

# Essentials of Geology

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Chapter 3



## Igneous Rocks



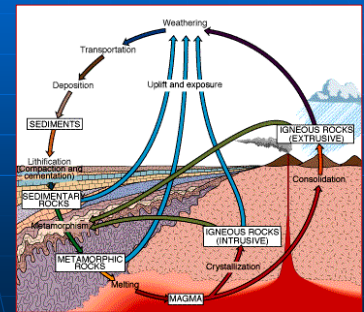
## The Properties and Behavior of Magma and Lava

- Magma is molten rock material below the surface
  - Lower density causes magma to move upward to the surface
  - Magma at the surface is lava
  - Pyroclastic materials result from the forceful eruption of magma into the atmosphere

## The Properties and Behavior of Magma and Lava

Magma extruded onto the surface forms volcanic or extrusive igneous rocks.

Magma that crystallizes within Earth's crust forms plutonic or intrusive igneous rocks.



## The Properties and Behavior of Magma and Lava

- Composition: defined by silica content
  - **Felsic**
    - Silica rich magma;
    - < 65% silica; abundant sodium, potassium, aluminum
  - **Intermediate**
    - Compositions between felsic and mafic
  - **Mafic**
    - Silica poor magma
    - < 52% silica; abundant calcium, iron, magnesium

## The Properties and Behavior of Magma and Lava

- How Hot is Magma and Lava?
  - Temperatures of erupting mafic lavas range between 1,000° and 1,200°C
  - Felsic lava eruptions are rarer and more violent; less is known about them
  - Rock is a poor conductor of heat; lava flows and plutons may retain heat for months to millions of years

## The Properties and Behavior of Magma and Lava



- Direct measurements come from low-risk volcanoes such as the mafic lavas of the Hawaiian Island volcanoes

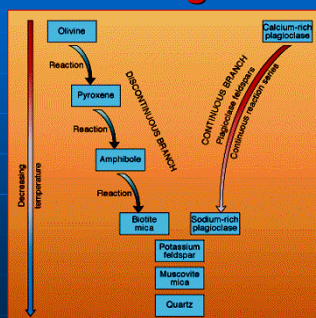
## The Properties of Magma and Lava

- Viscosity--Resistance to Flow
  - Temperature is a factor
  - Composition is a more important control
    - Formation of silica tetrahedra networks controls viscosity
    - Silica rich (felsic) magma/lavas are thick, viscous and resist flow
    - Silica poor (mafic) magma/lavas are thinner, have a lower viscosity and don't resist flow

## How Does Magma Originate and Change?

### Bowen's Reaction Series

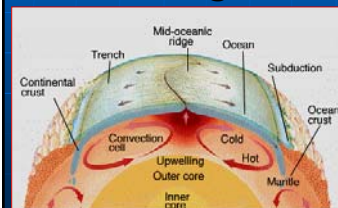
- shows how mafic, intermediate, and felsic magmas could derive from an original parent mafic magma
- Discontinuous branch
- Continuous branch



## How Does Magma Originate and Change?

### The Origin of Magma at Spreading Ridges

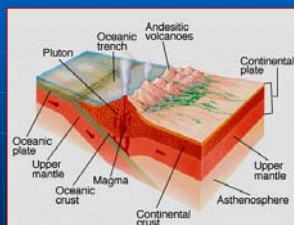
- Melting is initiated by a pressure decrease at spreading ridges
- Presence of water also decreases melting temperature
- Partial melting explains how mafic magmas are derived from an ultramafic source



## How Does Magma Originate and Change?

### Subduction Zones and the Origin of Magma

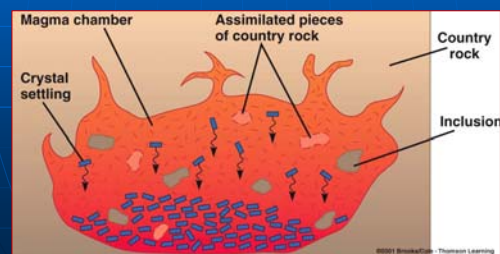
- Partial melting of a mafic crust results in intermediate and felsic magmas
- Melting of sediments and contamination with silica rich continental crust rocks also change the magma composition



## How Does Magma Originate and Change?

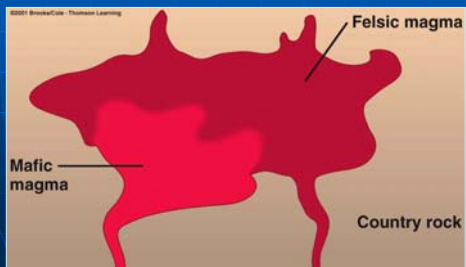
### Processes Resulting in Chemical Changes in Magma

- \*Crystal settling
- \*Assimilation



## How Does Magma Originate and Change?

- Processes Resulting in Chemical Changes in Magma
  - Magma mixing

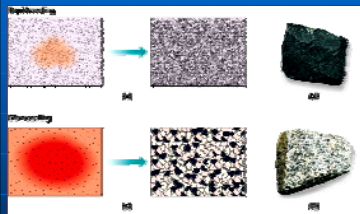


## Igneous Rocks-What are they and What are their Characteristics?

- Igneous Rocks form from crystallizing from a melt, or by explosive volcanic activity
- Igneous Rock Textures
  - Refers to the size, shape, and arrangement of mineral grains
  - Size relates to cooling rate, and indicates an intrusive or extrusive origin



## Igneous Rocks

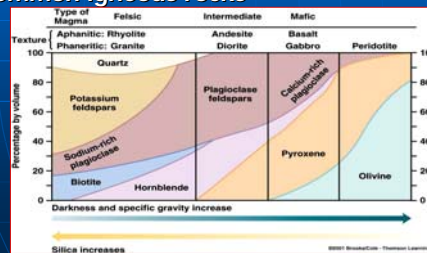


- Igneous Rock Textures
  - Aphanitic: fine grained, rapid cooling
  - Phaneritic: coarse grained, slow cooling
  - Porphyritic: phenocrysts and groundmass, two-stage cooling history

- Glassy: no crystal structure
- Vesicular: gas cavities
- Pyroclastic: fragments generated by explosive volcanism

## Igneous Rocks

- Classifying Igneous Rocks
  - Based on texture and composition
  - Chart shows relative proportions of chief mineral components and the textures of some common igneous rocks



## Igneous Rocks

- Classifying Igneous Rocks
  - Basalt and Gabbro



## Igneous Rocks

- Classifying Igneous Rocks
  - Andesite and Diorite





## Igneous Rocks

- Classifying Igneous Rocks
  - Rhyolite and Granite

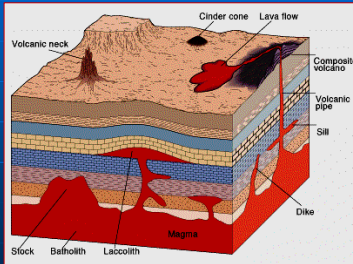


## Igneous Rocks

- Other Igneous Rocks
  - Pyroclastics
    - Tuff, breccia
  - Glassy
    - Obsidian
  - Vesicular
    - Scoria, Pumice



## Intrusive Igneous Bodies: Plutons- Their Characteristics and Origins



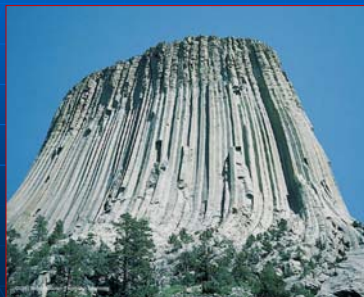
- Dikes and Sills
- Laccoliths
- Volcanic pipes/necks
- Batholiths/stocks

## Intrusive Igneous Bodies

- Dikes - discordant, tabular intrusions
- Sills - concordant, tabular intrusions



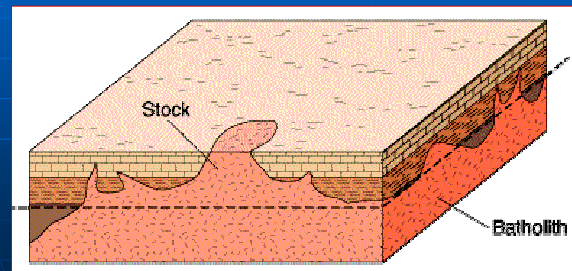
## Intrusive Igneous Bodies



- Volcanic Pipes and Necks

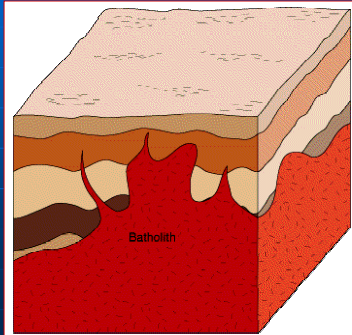
## Intrusive Igneous Bodies

- Batholiths and Stocks



## How are Batholiths Emplaced in Earth's Crust?

- Granitization
- Assimilation
- Origin from magma
  - Moves upward because of lower density
  - Deforms and moves country rock aside
  - Stopping



## How are Batholiths Emplaced in Earth's Crust?

- Stopping

