I. Environmental significance
II. Definition
III. 3 major classes
IV. The Rock Cycle
V. Secondary classification
VI. Additional sub-classes
VII. Important rock properties
Rocks
Definition of a rock

• Naturally occurring
• Solid
• Cohesive aggregate of one or more
  – minerals or
  – mineral materials*

* mineral materials include non-crystalline solids

Volcanic glass  Amber  Opal

Rocks
Definition of a rock

• Naturally occurring
• Solid
• Cohesive aggregate of one or more
  – minerals or
  – mineral materials*
  – plus/minus organic compounds

Tar  Bitumen
Rocks

3 Major Classes

Based on processes of formation

- Cooling of Magma (molten igneous rock)
- Lithification (turning to rock) of sediments
- Recrystallization under pressure and/or heat

Igneous
Sedimentary
Metamorphic

Rocks

The Rock Cycle
### Rocks
#### Secondary Classification

#### Processes of formation - Igneous

<table>
<thead>
<tr>
<th>Process</th>
<th>Example</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cooling of magma at depth</td>
<td>Plutonic (from Pluto, god of the underworld) e.g. granite</td>
</tr>
<tr>
<td>Cooling of lava (magma that erupts) at the surface</td>
<td>Volcanic (from a volcano) e.g. basalt</td>
</tr>
<tr>
<td>Fusing of rock fragments and ash erupted from volcano</td>
<td>Pyroclastic (pyr = fire, clast = fragment) e.g. tuff</td>
</tr>
</tbody>
</table>

#### Processes of formation - Sedimentary

<table>
<thead>
<tr>
<th>Process</th>
<th>Example</th>
</tr>
</thead>
<tbody>
<tr>
<td>Compaction and cementation of clasts (lithification)</td>
<td>Clastic sedimentary rocks e.g. sandstone</td>
</tr>
<tr>
<td>Biotic or abiotic precipitation of minerals from water</td>
<td>Coquina limestone Chemical sedimentary rocks</td>
</tr>
<tr>
<td></td>
<td>Evaporite</td>
</tr>
</tbody>
</table>
Rocks
Secondary Classification

Processes of formation - Metamorphic

- Heat from a local, adjacent source
- Heat and pressure at depth in the crust

Contact metamorphism (reddish zone around granite)
Regional metamorphism (entire subducting plate)

Additional Classification - Igneous

Texture - reflects cooling rate

Slow | Fast

- pegmatite
- porphyry
- Mixed rates
- obsidian
- tuff
Major Mineral Groups
Silicates (all with Si and O)

Aluminosilicates (felsic minerals)
- Al + Ca, Na, K
- Example: feldspar

Ferromagnesian silicates (mafic minerals)
- Fe, Mg
- Example: olivine

Major minerals (with quartz) of continental crust

Major minerals of oceanic crust

Rocks
Additional Classification - Igneous

Mineralogic composition

<table>
<thead>
<tr>
<th></th>
<th>Rhyolite</th>
<th>Andesite</th>
<th>Basalt</th>
</tr>
</thead>
</table>

Felsic → Mafic
Rocks
Additional Classification - Clastic Sedimentary Rocks

Grain size
- Conglomerate: Coarse
- Sandstone: Medium
- Shale: Fine

Major Mineral Groups
Nonsilicates

Rockforming minerals
- Carbonates, CO$_3$ (limestone)
- Halides (evaporites): Cl, F, or I salts

Accessory minerals
- Native Elements
- Sulfides, S + metal
- Sulfates, SO$_4$
- Oxides, O + metal
- Hydroxides, OH + metal
- Calcite, dolomite
- Halite, fluorite, silvite
- Gold, copper, graphite
- Pyrite, galena
- Gypsum
- Magnetite, hematite
- Gibbsite (Al), goethite (Fe)
Rocks
Additional Classification - Chemical Sediments

Calcite \([\text{CaCO}_3]\) or Dolomite \([\text{CaMg(CO}_3\text{)}_2]\)

Carbonates (Limestone, Dolomite)

Sulfates (gypsum) and Halides (halite, silvite)

Evaporites

Rocks
Additional Classification - Metamorphic

Texture - reflects “metamorphic grade”

Low
Medium
High

Slate
Schist
Gneiss
Rocks
Additional Classification - Metamorphic

Mineralogic composition - reflects “parent” rock

- Sandstone
- Limestone
- Shale
- Quartzite
- Marble
- Slate

Important Properties

Mechanical Properties: response to stress

- Folding of rocks occurs when they behave “plastically”
- Faulting (rupture of brittle rocks)
Rocks
Important Properties (continued)

Resistance to physical weathering

- Columnar basalt breaks along cracks that developed when lava cooled
- Weakly cemented sandstone is easily eroded by waves

Rocks
Important Properties (continued)

Resistance to chemical weathering by exposure to water

- Cave formation resulting from carbonate dissolution

A small proportion of carbonic acid molecules ionizes to form hydrogen ions (H+) and bicarbonate ions (HCO3⁻), making the water droplets slightly acidic.

The slightly acidic water dissolves potassium ions and silicic acids from feldspar.
Rocks

Important Properties (continued)
Capacity to store and transmit fluids (water, oil, gas) depends on size and abundance of pores (open spaces)

- Micropores in sandstones and carbonates
- Virtually no pores in granite
- Macropores in limestone, basalt, crystalline rocks