Study Guide

Dynamic Earth
Exam 3
1 hr (4:30 PM – 5:45 PM)

Tuesday
04/14/2009

Syllabus/Handouts

Exam Syllabus: Chapter 10 – 12 (Page 251 – 331)

Handouts: 3 (already uploaded in blackboard)

Exam: 100 pts

- Multiple Choice (40 questions/80 points)
- True/False (10 questions/20 points)

Study Guide

Exam 3

Chapter 10

Volcanism and Extrusive Rocks

Surface expressions created by magma emerging from the interior earth: some explosions are gentle and others are explosive

Eruptive Violence and Physical Characteristics of Lava

Violence of eruptions controlled by:

1) *Amount of Dissolved gases* in the magma

- Water vapor, carbon dioxide, sulfur dioxide, etc.
- The more dissolved gases, the more fluid the lava

2)*Viscosity*- a fluid's resistance to flow

- *Silica content:* Higher silica contents produce higher viscosities
- Lava *temperature:* Cooler lavas have higher viscosities

General Rules for Igneous rock composition (silica content)

1) Where mantle is melting magma low in silica
   - ocean ridges and oceanic hot spots (reason: oceanic crust is mafic or basaltic)

2) Where subduction zone occurs magma will range from low to high silica content
   - Ocean to ocean (low silica)
   - ocean to continent subduction (moderate silica)

3) Where crust is melting magma higher in silica.
   - continental hot spots

Common Extrusive Igneous Rocks

High Silica Content (Felsic)

Low Silica Content (mafic)

Moderate Silica Content

Textures of Volcanic Rocks

- Glassy – Obsidian
  - Cooled very quickly
- Fine Grained – Basalt
  - Cooled comparatively slowly
- Porphyritic – emplacement are surrounded by a fine grained to glassy rock- Andesite
  - Two stages of cooling, rapid then slow
- Vesicular – Pumice
  - Trapped and escaping gas
- Fragmental – Dust, Ash, Cinders, and Blocks and Bombs
  - Volcanic explosion

Texture

C.C. Plummer

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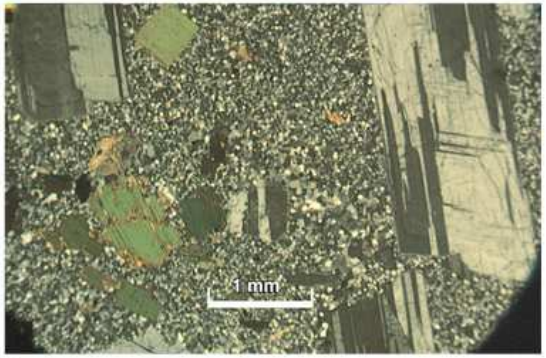

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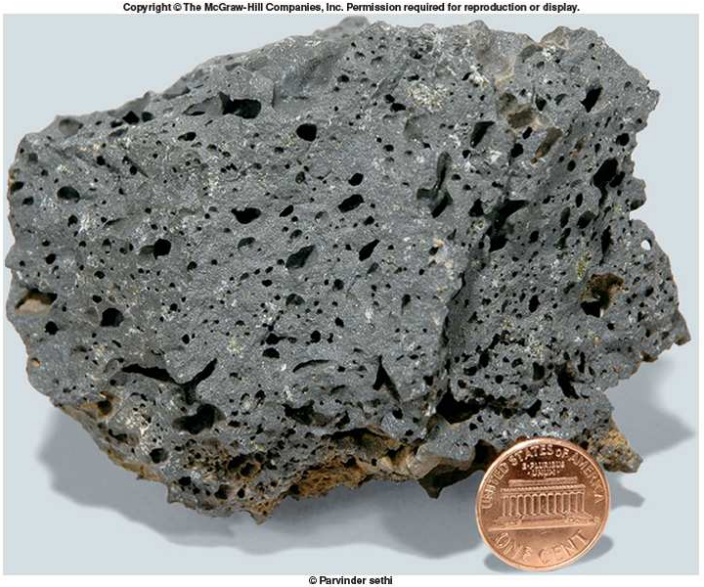
(A) © Parvinder Sethi (B) C. C. Plummer



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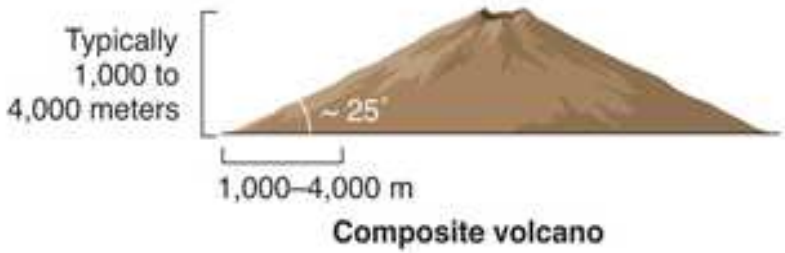
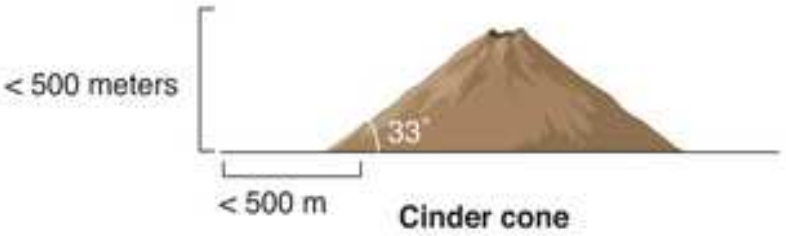
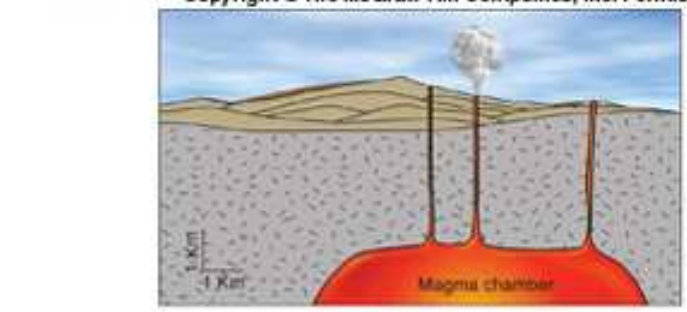
Types of Volcanoes

Profile of Volcano	Description	Composition
	**Shield Volcano** Gentle slopes – between 2° and 10°. The Hawaiian example rises 10 kilometers from the sea floor.	Basalt. Layers of solidified lava flows.
	**Composite Volcano** Slopes less than 33°. Considerably larger than cinder cones.	Layers of pyroclastic fragments and lava flows. Mostly andesite.
	**Cinder Cone** Steep slopes – 33°. Smallest of the three types.	Pyroclastic fragments

Caldera Formation e.g. Crater Lake, Oregon



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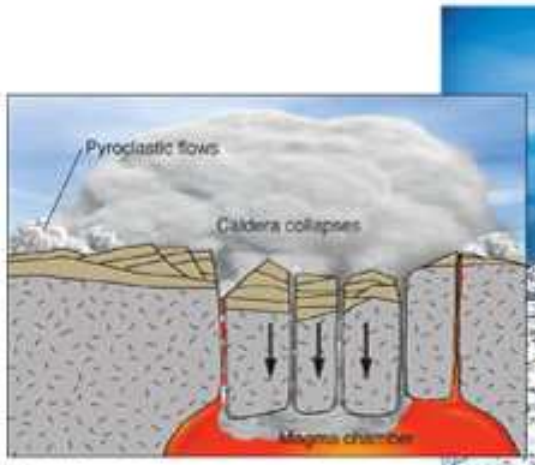

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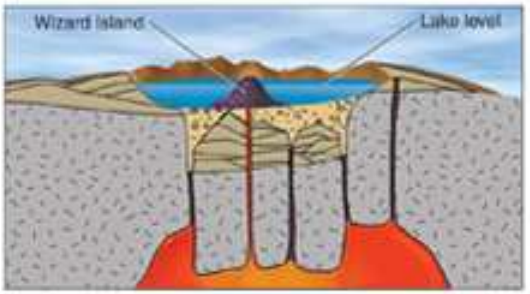

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Chapter 11

Intrusive Activity and Igneous Rocks

Igneous Rock Textures

- *Texture* refers to the size, shape and arrangement of grains or other constituents within a rock

- Texture of igneous rocks is primarily controlled by *cooling rate*

- Extrusive igneous rocks cool quickly at or near Earth's surface and are typically *fine-grained* (most crystals <1 mm)

- Intrusive igneous rocks cool slowly deep beneath Earth's surface and are typically *coarse-grained* (most crystals >1 mm)

Fine-grained igneous rock

Coarse-grained igneous roc

Intrusive Igneous Rocks

- Form within the interior of the Earth
- Cool more slowly than extrusive
- Grow bigger crystals

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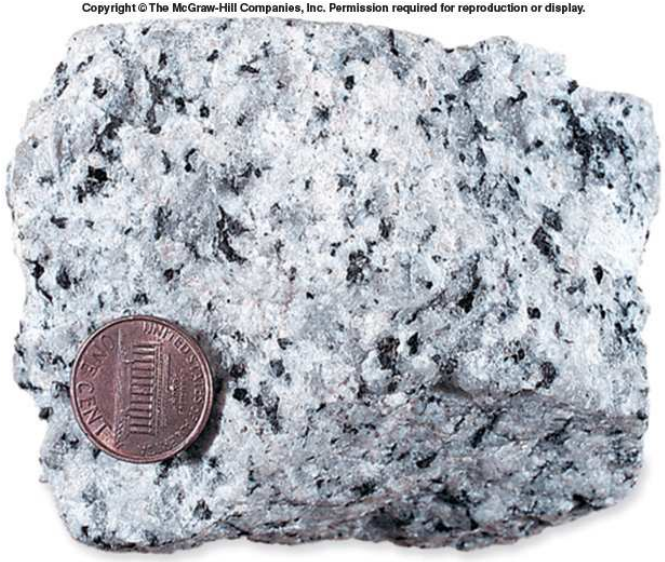
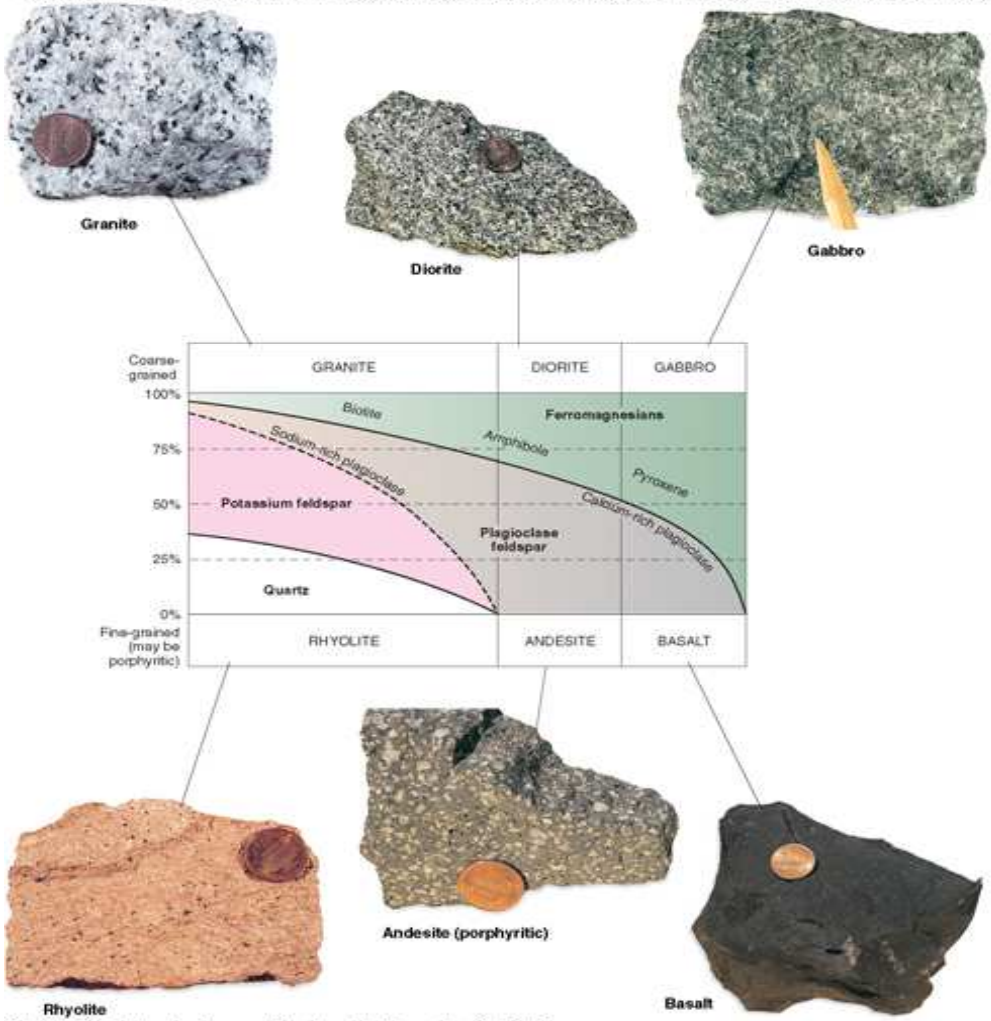


Granite

C.C. Plummer

Igneous Rock Identification

- Igneous rock names are based on *texture* (grain size) and mineralogic *composition*



Intrusive Rocks

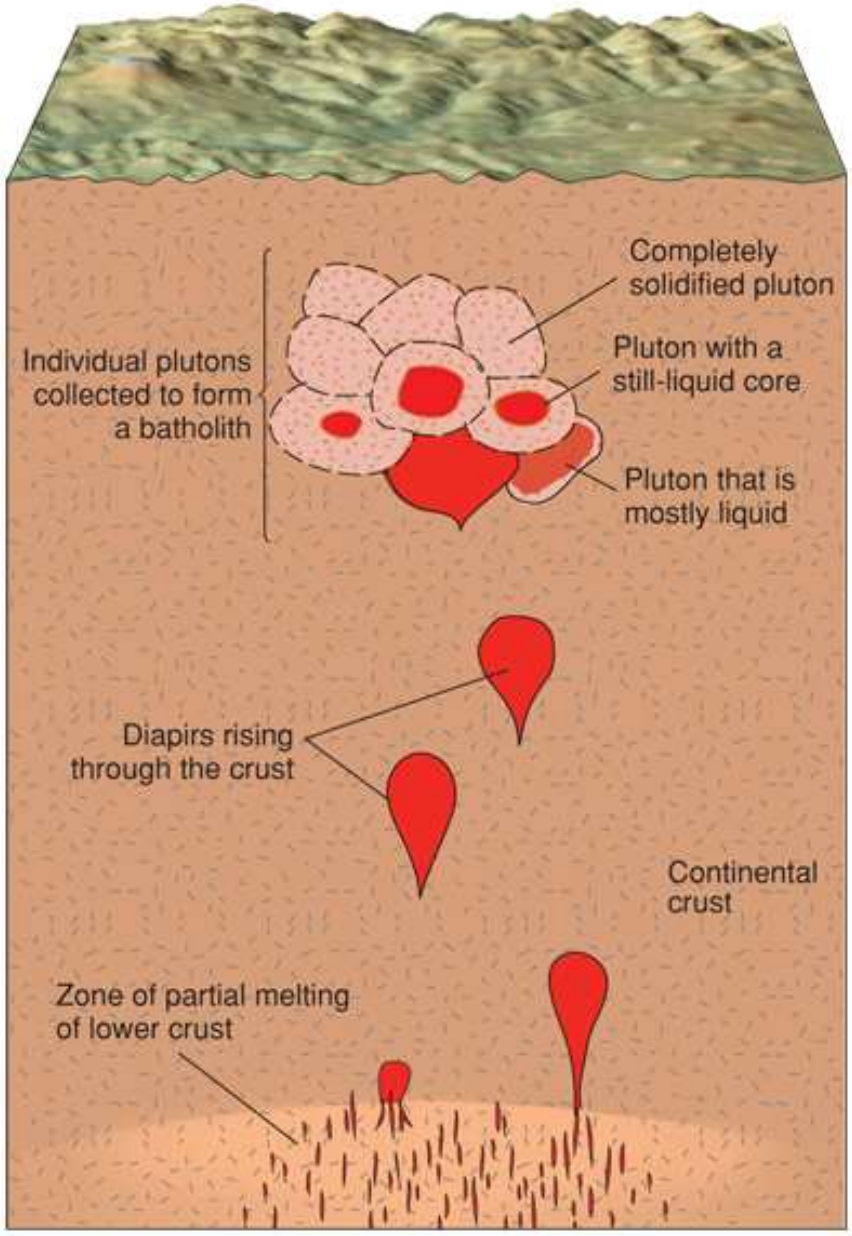
Extrusive Rocks

Photo of gabbro by Larry Davis; all others by C. C. Plummer

Igneous Rock Chemistry

- Rock chemistry, particularly *silica* (SiO_2) content, determines mineral content and general color of igneous rocks
  - *Mafic* rocks have ~50% silica, by weight, and contain dark-colored minerals that are abundant in iron, magnesium and calcium
    - Intrusive/extrusive mafic rocks - gabbro/basalt
  - *Felsic* rocks have >65% silica, by weight, and contain light-colored minerals that are abundant in silica, aluminum, sodium and potassium
    - Intrusive/extrusive felsic rocks - granite/rhyolite
  - *Intermediate* rocks have silica contents between those of mafic and felsic rocks
    - Intrusive/extrusive intermediate rocks - diorite/andesite
  - *Ultramafic* rocks have <45% silica, by weight, and are composed almost entirely of dark-colored ferromagnesian minerals
    - Most common ultramafic rock is **peridotite** (intrusive)

Mountains at Earth's surface



Types of Igneous Rocks

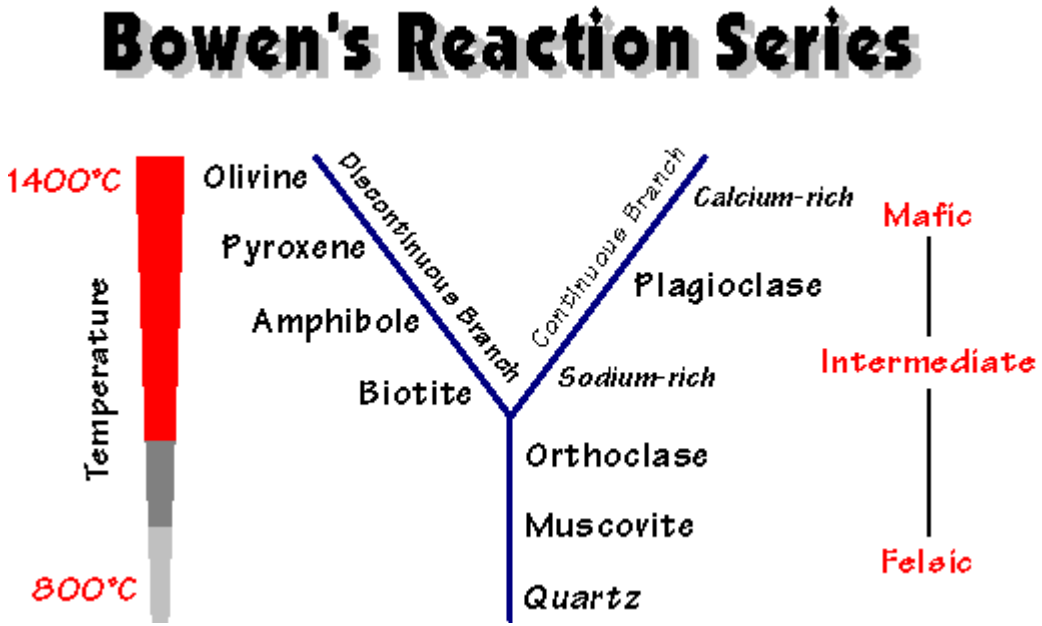
Depends on the

1. Mineral content

2. Temperature and pressure during crystallization

Magma Crystallization and Melting Sequence

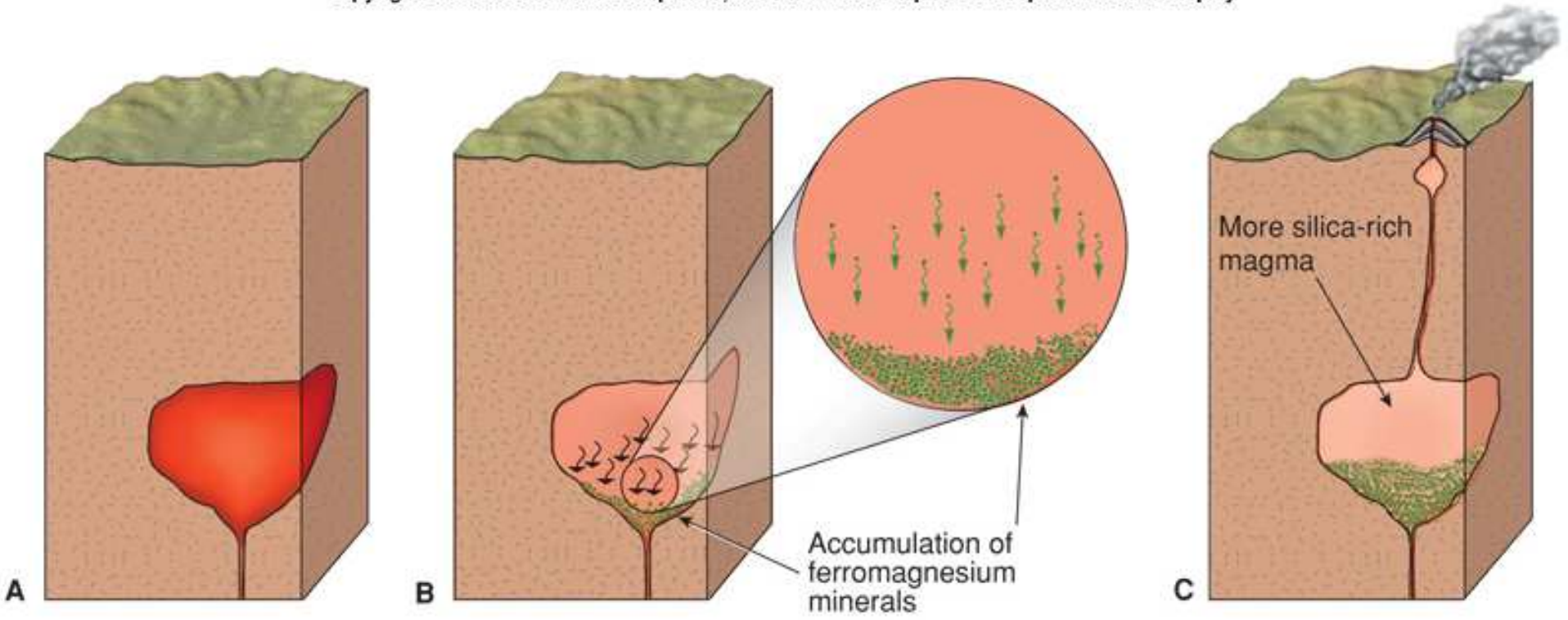
- Minerals crystallize in a predictable order (and melt in the reverse order), over a large temperature range, as described by *Bowen's Reaction Series*



Lessons from Bowen's Reaction Series

- Large variety of igneous rocks can be produced by *magma* at different temperature
- *Mafic Magma* will crystallize into *basalt* or *gabbro* if early-formed minerals are not removed from the magma
- *Intermediate Magma* will similarly crystallize into *diorite* or *andesite* if minerals are not removed
- Separation of early-formed ferromagnesian minerals from a magma body increases the silica content of the remaining magma
- Minerals melt in the reverse order of that in which they crystallize from a magma

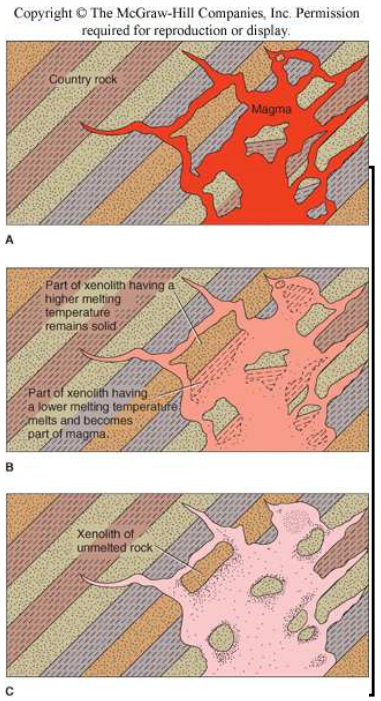
Fractional Crystallization – Differentiation

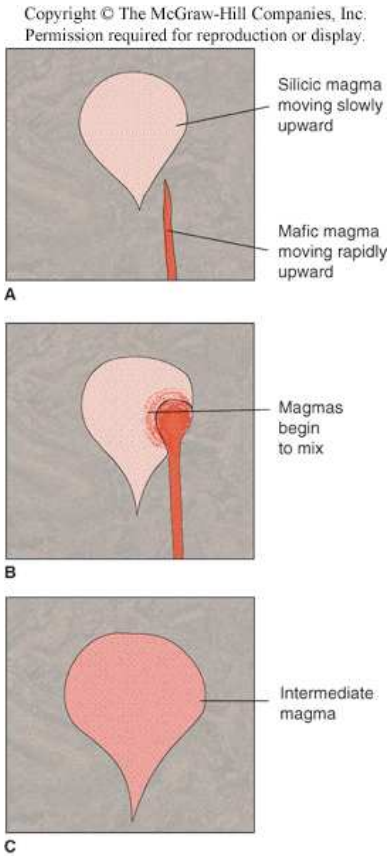


Magma Evolution

- *Assimilation* occurs when a hot magma, melts and incorporates more felsic surrounding country rock

- *Magma mixing* involves the mixing of more and less mafic magmas to produce one of intermediate composition





Weathering and Soil

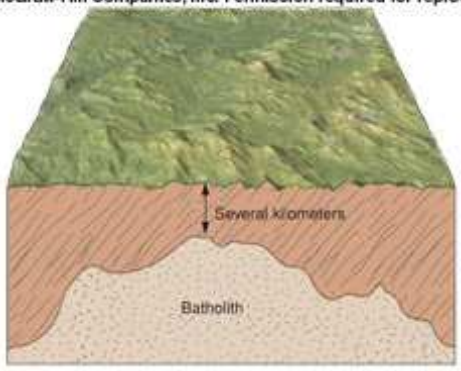
Chapter 12

Mechanical Weathering

- *Frost action*
- *Pressure release*
- *Plant growth*
- *Burrowing animals*
- *Human activity*
- *Thermal cycling*

Mechanical Weathering

- *Pressure release*
  - Removal of overlying rock allows expansion and fracturing – **Sheet Joints**



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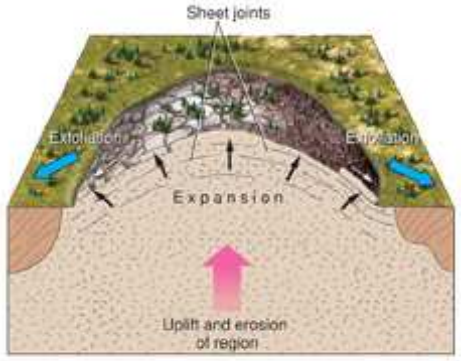

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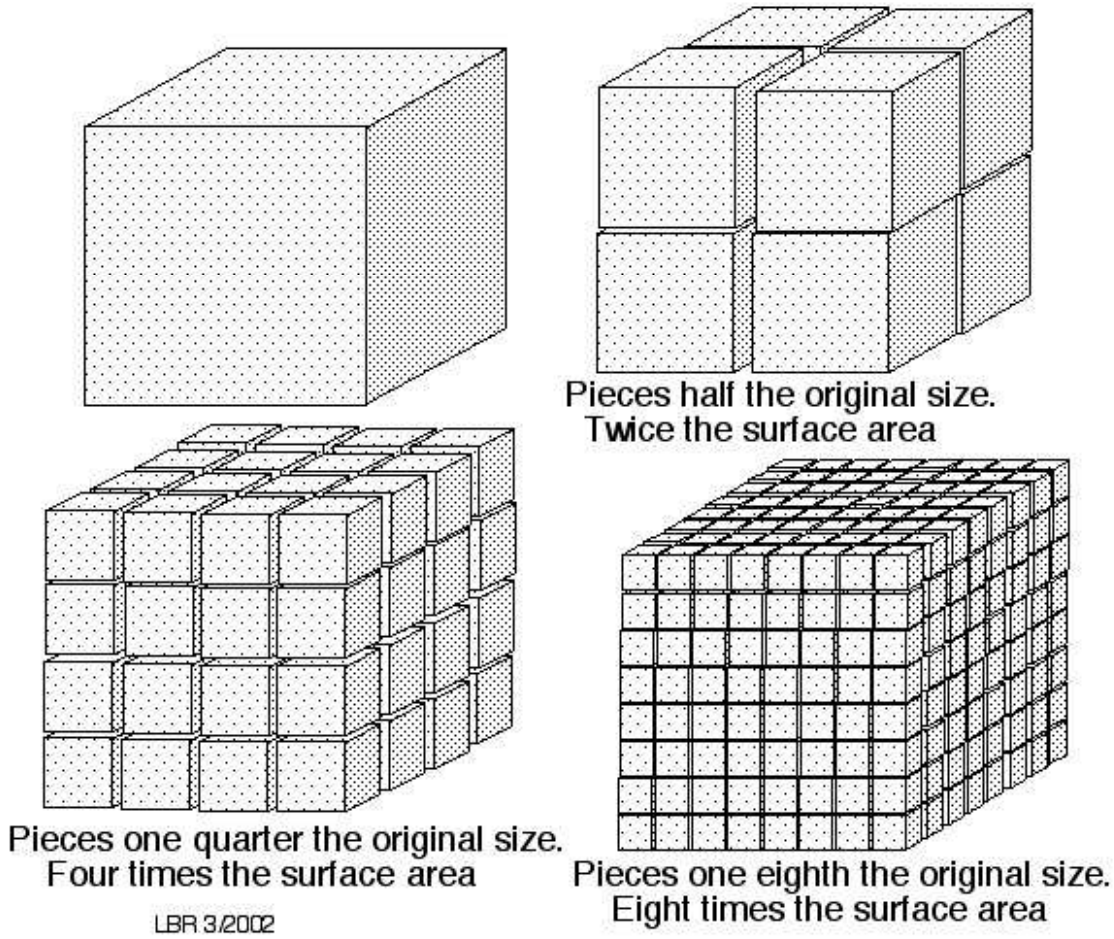
David McGeary

Mechanical weathering can play an important part of the chemical weathering processes



Chemical Weathering

Role of Carbon Dioxide (CO_2)

- *Acid dissolution*
  - Carbonic acid (H_2CO_3) from atmospheric CO_2 dissolved in water
  - Some minerals, such as calcite, may be totally dissolved
  - Human activity, such as mining and burning of fossil fuels, produces acids