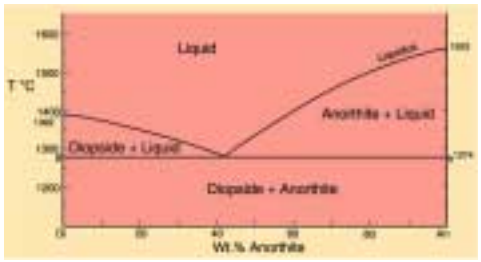
Eutectic and Peritectic Systems

Winter, Chapter 6

Eutectic Systems

Example: Diopside - Anorthite

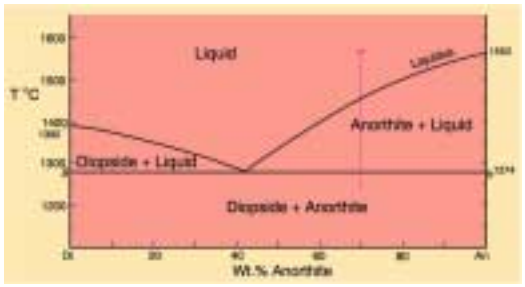
No solid solution



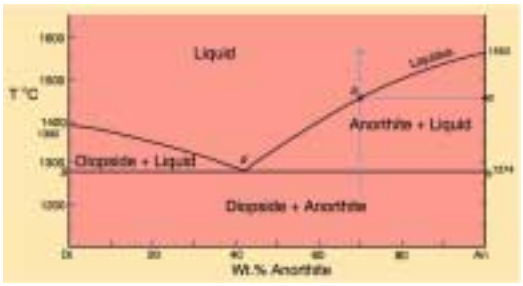
Isobaric T-X phase diagram at atmospheric pressure. After Bowen (1915), Amer. J. Sci. 40, 161-185.

Cooling from composition a:

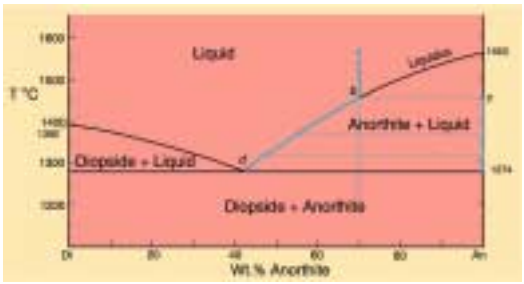
bulk composition = An_{70}



First crystal forms at 1455°C (point b)
with a compositon of pure An



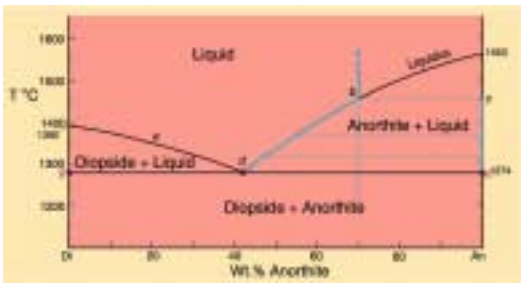
- Cooling continues as X_{liq} varies along the liquidus
- Continuous reaction: $liq_A \rightarrow$ anorthite + liq_B



At 1274°C $\phi = 3$ (three phases co-exist)

Therefore, F = 2 - 3 + 1 = 0 This is an invariant point

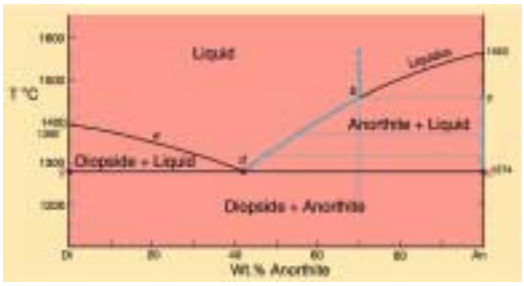
- (P) T and the composition of all phases is fixed
- Must remain at 1274°C as a discontinuous reaction proceeds until a phase is lost



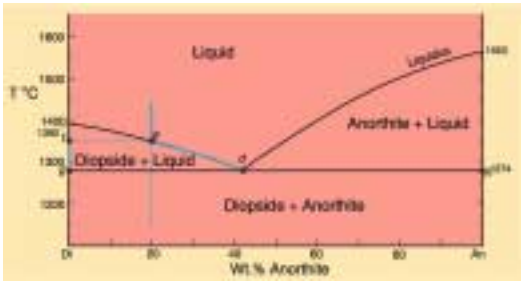
A discontinuous reaction occurs at d

Temperature remains constant at 1274

– Use geometry to determine liquid crystal ratios



Left of the eutectic there is a similar relationship



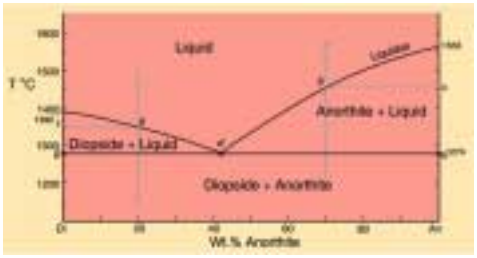
•The melt crystallizes over a T range up to ~280ºC

•A sequence of minerals forms over this interval

- And the number of minerals increases as T drops

•The minerals that crystallize depend upon T

- The sequence changes with the bulk composition



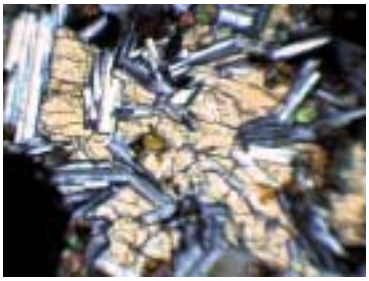
Augite Forms Before Plagioclase

Gabbro of the Stillwater Complex, Montana

This forms on the left side of the eutectic

Plagioclase Forms Before Augite

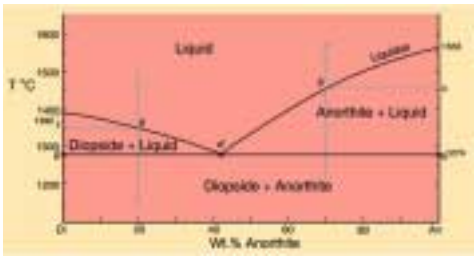
Ophitic texture



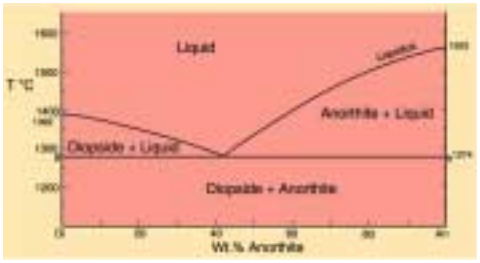
Diabase dike

This forms on the right side of the eutectic

- The last melt to crystallize in any binary eutectic mixture is the eutectic composition
- Equilibrium melting is the opposite of equilibrium crystallization
- Thus the first melt of any mixture of Di and An must be the eutectic composition as well



Fractional Crystallization



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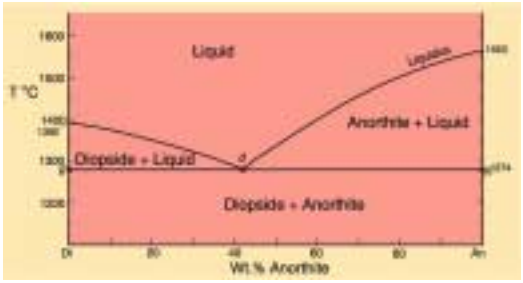
Partial Melting



Binary Peritectic Systems

Three phases involved: enstatite = forsterite + SiO_2

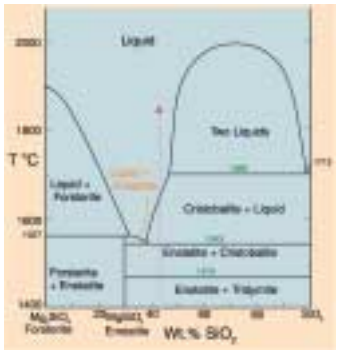
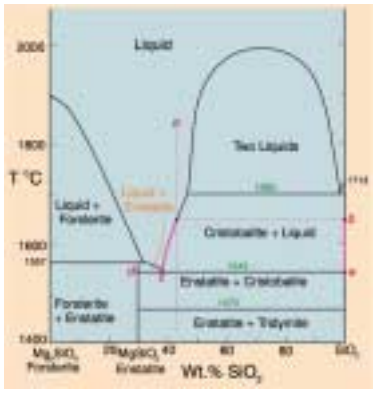


Figure 6-12. Isobaric T-X phase diagram of the system Fo-Silica at 0.1 MPa. After Bowen and Anderson (1914) and Grieg (1927). Amer. J. Sci.

Binary Peritectic Systems



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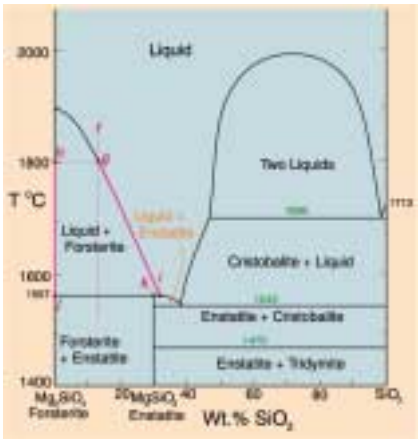


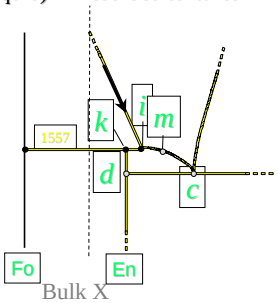
Figure 6-12. Isobaric T-X phase diagram of the system Fo-Silica at 0.1 MPa. After Bowen and Anderson (1914) and Grieg (1927). Amer. J. Sci.

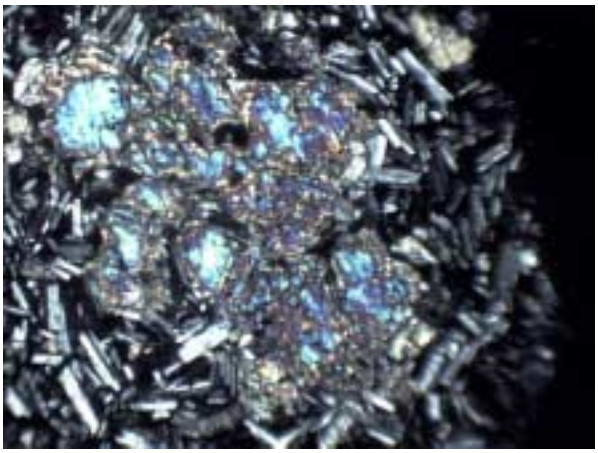
i = "peritectic" point

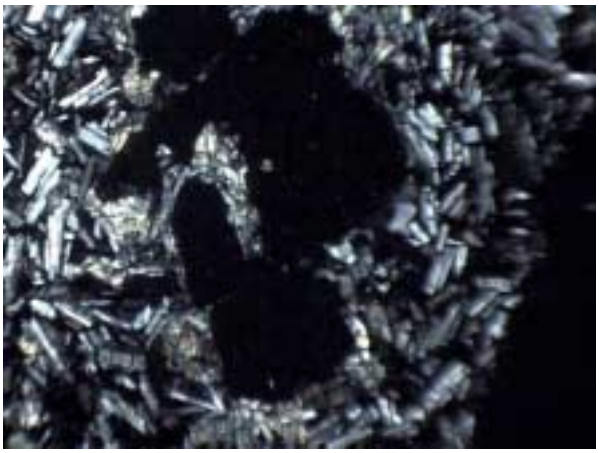
At 1557°C there is colinear equilibrium of Fo-En-liq

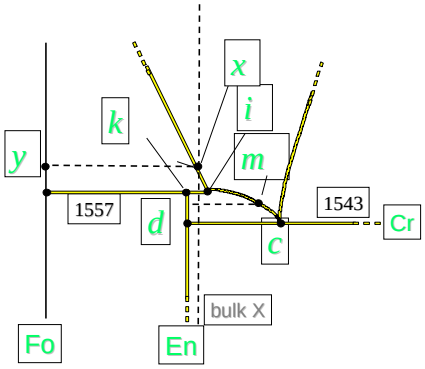
- geometry indicates a reaction: Fo + liq = En
- consumes olivine (and liquid) → resorbed textures

When is the reaction finished?







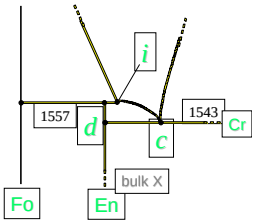


Incongruent Melting of Enstatite

- Melt of En does not produce a melt of same composition
- Rather En goes to Fo + Liq *i* at the peritectic

Partial Melting of Fo + En (harzburgite) mantle

- En + Fo also → firsl liq = *i*
- Remove *i* and cool
- Result = ?



Consequence For Basalt Magma

The Fo-En-Q system causes compositions to migrate from alkali basalt toward tholeiite as the degree of crystallication or melting progresses