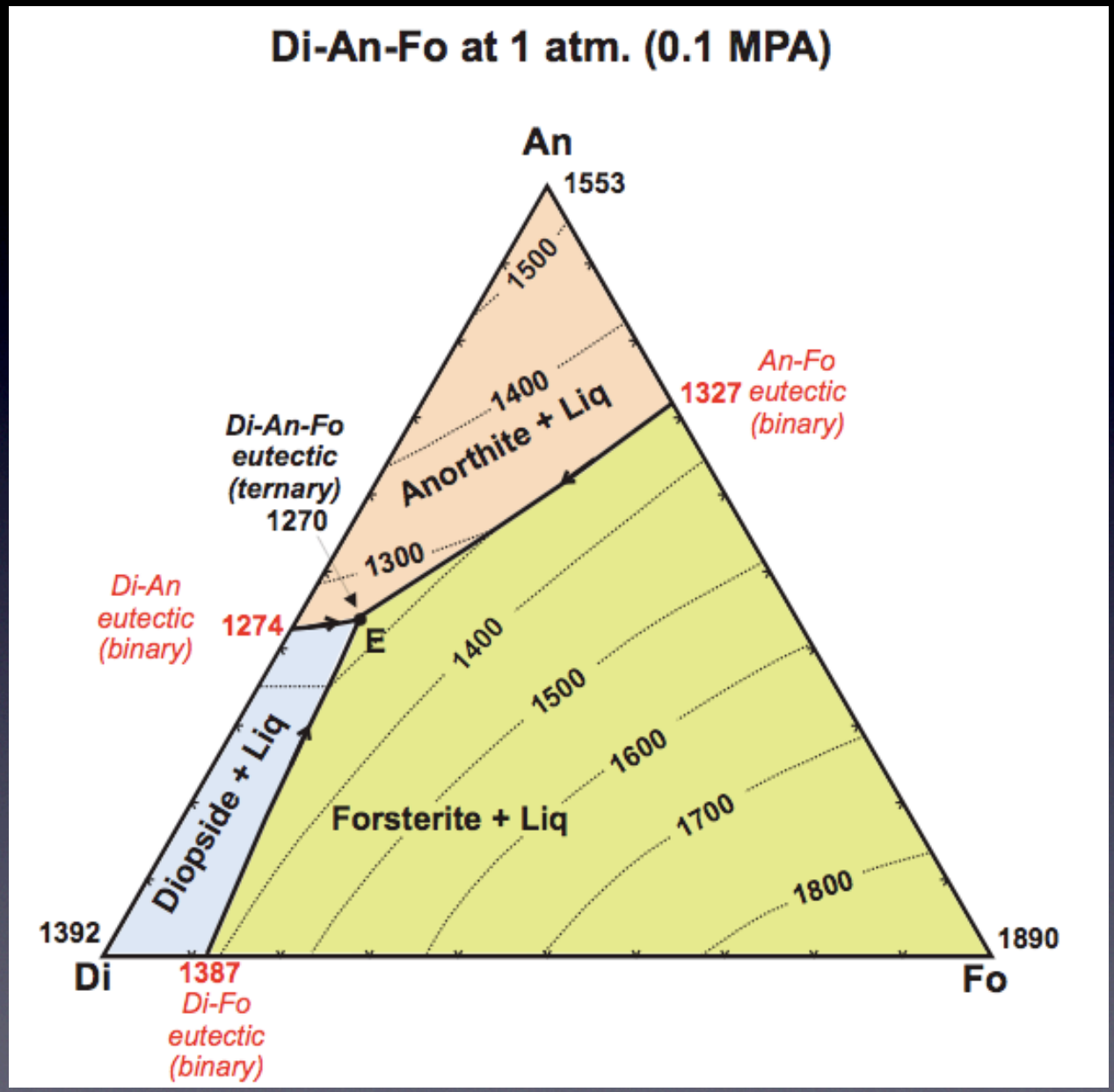
$$F + P = 4$$

- campos de estabilidad (2 fases: cxsA + líq) son **bivariantes**.
- líneas de equilibrio cotécticas (3 fases: cxsA+cxsB+líq) son **univariantes**
- el eutéctico ternario (4 fases: cxsA+cxsB+cxsC+líq) es **invariante**

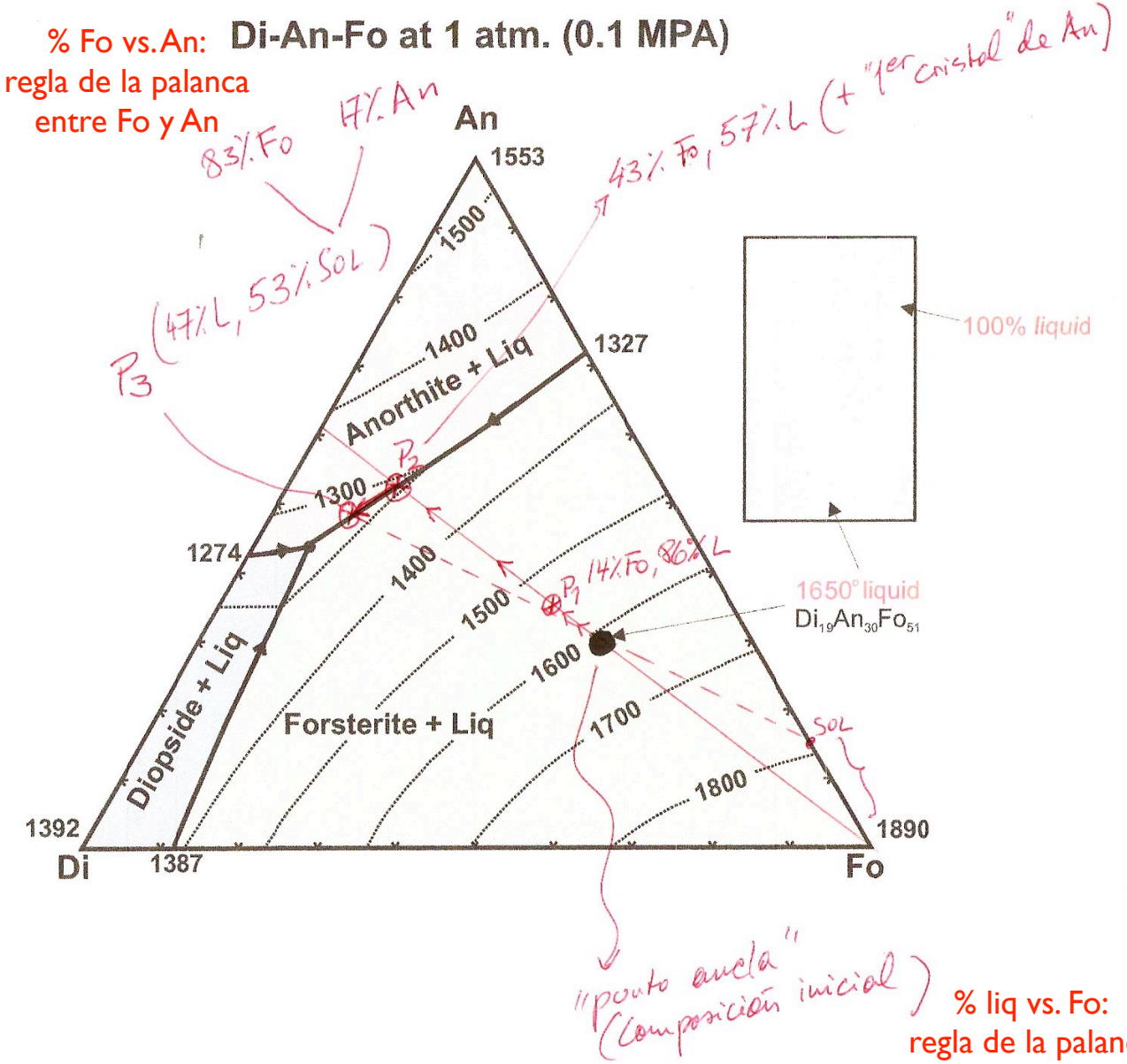

Fo-An-Qz
1 atm.
An
1553°
1500
anorthite
+ liquid
1400
1300
1400
1500
forsterite
+ liquid
1600
1700
1800
enstatite
+ liquid
1500
tridymite
+ liquid
1600
1700
1890°
1713°
Fo
En
Qz
T
Fo
forsterite
+ liquid
forsterite + anorthite
anorthite
+ liquid
An
T
An
anorthite
+ liquid
anorthite + tridymite
tridymite
+ liquid
Qz
T
forsterite
+ liquid
forsterite
+ enstatite
tridymite
+ liquid
enstatite + tridymite
Fo
En
Qz


T
Fo
forsterite + liquid
forsterite + anorthite
anorthite + liquid
An
T
An
anorthite + liquid
anorthite + tridymite
tridymite + liquid
Qz
An
1553°
1500
1400
1400
1270°
1229°
ternary peritectic
ternary eutectic
1500
peritectic curve
1600
cotectic curve
1500
1600
1700
1800
1700
1890°
1713°
Fo
En
Qz
1557° (binary peritectic)
1543° (binary eutectic)
T
forsterite + liquid
tridymite + liquid
forsterite + enstatite
enstatite + tridymite
Fo
En
Qz

pdf animado

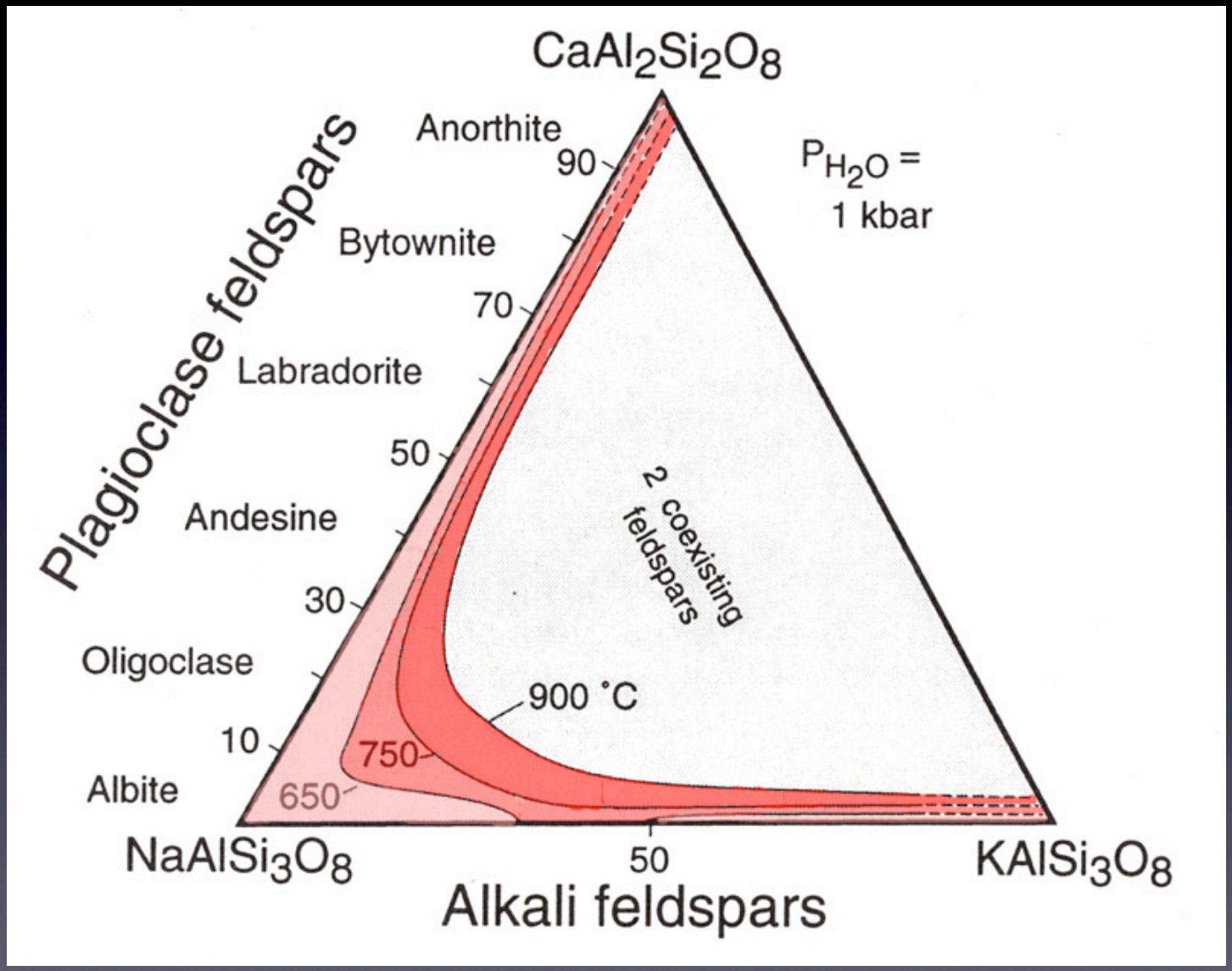

Di-An-Fo at 1 atm. (0.1 MPA)
An
1553
1500
1400
1300
Anorthite + Liq
An-Fo
1327 eutectic
(binary)
Di-An-Fo
eutectic
(ternary)
1270
Di-An
eutectic
(binary)
1274
E
Diopside + Liq
Forsterite + Liq
1400
1500
1600
1700
1800
1392
Di
1387
Di-Fo
eutectic
(binary)
1890
Fo

% Fo vs. An: regla de la palanca entre Fo y An



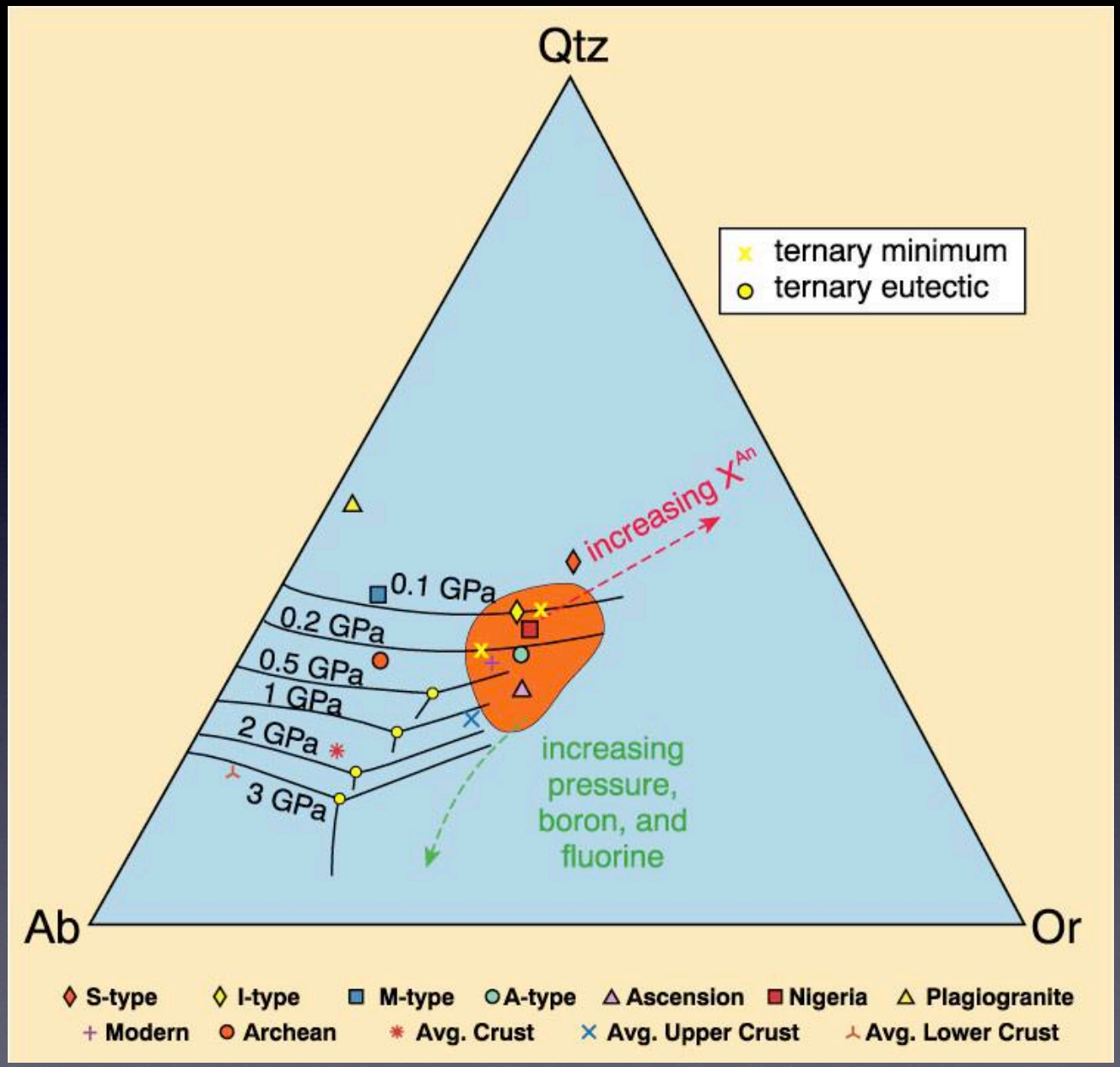
% liq vs. Fo: regla de la palanca entre P_i y Fo

Sistema Ab-An-Or (feldespatos)

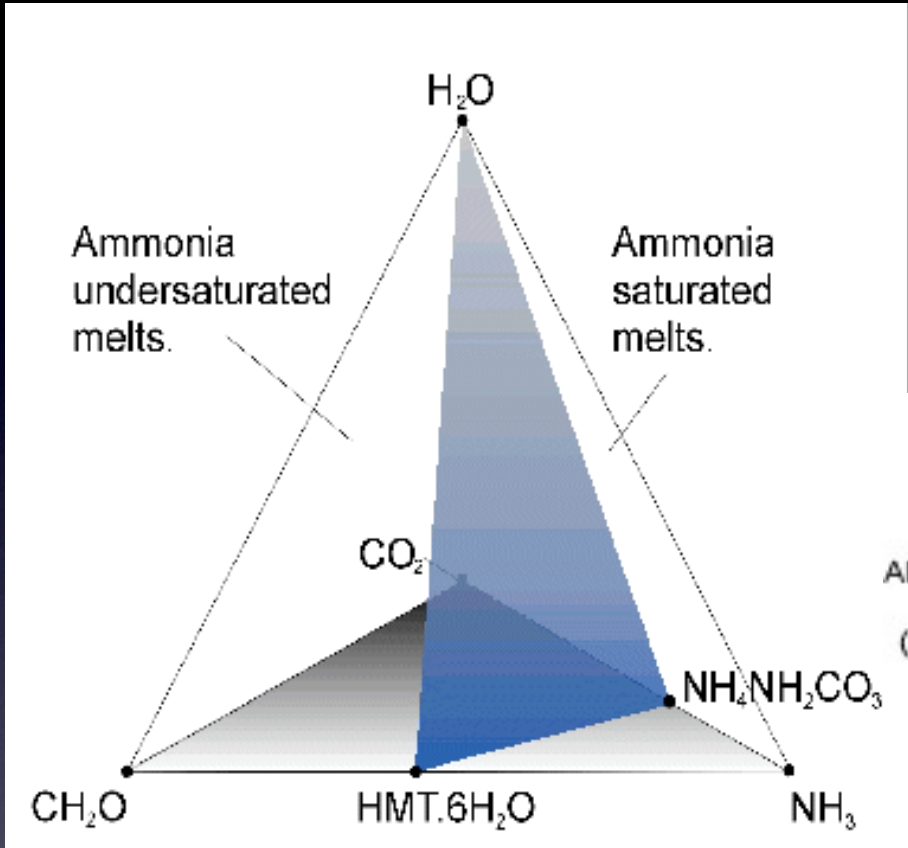


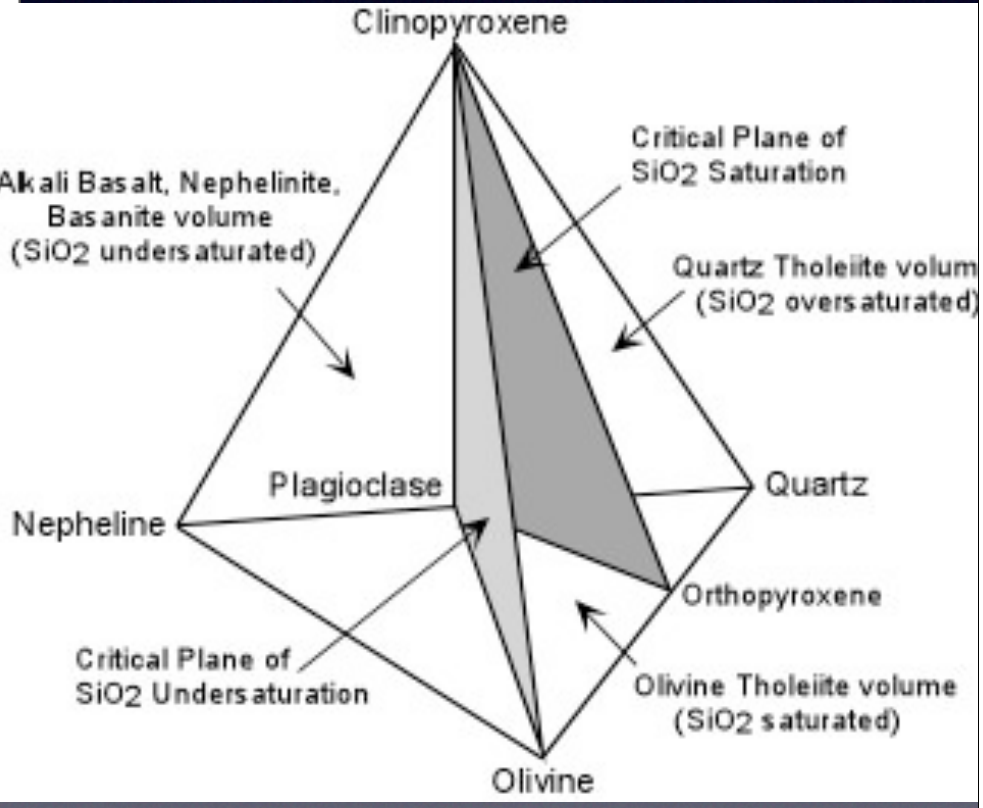
geotermometría???

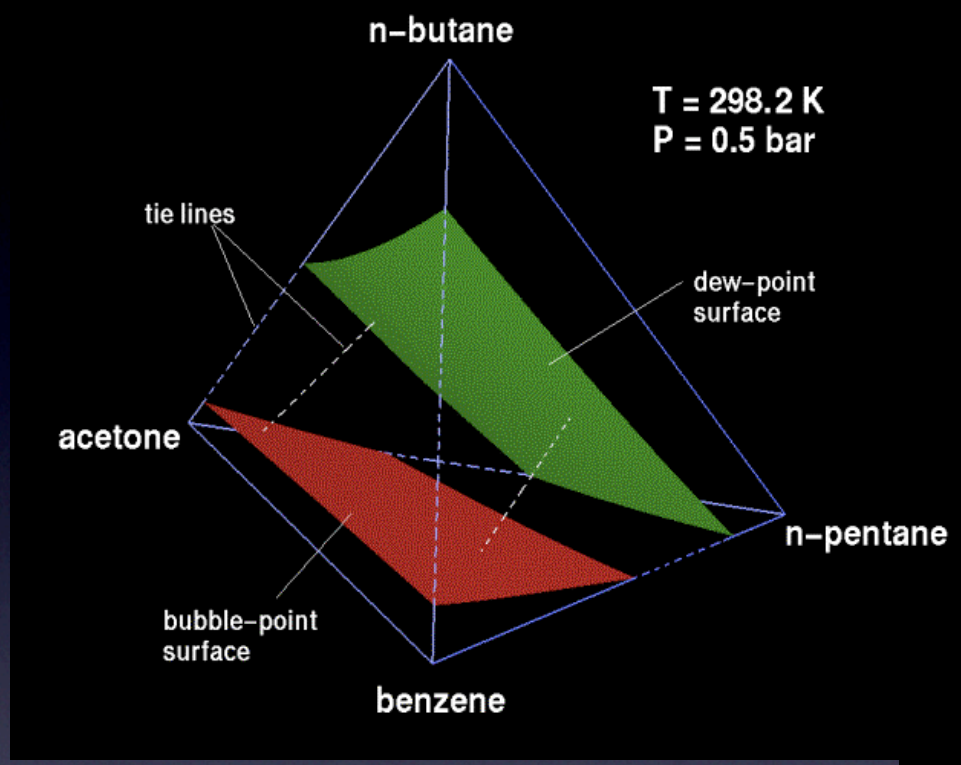
Sistema Ab-Qz-Or, mínimo térmico y generación de granitos

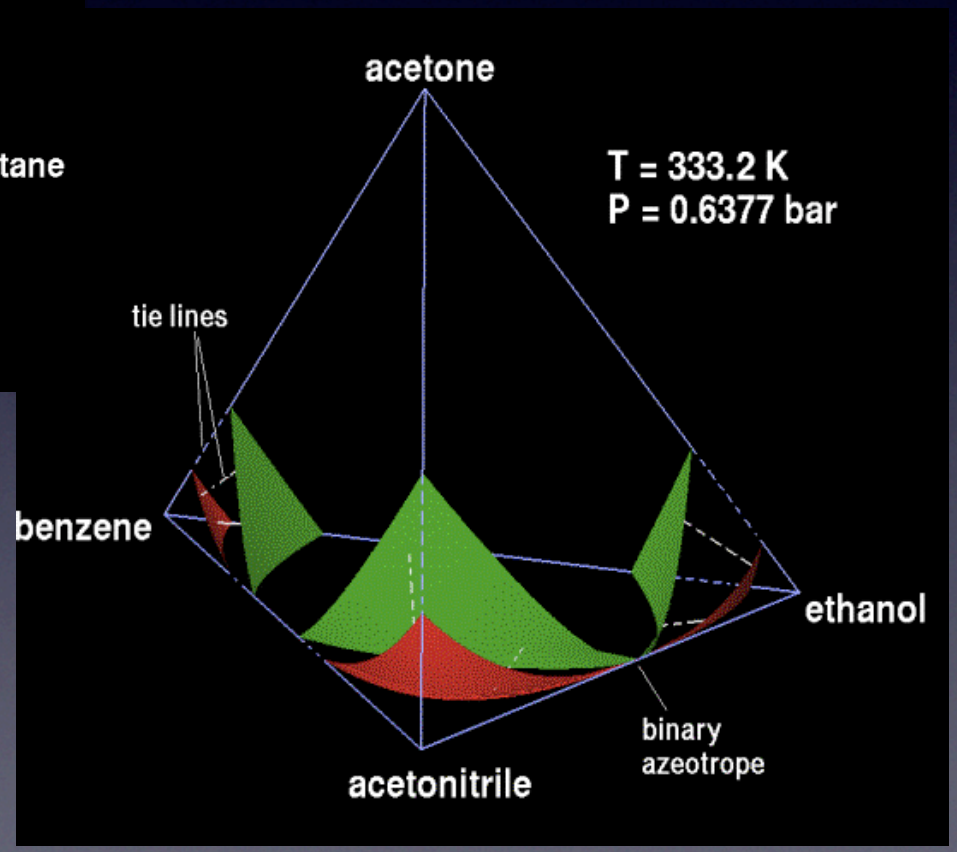
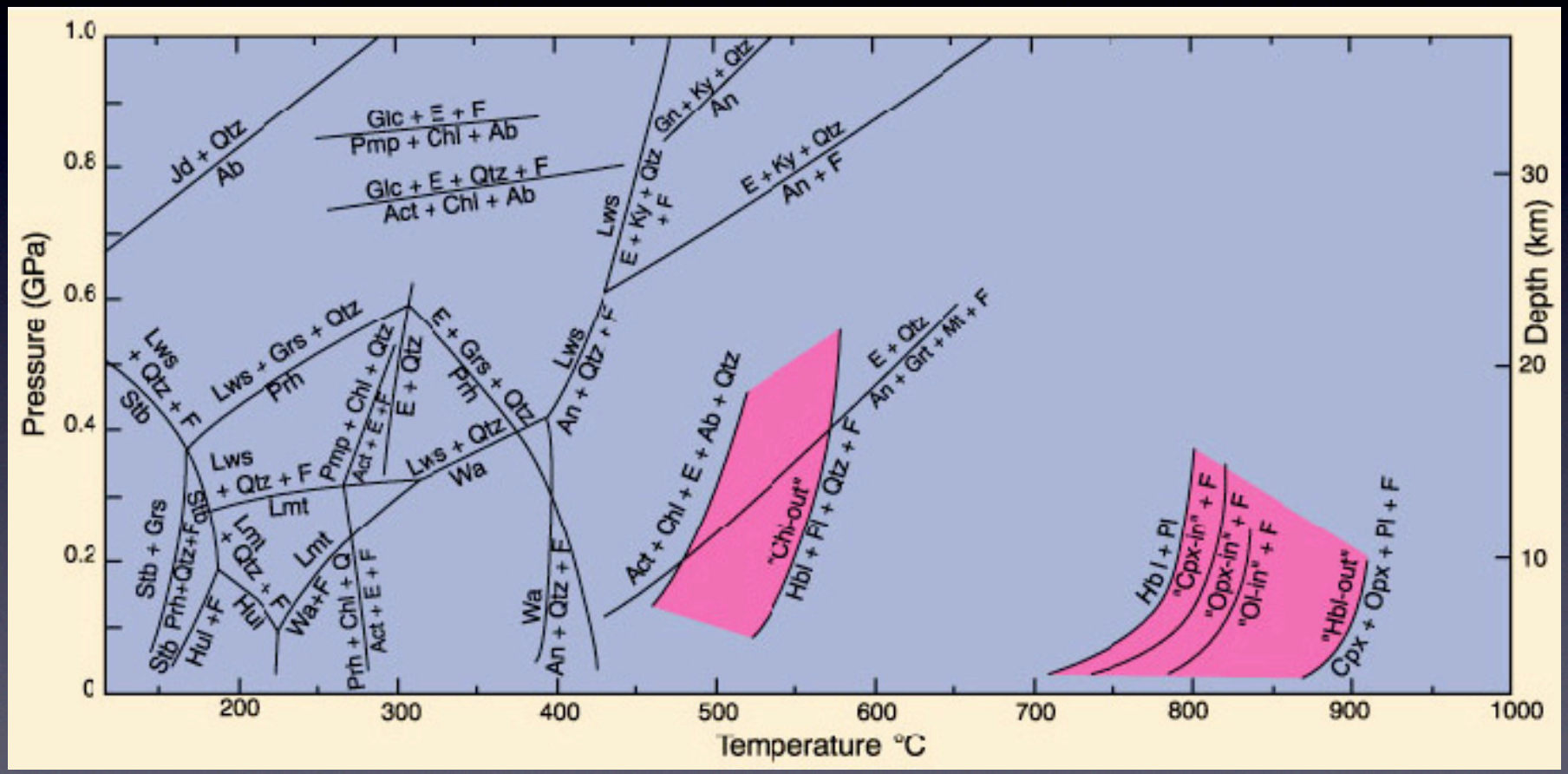


Sistemas Cuaternarios






n–butane
T = 298.2 K
P = 0.5 bar
tie lines
dew–point
surface
acetone
n–pentane
bubble–point
surface
benzene


acetone
T = 333.2 K
P = 0.6377 bar
tie lines
benzene
ethanol
binary
azeotrope
acetonitrile

Sistemas multicomponentes (c>4)