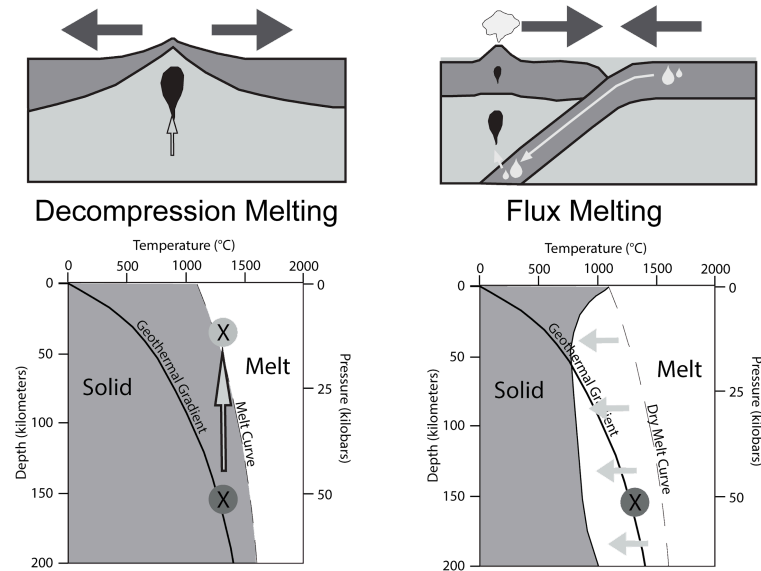


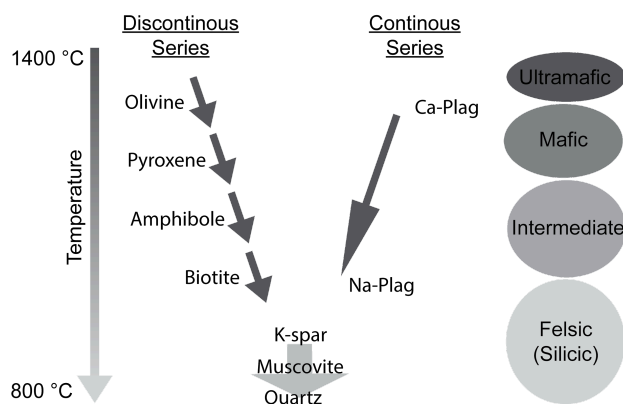
First some review of Melts:

Melting



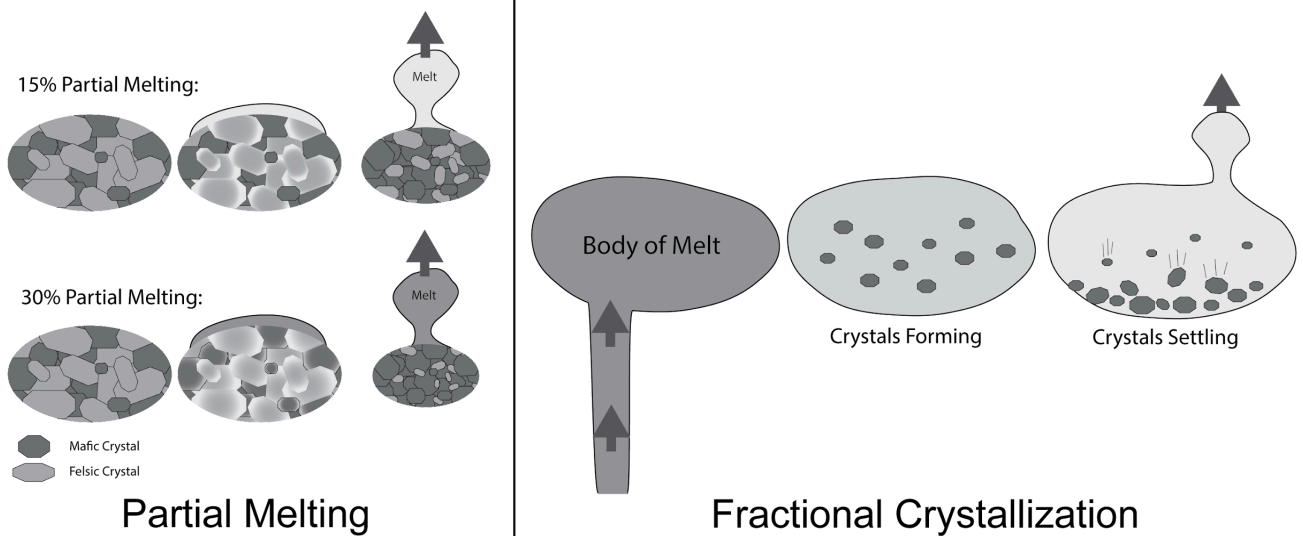
Most melt is generated in the upper mantle, just underneath the crust. The primary way (decompression) is through the upwelling of mantle at spreading centers. By rising quickly, pressure drops substantially before temperature can lower, and the system crosses into the zone of melt. The secondary way (Flux) is the addition of water from a subducting slab to the mantle. Addition of water to the system lowers the melting curve, allowing some melting of the mantle to occur.

Crystallizing (Bowen's reaction series)

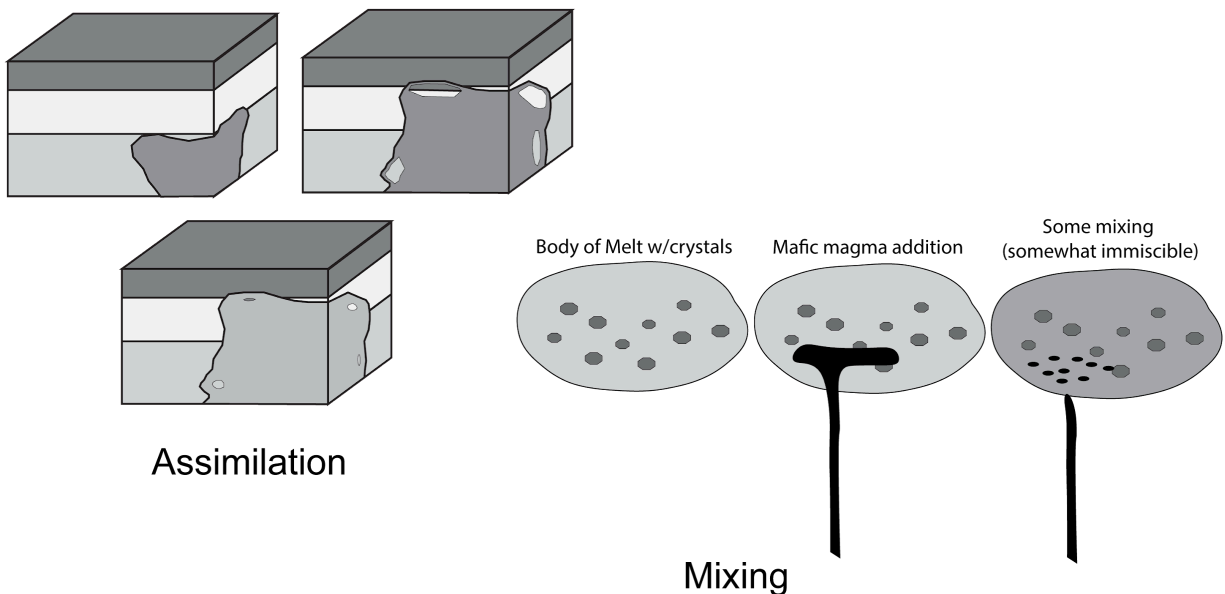


Developed by N.L. Bowen (and colleagues) in the early 1900's. This reaction series represents the results of many melting and crystallization experiments aimed at determining the sequence of minerals that crystallize from a melt. The Bowen's reaction series has exceptions, however it is still accepted as the general model today.

Modifying Melt Compositions



[Partial melting] affects the melt where it is created, depending on how much material is melted, with higher amounts of melting, more mafic minerals will melt and contributed to the melt composition.
[Fractional crystallization] affects the melt as mafic crystals form first (recall: Bowen's Reaction Series), they effectively remove mafic components from the remaining melt.



[Assimilation] affects the melt when large blocks of country rock are incorporated into the melt, and if some melting of those blocks occurs, their chemistry will be added to the melt.
[Mixing] affects the melt when two melts of different chemistry come into contact.

Now, test your knowledge:

Briefly define the following terms:

geothermal gradient –

decompression melting –

flux melting –

felsic –

mafic -

partial melting –

fractional crystallization –

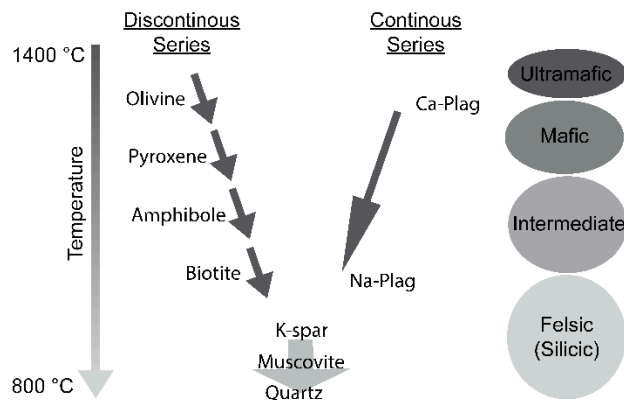
assimilation –

mixing –

Answer the following:

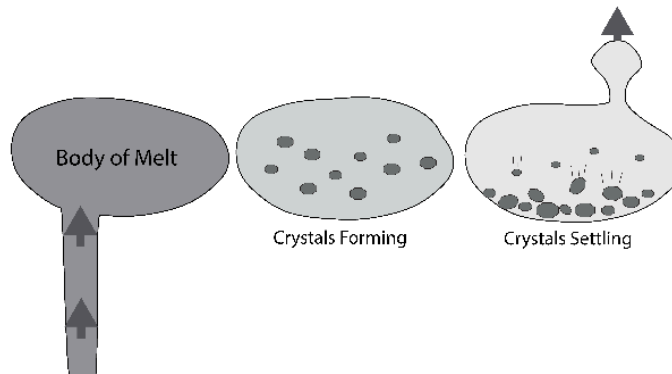
1. There are many places on Earth's surface where we can observe active volcanoes. There is also a large amount of rocks on or near the surface which formed from intrusive (plutonic) or extrusive (volcanic) igneous processes. Where does all the melt fueling volcanoes and forming igneous/volcanic rocks come from?
 - A. The outer core is molten (liquid), much of this material finds its way to the surface.
 - B. The crust is melted by the Earth's interior heat.
 - C. Select areas of mantle rock will melt in certain special conditions.
 - D. Mantle plumes are the source of melt on the surface.

2. During decompression melting, a portion of the mantle will experience significant:
 - A. Increased Temperature
 - B. Increased Pressure
 - C. Decreased Temperature
 - D. Decreased Pressure
3. The answer to question #2 is best explained to occur during decompression melting because:
 - A. The mantle rises quickly, not allowing enough time for the rock to cool through conduction.
 - B. Water is added to the mantle, lowering the melting temperature of the rock.
 - C. Part of the mantle is uncovered in an area between two spreading tectonic plates.
 - D. New material from the liquid outer core arrives, heating the surrounding rock.
4. What causes flux melting?
 - A. The mantle rises quickly, not allowing enough time for the rock to cool through conduction.
 - B. Water is added to the mantle, lowering the melting temperature of the rock.
 - C. Part of the mantle is uncovered in an area between two spreading tectonic plates.
 - D. New material from the liquid outer core arrives, heating the surrounding rock.



5. According to Bowen's reaction series, the first types of rocks (collection of crystals) to form from a melt would be:
 - A. Ultramafic (ultra-low silica)
 - B. Mafic (low silica)
 - C. Intermediate (intermediate silica)
 - D. Felsic (silicic)
6. In the Bowen's reaction series diagram, "Ca-Plag" stands for:
 - A. Calcedonic Plagioclase
 - B. Calcium Plagioclase
 - C. Calcitrant Plagioclase
 - D. Calvin Plagioclase

7. According to Bowen's reaction series, what mineral pair is unlikely to be found together in nature?
- A. Olivine and Ca-Plag
 - B. Ca-Plag and Quartz
 - C. Olivine and Quartz
 - D. Biotite and K-spar
8. When heating a hypothetical rock made of Muscovite, Na-Plag, Biotite, and Amphibole; you would anticipate which phase to begin melting firstly?
- A. Muscovite
 - B. Na-Plag
 - C. Biotite
 - D. Amphibole



9. Use Bowen's reaction series to determine which type of minerals (i.e. mafic or felsic) will crystallize from a melt firstly. Based on your answer, what affect does 'removing' these crystals from the melt (by virtue of them sinking to the bottom of the magma chamber) have on the residual (remaining) melt?
- A. Makes the melt more mafic.
 - B. Makes the melt more felsic.
 - C. Makes the melt more capable of accepting more melt from below.
 - D. Forces the crystals to settle to the bottom of the melt.
10. Melt will ascend (rise) in the crust until it stalls, meaning it reaches equal buoyancy with the surrounding country rock. This means that the melt has a similar mafic/felsic character as the surrounding rock. What do you think changing the melt through fractional crystallization will allow to happen?
- A. The residual melt will become more felsic, and will again ascend in the crust.
 - B. The residual melt will become more mafic, and will again ascend in the crust.
 - C. The residual melt will become more felsic, and will begin to descend in the crust.
 - D. The residual melt will become more mafic, and will begin to descend in the crust.

Now, think deeper:

On your own:

11. Where do you suppose is the closest place to you where you could go to physically see molten rock?

12. What tectonic setting do you suppose creates the most melt on Earth (by volume)? Why?

13. Why do we characterize melts and igneous rocks according to their silica content?

Working in groups of 2 or 3 answer the following:

14. Discuss your answers to question 12. If you had different answers, discuss reasons why, write them here. If you had the same answer, can you rank different melt producing tectonic settings in order of volume of melt produced?

15. Discuss your answers to question 13. Did your partner have a different answer than you? Write it down here.