There are 3 major types of rocks

**IGNEOUS** – formed from molten magma

**SEDIMENTARY** – formed from sediment (soil, sand, etc.)

**METAMORPHIC** – formed by applying heat and pressure to other existing rocks
The Rock Cycle – a representation of the interrelationship between different types of rocks.
Characterizing Rocks

The three major characterizing features of rocks are:

• Color
• Composition (Mineralogy/Chemistry)
• Texture

Note: Even the most sophisticated geological classification schemes are based on these features
Characterizing Rocks

Classification by Color

Color Index (used mainly for igneous rocks)

- Leucocratic – light color
- Mesocratic – intermediate color
- Melanocratic – dark color

and/or

- Felsic – rich in light colored minerals
- Mafic – rich in dark colored minerals
Igneous Rocks

Textures of Igneous Rocks

• **Aphanitic** – fine-grained. Individual grains can’t be seen with naked eye

• **Phaneritic** - grains easily seen with the naked eye

• **Porphyritic** – larger grains in finer grains

• **Inclusions**
  > **Xenoliths**
  > **Xenocrysts**
Phaneritic Texture
Aphanitic Texture
Vesicular & Glassy Textures
Xenoliths
<table>
<thead>
<tr>
<th>Texture</th>
<th>Felsic (light color)</th>
<th>Intermediate</th>
<th>Mafic (dark color)</th>
<th>Ultramafic</th>
</tr>
</thead>
<tbody>
<tr>
<td>Coarse</td>
<td>Granite</td>
<td>Diorite</td>
<td>Gabbro</td>
<td>Peridotite</td>
</tr>
<tr>
<td>Fine</td>
<td>Rhyolite</td>
<td>Andesite</td>
<td>Basalt</td>
<td></td>
</tr>
<tr>
<td>Vesicular</td>
<td>Pumice</td>
<td>Scoria</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Glassy</td>
<td></td>
<td></td>
<td>Obsidian</td>
<td></td>
</tr>
</tbody>
</table>

**Minerals Present**

- Quartz
- K-feldspar
- Na-plagioclase
- Na-CA plagioclase
- Amphibole
- Ca plagioclase
- Pyroxene
- Olivine
Table 2.1  Igneous rock identification key. Color, with associated mineral composition, is shown along the top axis. Each rock in a column has the color and composition indicated at the top of the column. Texture is shown along the left side of the key. Each rock in a row has the texture indicated for that row. To determine the name of a rock, intersect the appropriate column (color & mineral composition) with the appropriate row (texture) and read the name at the place of intersection.

IGNEOUS ROCK IDENTIFICATION KEY

<table>
<thead>
<tr>
<th>Color Index and Graphic Illustration</th>
<th>0%</th>
<th>15%</th>
<th>45%</th>
<th>85%</th>
<th>100%</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>COLOR</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Light</td>
<td>Light</td>
<td>Medium</td>
<td>Dark</td>
<td>Very dark</td>
<td></td>
</tr>
<tr>
<td>Increasing silica content</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Felsic</td>
<td>Felsic</td>
<td>Intermediate</td>
<td>Mafic</td>
<td>Ultramafic</td>
<td></td>
</tr>
<tr>
<td>Increasing iron and magnesium</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>CHEMICAL COMPOSITION</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Quartz</td>
<td>Quartz</td>
<td>Potassium feldspar</td>
<td>Amphibole</td>
<td>Olivine/Pyroxene</td>
<td></td>
</tr>
<tr>
<td>Potassium feldspar</td>
<td>Potassium feldspar</td>
<td>Plagioclase feldspar</td>
<td>Plagioclase feldspar</td>
<td>Pyroxene</td>
<td></td>
</tr>
<tr>
<td>Amphibole</td>
<td>Amphibole</td>
<td>Plagioclase feldspar</td>
<td>Plagioclase feldspar</td>
<td>Pyroxene</td>
<td></td>
</tr>
<tr>
<td>Olivine/Pyroxene</td>
<td>Olivine/Pyroxene</td>
<td>Plagioclase feldspar</td>
<td>Plagioclase feldspar</td>
<td>Pyroxene</td>
<td></td>
</tr>
<tr>
<td>Pyroxene</td>
<td>Pyroxene</td>
<td>Olivine</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Dominant Minerals</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Texture</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Coarse Grained¹</td>
<td>Granite</td>
<td>Diorite</td>
<td>Gabbro</td>
<td>Peridotite</td>
<td></td>
</tr>
<tr>
<td>Fine Grained²</td>
<td>Rhyolite</td>
<td>Andesite</td>
<td>Basalt³</td>
<td>Uncommon</td>
<td></td>
</tr>
<tr>
<td>Porphyritic³</td>
<td>“Porphyritic” precedes any of the above names whenever there are appreciable phenocrysts</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Glassy</td>
<td>Obsidian (compact glass)</td>
<td>Pumice (frothy glass)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Fragmental</td>
<td>Tuff (fragments less than 2 mm)</td>
<td>Volcanic Breccia (fragments greater than 2 mm)</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

¹ Also called phaneritic. Crystals generally 1-10 mm (1 cm). The term pegmatite is added to the rock name when crystals are greater than 1 cm; e.g., granite-pegmatite.

² Also called anhedral. Crystals generally less than 1 mm.

³ For example, a granite with phenocrysts is called porphyritic granite.

⁴ Basalt with a cinder-like appearance that develops from gas bubbles trapped in cooling lava (a texture referred to as vesicular) is called scoria.
<table>
<thead>
<tr>
<th>Detrital Rocks</th>
<th>Chemical Rocks</th>
</tr>
</thead>
<tbody>
<tr>
<td>Conglomerate</td>
<td>Limestone</td>
</tr>
<tr>
<td>Sandstones</td>
<td>Chert (Flint)</td>
</tr>
<tr>
<td>Siltstone</td>
<td>Salt (Evaporite)</td>
</tr>
<tr>
<td>Shale</td>
<td></td>
</tr>
</tbody>
</table>
Detrital Sedimentary Rocks

Detrital rocks are classified based on particle size and grain shape.

<table>
<thead>
<tr>
<th>Size Range (millimeters)</th>
<th>Particle Name</th>
<th>Common Sediment Name</th>
<th>Detrital Rock</th>
</tr>
</thead>
<tbody>
<tr>
<td>&gt;256</td>
<td>Boulder</td>
<td></td>
<td></td>
</tr>
<tr>
<td>64–256</td>
<td>Cobble</td>
<td>Gravel</td>
<td>Conglomerate or breccia</td>
</tr>
<tr>
<td>4–64</td>
<td>Pebble</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2–4</td>
<td>Granule</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1/16–2</td>
<td>Sand</td>
<td>Sand</td>
<td>Sandstone</td>
</tr>
<tr>
<td>1/256–1/16</td>
<td>Silt</td>
<td>Mud</td>
<td>Shale, mudstone, or siltstone</td>
</tr>
<tr>
<td>&lt;1/256</td>
<td>Clay</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Detrital Sedimentary Rocks

- **Conglomerates**
  - Poorly Sorted particle sizes
  - Well-rounded particles
  - Usually particles are gravel sized
Close up
Detrital Sedimentary Rocks

- **Breccia**
  - Poorly sorted grains
  - Angular grains
  - Gravel sized grains
Close up
Detrital Sedimentary Rocks

- **Sandstone**
  - Well sorted particles
  - Particles can be angular to rounded
  - Sand-sized Particles
Detrital Sedimentary Rocks

- Shale
  - Microscopic grain size
  - Consist of silt and clay size grains
  - Cannot see grains with naked eye
  - Occur in “quiet” depositional environments
Chemical Sedimentary Rocks

- **Classification**
  - Inorganic - Not produced by living things.
  - Biochemical - Are produced by or are remnants of living things (e.g. shell fragments, coral reefs, etc)
Chemical Sedimentary Rocks

- **Limestone**
  - Most abundant chemical rock
  - Inorganic (oolitic limestone, Travertine) or Biochemical (Chalk, Coquina)
Limestone (Chemical Rocks)

- **Travertine**
  - Common in caves
  - Happen when calcium carbonate is precipitated out of groundwater
Limestone (Chemical Rocks)

- **Coquina**
  - Consists of loosely cemented shell fragments

![Image of a rock sample with a scale of 5 cm and a close-up view](image_url)

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Fossiliferous limestone

Limestone
Fine-grained limestone
Chemical Sedimentary Rocks

- **Chert (Flint)**
  - Consists of Microcrystalline Silica
  - Two major occurrences of chert
    - Irregular shaped nodules in limestone
    - layers of rock
  - Most likely Biochemical
A. Cross-section through a geoid showing silica layering
B. Flint
Table 2.3  Sedimentary rock identification key. Sedimentary rocks are divided into two groups, detrital and chemical, depending upon the type of material that composes them. Detrital rocks are further subdivided by the size of their grains, while the subdivision of the chemical rocks is determined by composition.

<table>
<thead>
<tr>
<th>DETRITAL ROCKS</th>
<th></th>
<th>CHEMICAL ROCKS</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Texture</strong></td>
<td><strong>Composition</strong></td>
<td><strong>Texture</strong></td>
</tr>
<tr>
<td>- Coarse (over 2 mm) with large grains</td>
<td>Rounded fragments of quartz and/or chert</td>
<td>Fine to coarse crystalline</td>
</tr>
<tr>
<td>- Medium (1/16 to 2 mm) feels “sandy”</td>
<td>Angular fragments of quartz and/or chert</td>
<td>Visible shells and shell fragments loosely cemented</td>
</tr>
<tr>
<td>- Fine (1/16 to 1/256 mm)</td>
<td>Quartz usually dominates (If abundant feldspar is present the rock is called Arkose)</td>
<td>Various size shells and shell fragments cemented with calcite cement</td>
</tr>
<tr>
<td>- Very fine (less than 1/256 mm)</td>
<td>Quartz and clay</td>
<td>Microscopic shells and clay</td>
</tr>
<tr>
<td></td>
<td>Quartz and clay</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Metamorphic Rocks

- Classified into two main groups
  - Foliated Rocks
  - Non-foliated Rocks
SEDIMENTARY Metamorphism METAMORPHIC stress

...changes to...

Shale... 0 1/256 mm

...Slate

A. Foliated texture

...changes to...

Quartz sandstone...

0 2 mm

...Quartzite

B. Nonfoliated texture
Metamorphic Rocks

Foliated Rocks

- Progression of Shale to Gneiss
  - Slate Low Metamorphic Grade
  - Phyllite
  - Schist
  - Gneiss High Metamorphic Grade
Metamorphic Rocks

Foliated Textures

- Slaty - very fine-grained, fissile
- Phyllitic - fine-grained, foliated, shiny
- Schistose - foliated, large grains visible
- Gneissic - light and dark bands
Slate

- Parent Rock
  - Shale
- Slaty Cleavage
Phyllite

- Parent Rock
  - Slate
- Characteristic sheen/shine
- Phyllitic Texture
Schist

- Parent Rock
  - Phyllite
- Characteristic scaly appearance
- Schistosity
Gneiss

- Parent Rock
  - Schist
- Characteristic of light and dark banding
- Gneissic Texture
Metamorphic Rocks

Non-foliated Rocks

- Rocks that show no Foliation
  - Crystalline Rocks
  - Marble
  - Quartzite
  - Anthracite (coal)
Marble

- Parent Rock
  - Limestone or Dolostone
- Reacts to Acid
(b) Marble
Quartzite

- Parent Rock
  - Sandstone
- Moderate to high metamorphism
- Very Hard
Anthracite (coal)

- Parent material
  - Plant matter
- High metamorphism
- Shinny and hard
Table 2.5 Metamorphic rock identification key. Metamorphic rocks are divided into the two textual groups, foliated and nonfoliated. Foliated rocks are further subdivided based upon the size of the mineral grains.

<table>
<thead>
<tr>
<th>Foliated Oriented</th>
<th>Very fine</th>
<th>Slate</th>
<th>Increasing Metamorphism</th>
<th>Medium to Coarse</th>
<th>Schist</th>
<th>Gneiss</th>
<th>Excellent rock cleavage, smooth dull surfaces</th>
<th>Shale, mudstone, or siltstone</th>
</tr>
</thead>
<tbody>
<tr>
<td>Foliated Banded</td>
<td>Fine</td>
<td>Phyllite</td>
<td>Breaks along wavey surfaces, glossy sheen</td>
<td>Phyllite</td>
<td></td>
<td></td>
<td></td>
<td>Slate</td>
</tr>
<tr>
<td>Nonfoliated</td>
<td>Medium to Coarse</td>
<td>Schist</td>
<td>Micaceous minerals dominate, scaly foliation</td>
<td>Gneiss</td>
<td></td>
<td></td>
<td>Compositional banding due to segregation of minerals</td>
<td>Schist, granite, or volcanic rocks</td>
</tr>
<tr>
<td></td>
<td>Medium to Coarse</td>
<td>Gneiss</td>
<td>Banded rock with zones of light-colored crystalline minerals</td>
<td>Migmatite</td>
<td></td>
<td></td>
<td></td>
<td>Gneiss</td>
</tr>
<tr>
<td></td>
<td>Medium to Coarse</td>
<td>Marble</td>
<td>Interlocking calcite or dolomite grains</td>
<td>Marble</td>
<td></td>
<td></td>
<td></td>
<td>Limestone, dolostone</td>
</tr>
<tr>
<td></td>
<td>Medium to Coarse</td>
<td>Quartzite</td>
<td>Fused quartz grains, massive, very hard</td>
<td>Quartzite</td>
<td></td>
<td></td>
<td></td>
<td>Quartz sandstone</td>
</tr>
<tr>
<td></td>
<td>Fine</td>
<td>Hornfels</td>
<td>Usually, dark massive rock with dull luster</td>
<td>Hornfels</td>
<td></td>
<td></td>
<td></td>
<td>Any rock type</td>
</tr>
<tr>
<td></td>
<td>Fine</td>
<td>Anthracite</td>
<td>Shiny black rock that may exhibit conchoidal fracture</td>
<td>Anthracite</td>
<td></td>
<td></td>
<td></td>
<td>Bituminous coal</td>
</tr>
<tr>
<td></td>
<td>Medium to very coarse</td>
<td>Fault breccia</td>
<td>Broken fragments in a haphazard arrangement</td>
<td>Fault breccia</td>
<td></td>
<td></td>
<td></td>
<td>Any rock type</td>
</tr>
</tbody>
</table>