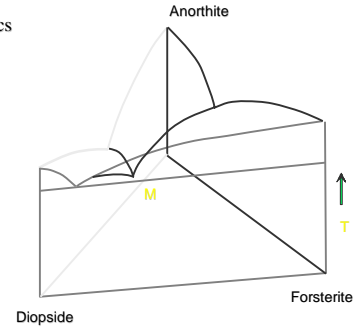


# Ternary Systems

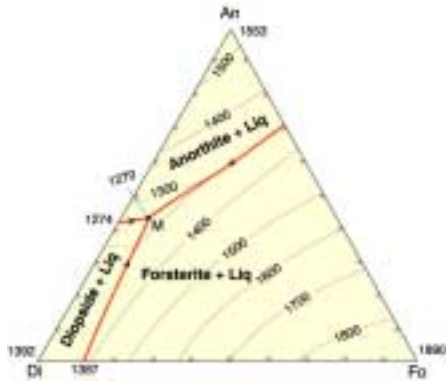
Readings:  
Winter Chapter 7

## C = 3: Ternary Systems: Example 1: Ternary Eutectic Di - An - Fo

Note three binary eutectics  
No solid solution  
Ternary eutectic = M

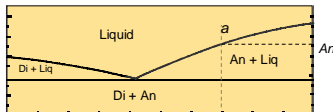
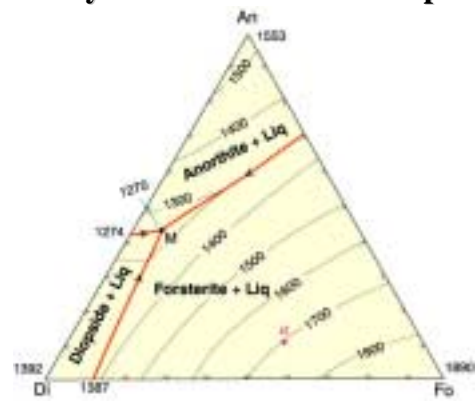


### T - X Projection of Di - An - Fo

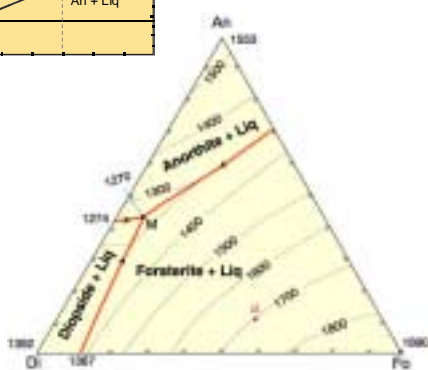


Isobaric diagram illustrating the liquidus temperatures in the Di-An-Fo system at atmospheric pressure (0.1 MPa). After Bowen (1915), A. J. Sci., and Morse (1994), Basalts and Phase Diagrams. Krieger Publishers.

### Crystallization Relationships



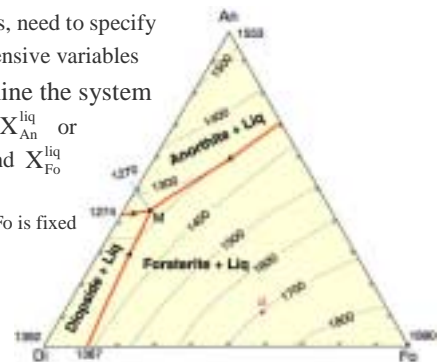
Pure Fo forms  
Just as in binary  
 $\phi = ?$   
 $F = ?$

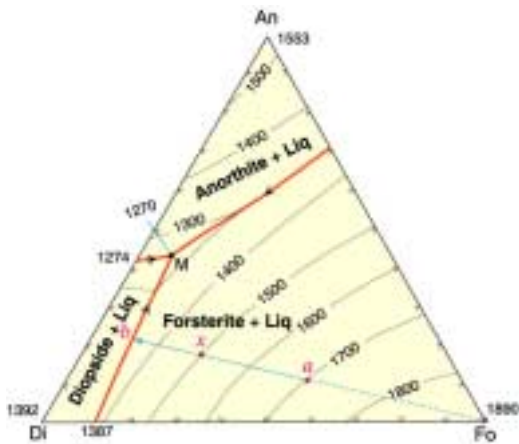


$\phi = 2$  (Fo + Liq)  
 $F = 3 - 2 + 1 = 2$   
If on liquidus, need to specify only 2 intensive variables to determine the system

$\phi = T$  and  $X_{An}^{liq}$  or  
 $\phi = X_{An}^{liq}$  and  $X_{Fo}^{liq}$

X of pure Fo is fixed



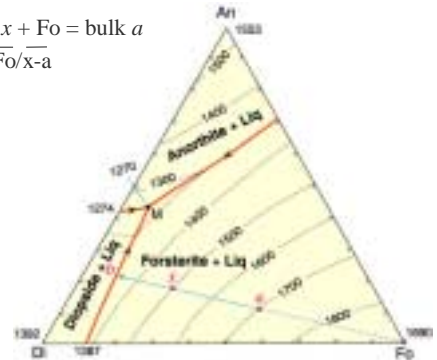


Lever principle → relative proportions of liquid & Fo

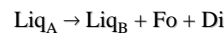
• At 1500°C

$$\varnothing \text{Liq } x + \overline{\text{Fo}} = \text{bulk } a$$

$$\varnothing x/\text{Fo} = \frac{a - \overline{\text{Fo}}}{x - a}$$

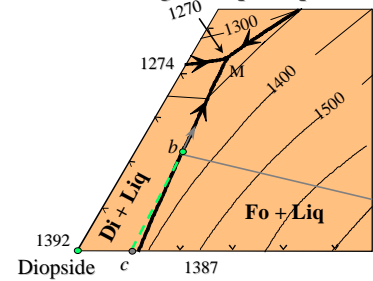


• New continuous reaction as liquid follows cotectic:



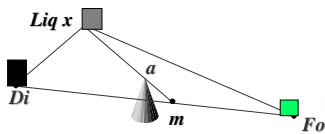
• Bulk solid extract

• Di/Fo in bulk solid extract using lever principle



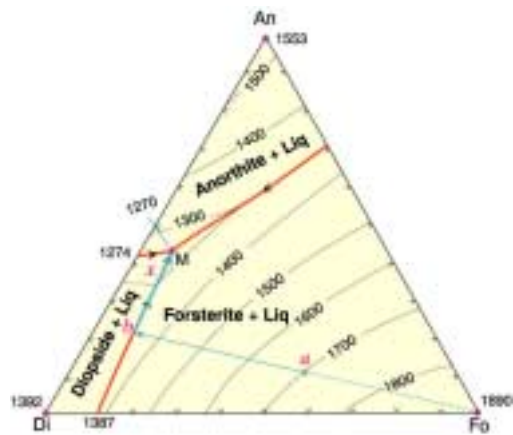
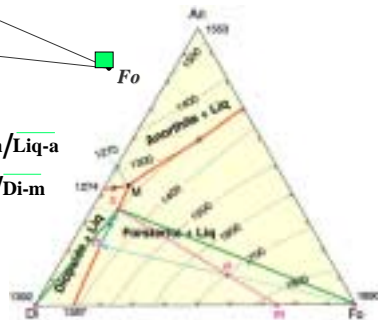
• At 1300°C liquid = X

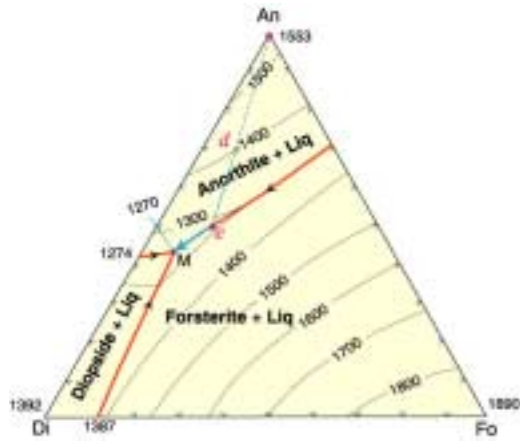
• Imagine triangular plane X - Di - Fo balanced on bulk a



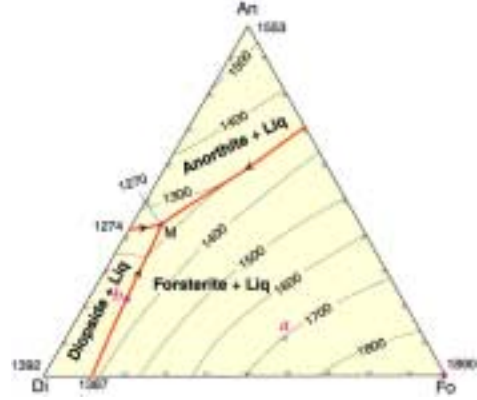
$$\text{Liq}/\text{total solids} = \frac{a - m}{\text{Liq} - a}$$

$$\text{total Di}/\text{Fo} = \frac{m - \text{Fo}}{\text{Di} - m}$$





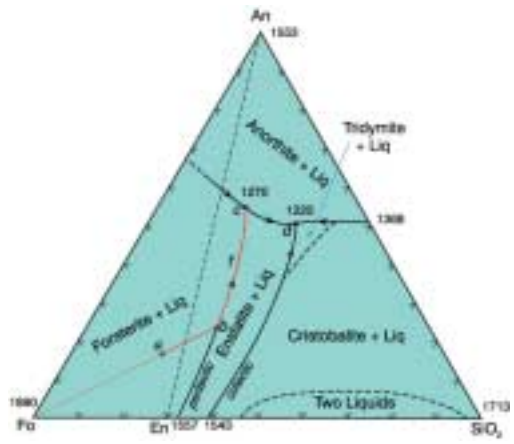
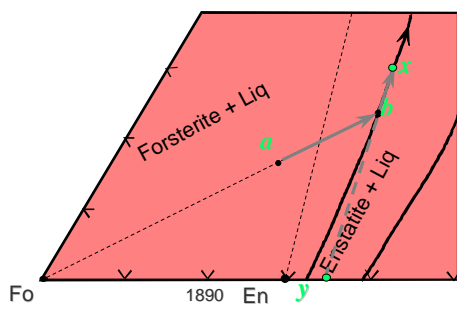
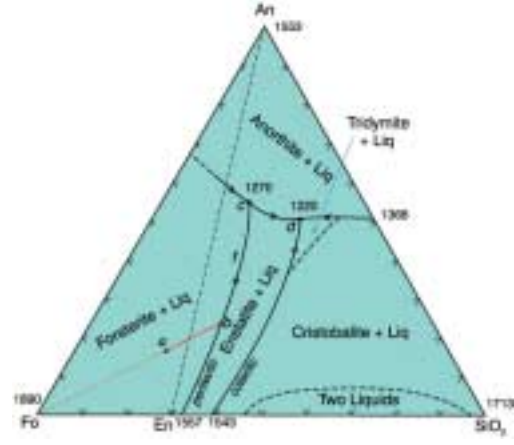
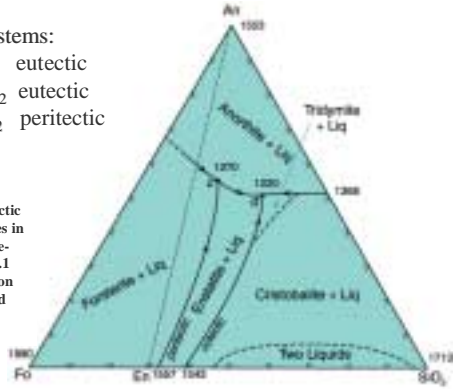
Partial Melting (remove melt):



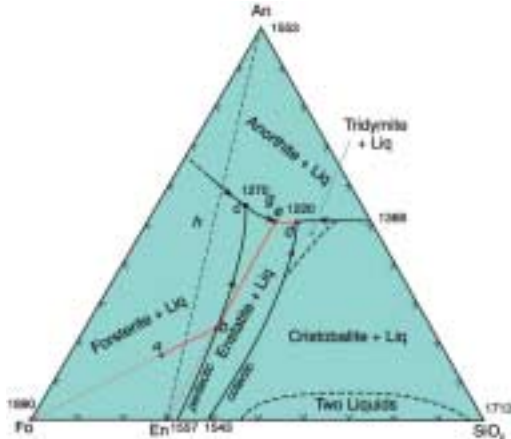
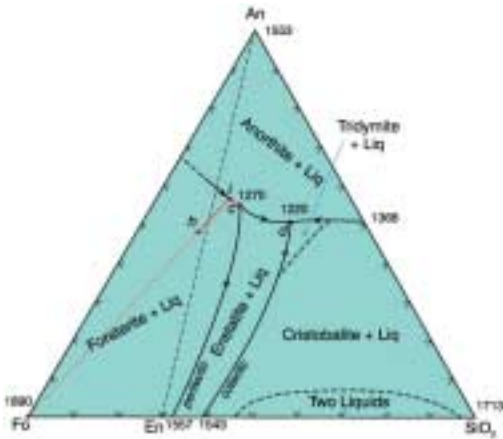
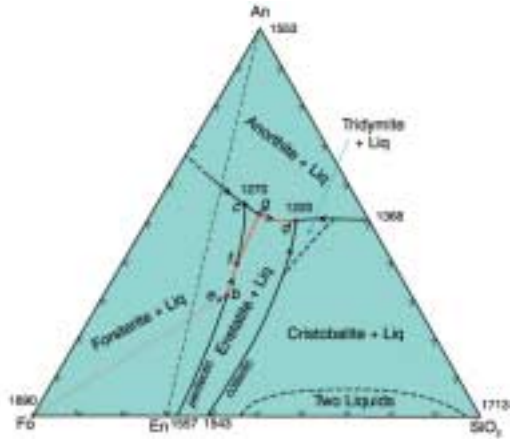
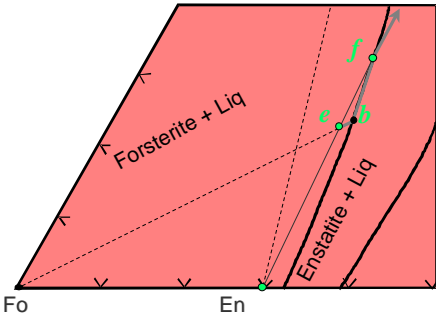
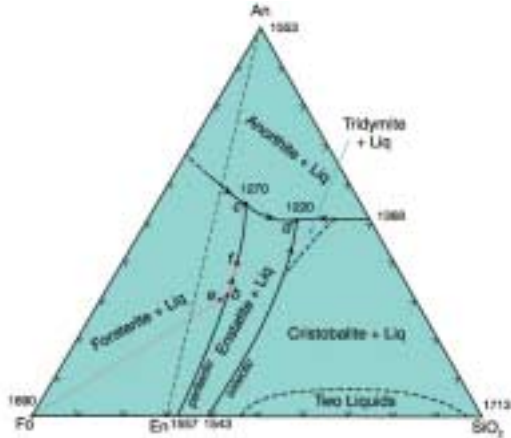
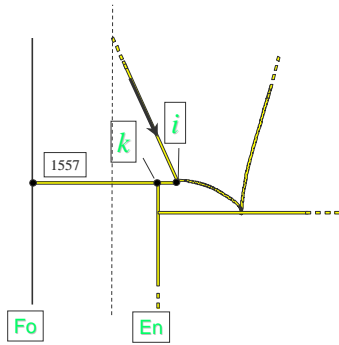
**Fo - An - SiO<sub>2</sub> (at 0.1 MPa)**

- 3 binary systems:
- Fo-An eutectic
- An-SiO<sub>2</sub> eutectic
- Fo-SiO<sub>2</sub> peritectic

Isobaric diagram illustrating the cotectic and peritectic curves in the system forsterite-anorthite-silica at 0.1 MPa. After Anderson (1915) A. J. Sci., and Irvine (1975) CIW Yearb. 74.

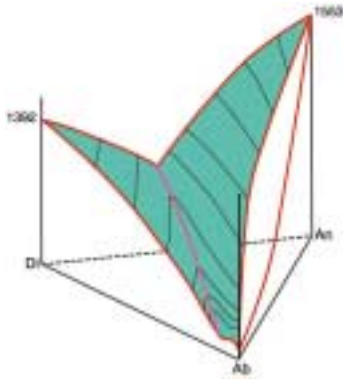


Works the same way as the Fo - En - SiO<sub>2</sub> binary



## Diopside-Albite-Anorthite

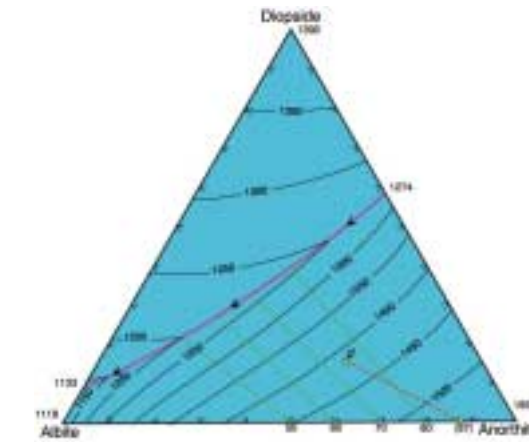
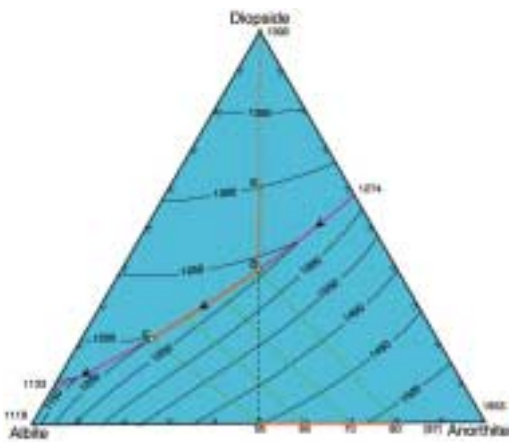
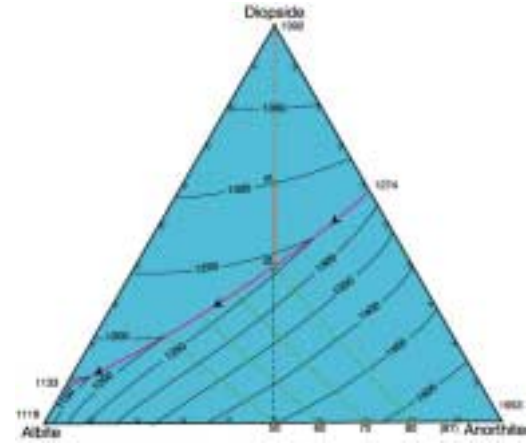
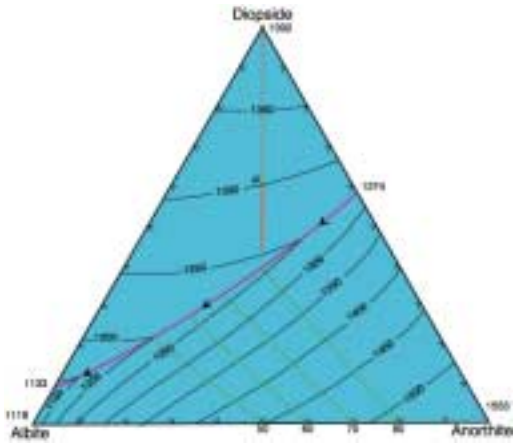
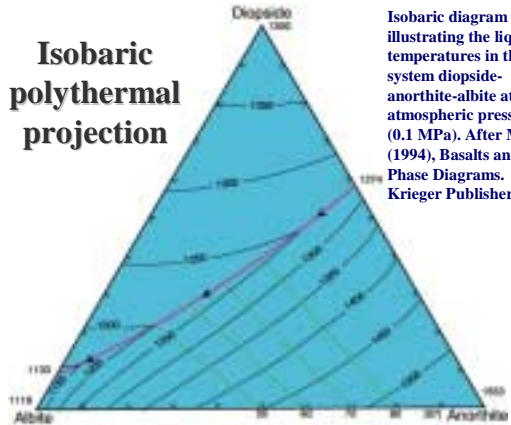
Isobaric diagram illustrating the liquidus temperatures in the system diopside-anorthite-albite at atmospheric pressure (0.1 MPa). After Morse (1994), Basalts and Phase Diagrams. Krieger Publishers

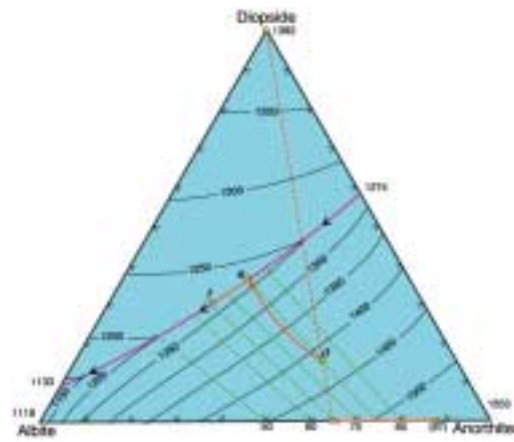
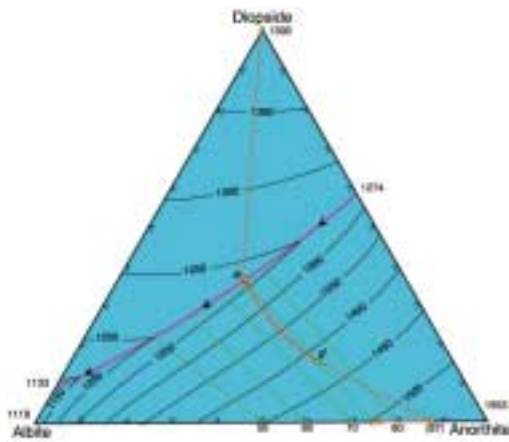


Di - An Eutectic  
 Di - Ab Eutectic  
 Ab - An solid solution

## Isobaric polythermal projection

Isobaric diagram illustrating the liquidus temperatures in the system diopside-anorthite-albite at atmospheric pressure (0.1 MPa). After Morse (1994), Basalts and Phase Diagrams. Krieger Publishers.





Binary character is usually maintained when a new component is added

- ☞ Eutectic behavior remains eutectic
- ☞ Peritectic behavior remains peritectic
- ☞ Solid solutions remain so as well