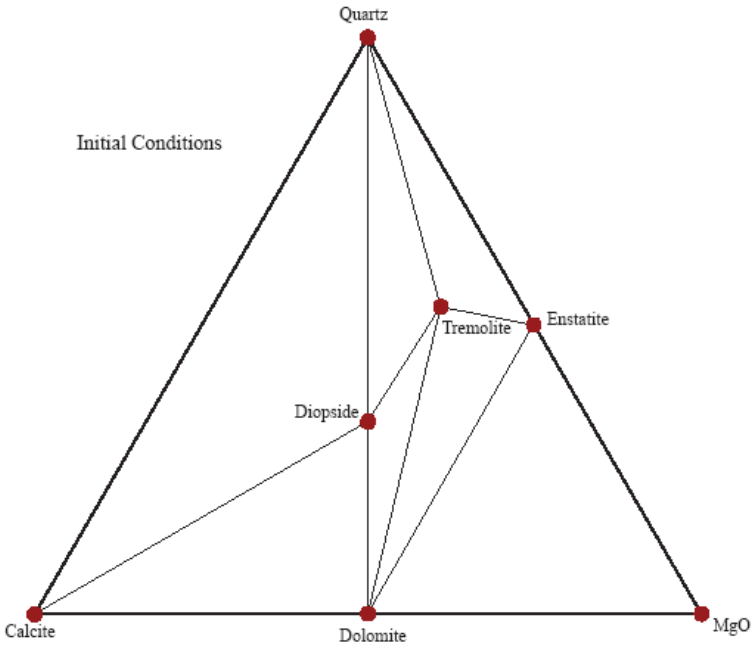
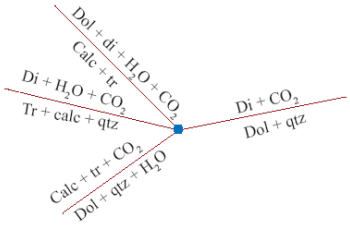
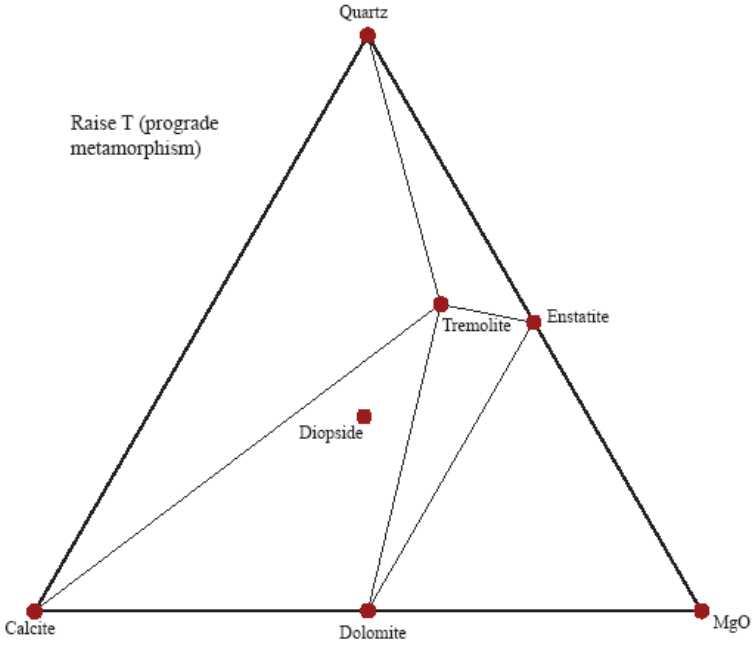
12.109 Lecture Notes
December 1, 2005

How does fluid composition vary during metamorphism?







Hit reaction curve
$dol + qtz + H_2O \rightleftharpoons$
$calc + tr + CO_2$
Fluid composition becomes more CO_2 rich

Will reach invariant point, and then travel along $calc + tr \rightleftharpoons dol + di + H_2O + CO_2$ curve (univariant). When reaction is complete, the composition leaves the curve. The fluid composition remains constant as T increases.

Fluid composition changes during metamorphism, depends on bulk composition of rock. Fluid can also sometimes buffer reactions – this is controlled by the fluid to rock ratio.

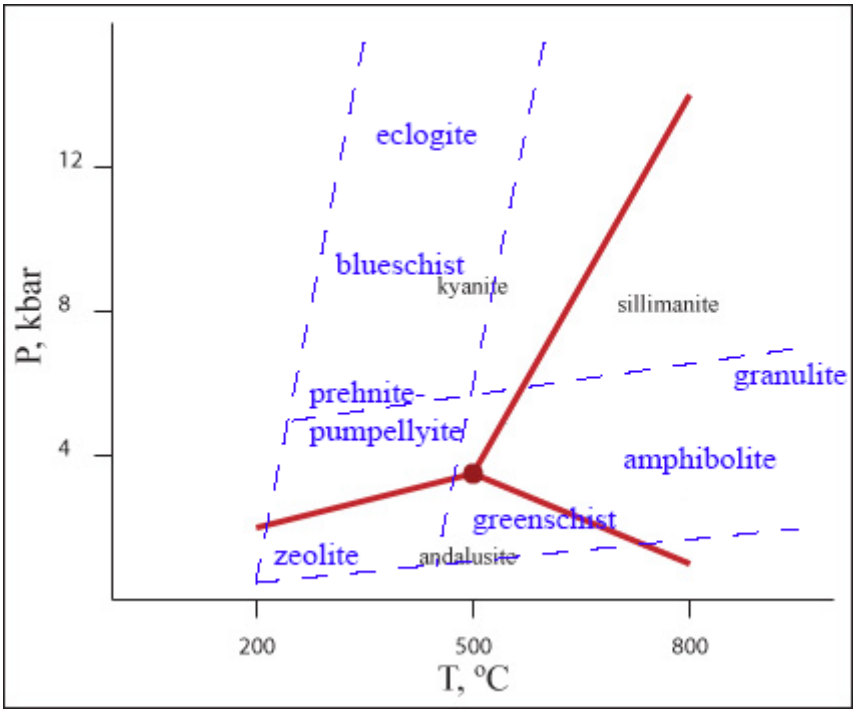
Metamorphism of Mafic Rocks

Ex. basalts

See Spear, Ch. 11

Chemically complex—system not easy to look at graphically
$SiO_2 – Al_2O_3 – FeO – MgO – CaO – K_2O – Na_2O – H_2O$
8 components → 10 phases!

ACF triangle diagram – Al_2O_3, FeO + MgO, CaO
Facies for metamorphic rocks – mineral assemblage characteristic of a set of P-T conditions for a particular bulk composition
At low T, metamorphic minerals only appear in small amounts



Zeolite facies – rich diversity of minerals, often form in holes in igneous rocks

Analcine $NaAlSi_2O_6 \bullet (H_2O)$

Analcine + qtz $\rightleftharpoons$ albite + H_2O

Lamontite $CaAl_2Si_4O_{12} \bullet 4(H_2O)$

Lamontite + qtz $\rightleftharpoons$ lawsonite $CaAl_2Si_2O_7(OH)_2 \bullet H_2O$

Warikite $CaAl_2Si_4O_{12} \bullet 2(H_2O) \rightleftharpoons$ lawsonite + qtz

Prehnite $Ca_2Al_2Si_3O_{10}(OH)_2$

Pumpellyite $Ca_2Fe_2^{3+}Si_3O_{10}(OH)_2$

Breaks down to epidote + chlorite + albite + qtz ← lower greenschist facies

Amphibolite facies – marked by the appearance of amphibole and plagioclase (albite-anorthite solid solution). Plagioclase is not appearing for the first time in this facies, but as T goes up, the variety changes from pure albite to about 20% anorthite

Zoisite (like epidote, but Al rather than Fe^{3+}) + qtz → actinolite + H_2O

Zoisite + chlorite + qtz → actinolite + anorthite + H_2O

@ higher T, make hornblende

Granulite facies – appearance of orthopyroxene

Hornblende + qtz → cpx + opx + plag + H_2O

Blueschist – albite + chlorite → glaucophane $Na_2Mg_3Al_2Si_8O_{22}(OH)_2$ + H_2O

2 jadeite + 1 talc

Classic blueschist assemblage: glaucophane + lawsonite (10% H_2O!) + chlorite

Eclogite – garnet, cpx (Ca and Na, apple green colored), NO PLAGIOCLASE

Omphacite

Diopside + jadeite