

Melting

Reference:

Encyclopedia of Volcanoes, pp. 55-68

Heat of fusion

- About 300 times the rock's specific heat
- Melting of rock consumes much heat
- ΔS_f is the entropy of fusion, the entropy necessary to melt the substance

Processes

- Adiabatic melting
 - Heat flow by conduction is negligible
- Isentropic melting
 - Entropy is constant
 - Adiabatic conditions
 - Reversible process

Causes of Melting

- Decompression
- Changing composition
- Increasing temperature
- Where and how can these processes occur in the Earth?

Decompression Melting

- Occurs in mid-ocean ridges and ocean islands
- Mantle that rises in a convection cell will decompress
- The system undergoes partial melting, that is, liquid and solid can exist in equilibrium
- Adiabatic system; Pressure causes all temperature change

Melting by Changing Composition

- Responsible for island arc volcanism
- Water expelled from a down-going slab can lower the melting point of material lying above
- The amount of melt depends on quantity of water and the temperature

Changes in Composition

- Increase in water pressure
 - Lowers the solidus
- Subduction zones
 - Peridotite wedge
 - Over subducting oceanic crust

Increasing Temperature

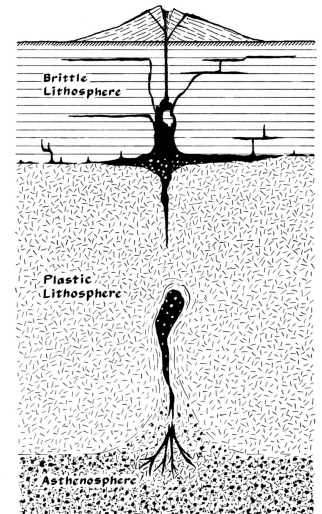
- Early planetary impacts create melts
- The cold subducting slab may be melted as it dives deeper into the Earth

Temperature Increase

- Mechanical deformation
 - Friction generates heat
- Mass transfer of rock
 - Descending oceanic lithosphere
 - Basaltic underplating of continental crust

Magma Generation

- Partial melting
 - Upper mantle
 - Deep crust
- Magma density
- Less than surroundings



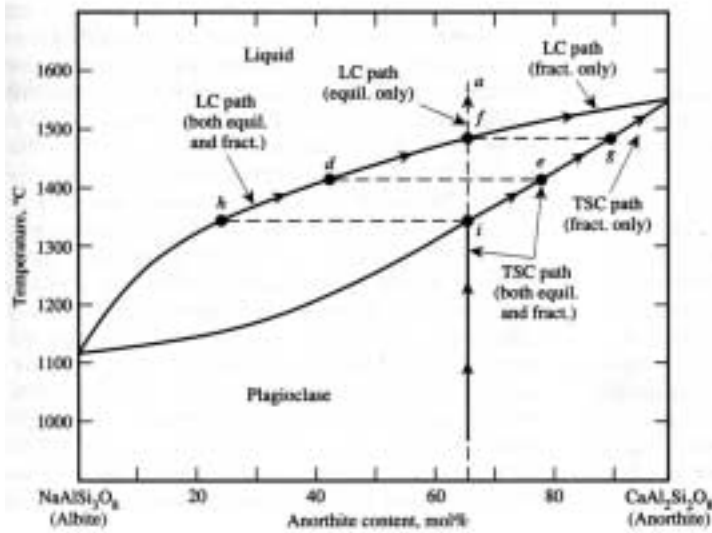
MASH

Hilderth and Moorbath (1988) Refer to processes that take place beneath continental crust in subduction zones

- Melting
- Assimilation
- Storage
- Homogenization

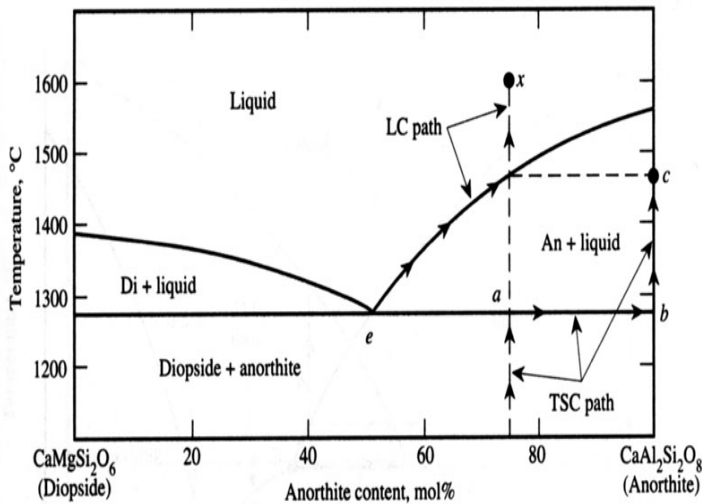
Ab-An System

- Melts are enriched in Na & Si
- Residual is enriched in Ca & Al



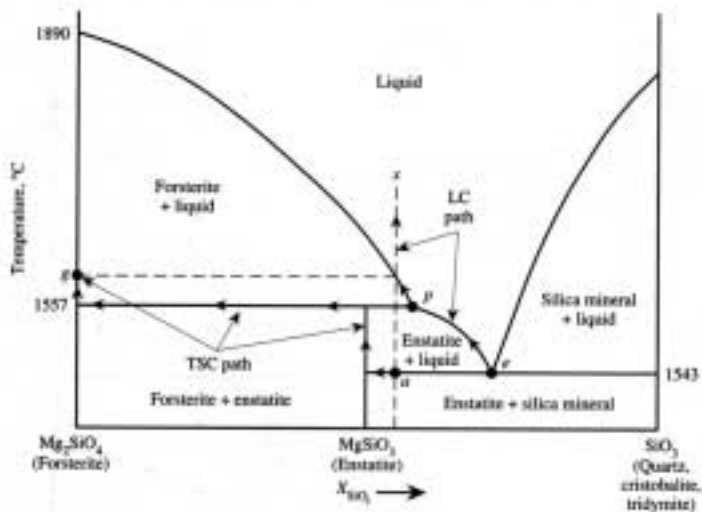
Di-An System

- Initial melts have eutectic composition
 - Basalt
- Residual enriched in end-member composition
 - Pyroxene and olivine



Fo-Q System

- Initial melts have eutectic or peritectic composition
- Residual rock is enriched in Fo or Q, depending on the starting composition



Amount and Depth of Melting

- Shallow melting produces tholeiite magma
- Deep melting produces alkali magmas
- The larger the degree of melting, the closer the composition is to the source region

