

## Intro to Rocks with Focus on Igneous Rocks

### I. Rocks

A. Defined - aggregates of one or more minerals

B. Three Rock Types (based on their mode of origin)

1. Igneous: rocks crystallize from molten magma
  - a. Heating and melting of rocks to form magma
  - b. cooling of magma to form igneous rocks
  
2. Sedimentary: rocks form at near earth's surface
  - a. Weathering of pre-existing rocks at surface
  - b. Erosion and transport of sediment
    - (1) agents of transport
      - (a) wind
      - (b) water
      - (c) ice
      - (d) gravity
  - c. Deposition and lithification of sediment
  
3. Metamorphic: rocks formed by alteration of pre-existing rocks
  - a. agents of metamorphism
    - (1) heat
    - (2) pressure
    - (3) chemically active fluids

C. Rock Cycle

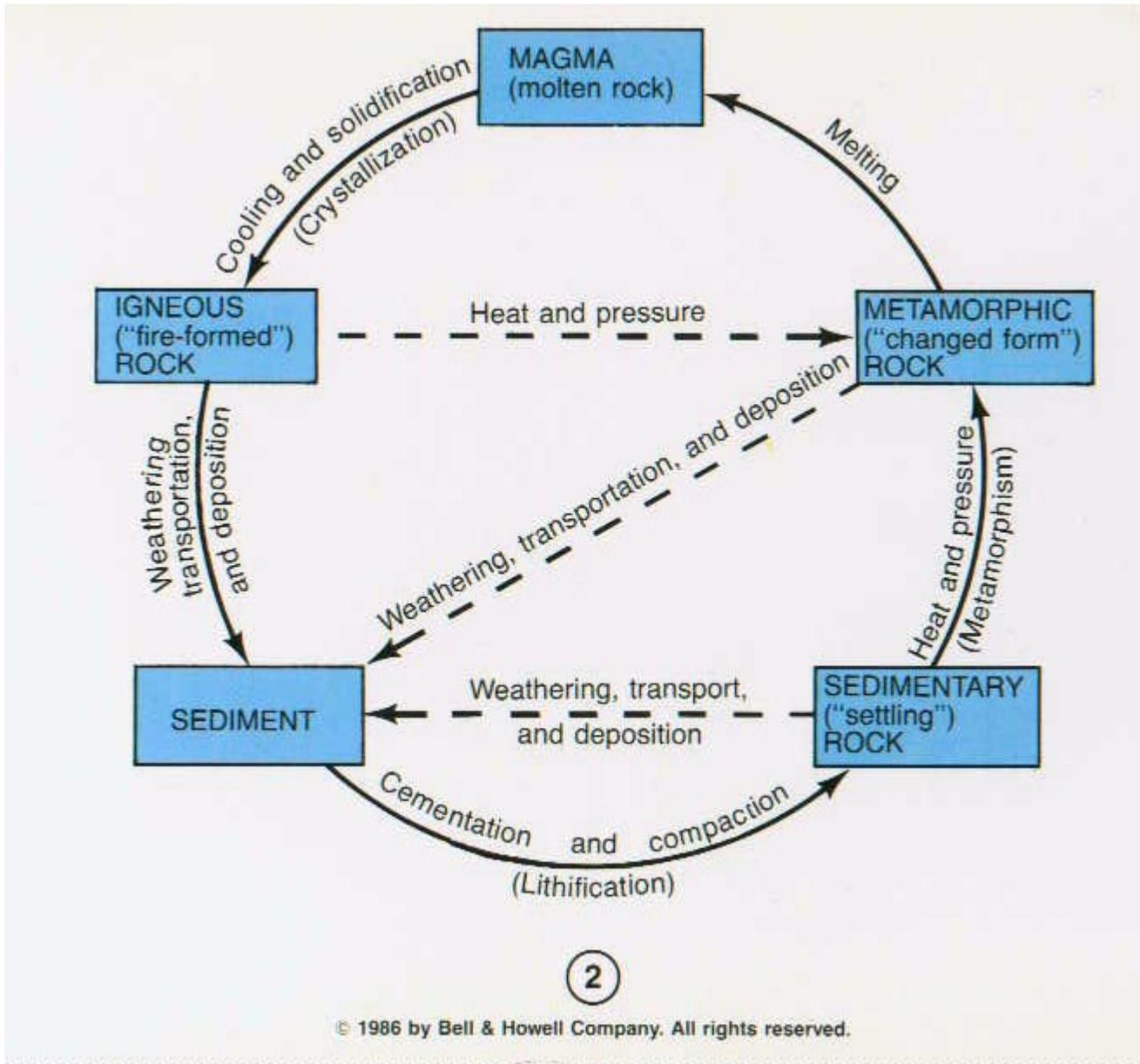
1. Full cycle: magma-----cooling/crystallization---igneous rocks---weathering----sediment----lithification/compaction----sedimentary rocks---pressure and temperature----metamorphism----metamorphic rocks----remelting-----igneous rocks

### II. Focus on Igneous Rocks

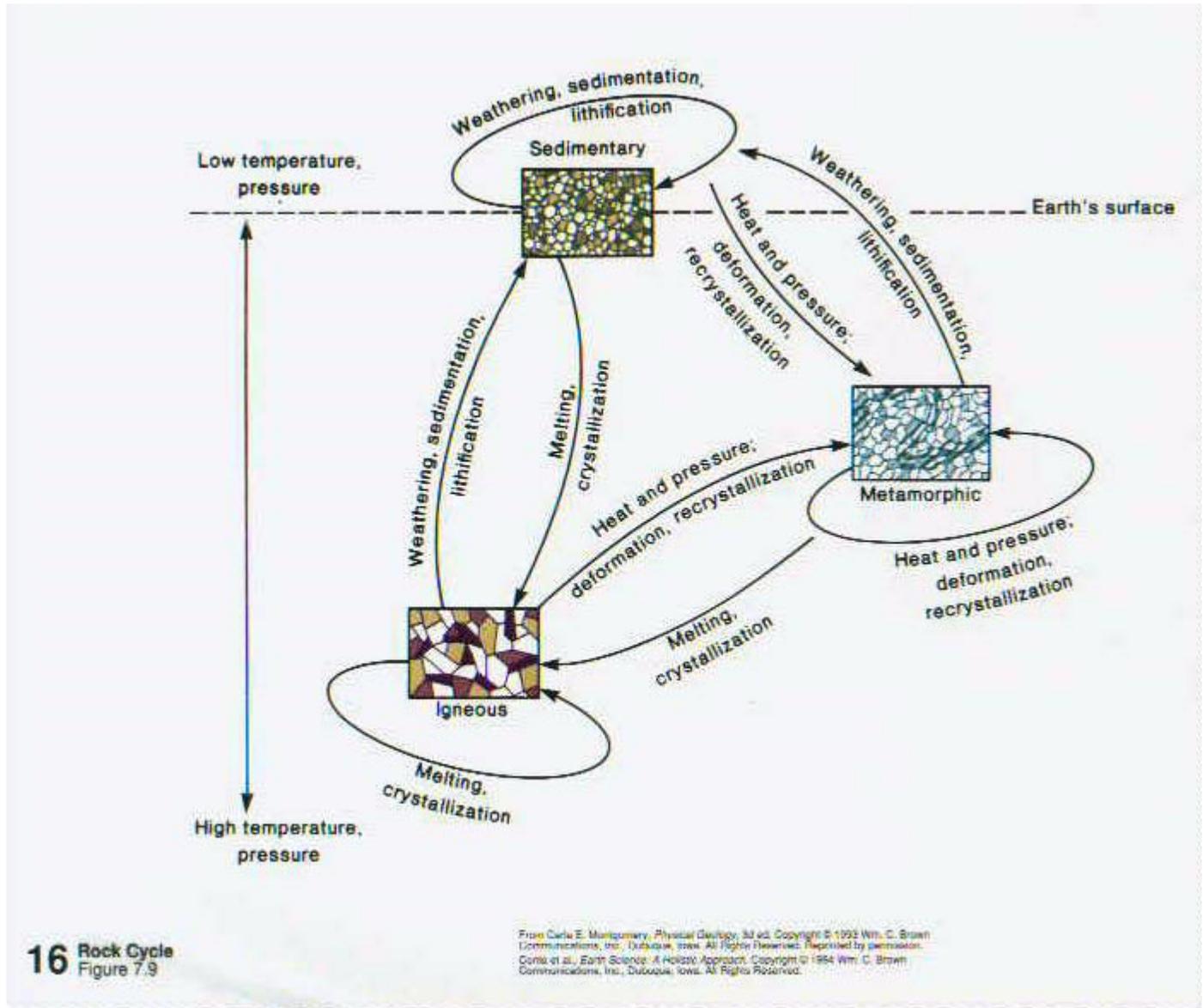
A. Igneous Rocks- a rock (or agglomeration of one or more minerals) that results from the cooling of magma, or molten rock.

1. As the magma cools, minerals crystallize from the molten rock.
  - a. Magma - molten or hot liquid rock, originates beneath the earth's surface (up to 120 miles beneath), composed of elements found in silicate minerals, water vapor, and gases.
  
  - b. Lava - magma that is extruded onto the earth's surface via volcanic eruptions (hot magma is confined at depth beneath surface, relatively lighter than confining rock, rises upward, may eventually erupt onto earth surface).

# Simplified Diagram of Rock Cycle



# Rock Cycle - Expanded Version with Process Interactions Listed



- c. Extrusive Igneous Rocks or Volcanic Ig. Rocks - rocks which solidify from lava (or were extruded onto earth's surface)
- d. Intrusive Igneous Rocks or Plutonic Ig. Rocks - rocks which solidify from magma beneath the earth's surface.

## 2. Magma Crystallization Process

- a. Hot, molten magma: ions of elements are moving freely in a fluid, unordered state, as magma cools, the ions slow and begin to form atomic bonds, arranging themselves in orderly patterns --- known as process of crystallization.
- b. Rates of cooling strongly influence size of mineral crystals that develop from magma/lava.
  - (1) Slow Cooling - few centers of crystal growth develop, ions allowed to migrate over larger distances - results in rather large mineral crystals .
  - (2) Fast Cooling - many centers of crystal growth, ions readily bond together, results in smaller mineral crystals.
  - (3) Very rapid cooling - if magma is quenched instantly, not sufficient time for ions to bond, results in randomly distributed ions frozen - referred to as glass similar to manmade glass.
  - (4) Multi-phase cooling: slow partial magma cooling, followed by fast lava cooling
    - (a) Porphyritic Rocks- mixed small and large mineral crystals

## 3. Naming Igneous Rocks - Based on composition and texture of igneous rock.

- a. Mafic Rocks (from Mag and Fe) - generally darker colored rocks relatively high in iron, magnesium, calcium and low in silicon. Associated with high temperature end of bowens Reaction Series.
  - (1) Gabbro = plutonic = phaneritic = mafic composition
  - (2) Basalt = volcanic = aphanitic = mafic composition (Ca-rich plag., and Pyroxene).
- b. Felsic (from feldspar and silica) Rocks - generally lighter in color, high in silica, Na, Potassium - consist mainly of quartz, K-feldspar, and Plagioclase
  - (1) Granite = plutonic = phaneritic = felsic composition
  - (2) Rhyolite = volcanic = aphanitic = felsic composition

- c. Intermediate - admixtures of both felsic and mafic, dominated by amphibole, intermediate plagioclase feldspar, biotite.
  - (1) Diorite = plutonic = phaneritic = intermediate composition
  - (2) Andesite = volcanic = aphanitic = intermediated comp.
- d. Ultramafic = very rich in iron and mag., olivine and pyroxene, Ca-rich plagioclase
  - (1) intrusive variety only = Peridotite - common in upper mantle

## B. Naming of Igneous Rocks

### 1. Classification Basis

#### a. Mineral Composition

- (1) felsic minerals
  - (a) quartz
  - (b) feldspar
  - (c) plagioclase
- (2) mafic minerals
  - (a) amphibole (hornblende)
  - (b) biotite
  - (c) pyroxene

#### b. Rock Texture

- (1) aphanitic = microcrystalline
- (2) phaneritic = crystals visible with eye
- (3) porphyritic = mixed fine and coarse mineral crystals

### Basic Igneous Rock Scheme

Texture	Mineralogy	Name	Interpretation
aphanitic	felsic	rhyolite	volcanic rock
phaneritic	felsic	granite	plutonic rock
aphanitic	intermediate	andesite	volcanic rock
phaneritic	intermediate	diorite	plutonic rock
aphanitic	mafic	basalt	volcanic rock
phaneritic	mafic	gabbro	plutonic rock