Rocks

Rock Cycle, Types of Rocks

3.1 Rocks

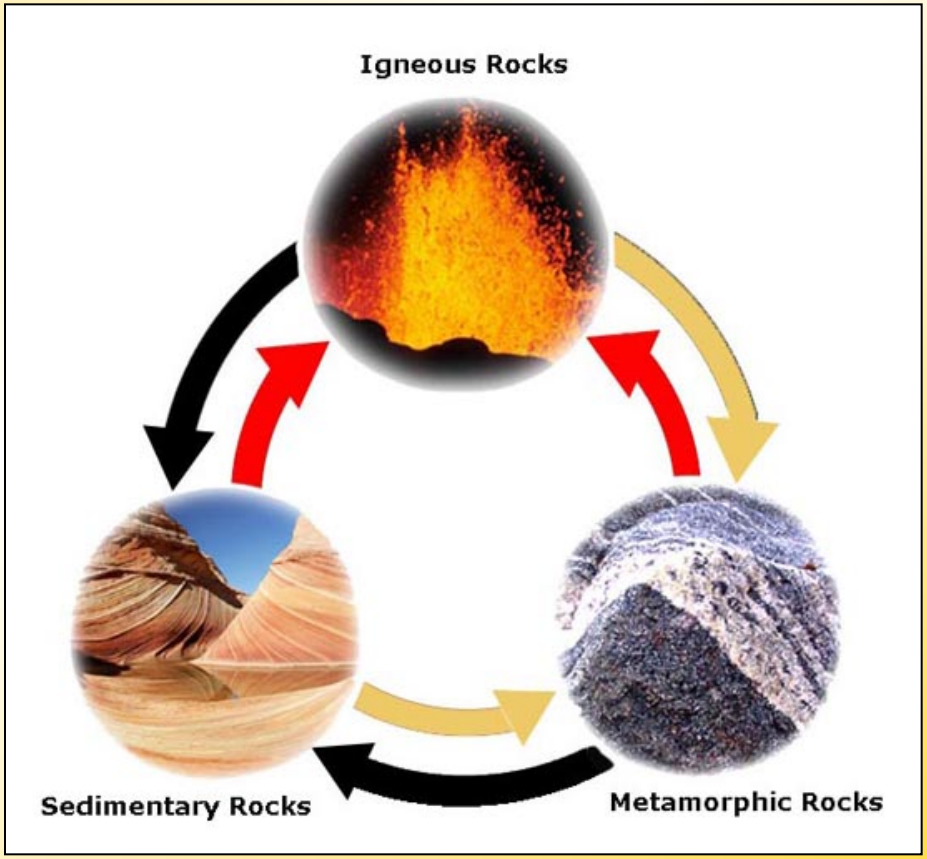
- **Rocks**: any solid mass of mineral or mineral-like matter occurring naturally as part of our planet.
  - Most rocks are mixtures of minerals.
  - Some rocks are made of just one mineral.

- Rocks are classified on how they form.
- Rocks can change type from one to another over time.
- There are 3 main types of rocks:

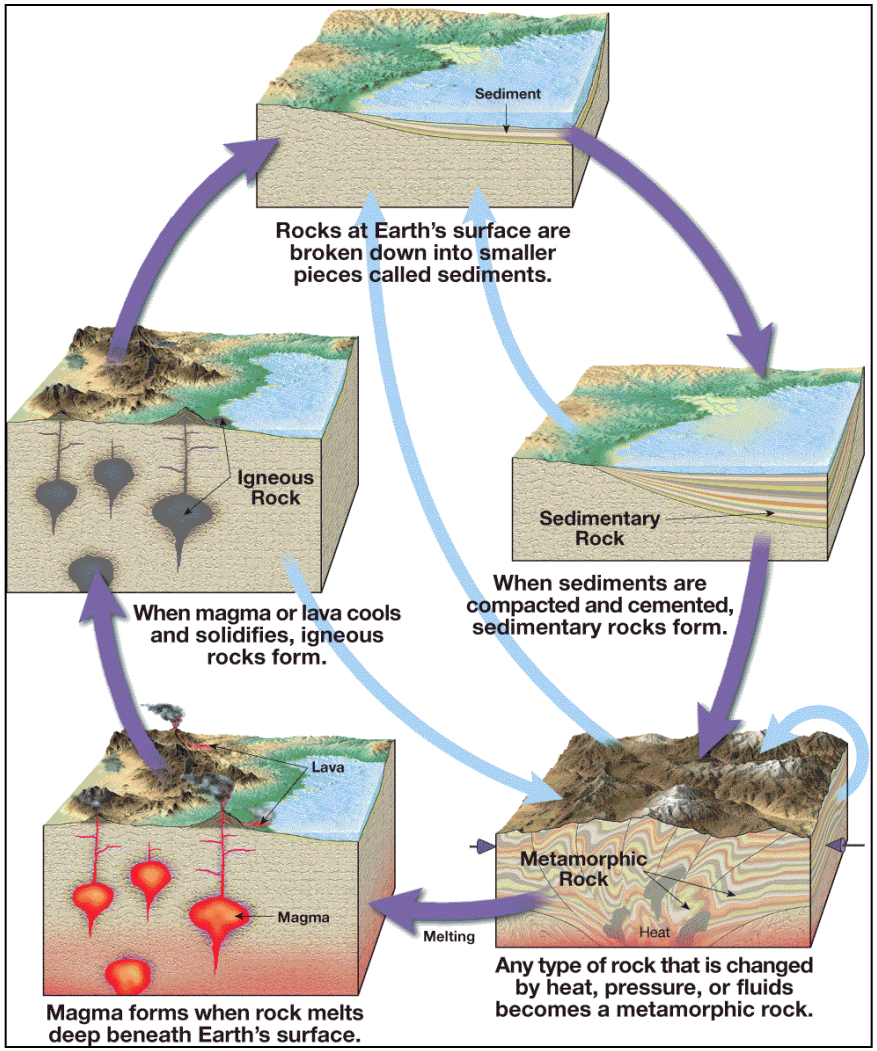
1. Igneous
2. Sedimentary
3. Metamorphic

3.1 The Rock Cycle

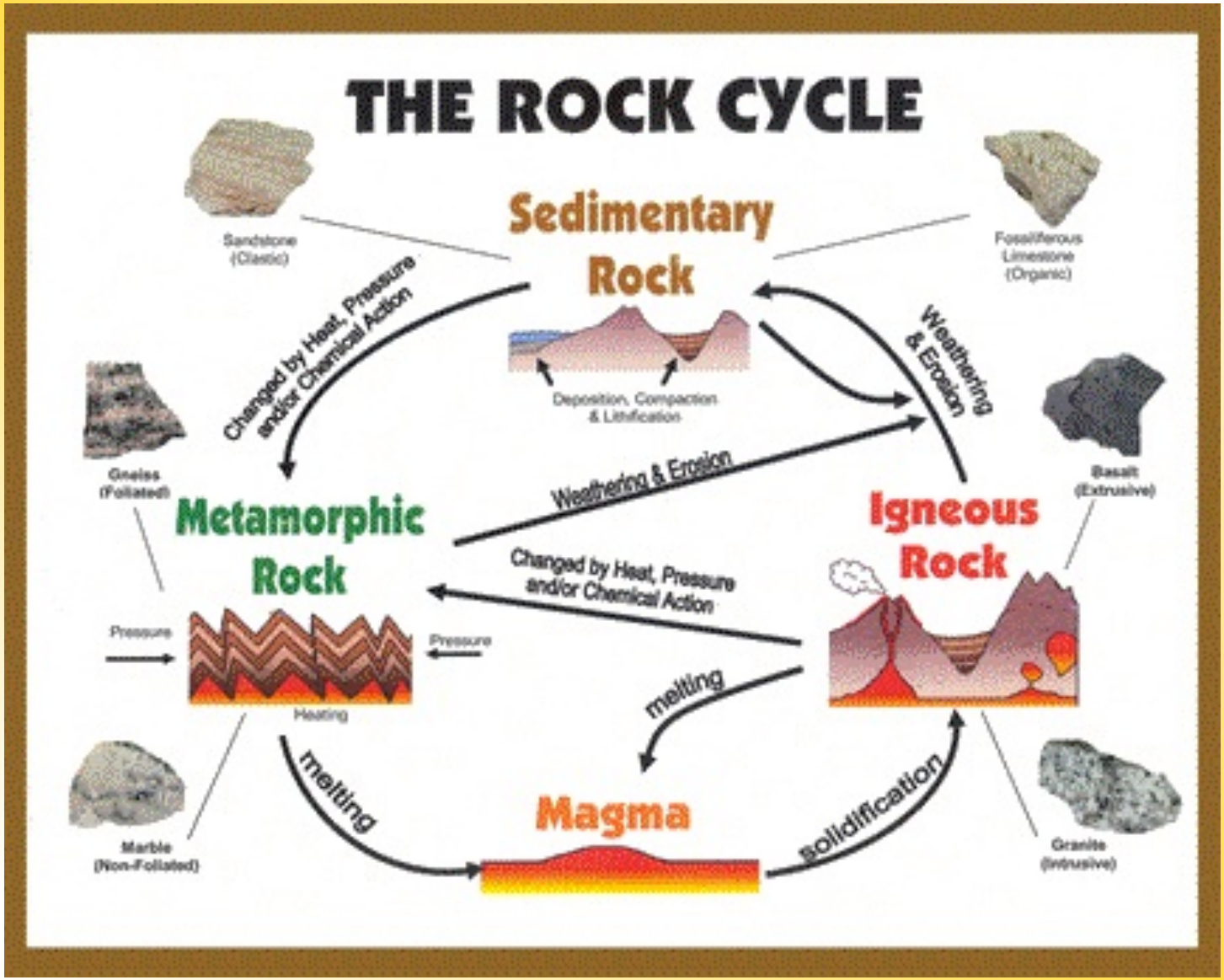
- **Rock Cycle**: Shows the relationships between Earth's water, air, and land; this can cause rocks to change from one type to another.
- Changes in the rock cycle take place over long periods of time.



3.1 The Rock Cycle



3.1 The Rock Cycle



3.1 The Rock Cycle

Igneous rock is formed by the crystallization of molten magma.

- **Magma** is molten material that forms deep beneath the Earth's surface.
- **Lava** is magma that reaches the surface.
- When magma cools and hardens beneath the surface, or from a volcanic eruption, igneous rock is formed.

3.1 The Rock Cycle

Sedimentary rock is formed from the weathered products of preexisting rocks that have been transported, deposited, compacted, and cemented.

- **Weathering** is a process in which rocks are broken down by water, air, and living things.
- **Sediment** is weathered pieces of Earth elements.
- Sediments are compacted and cemented to form sedimentary rocks.

3.1 The Rock Cycle

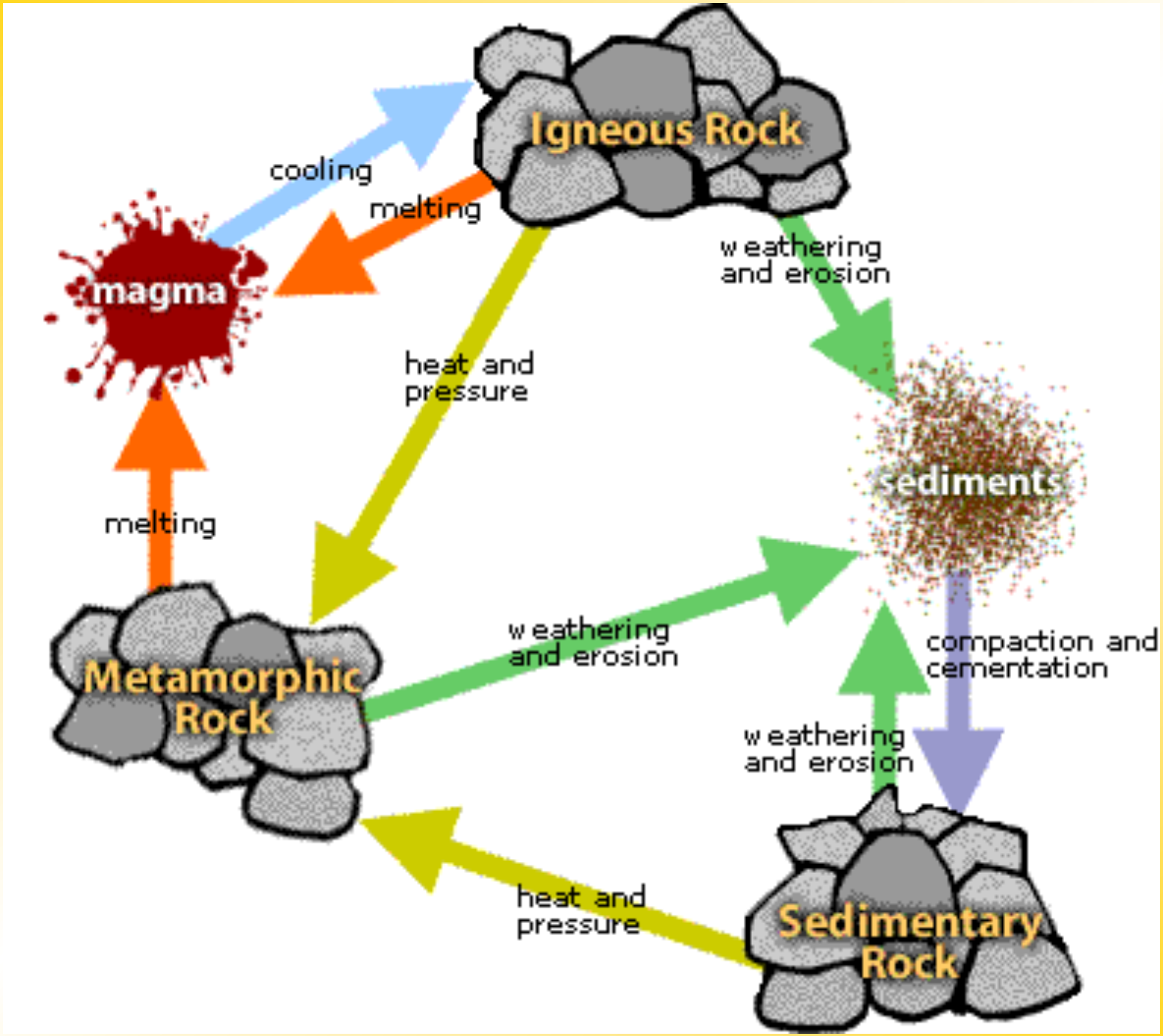
Metamorphic rock is formed by the change of pre-existing rock deep within Earth (but still in the solid state) by heat, pressure, and/or chemically active fluids.

- Extreme pressure and temperature conditions *change* sedimentary rock into metamorphic rock.

3.1 The Rock Cycle

Energy that drives the Rock Cycle:

- Processes driven by heat from the Earth's interior are responsible for forming both **igneous** rock and **metamorphic** rock.
- Weathering and the movement of weathered materials are external processes powered by **energy from the sun**.
- External processes produce **sedimentary** rocks.


Igneous Rock
cooling
melting
magma
weathering
and erosion
heat and
pressure
sediments
melting
Metamorphic
Rock
weathering
and erosion
compaction and
cementation
weathering
and erosion
heat and
pressure
Sedimentary
Rock

Igneous Rock

3.2 Igneous Rock

- Igneous rock forms when molten rock (magma) cools and hardens
- Classified by: composition and texture
  - **Coarse-grained** texture is caused by slow cooling resulting in larger crystals.
  - **Fine-grained** texture is caused by quick cooling resulting in smaller, interconnected mineral grains.


Basalt

3.2 Igneous Rock Texture

Course-grained

Fine-grained

3.2 Igneous Rock Texture

- **Glassy texture** is caused by very rapid cooling.
- **Porphyritic** texture is caused by different rates of cooling resulting in varied sized minerals.

Obsidian - glassy


Porphyritic texture

3.2 Igneous Rock Composition

- **Granitic** composition rocks are made mostly of light-colored quartz and feldspar.
- **Basaltic** composition rocks are made mostly of dark-colored silicate minerals and plagioclase feldspar.

3.2 Igneous Rock Composition

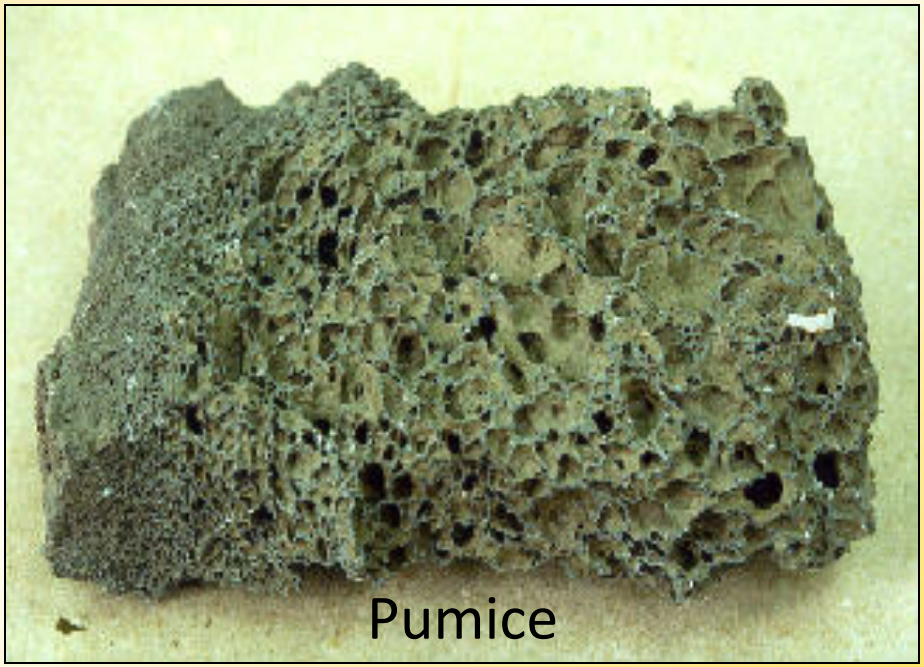
- **Andesitic** composition rocks are between granitic light-color minerals and basaltic composition dark-colored minerals.
- **Ultramafic** composition rocks are made mostly from iron and magnesium-rich minerals.

3.2 Intrusive Igneous Rock

- Igneous rock forms when cooling of magma takes place <u>slowly beneath Earth's surface</u>

3.2 Extrusive Igneous Rock

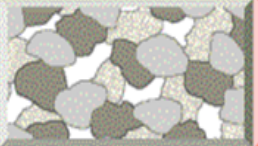
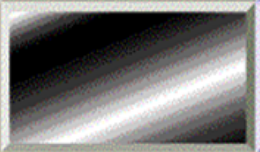
- Igneous rock forms when cooling of **lava** takes place <u>quickly on the Earth's surface</u>



Pumice

3.2 Classification of Igneous Rocks

Table 1 Classification of Major Igneous Rocks

			Granitic	Andesitic	Basaltic	Ultramafic
Chemical Composition						
Dominant Minerals			Quartz Potassium feldspar Sodium-rich plagioclase feldspar	Amphibole Sodium- and calcium-rich plagioclase feldspar	Pyroxene Calcium-rich plagioclase feldspar	Olivine Pyroxene
TEXTURE	Coarse-grained		**Granite**	**Diorite**	**Gabbro**	**Peridotite**
	Fine-grained		**Rhyolite**	**Andesite**	**Basalt**	**Komatiite** (rare)
	Porphyritic		"Porphyritic" precedes any of the above names whenever there are appreciable phenocrysts.			Uncommon
	Glassy		**Obsidian** (compact glass) **Pumice** (frothy glass)			
Rock Color (based on % of dark minerals)			0% to 25%	25% to 45%	45% to 85%	85% to 100%

Sedimentary Rock

3.3 Sedimentary Rock

All sedimentary rocks begin to form when existing rocks are broken down into sediments.

- Sediments are:
  - Rock pieces
  - Mineral grains
  - Shell fragments

3.3 Sedimentary Rock

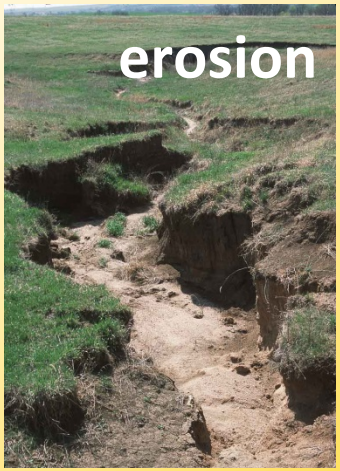
Sedimentum *Latin word for settling* – sedimentary rocks form when solids settle out of fluids.

Sedimentary rocks form from 1 of 2 main processes:

1. Weathering, erosion and deposition
2. Compaction and cementation

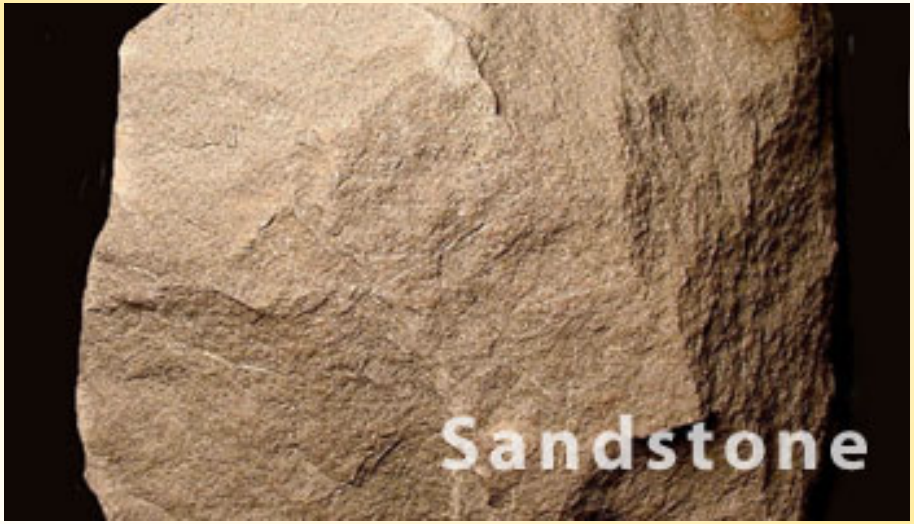
3.3 Weathering, erosion and deposition

- Weathering breaks down rocks into sediments.
  - Chemical weathering changes minerals in rocks into new substances.
  - Physical weathering breaks rocks into smaller pieces.
- Erosion involves weathering and the removal of rock.
  - When water, wind, ice or gravity loses energy, it drops the sediments (deposition).



3.3 Compaction and Cementation

- Lithification: when deposited sediments turn to rock.
  - Compaction squeezes or compacts sediments.
  - Cementation is when dissolved minerals get deposited into tiny spaces among sediments.



3.3 Classification of Sedimentary Rocks

- There are 2 main groups of sedimentary rocks, based on how they form:
  1. Clastic sedimentary rocks
  2. Chemical sedimentary rocks
- Features of a sedimentary rock can serve as clues about where and when they were formed.
  - Layers of sedimentary rock represents a period of deposition (oldest at bottom, newest at top)
  - Fossils can show if rock formed on land or in water.

3.3 Clastic Sedimentary Rocks

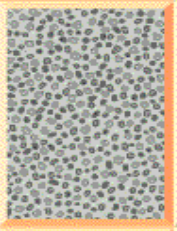
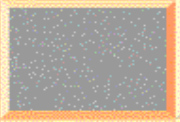
- Rocks made of weathered bits of rocks and minerals.
- Grouped according to the size of their sediments.
  - Conglomerate: rounded, gravel-sized sediments
  - Breccia: angular particles.
  - Sandstone: sand-size grains.
  - Shale: very fine-grained (most common sedimentary rock)

3.3 Chemical Sedimentary Rocks

- Form when dissolved substances precipitate, or separate, from water
  - Usually form when water evaporates or boils off leaving behind a solid.
- Examples:
  - Limestone (most common)
  - Rock salt
  - Flint
  - Rock gypsum

3.3 Classification of Sedimentary Rocks

Clastic Sedimentary Rocks

Texture (grain size)		Sediment Name	Rock Name
Coarse (over 2 mm)		Gravel (rounded fragments)	**Conglomerate**
		Gravel (angular fragments)	**Breccia**
Medium (1/16 to 2 mm)		Sand	**Sandstone**
Fine (1/16 to 1/256 mm)		Mud	**Siltstone**
Very fine (less than 1/256 mm)		Mud	**Shale**

Chemical Sedimentary Rocks

Composition	Texture (grain size)	Rock Name	
Calcite, $CaCO_3$	Fine to coarse crystalline	**Crystalline Limestone**	
		Travertine	
	Visible shells and shell fragments loosely cemented	**Coquina**	**Biochemical Limestone**
	Various size shells and shell fragments cemented with calcite cement	**Fossiliferous Limestone**	
	Microscopic shells and clay	**Chalk**	
Quartz, SiO_2	Very fine crystalline	**Chert (light colored) Flint (dark colored)**	
Gypsum $CaSO_4 \cdot 2H_2O$	Fine to coarse crystalline	**Rock Gypsum**	
Halite, NaCl	Fine to coarse crystalline	**Rock Salt**	
Altered plant fragments	Fine-grained organic matter	**Bituminous Coal**	

Metamorphic Rock

3.3 Metamorphic Rock

- Metamorphism: to change form.
- Metamorphic rocks form when existing rocks re changed by heat & pressure.

3.3 Metamorphic Rock

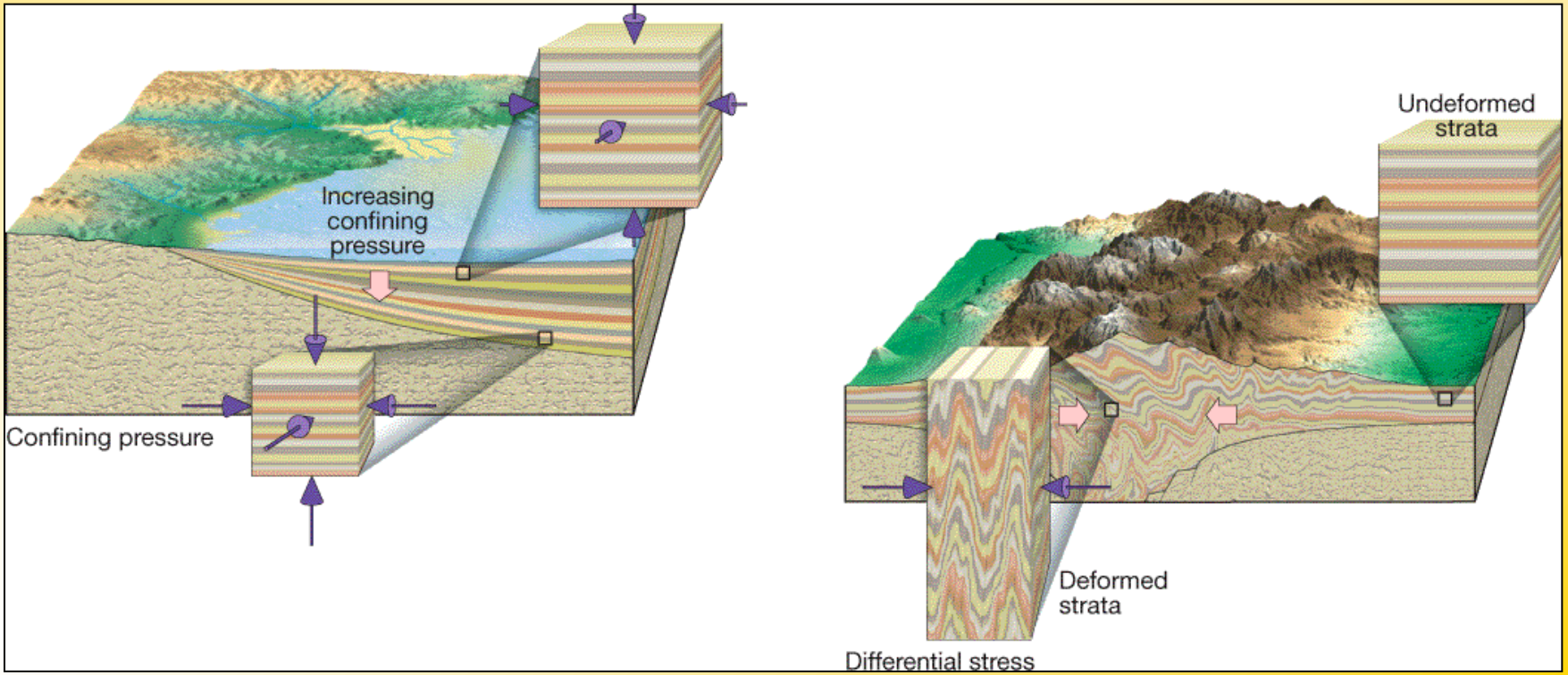
- Rocks are heated, squeezed, folded, or chemically changed by contact with hot fluids.
- Conditions for change are found a few kilometers below the Earth's surface and extend into the upper mantle.

3.3 Metamorphic Rock Formation

- Contact Metamorphism
  - Hot magma forces its way into rock.
  - Produces low-grade metamorphism (minor changes in rock).
  - Changes happen because of a rise in temperature.
- Common example: marble
  - Marble forms when magma moves into limestone.

3.3 Metamorphic Rock Formation

- Regional Metamorphism
  - Large areas of rocks are subjected to extreme pressure and temperature.
  - Results in large-scale deformation & high-grade metamorphism.



3.3 Metamorphic Rock Formation

- 3 Agents of Metamorphism:
  1. **Heat**: provides the energy needed to drive chemical reactions
  2. **Pressure** (stress): causes a more compact rock with greater density
  3. **Reactions in Solution** (hydrothermal solutions): hot water-based solutions escaping from the mass of magma cause recrystallization by dissolving original minerals and then depositing new ones.

3.3 Classification of Metamorphic Rock

2 main categories of metamorphic rock

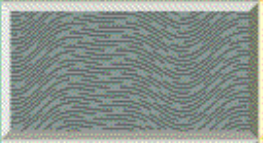
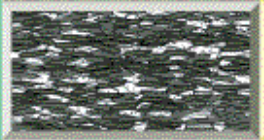
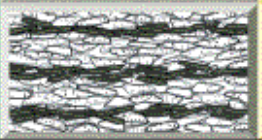
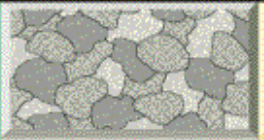
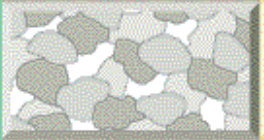
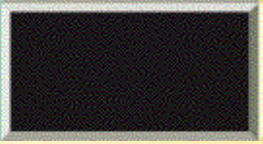
1. **Foliated**: has a banded or layered appearance
   - minerals align in the same direction.
2. **Non-foliated**: does not have a banded texture
   - Most contain only one mineral.

Gneiss: foliated.

Marble: non-foliated.

3.3 Classification of Metamorphic Rock

Table 3 Classification of Major Metamorphic Rocks

Rock Name		Texture		Grain Size	Comments	Parent Rock
Slate	Increasing Metamorphism	Foliated		Very fine	Smooth dull surfaces	Shale, mudstone, or siltstone
Phyllite				Fine	Breaks along wavy surfaces, glossy sheen	Slate
Schist				Medium to Coarse	Micaceous minerals dominate	Phyllite
Gneiss				Medium to Coarse	Banding of minerals	Schist, granite, or volcanic rocks
Marble		Nonfoliated		Medium to coarse	Interlocking calcite or dolomite grains	Limestone, dolostone
Quartzite				Medium to coarse	Fused quartz grains, massive, very hard	Quartz sandstone
Anthracite				Fine	Shiny black organic rock that fractures	Bituminous coal