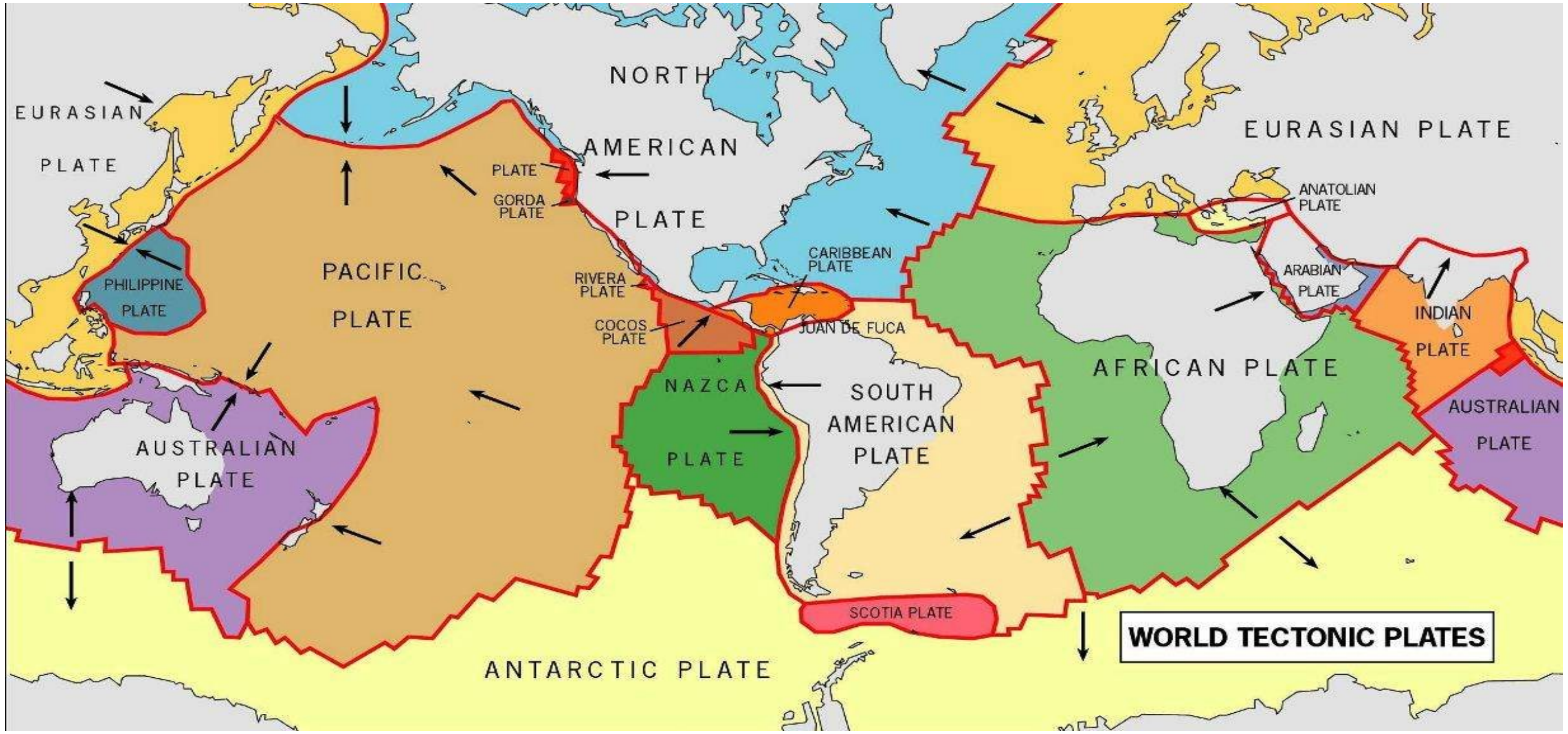
1602 Lab 8 – Seafloor Spreading / Plate Tectonics and Igneous Rocks

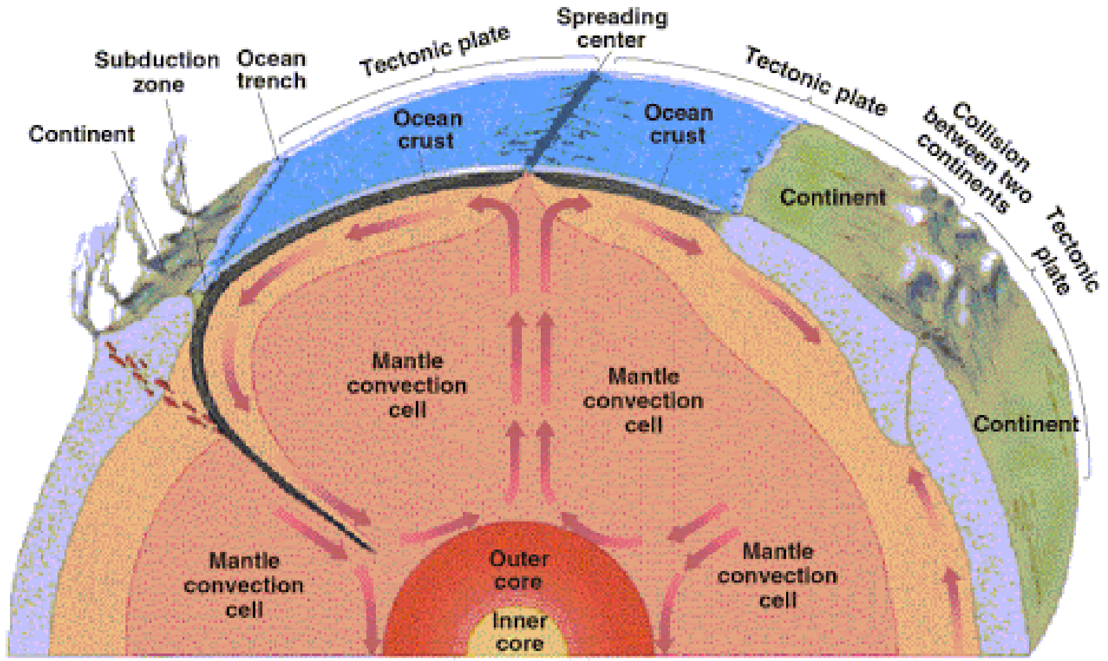
Plate Tectonics

- Is the concept that the surface of the Earth is divided into rigid portions of the lithosphere that can move horizontally and due to their movement, we have earthquakes, volcanoes, and mountains. This also explains the jig-saw puzzle nature of the continents.



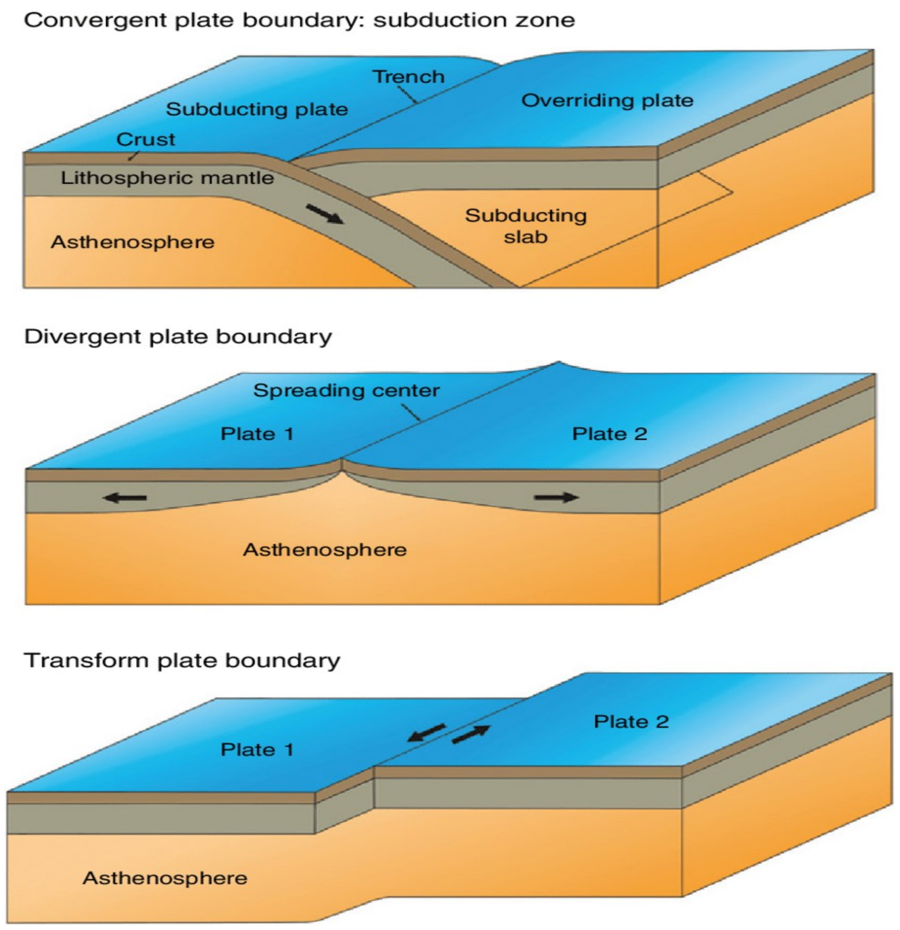
What are the Drivers of Plate Tectonics?

- Mantle Convection: The process of warm less dense mantle material rising through the planet gradually cools and then sinks, this creates a <u>convection cell.</u>
- The other primary force is the downward pull of the sinking tectonic plates at convergent boundaries (subduction zones).



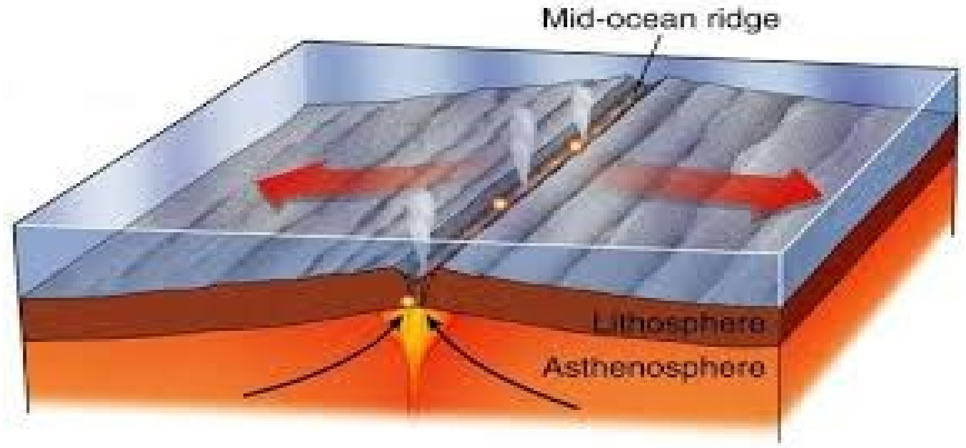
Types of Plate Boundaries

1. Convergent: Two plates colliding and one going underneath another. Ex: Subductions Zones and (most) Mountain Belts
2. Divergent: Two plates moving away from each other. Ex: Seafloor Spreading Ridges
3. Transform: Two plates sliding past one another.



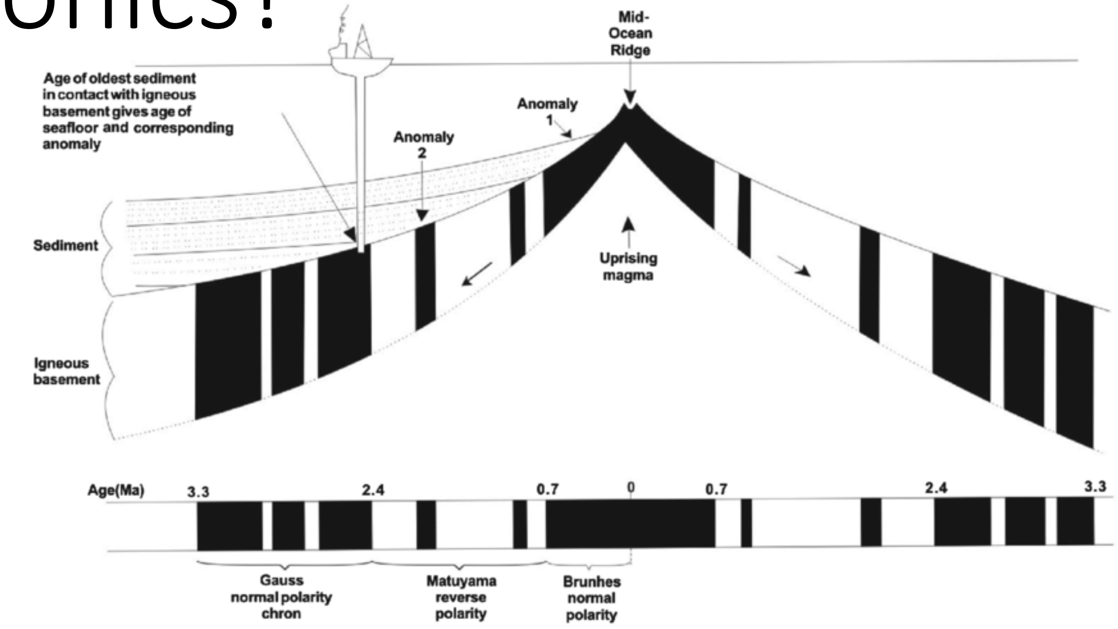
Seafloor Spreading

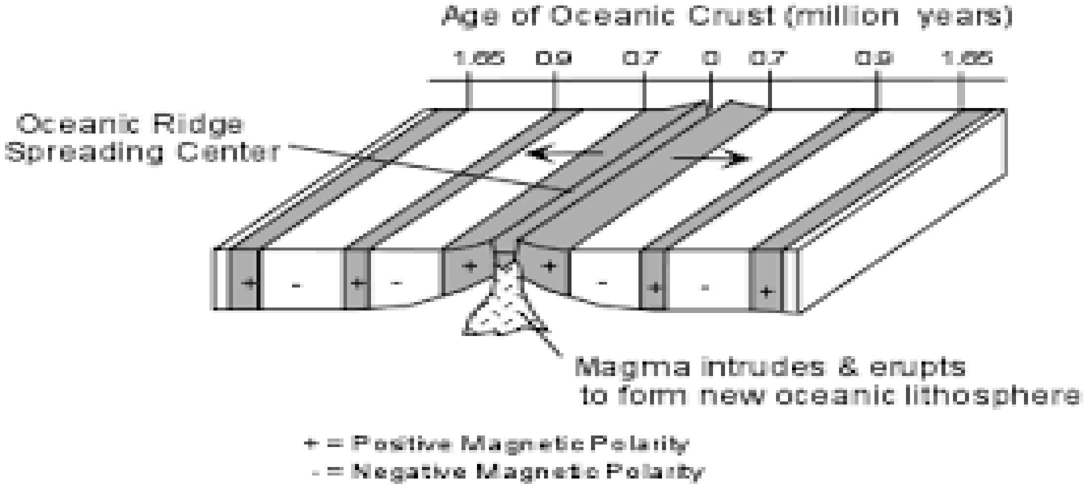
- At divergent boundaries if the plates move far enough away from each other, the result is that new molten material will rise to the to the surface and create new crust at <u>spreading centers (ridges).</u>
- As material rises the result is that the two tectonic plates will move away from each other. This means that you will find the youngest crust near the ridge and the age of the crust gets older the further you are from the ridge.



How to Verify Plate Tectonics?

- We can verify plate tectonics via paleomagnetism and magnetic reversals.
- Paleomagnetism: Is the remnant magnetism recorded in rocks that can be used to measure the intensity and direction of the Earth's magnetic field.
- Magnetic Reversals: Throughout time the Earth's magnetic field flips direction and reverses relative to today's magnetic field.



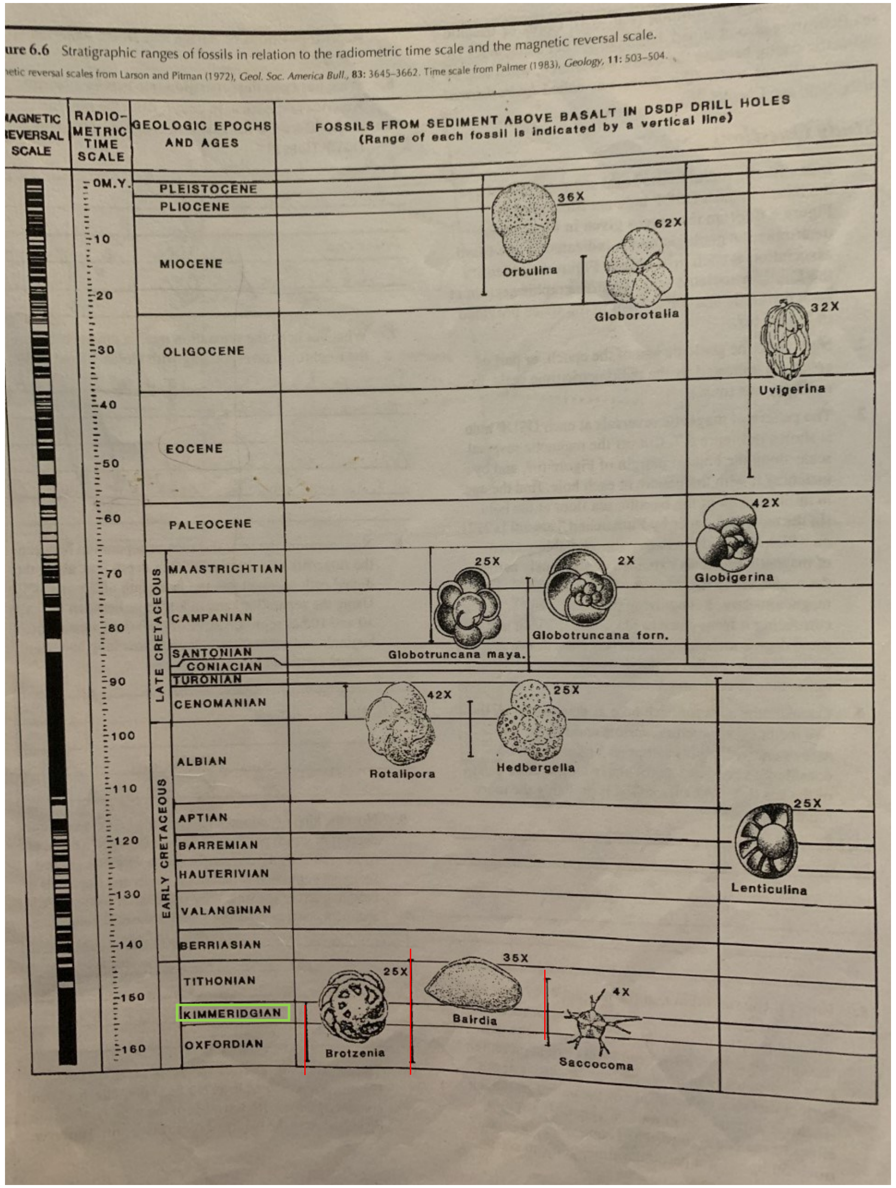


Spreading Rate Calculations and Age Correlations

- If we know the distance know the distance from the ridge to the anomaly we are studying and the age. We can calculate a spreading rate.
- Two types of spreading rates:
- **Half Spreading Rate**: Is the rate of the one tectonic plate to the ridge.
- **Full Spreading Rate**: Is the rate of one tectonic plate relative to the other.
- We can figure out the age specific anomalies by more than just radiometric dating. We can calculate ages based on spreading rates and fossil assemblages.
- When it comes to age correlation via fossil assemblages, we do this based on their first and last appearances in the rock record.
- As oceanic crust become older, it becomes denser and subsides. This allows thick packages of sediments to be deposited in the areas further away from the ridge.

Example of Spreading Rate Calculation and Fossil correlation.

- Spreading Rate Calculations
- Distance to anomaly = 200 km ; Time (age) = 100 Ma
- ½ Spreading rate = 200 km/ 100Ma = 2 km/Ma
- Full spreading Rate = 2(2 km/Ma) = 4 km/Ma
- We sometimes want to have these rates in smaller units such as mm/yr or cm/yr.
- 1 km = 100,000 cm
- 100 Ma = 100,000,000 Years
- 1 km/Ma = 100,000 cm / 1,000,000 yrs = 0.1 cm/yr
- 4 km/Ma x 0.1 cm/yr = 0.4 cm/yr
- 4 km/Ma = 4 mm/yr



Ex: If we had a sample that contained Brotzenia, Bairdia, Saccocoma. We look for where their datums (red) overlap and where this overlap occurs is the age of the sample (green).

Igneous Rocks

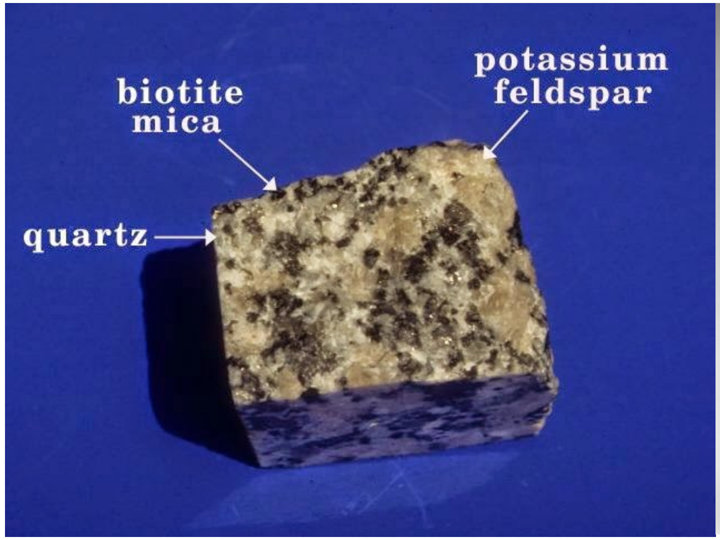
- Are formed due to the cooling of molten rock material.
- We identify them based on their texture (the size/visibility of their crystals) and composition (the minerals that the rock is made of).
- Common minerals found in igneous rocks: Quartz, plagioclase feldspar, potassium feldspar (k-spar), hornblende, pyroxene, olivine, and biotite

Igneous Rock Textures

- Coarse Grained (**<u>phaneritic</u>**): Is an igneous rock texture in which almost all the crystals can be seen with the naked eye. > 1 mm
  - Ex: Granite, Diorite, Gabbro
- Fine-Grained (**<u>aphanitic</u>**): Crystals too small to be seen with the unaided eye. (This usually indicates rapid cooling)
  - Ex: Rhyolite, Andesite, Basalt
- **<u>Glassy</u>**: Suggests rapid cooling, but none or very few crystals form. It takes on the texture of glass.
  - Ex: Obsidian
- **<u>Vesicular</u>**: Some gas bubbles that form in the rock during cooling never pop and become preserved in the rock as empty cavities (vesicles). These can range in size and can be very abundant in some igneous rocks.
  - Ex: Pumice and Scoria
- **<u>Pyroclastic</u>**: Are what forms in explosive eruptions that expel gas, volcanic ash, lavas and rock/mineral fragments. When deposition finally occurs there is a lot of broken material and ash (generally).
  - Ex: Tuff

Examples of Textures

From top left to bottom right:
Phaneritc (granite), Aphanitic (basalt), Glassy (obsidian), Vesicular (pumice), Vesicular again (scoria), Pyroclastic (tuff)



Composition

- We can broadly categorize igneous rocks based on their compositions.
- **Felsic:** Igneous rocks with a felsic composition tend to be lighter in color (usually a whiteish pink/pink in color). Felsic rocks tend to consist of quartz, k-spar, plagioclase feldspar, muscovite, biotite and hornblende.
- **Intermediate:** Are typically white to grey in color. Generally containing light colored minerals such as plagioclase, minor amounts of quartz and k-spar, and some dark minerals like hornblende and biotite.
- **Mafic/Ultramafic**: Tend to be dark colored (near black or even sometimes green). These tend to be composed of calcium rich plagioclase and iron-magnesium minerals like pyroxenes and olivine

Examples of Igneous Rocks Classified by Texture and Composition

Felsic
Phaneritic (top) - Granite
Aphanitic (bottom) - Rhyolite

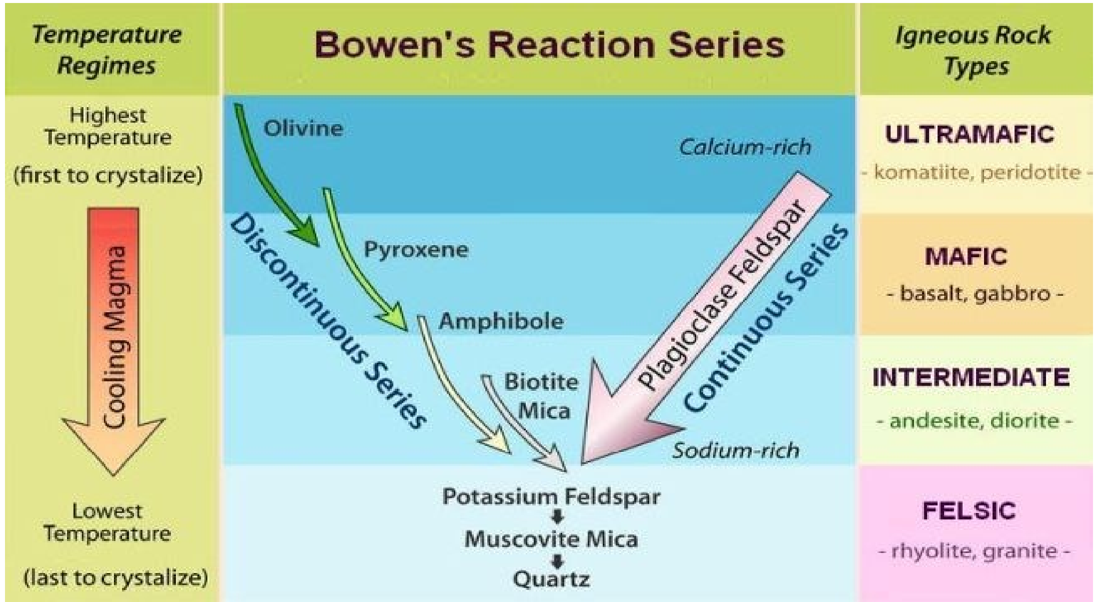
Intermediate
Phaneritic (top) - Diorite
Aphanitic (bottom) - Andesite

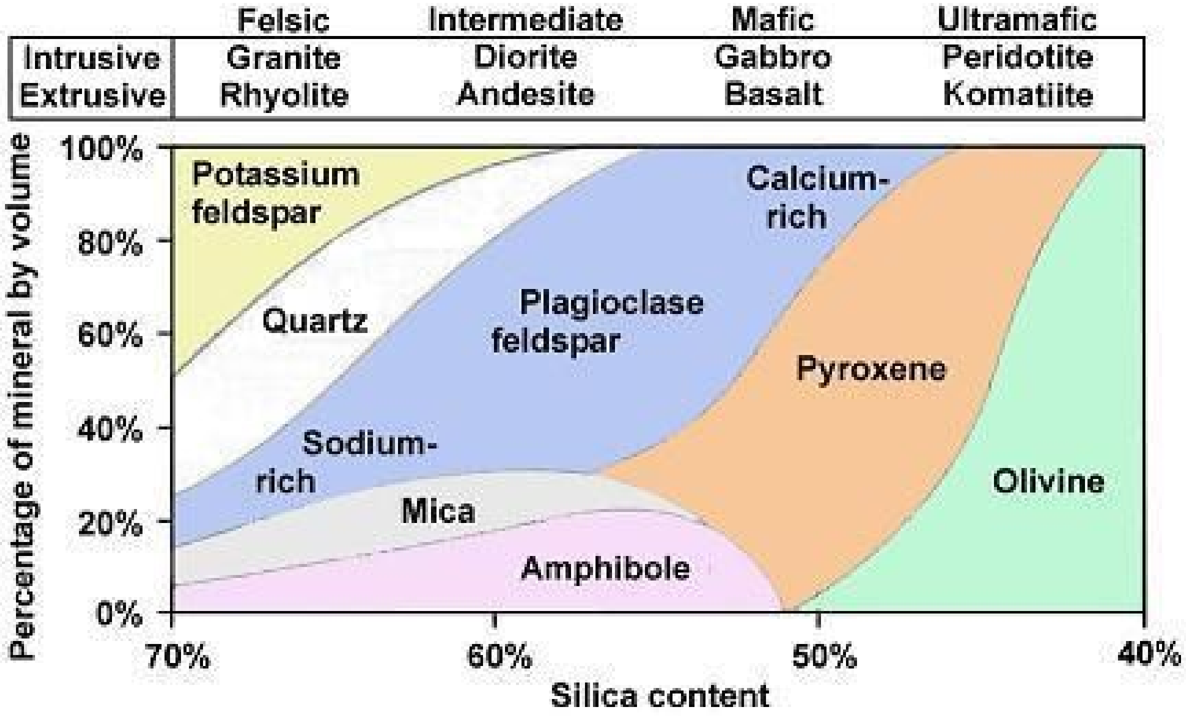
Mafic
Phaneritic (top) - Gabbro
Aphanitic (bottom) - Basalt

Ultramafic
Phaneritic (top) - Peridotite
Aphanitic (bottom) – None (maybe komatiites)

Bowen’s Reaction Series and Modal Abundances

- Bowen’s reaction series (below) gives us insight into the sequential formation of minerals as a magma/lava cools.
- It also gives insight into the key minerals that certain igneous rocks are composed of.





(Above) Generalized modal abundances of common felsic, intermediate, mafic and ultramafic rocks.

Lab Assignment

- Pages 183 – 184 # 1 - 7 omit # 8
- Pages 185 – 188 #1 – 9 omit #10
- Identify the 8 igneous rock samples and fill in the table on page 197
- All pages are to be scanned and submitted to moodle or via LSU email by the end of lab time.

Igneous Rock Samples

- Go to each link and observe the rocks and then fill in the table on page 197 using the powerpoint and knowledge from your reading.

1. https://sketchfab.com/3d-models/biotite-hornblende-granite-3-st-cloud-7-17-8da42a5347504da3a6307f13c73c3801
2. https://sketchfab.com/3d-models/basalt-from-somerset-cty-nj-8-9-9489f24d0e844e7e9ffee133a1531cc7
3. https://sketchfab.com/3d-models/gabbro-297a1115c86e4a12a480213768b795a4
4. https://sketchfab.com/3d-models/basaltic-scoria-tenerife-spain-igneous-rock-b598bf4042f84f808ee09755e6be0603
5. https://sketchfab.com/3d-models/peridotite-nodule-bomb-ca32660f4ffe410ba56e4aaf9b5bc534
6. https://sketchfab.com/3d-models/rhyolite-9936c0b4b2784d51bcba47e9167d201b
7. https://sketchfab.com/3d-models/hornblende-andesit-43e80e5502a44ee9814578552645fd19
8. https://sketchfab.com/3d-models/obsidian-c91a60c2ef2d4e28aa280c9df2afed9b