

## **Igneous Rocks**

### Magma

- molten rock material consisting of liquid rock and crystals.
- A variety exists, but here are the end members:

### Types of Magma

#### Basaltic, Basic or Mafic

- very hot (900-1200°C)
- very fluid
- low SiO<sub>2</sub> (silica) content (~50%)
- mafic (magnesium and iron rich) minerals
- volatile gases are low
- produces “flowing” volcanoes: lava flows

#### Silicic, Felsic, Acidic or Granitic

- less than 850°C
- highly viscous
- high SiO<sub>2</sub> content (~65-77%)
- felsic (feldspar and silica rich, like quartz) minerals
- volatile gases may reach 15%
- H<sub>2</sub>O, CO<sub>2</sub> – volatile gasses

Magma eventually cools to form igneous rock. It can cool:

- 1) Intrusively, beneath the surface – also called plutonic rock
  - >Most common type: granite
  - >Later uplift exposes them
  - >One of the most common rocks found in the continental crust
- 2) Extrusively, on top of the surface – also called volcanic rock
  - >Most common type: basalt
  - >The most common rock found in the ocean crust

### Properties of Igneous Rocks

- Elements you find in igneous rocks:
  - Si, O, Al, Ca, Na, K, Fe, Mg
- *SiO<sub>2</sub> and water control the physical properties of magma, such as density, viscosity, and the manner in which it is extruded.*

## **EXTRUSIVE ROCK BODIES**

- ***Silicic or Felsic Lava Flows*** (Pyroclastic)
  - 1) Air Fall Tuffs are produced when the ash falls out of the atmosphere to the ground and accumulates.
  - 2) Ash Flow Tuffs form from particles that move laterally across the surface in a gas-charged flow which moves like a lava flow, but much more rapid. They can reach speeds of over 250 km/hr, and are capable of mass destruction.
  - When the flow comes to rest, the particles of hot, crystal fragments, glass and ash may fuse to form a rock called a welded tuff. Some of these flows form rock units over 100 meters thick and cover thousands of square kilometers. As the mass of rock cools, columnar joints may form.

Volcano Type: Stratovolcano or Composite Cone

- Explosive eruptions of silicic volcanoes can blow out large volumes of ash and magma. As a result, the summit area sometimes collapses, forming a large basin-shaped depression known as a caldera.

Caldera Formation (insert your pretty drawings here)

## ***Basaltic or Mafic Lava Flows***

Basaltic Flows

- These are the most common on Earth. The lava is generally extruded from fractures and fissures in the crust. These lavas can flow at speeds as high as 30-40 km/hr down steep slopes, but rates of 20 km/hr are unusually rapid.

Types of basaltic flows:

(Time for you to learn some Hawaiian)

- AA - slow moving and 3-10 m thick. As it moves slowly, the crust is broken into a jumbled mass of angular blocks and clinkers.
- Pahoehoe flows – faster moving and thinner, more a roapy look

Volcano Types:

1) Shield Volcano

2) Cinder Cone

Comparative Scale of all three types of volcanoes:

Other extrusive features (most of these occur as basalt):

- Columnar Jointing - a system of fractures that splits a rock body into long prisms, or columns that results from contraction of the lava.
- Lava Tubes - these are created when lava breaks through an already solidified area and empties a flow space (conduit).
- Pressure Ridge - the crust of the flow arches and cracks, releasing gas and lava.
- Fissure - a crack or vent opening where lava can escape.
- Spatter Cones - result from the splashing of lava around a fountain or vent where lava escapes.
- Tephra - volcanic ash, dust and debris thrown into the air.
  - Bombs - big stuff
  - Ash and Dust - little stuff

## **INTRUSIVE ROCK BODIES**

Batholiths: Masses of coarsely crystalline rock, generally of granitic composition

>Largest intrusive bodies of the Earth's crust.

>It is difficult to determine their exact depth, but they do not extend into the mantle (in other words, their maximum depth is 60 km).

Examples: Sierra Nevada, Coast Ranges, Much of the rockies

Dikes and Sills: Dikes cut across the pre-existing rock layers, Sills are parallel to pre-existing rock layers

Laccolith - larger intrusion parallel to pre-existing rock layers.

## **Differentiation of Magma**

What governs composition of magma?

1) Assimilation: chunks of material that fall into the magma chamber and become dissolved into the magma . . .

2) Magma mixing

3) Fractional crystallization

- olivines, pyroxenes, Ca- Plag, crystallization first.
- *left over melted stuff increases in SiO<sub>2</sub> content*
- *Partial Melting*

Bowens Reaction Series governs what crystallizes or melts first and last.

### **Igneous Rock Textures:**

1) Glassy - This texture develops when molten rock material cools so rapidly that the migration of ions to form crystal grains is inhibited. Glassy texture typically forms on the crust of lava flows and in viscous magma.

A volcanic texture.

Example: Obsidian

2) Aphanitic - This texture consists of mineral grains too small to be seen without a microscope, which is a result of rapid cooling.

A volcanic texture.

Example: Basalt

3) Vesicular - Gas bubbles are trapped in this form of rock. The result is a rock with numerous cavities, which can range in size from almost microscopic (Pumice) to a few millimeters (Scoria).

A volcanic texture.

Examples: Pumice, Scoria

4) Pyroclastic - This texture forms when crystals, fragments of rock, and glass are blown out of a volcano as ash. Generally the particles fall to Earth and accumulate in sediment like layers. Ash flows are very hot, and move close to the ground, and the individual fragments become fused in a dense mass.

A volcanic texture.

Example: Tuff

5) Phaneritic - This texture consists of grains large enough to be seen with the unaided eye. Grains are roughly the same size and interlock to form a tight mass. The large crystals suggest a relatively slow rate of cooling.

A Plutonic Texture.

Example: Granite

6) Pegmatitic - occur when there is an extremely slow rate of cooling, resulting in huge crystals. Many of our gemstones and minerals are produced this way.

A Plutonic Texture.

Example: Granite Pegmatite

7) Porphyritic - This texture occurs in conjunction with aphanitic or phaneritic rocks (resulting in porphyritic aphanitic or porphyritic phaneritic texture), and results from two separate rates of cooling. The larger crystals were produced by a slow cooling rate, and the smaller crystals by a faster rate.

Show pretty examples here: