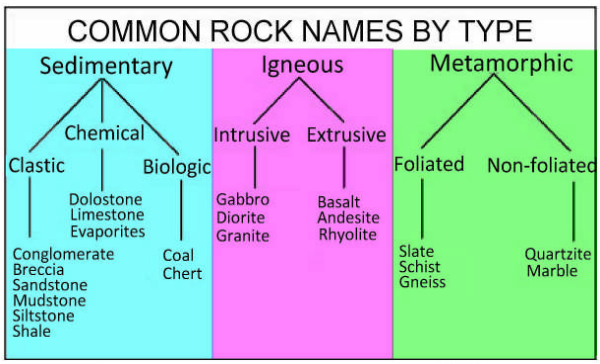
Chapter Outlines



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>

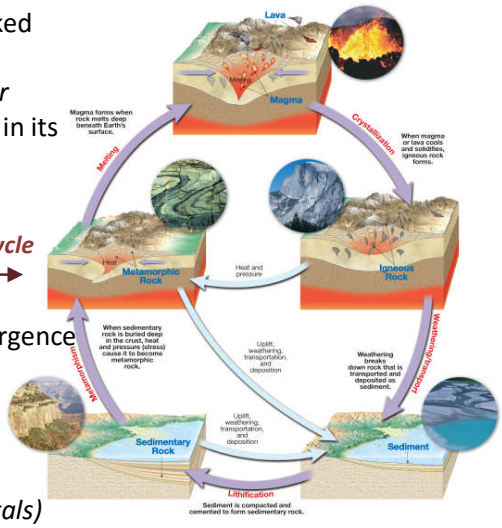
Rocks

I. **The Rock Cycle**

A. Shows the interrelationships among the three rock types

B. Although usually very slowly, crustal rock endlessly continues to be reworked and changed to different types of rock. When a rock finds itself in a new environment due to erosional or tectonic processes *(therefore physically or chemically unstable),* changes will take place in that rock making it 'stable' in its new environment. This is often called '**weathering**'.

C. The full cycle does not always follow the same path owing to 'shortcuts' or interruptions



The Rock Cycle

II. **Igneous rocks**

A. Forms as **magma**, cools and crystallizes

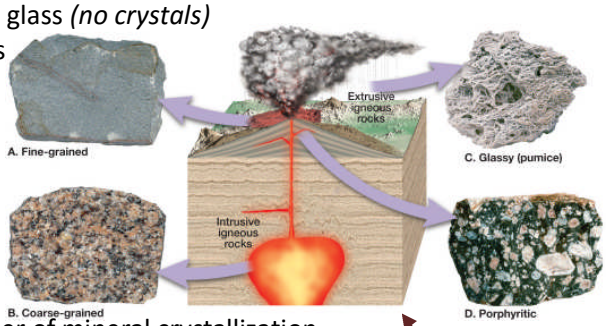
1. Most magmas form *(melt)* in areas of tectonic plate divergence or convergence
2. Rocks formed inside Earth are called **plutonic** or **intrusive rocks**
3. Igneous rocks formed on Earth's surface are formed from lava and are called **volcanic** or **extrusive rocks**

B. Crystallization of magma

1. During slow cooling, ions arrange themselves into orderly patterns *(crystals)*
2. **Crystal size** is determined by the **rate of cooling** - slow rate produces large crystals, fast rate produces microscopic crystals, very fast rate produces glass *(no crystals)*

C. Classification is based on the rock's texture and mineral constituents

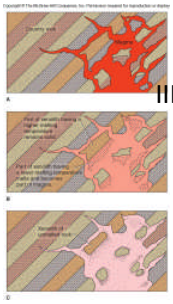
1. **Texture** - size and arrangement of crystals. Types include:
   a. Fine-grained—fast rate of cooling
   b. Coarse-grained—slow rate of cooling
   c. Porphyritic *(two crystal sizes)*—two rates of cooling
   d. Glassy—very fast rate of cooling
   e. Vesicular – small voids from gas bubbles
2. **Mineral composition**
   a. Explained by Bowen's reaction series, which shows the order of mineral crystallization
   b. Influenced by 'crystal settling' in the magma
   c. Also the result of the parent material



Different textures from the same original magma

D. Nomenclature of igneous rocks

1. **Granitic rocks** – are composed almost entirely of light-colored silicates like quartz and feldspar
   a. Also referred to as **<u>felsic</u>**: ***<u>fel</u>***dspar and ***<u>si</u>***lica *(quartz)*
   b. High silica content *(above 65 percent)*
   c. Common rock is **granite** *(when intrusive)* and **rhyolite** *(when extrusive)*
2. **Basaltic rocks** - contain substantial dark silicate minerals and calcium-rich plagioclase feldspar
   a. Also referred to as **<u>mafic</u>**: ***<u>ma</u>***gnesium and ***<u>f</u>***errum *(iron)*
   b. Lower silica content *(45 to 52 percent)*
   b. Common rock is **gabbro** *(when intrusive)* and **basalt** *(when extrusive)*
3. Other compositional group
   a. Andesitic *(or intermediate)*
   b. Silica content from 53 to 65 percent
   c. Common rock is **diorite** *(when intrusive)* and **andesite** *(when extrusive)*
4. **Magma viscosity**
   a. High silica content = high viscosity, high temperature = low viscosity, high gas content = low viscosity. In a viscous lava, high gas content = explosiveness.



Magma intrusion followed by cooling

E. Intrusive rock bodies include: diapirs, batholiths, dikes, sills, and volcanic necks

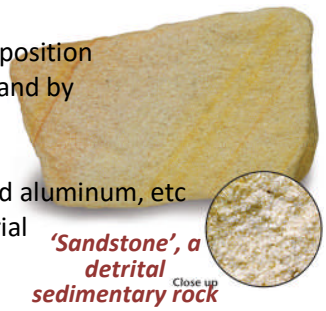
III. **Sedimentary rocks** – Sedimentary rocks are classified by their origin, texture, and composition

A. Sediment forms by the weathering of preexisting rock, by chemical precipitation, and by accumulation of the skeletal remains of microscopic organisms on an ocean floor

B. Used to reconstruct much of Earth's history

C. Economic importance include: coal, petroleum and natural gas, sources of iron and aluminum, etc

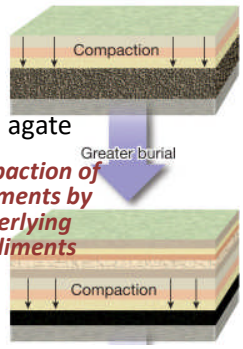
D. Classification of sedimentary rocks - two groups based on the source of the material



'Sandstone', a detrital sedimentary rock

1. **Detrital rocks** – made from solid particles
   a. Classified by particle size: clay → silt → sand → gravel
   b. Common rocks are: shale *(most abundant),* siltstone, sandstone, conglomerate
2. **Chemical rocks** – made from material that was once in solution and precipitated to form sediment
   a. Directly precipitated as the result of physical processes *(evaporation, etc.)*
   b. Precipitated through life processes *(biochemical origin)*
   c. Common chemical sedimentary rocks
      a. Limestone *(most abundant)* - includes coquina, chalk, travertine
      b. Microcrystalline quartz *(precipitated quartz)* - includes chert, flint, jasper, agate
      c. Evaporites – includes rock salt, gypsum
      d. Coal – includes lignite, bituminous

Evaporites of the Bonneville Salt Flats in Utah



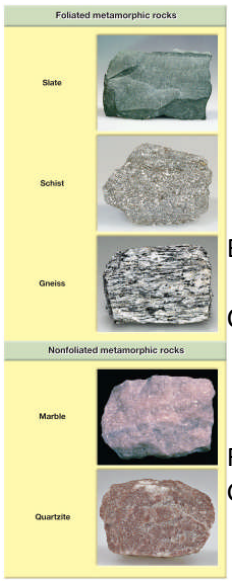
Compaction of sediments by overlying sediments

E. Sedimentary rock is produced through lithification – the process includes:
1. **Consolidation** - of sediments on the sea floor *(settling into layers of sediment)*
2. **Compaction** – by weight of more and more sediments being deposited over them
3. **Cementation** – by chemicals in the groundwater *(calcite, or silica, or iron oxide)*

F. Sedimentary features include: strata *(or beds),* fossils, cross-bedding, graded beds, ripple marks, mud cracks, etc

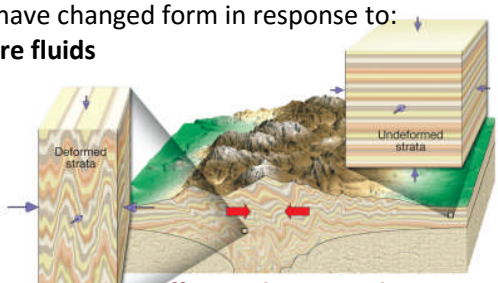
G. Sedimentary rocks constitute about 75 percent of all rock outcrops on the continents

IV. **Metamorphic rocks** – are classified by texture and mineral composition



A. Pre-existing rocks *(igneous, sedimentary, or metamorphic)* that have changed form in response to: increased **heat**, increased **pressure**, or hot **chemically active pore fluids**

In general metamorphism causes:
1. growth of new minerals
2. Deformation and rotation *(alignment)* of mineral grains
3. Recrystallization of minerals as larger grains
4. Production of strong brittle rock



Differential pressure during mountain building

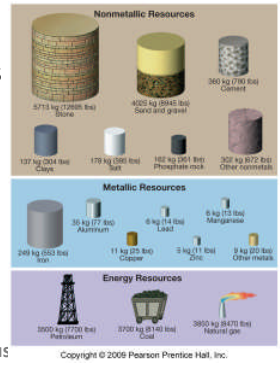
B. Degrees of metamorphism can be low grade *(shales to slate)* or hi-grade *(original features are obliterated)*

C. Metamorphic settings
1. **Contact metamorphism** occurs near a mass of magma and is driven only by a rise in temperature
2. **Regional metamorphism** results from directed pressures and high temperatures during mountain building

F. Metamorphic textures – include foliated texture *(from differential pressure)* and nonfoliated texture

G. Common metamorphic rocks include:
1. **Foliated** rocks: slate, schist, gneiss *(3 upper rocks in illustration to the left)*
2. **Nonfoliated** rocks: marble, quartzite *(2 lower rocks in illustration to the left)*

Examples of resources from the Earth



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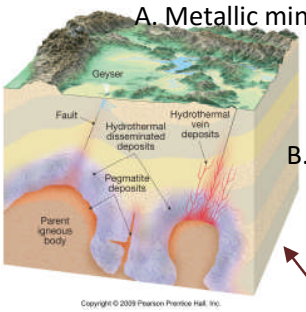
V. Resources from rocks and minerals

A. Metallic mineral resources – are commonly a result of igneous and metamorphic processes

Most important ore deposits are generated from hydrothermal *(hot-water)* solutions containing metal-rich fluids. These produce vein deposits and disseminated deposits distributed throughout the rock



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Hydrothermal processes & deposits

B. Nonmetallic mineral resources - two broad groups:
1. Building materials *(limestone, gypsum, sand & gravel, etc.)*
2. Industrial minerals *(fluorite, corundum, sylvite, etc.)*