Chapter Outlines

NOTE: This is intended to help students 'organize' their understanding of each topic. It is <u>not</u> a comprehensive study guide for quizzes or midterms, i.e. <u>study your text!</u>

Volcanism

Volcanism, or **volcanic activity**, is the venting of liquid magma at the surface of Earth. Occasionally explosive, the process is important in producing continental and oceanic crust. **Volcanoes** are hills or mountains that form around the vent and consist of cooled magma, rock fragments, and 'dust' from the eruptions.

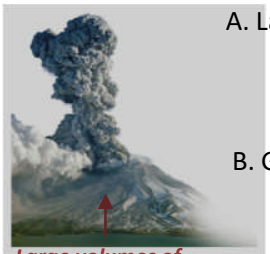
I. Volcanic eruptions

Pahoehoe lava

A. **Viscosity of magma** - affects the violence of an eruption
1. Viscosity is a measure of a material's resistance to flow
2. Factors affecting viscosity
   a. **Temperature** - hotter magmas are less viscous
   b. Composition - **high silica** *(felsic)* = high viscosity, **low silica** *(mafic)* = more fluid
   c. Dissolved gases
      1. Gas content affects magma mobility when the gas expands near the surface
      2. Violence of an eruption is related to how easily gases escape from magma
         a. Fluid basaltic lavas are generally 'quieter'
         b. Highly viscous magmas produce explosive eruptions

Aa lave →

II. Materials extruded during an eruption

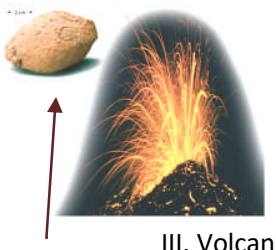


Large volumes of gas from volcanoes

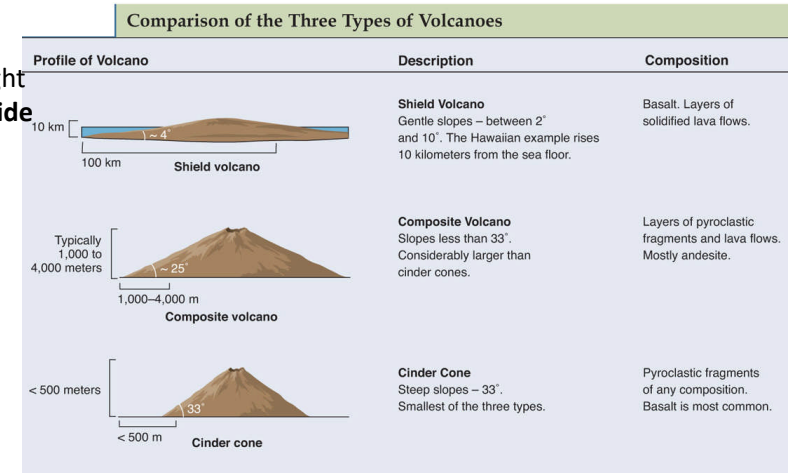
A. Lava flows
1. Types of basaltic lava
   a. **Pahoehoe lava** *(resembles braids in ropes)*
   b. **Aa lava** *(rough, jagged blocks)*

B. Gases
1. One to six percent of magma by weight
2. Mainly **water vapor** and **carbon dioxide**

C. Pyroclastic materials
1. **Ash** and **dust**—fine, glassy fragments
2. **Pumice**—from 'frothy' lava
3. **Cinders**—'pea-sized'
4. **Lapilli**—'walnut-sized'
5. **Blocks**—hardened lava
6. **Bombs**—ejected as hot lava
7. **Lahar** – volcanic mud flow



Volcanic 'bomb'

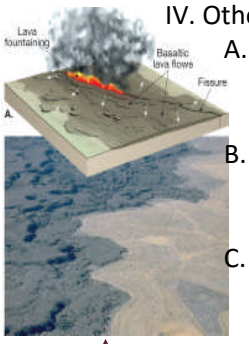


III. Volcanoes

A. General features
1. Opening at summit – either a **crater** or a **caldera**
2. **Vent** *(connected to the magma chamber via a 'pipe')*

B. Types of volcanoes
1. **Shield volcano** – large, broad, slightly domed, primarily basalt lava
2. **Cinder cone** – small, very steep, built from ejected lava fragments
3. **Composite cone** – large, steep, built from alternating lava and pyroclastic flows, often very violent
   a. Most are adjacent to the Pacific Ocean *(e.g., Fujiyama, Mount Shasta)*
   b. Primarily andesite and rhyolite lavas

C. Volcano status
1. **Active** – those that erupt regularly
2. **Dormant** – not now active but was active within historical times
3. **Extinct** – no written record of erupting and considered by geologist to have no chance of erupting



A giant fissure and the resultant plateau basalts

IV. Other volcanic landforms

A. **Calderas** – formed from a collapse into the magma chamber

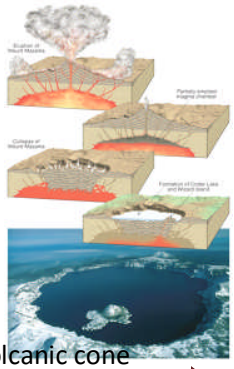
1. Steep-walled depression at the summit
2. Size exceeds 1 kilometer in diameter

B. **Fissure eruptions** and **plateau lavas** – normally occur above large mantle plumes

1. Fluid basaltic lava extruded from crustal fractures called fissures
2. Produces large flood basalts such as the **Columbia Plateau**

C. **Volcanic pipes** and **necks**

1. Pipes are short conduits that connect a magma chamber to the surface
2. Volcanic necks are resistant 'pipes' left standing after erosion has removed the volcanic cone



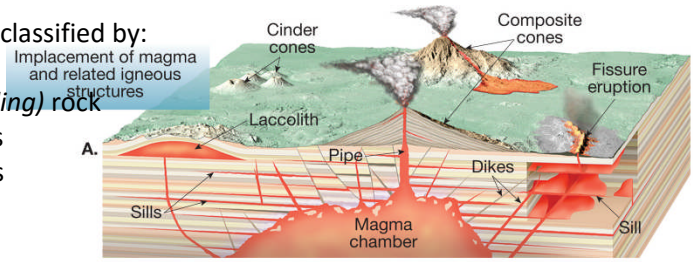
The 'Crater lake caldera'

V. Intrusive igneous activity

A. Most magma is emplaced and solidified at depth

B. An underground igneous body is called a **pluton** – classified by:

1. Shape - **tabular** *(sheetlike)* or **massive**
2. Orientation with respect to the host *(surrounding)* rock
   a. **Discordant**—cuts across sedimentary beds
   b. **Concordant**—parallel to sedimentary beds

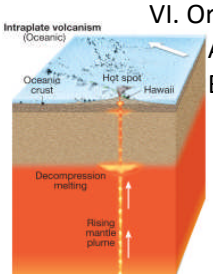


Intrusive structures

C. Types of igneous intrusive features

1. **Dike**, a tabular, discordant pluton
2. **Sill**, a tabular, concordant pluton
3. **Laccolith, s**imilar to a sill, lens-shaped mass, pushes *(arches)* overlying strata upward
4. **Batholith** – a coalescing of multiple smaller plutons
   a. Surface exposure 100+ square kilometers *(smaller bodies often are termed stocks)*
   b. Frequently form the granitic cores *(backbones)* of mountains such as the Sierra Nevada

VI. Origin of magma – much of the rock in the upper mantle and lower crust is already near its melting point

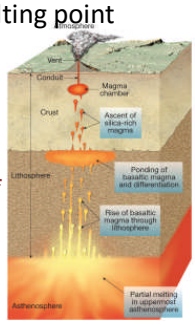


A hot spot created by a mantle plume

A. Magma originates when essentially solid rock located in the crust and upper mantle melts

B. Role of heat

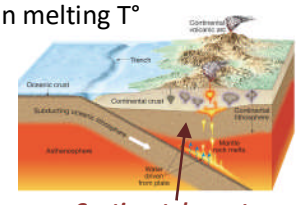
1. Earth's natural temperature increases with depth, but not sufficiently to melt rock at the lower crust and upper mantle based solely on temperature gradient
2. Additional heat is generated by:
   a. Heating of crustal rocks during subduction
   b. Rising, hot mantle rocks *(plumes)*



Generalized view of partial melting in asthenosphere finding its way to Earth's surface

C. Role of pressure

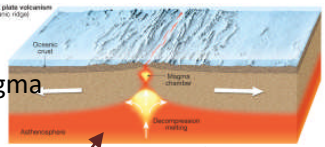
1. Increase in confining pressure with depth causes an increase in melting temperature
2. Drop in confining pressure can cause decompression melting as a result of drop in melting T°
   - occurs when rock ascends, such as occurs at mid-ocean ridges
3. Role of volatiles – primarily water
   a. Increased water content will cause rock to melt at a lower temperature
   b. This plays an important role in magma formation at subducting ocean plates
4. **Partial melting**
   a. Melting occurs over a range of temperatures
   b. Partial melting produces a magma with higher silica content than the original rock *(see Bowen's reaction series)*



Continental arc at a subduction zone

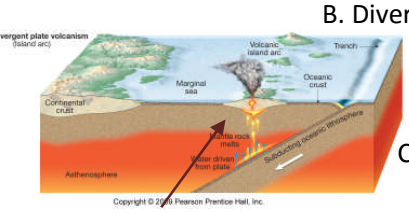
VII. Plate motions provide the mechanism by which mantle & crustal rocks melt to form magma

A. Convergent plate boundaries – descending plates generate magma
   - Magma slowly rises upward – creating **island arcs** and **continental volcanic arcs**



Melting from 'decompression' at divergent boundary

B. Divergent plate boundaries – mid-ocean ridges
   - The greatest volume of volcanic rock is produced at oceanic ridges as a result of crustal thinning at diverging plates and the resultant decompression melting of rising materials



Island arc formation at a subduction zone

C. Intraplate igneous activity – **hot spots**
   - Plumes of hot mantle material rise to form localized volcanic regions, island chains, and sometimes extensive plateau basalt flows