

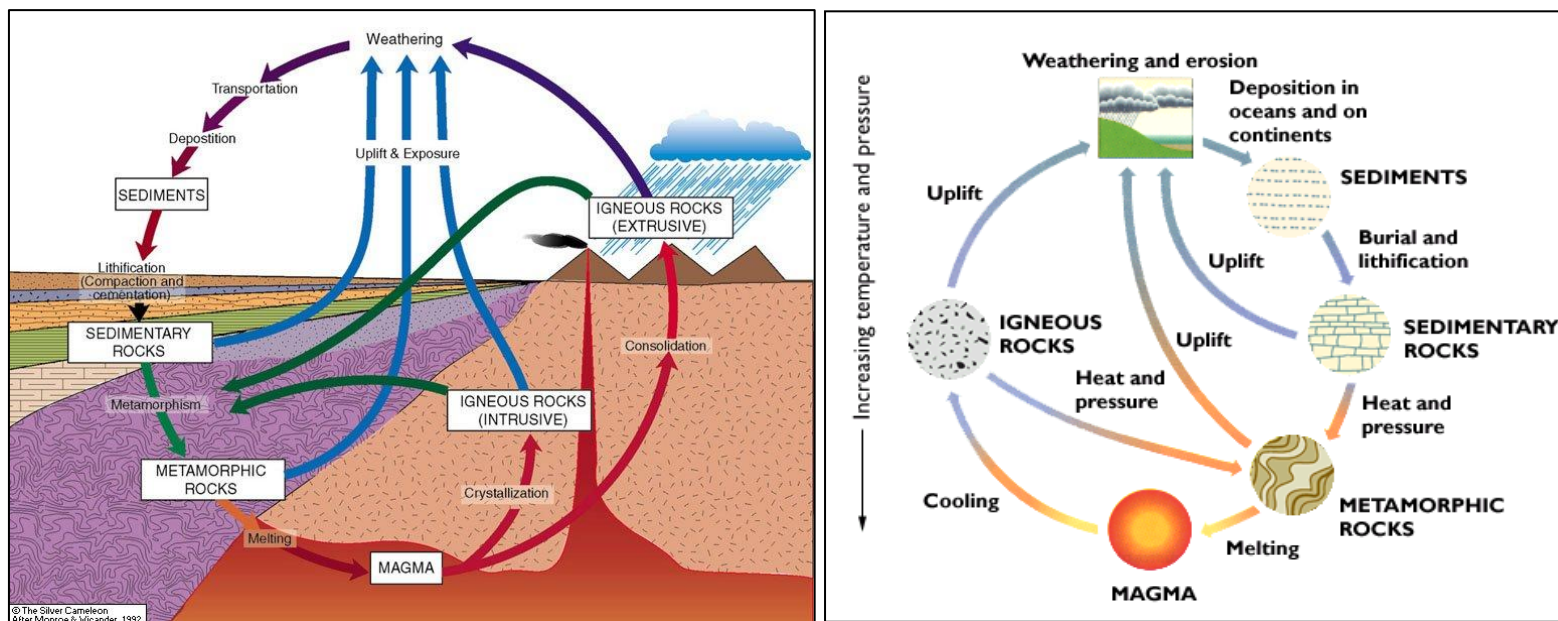
## Rocks

A naturally occurring aggregate of one or more minerals (e.g., granite), or a body of non-crystalline material (e.g., obsidian glass), or of solid organic material (e.g., coal).

## Rock Cycle

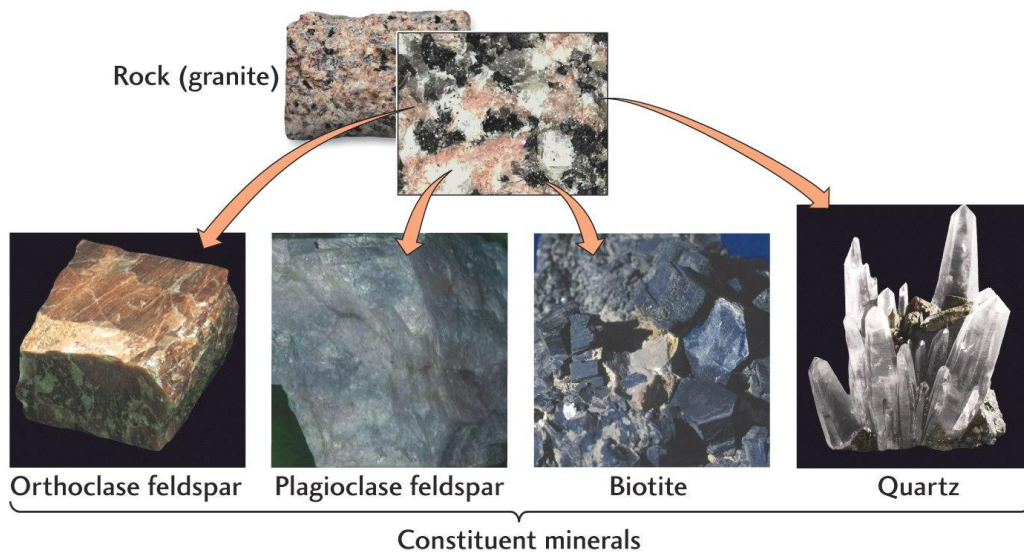
A sequence of events involving the formation, alteration, destruction, and reformation of rocks as a result of magmatism, weathering, erosion, deposition, lithification and metamorphism. It reflects the interactions between the plate tectonic and climate systems.

- The rock cycle is a set of processes that converts one rock type into another.
- The rock cycle is driven by tectonic processes.
- Plate collisions cause mountain ranges and volcanoes to grow. These are then weathered and eroded, producing sedimentary rocks.



- The rock cycle reflects the interaction of climate and plate tectonics.
- Igneous and metamorphic rocks are created at active plate boundaries.
- Erosion of mountains produces new sedimentary rocks.

### Minerals in rocks



### Rock Properties

Rock properties are controlled by:

1. Mineralogy
2. Texture
  - \* size and shapes of constituent minerals.
  - \* arrangement of the grains (minerals) in the rock.

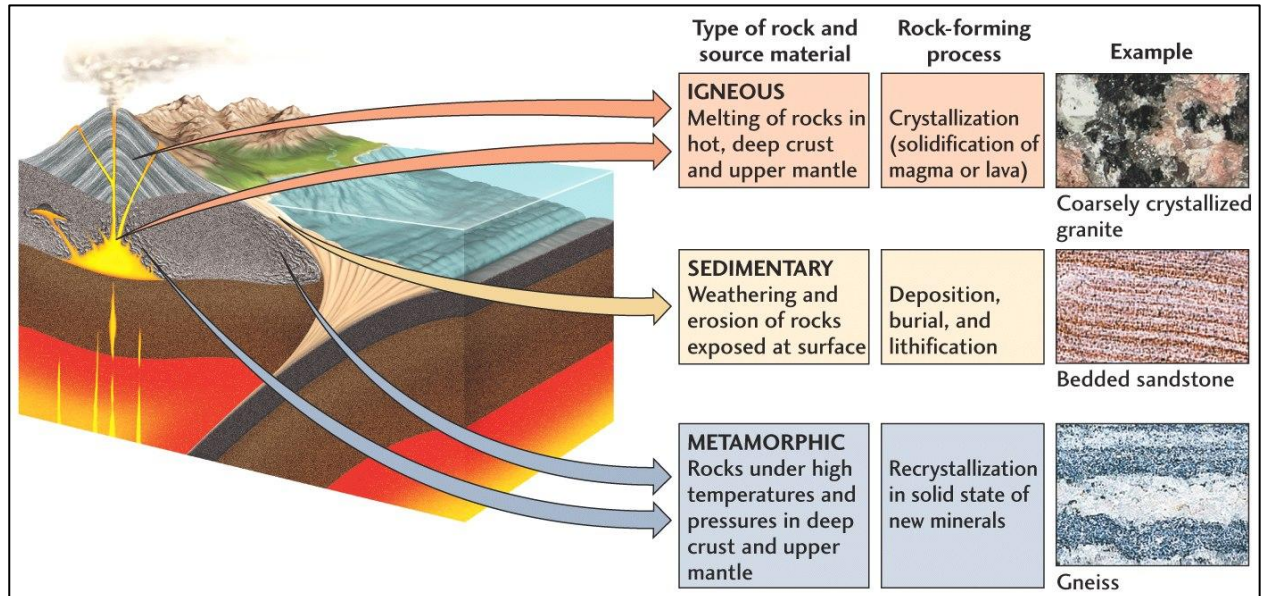
### Comparing Rocks



### Type of the rocks

1. Igneous Rocks: rocks formed directly from magmas either beneath (intrusive) or on (extrusive) the Earth's surface.
2. Sedimentary Rocks: rocks deposited in or by water (lakes, rivers, oceans), wind, and/or ice – products of weathering, erosion, and deposition at the Earth's surface

3. Metamorphic Rocks: any rock in which original minerals are altered during exposure to different temperatures, pressures and/or fluids (precursor may be sedimentary, igneous or metamorphic).

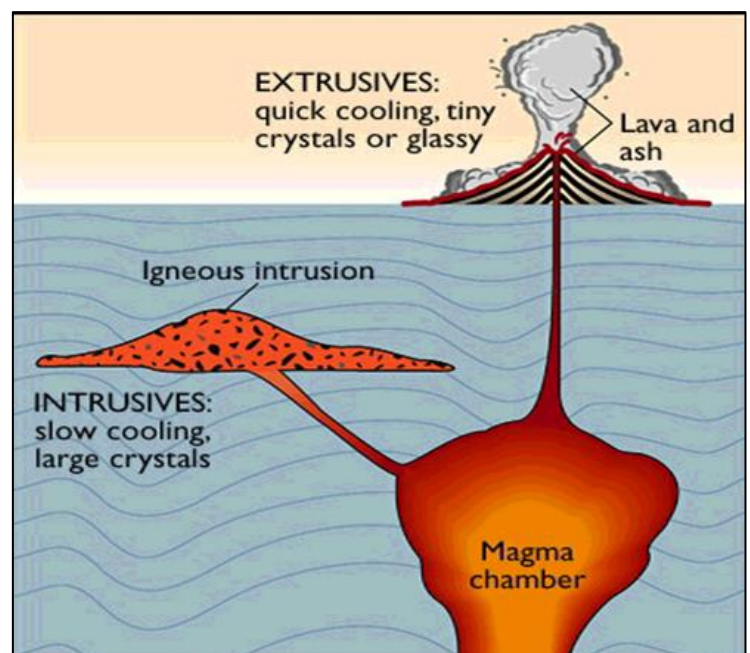








## Igneous Rocks

- Igneous rocks form by crystallization from a magma
- Magma – is a mass of melted rock that originates deep in the crust or upper mantle
- The rate of magma cooling defines the type of igneous rock that results – fine grained *extrusive*, or coarse-grained *intrusive*.

**INTRUSIVE (plutonic):** Minerals nucleate and grow when magma in the Earth cools to the point at which minerals are more stable than magma.

**EXTRUSIVE (volcanic):** Same as intrusive rocks, but faster cooling at the surface typically forms smaller crystals (fine-grained).



Common igneous rocks				
	GRANITE	PEGAMATITE	SYENITE	GABBRO
Plutonic or intrusive igneous rocks				
	VOLCANIC SCORIA	PUMICE	OBSIDIAN	BASALT
Volcanic or extrusive igneous rocks				

## Magma

Is molten rock material below the earth surface. Magma at the surface is lava.

### Types of Magma:

Chemical composition of magma is controlled by the abundance of elements in the Earth. Since oxygen is so abundant, chemical analyses are usually given in terms of oxides. SiO<sub>2</sub> is the most abundant oxide.

1. *Mafic or Basaltic*

2. *Intermediate or Andesitic*

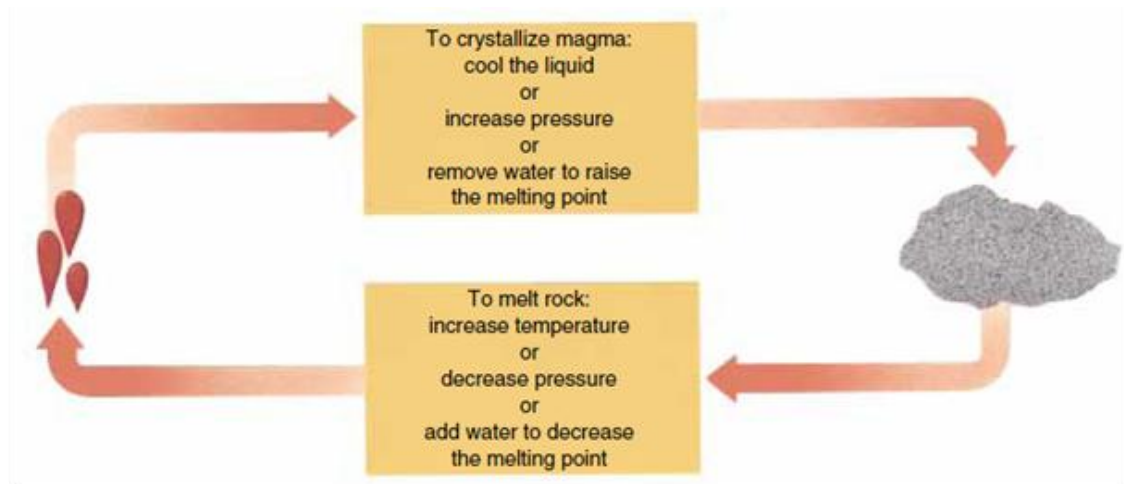
3. *Felsic or Rhyolitic*

### Igneous rocks type and properties according to Magma type

Summary Table						
Magma Type	Solidified Volcanic Rock	Solidified Plutonic Rock	Chemical Composition	Temperature	Viscosity	Gas Content
Mafic or Basaltic	Basalt	Gabbro	45-55 SiO <sub>2</sub> %, high in Fe, Mg, Ca, low in K, Na	1000 - 1200 °C	Low	Low
Intermediate or Andesitic	Andesite	Diorite	55-65 SiO <sub>2</sub> %, intermediate in Fe, Mg, Ca, Na, K	800 - 1000 °C	Intermediate	Intermediate
Felsic or Rhyolitic	Rhyolite	Granite	65-75 SiO <sub>2</sub> %, low in Fe, Mg, Ca, high in K, Na	650 - 800 °C	High	High

### Processes that form Magma:

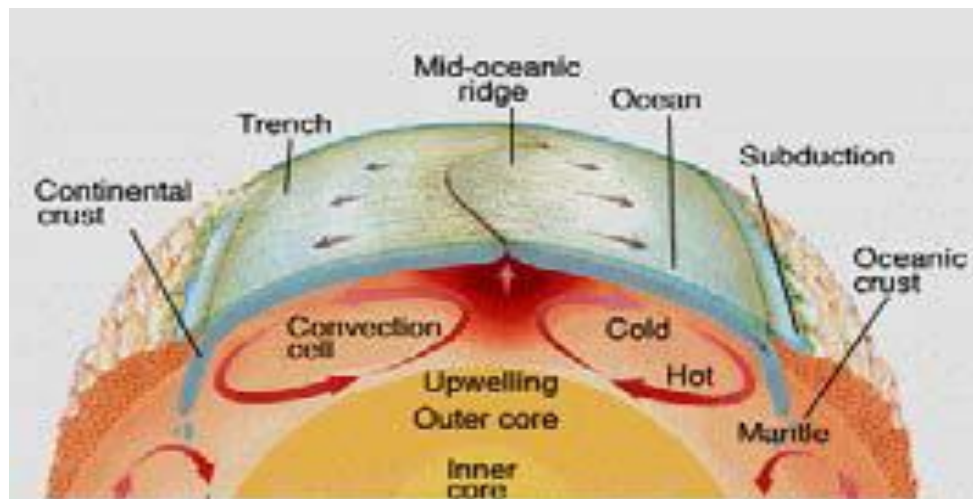
1. Rising Temperature
2. Decreasing Pressure
3. Addition of Water



### Environments of Magma formation:

Magma forms in three tectonic environments:

1. Spreading centers (Divergent boundaries)
2. Mantle plumes (Hot Spot)
3. Subduction zones (Convergent boundaries)



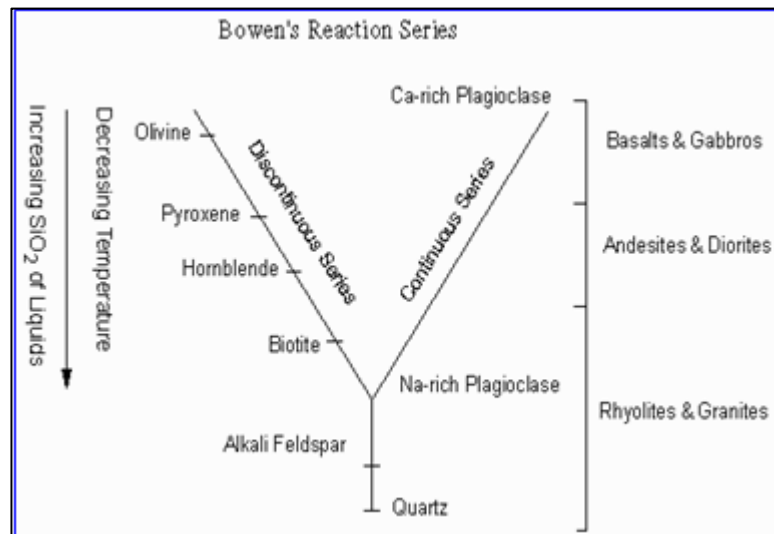
### Bowen's Reaction Series:

Bowen found by experiment that the order in which minerals crystallize from a basaltic magma depends on temperature.

It shows how mafic, intermediate, and felsic magmas could derive from an original parent mafic magma.

- **Discontinuous branch**

- **Continuous branch**



**Lava:** Molten rock that has flowed out onto the Earth's surface (i.e. magma when reaches the Earth's surface is called lava).

**Lava flows:** sheets or mounds of lava that flow out onto the ground surface or sea floor in molten form and then solidify



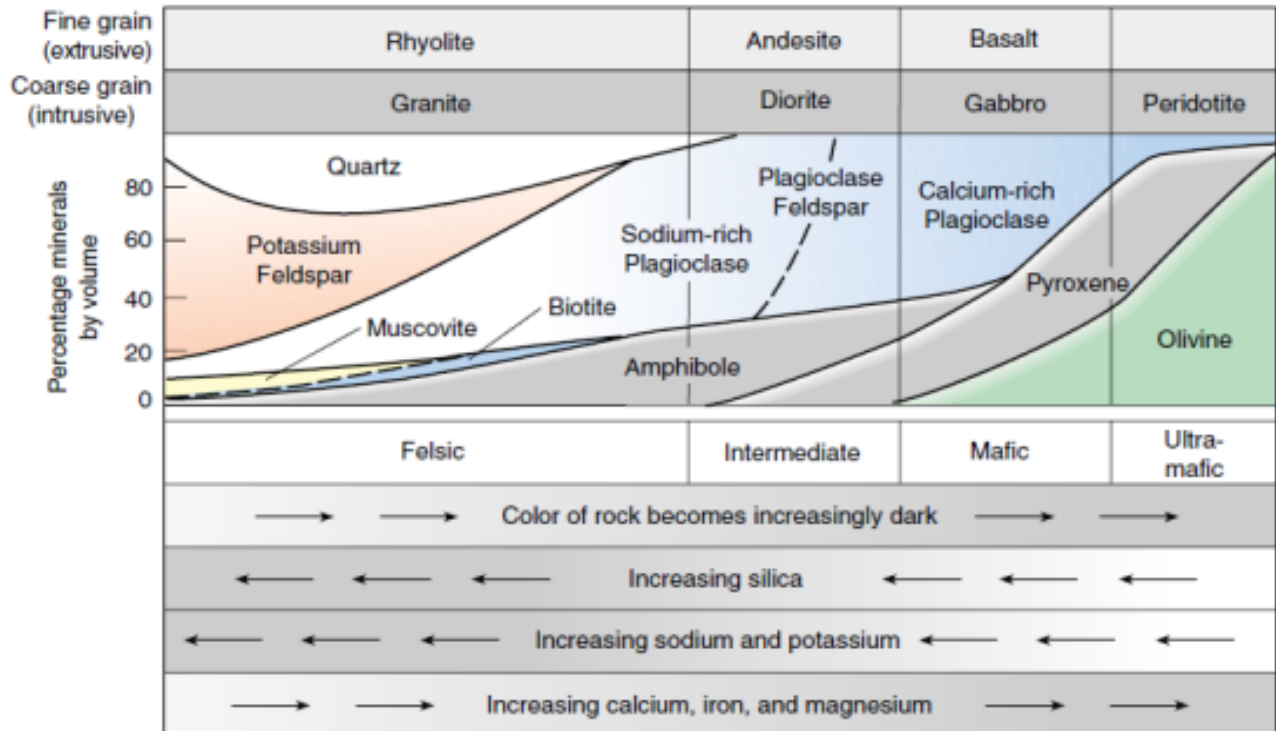
### **Igneous Rock Textures:**

Volcanic rocks are usually fine grained, whereas plutonic rocks are medium or coarse grained.

- **Aphanitic:** fine grained, rapid cooling.
- **Phaneritic:** coarse grained, slow cooling.
- **Porphyritic:** phenocrysts and groundmass, two stage cooling history.
- **Glassy:** no crystal structure.
- **Vesicular:** gas cavities.
- **Pyroclastic:** fragments generated by explosive volcanism.

## Classifying Igneous Rocks:

Generally the classification of igneous rocks is based on texture and composition. Chart shows relative proportions of chief mineral components and the textures of some common igneous rocks.



## Origins of common Igneous Rocks:

### A. Basalt and Basaltic Magama

- Formed from oceanic crust
- At temperature of about 1100°C
- Contains about 50% Silica, 1-2% water

### B. Granite and Granitic Magama

- Formed from continental crust
- At temperature of between 700-900°C
- Contains about 70% Silica, up to 10% water

### C. Andesite and Andesitic Magama

- Formed from continental crust
- At temperature similar to that of Granitic
- Contains more than 50% Silica, less than 10% water