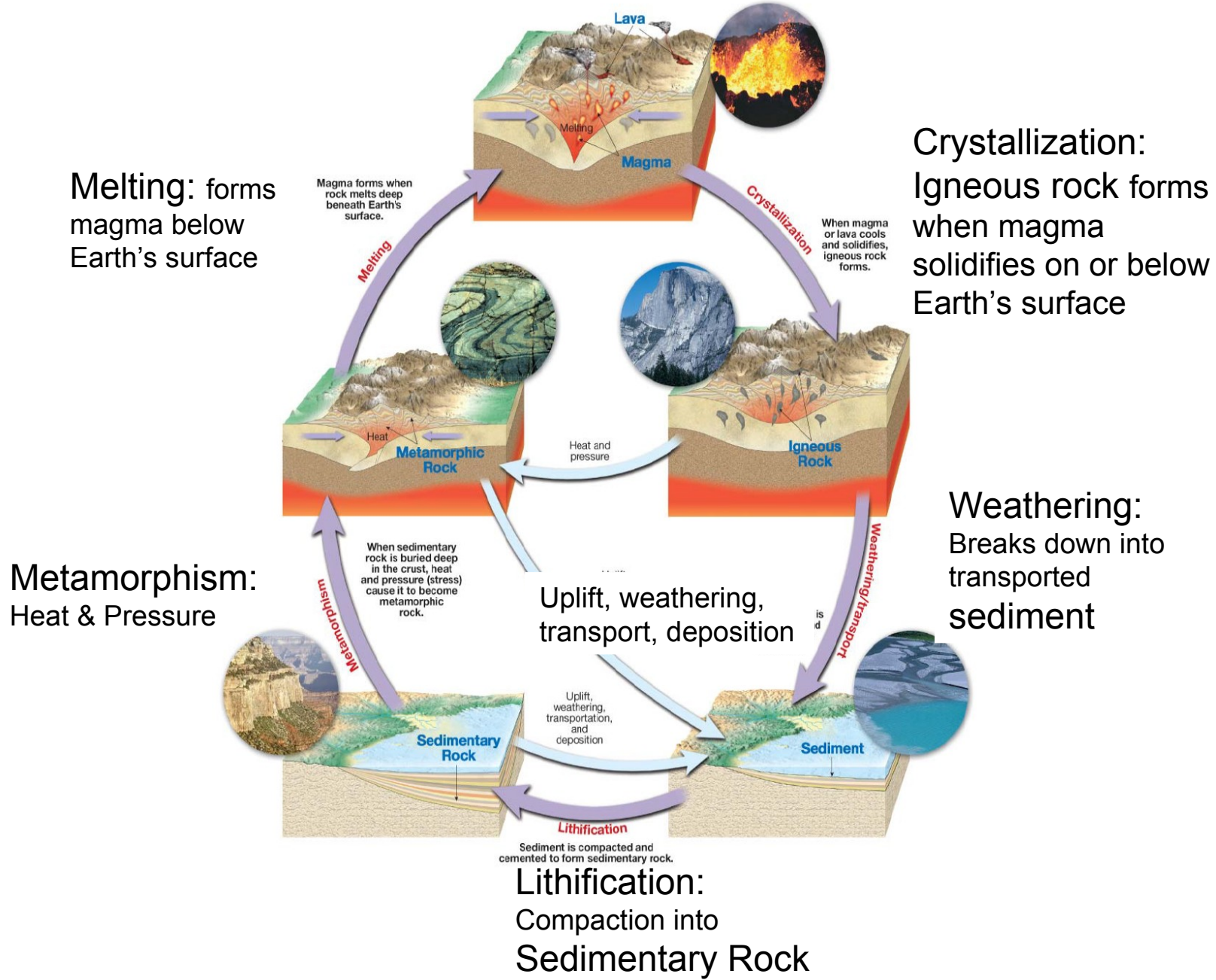


Chapter 7: Rocks and Minerals

1. [Igneous Rocks](#)
2. [Sedimentary Rocks](#)
3. [Metamorphic Rocks](#)
4. [The Rock Cycle and Mineral Resources](#)

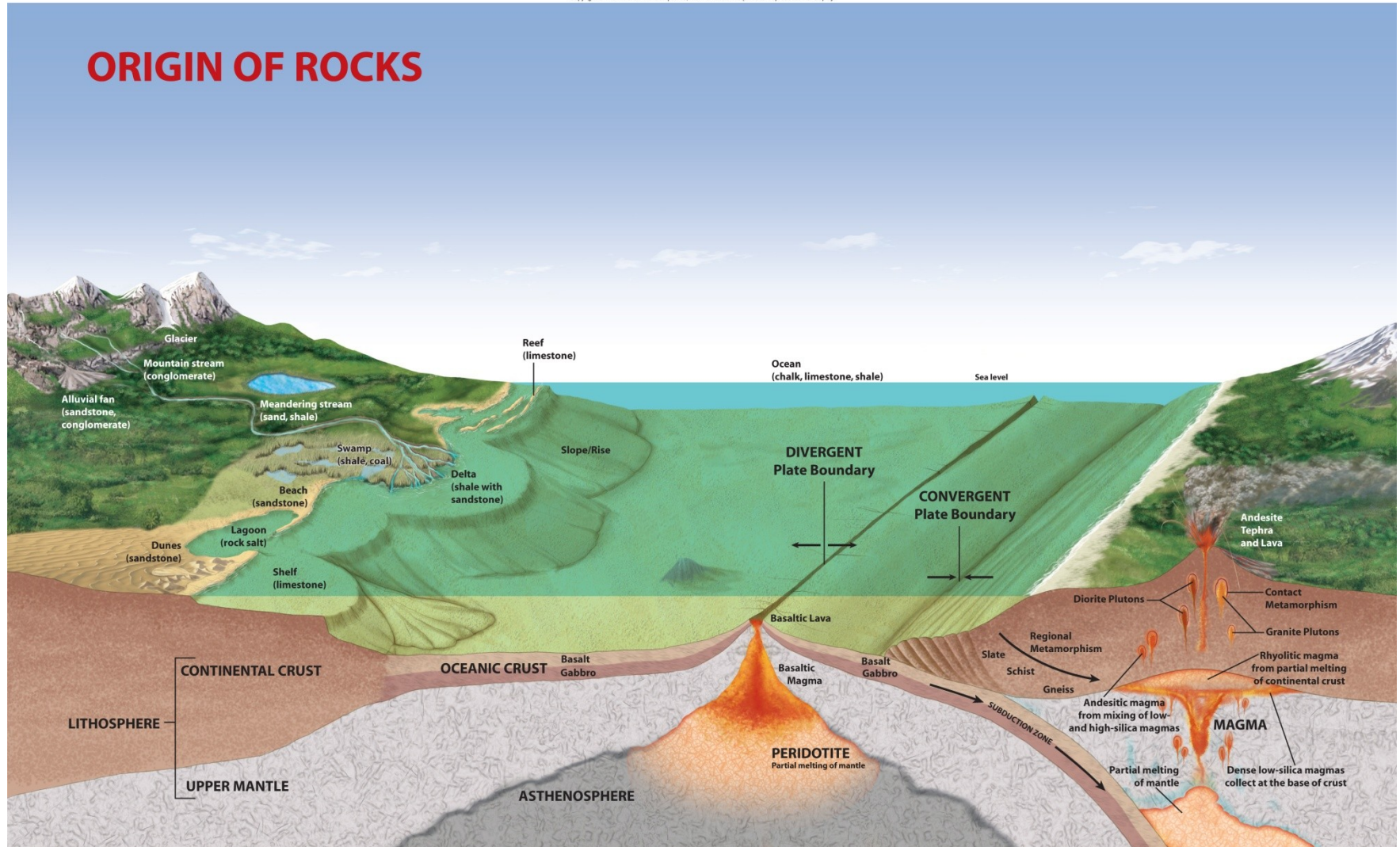
Rock Cycle



Igneous Rocks

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ORIGIN OF ROCKS

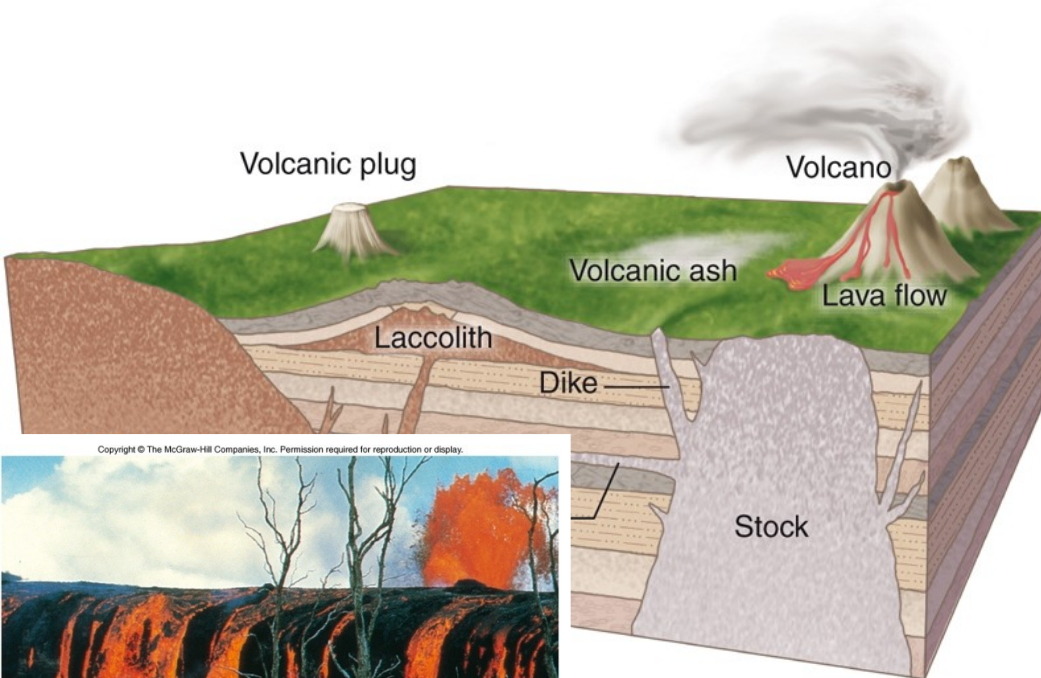


Igneous Rocks

Two types of igneous rocks are classified based on texture and composition

The same magma can form both rock types

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1. **Volcanic rocks** – form when magma rises to Earth's surface

- Produces volcanoes, lava flows, tephra
- Molten rock cools rapidly on surface,

2. **Plutonic rocks** – form when magma solidifies below Earth's surface

- Produces **plutons** that remain hidden until exposed by erosion
- Molten rock cools slowly

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ORIGIN OF ROCKS

The diagram illustrates the origin of rocks through various geological processes and environments. It is divided into several layers and regions:

- Surface Features and Environments:**
 - Glacier**
 - Mountain stream (conglomerate)**
 - Alluvial fan (sandstone, conglomerate)**
 - Meandering stream (sand, shale)**
 - Swamp (shale, coal)**
 - Beach (sandstone)**
 - Dunes (sandstone)**
 - Lagoon (rock salt)**
 - Shelf (limestone)**
 - Delta (shale with sandstone)**
 - Reef (limestone)**
 - Slope/Rise**
- Oceanic Features:**
 - Ocean (chalk, limestone, shale)**
 - Sea level**
- Plate Boundaries:**
 - DIVERGENT Plate Boundary**: Shown with arrows pointing away from each other.
 - CONVERGENT Plate Boundary**: Shown with arrows pointing towards each other.
- Crustal Types:**
 - CONTINENTAL CRUST**
 - OCEANIC CRUST**
- Subduction Zone:** Indicated by a downward arrow, showing the oceanic crust being forced under the continental crust.
- Magma Formation:**
 - Basaltic Lava** and **Basaltic Magma** are shown at the divergent boundary.
 - Basalt Gabbro** is shown in the oceanic crust.
 - Andesite Tephra and Lava** are shown at the convergent boundary.
 - Diorite Plutons** and **Granite Plutons** are shown in the continental crust.
 - Andesitic magma from mixing of low- and high-silica magmas** is shown in the subduction zone.
 - Rhyolitic magma from partial melting of continental crust** is shown in the continental crust.
 - Dense low-silica magmas collect at the base of crust** is shown in the subduction zone.
- Metamorphism:**
 - Contact Metamorphism** is shown near the plutons.
 - Regional Metamorphism** is shown in the subduction zone.
- Rock Types:**
 - Slate**, **Schist**, and **Gneiss** are shown in the subduction zone.
- Upper Mantle:**
 - PERIDOTITE** is shown in the upper mantle.
 - Partial melting of mantle** is shown in the upper mantle.
- Other Labels:**
 - LITHOSPHERE**
 - ASTHENOSPHERE**

Sedimentary Rocks

Sedimentary rocks form as horizontal layers

- oldest layers at bottom, youngest at top

Three types of sedimentary rocks

- Clastic, Chemical, Biochemical

1. Generation

- Physical and chemical breakdown of any rock at Earth's surface (weathering or erosion) to form sediment

2. Transportation

- Erosion → Sediment moved from place of origin by streams, wind, glaciers
- Size of transported grains depends on velocity of transport medium

3. Lithification

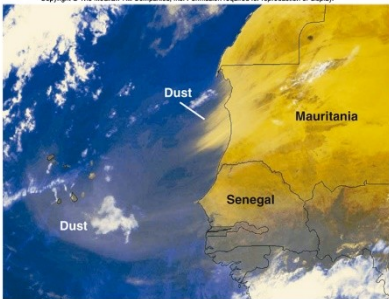
- Over time, sediment is slowly compacted and grains are cemented together to form a new rock (lithification)

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Sediment generated by weathering of Himalayas and transported in rivers – minerals and rock fragments

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Sediment (dust) transported by prevailing winds from Africa toward the Atlantic Ocean

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Sediments of different grain size

© U.S. Park Service

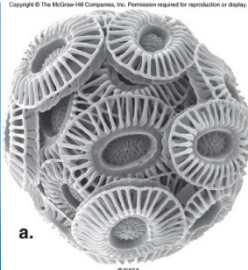
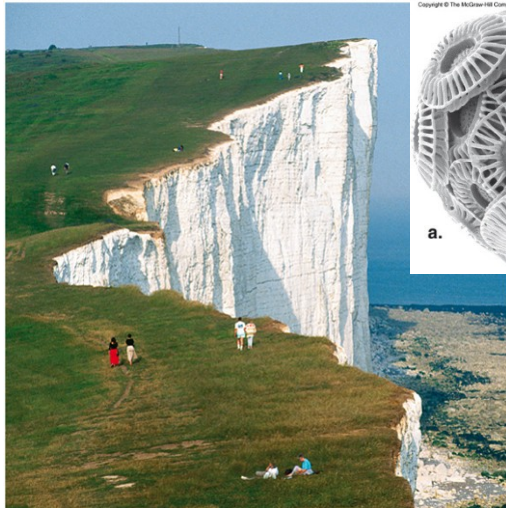
Sedimentary Rocks



*Salt deposited on
floor of ancient Lake
Bonneville, Utah*

- CHEMICAL:
- Form when minerals precipitate (crystallize) from a solution as a result of changing physical conditions
 - Solutions = fresh water in lakes, groundwater or seawater
 - Changing conditions commonly = increased temperatures (evaporation)
 - **evaporites** -- precipitation from evaporation

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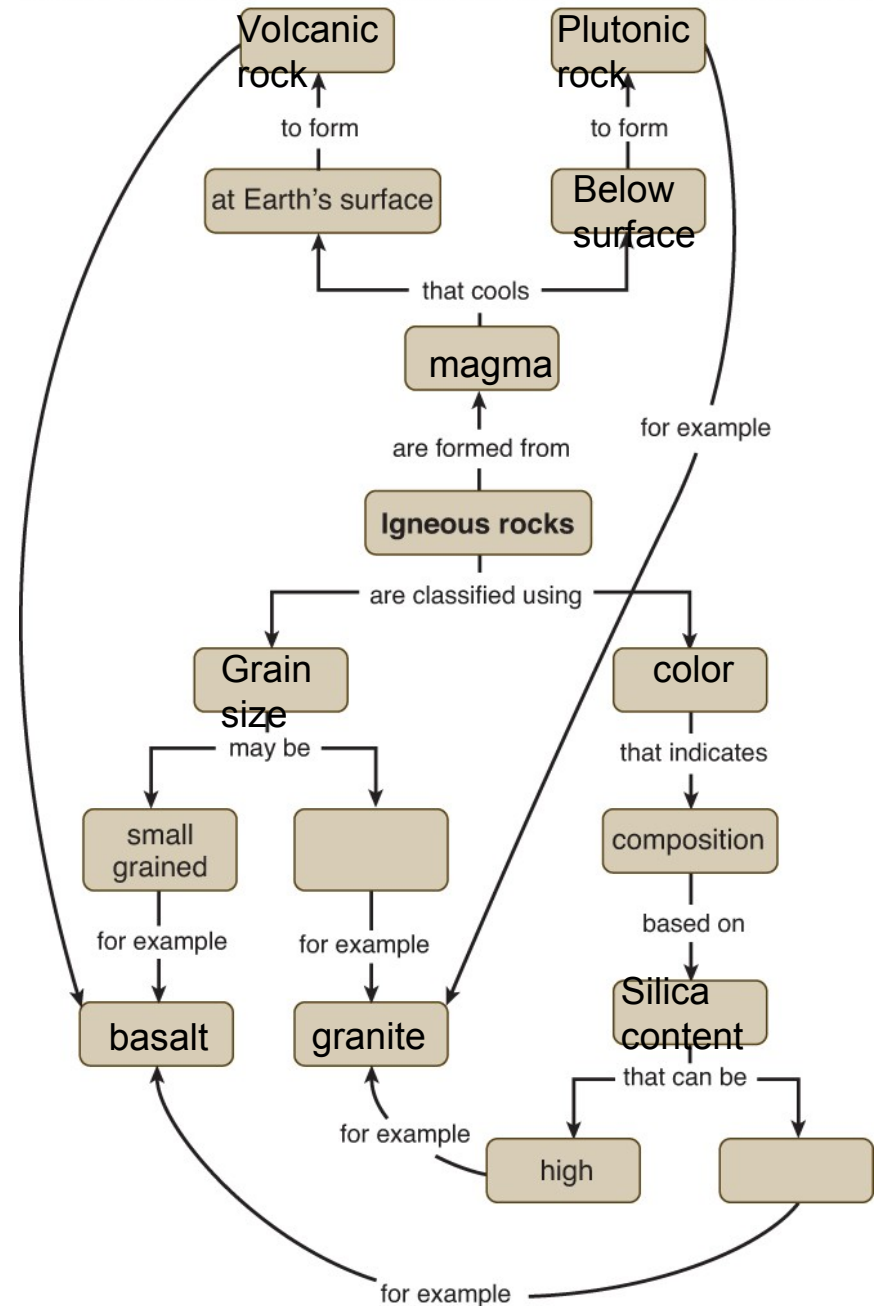


- BIOCHEMICAL:
- Link the biosphere and geosphere
- Form due to actions of living organisms that extract minerals or from the remains of dead organisms
- Limestone is a CHALK biochemical rock. made from microscopic (clay-sized) coccolithophore organisms
- . Chalk indicates specific marine conditions in geologic past

Rocks and Minerals

Checkpoint 7.12

Some terms are **magma**,
basalt, **plutonic rocks**
and **volcanic rocks**

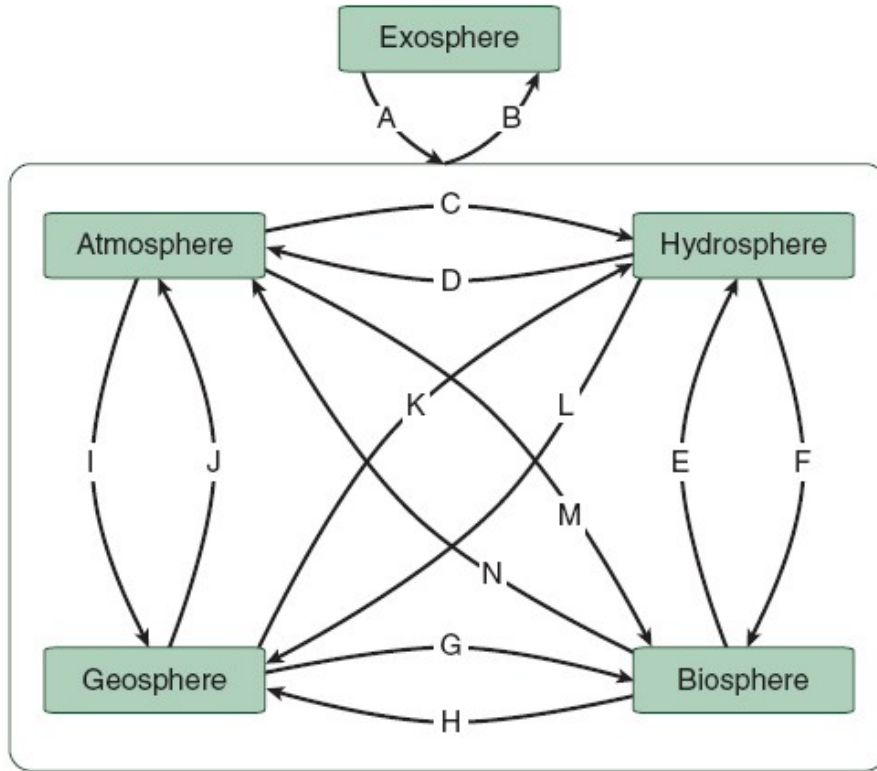


Rocks and Minerals Concept Map

Interactions between the earth system and rocks and minerals.

Some choices (Think of others):

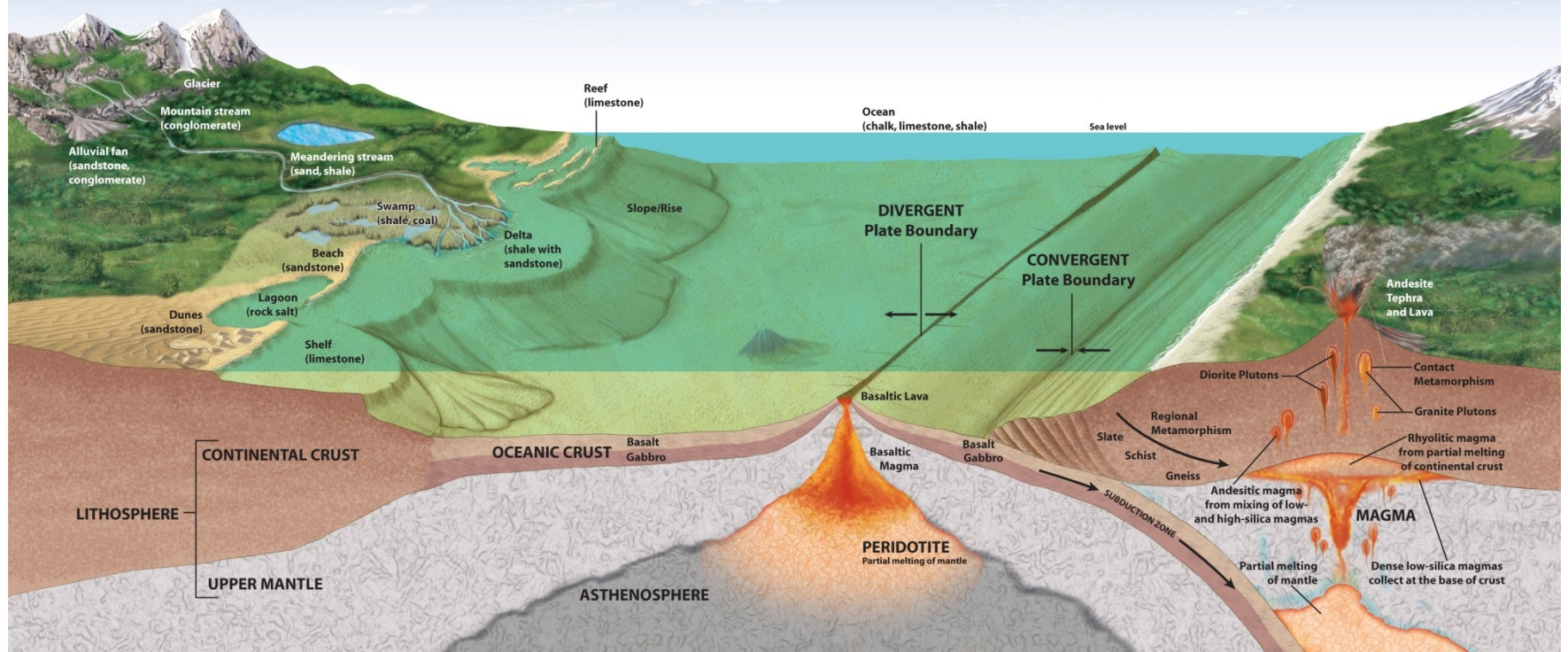
- A Solar energy causes evaporation of seawater → chemical sedimentary rocks
- C Sahara Dust carried by wind to Atlantic ocean
- D Evaporation of sea water → chemical sedimentary rock in Geosphere
- F Marine organisms extract calcium carbonate from the ocean
- H Formation of biochemical sedimentary rocks, (coal)
- I Wind deposits sediment when its velocity decreases
- K Weathering dissolves some elements in water
- L Formation of chemical sedimentary rock
- M Plants that form coal extract carbon in atmosphere
- N Burning fossil fuels releases carbon to atmosphere



Metamorphic Rocks

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ORIGIN OF ROCKS



Metamorphic Rocks

Metamorphism

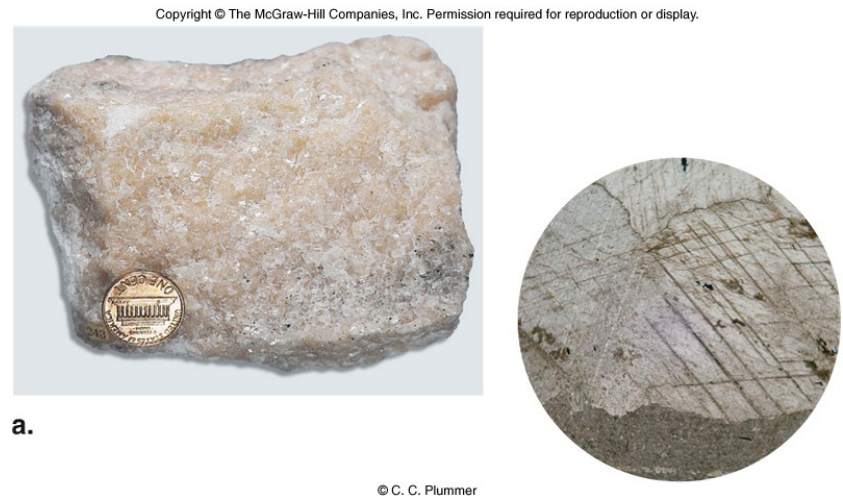
- Changes in mineral composition and texture that can occur in any solid rock
- Changes due to increasing **temperature** and/or **pressure** and/or the **presence of fluids**.
 - Temperatures high enough to promote chemical reactions but not high enough to cause melting
 - Approximately 200°C → 1100°C, depending on rock type and conditions
 - Similar temperatures found deep in crust or near magma chambers

Metamorphic Rocks

Two types of metamorphism

1. Contact metamorphism

- Changes due to increases in temperature where rocks come in contact with heat source (e.g. magma chamber)
 - Example: limestone around a magma chamber is baked by the heat to form marble



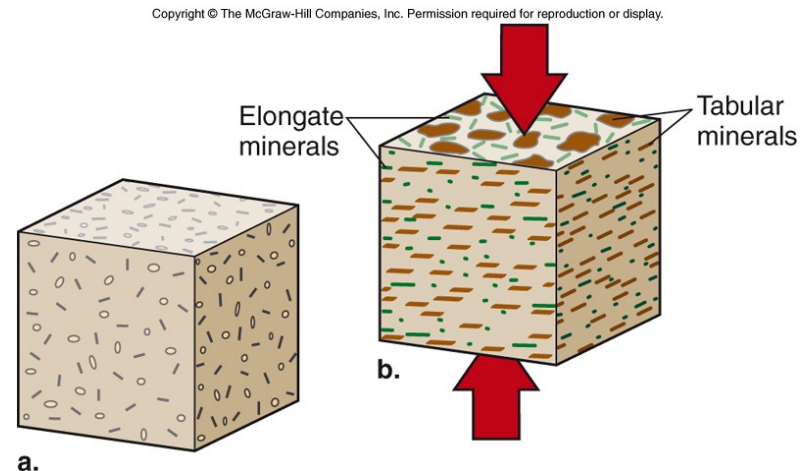
Marble (above) and limestone have similar composition but marble typically has a larger grain size

Metamorphic Rocks

Two types of metamorphism

2. Regional metamorphism

- Increased heat and pressure associated with associated with plate tectonic processes that form mountains
 - Increased pressures and temperatures cause tabular minerals to take on a preferred orientation, **foliation**, perpendicular to direction of pressure



Foliation is produced when tabular minerals grow perpendicular to the direction of pressure.

Metamorphic Rocks

Increased pressures and temperatures cause tabular minerals to take on a preferred orientation, **foliation**, perpendicular to direction of pressure

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a.

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Unmetamorphosed, non-foliated original rock (granite) with random distribution of minerals



Metamorphic rock (gneiss) with foliation illustrates parallel alignment of minerals

C.

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Metamorphic Rocks

Two types of metamorphism

2. Regional metamorphism

- Higher temperatures and pressures yield more intense metamorphism
- Grain size increases with degree of metamorphism (metamorphic grade)
- Rock names vary with grain size

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Table 7.6 Metamorphic Rocks Based on Foliation and Texture (Grain Size)			
Grain size			
Foliation	Fine (< 0.1 mm)	Medium (~0.1–4 mm)*	Coarse (> 2 mm)*
No	Hornfels	Marble, quartzite	Marble, quartzite
Yes	Slate, phyllite	Schist	Gneiss

* Approximate sizes for comparison purposes only.

Rocks and Minerals Concepttest

The conversion from bread to toast can be seen as an analog for the formation of a metamorphic rock by:

A. Contact metamorphism

B. Regional metamorphism

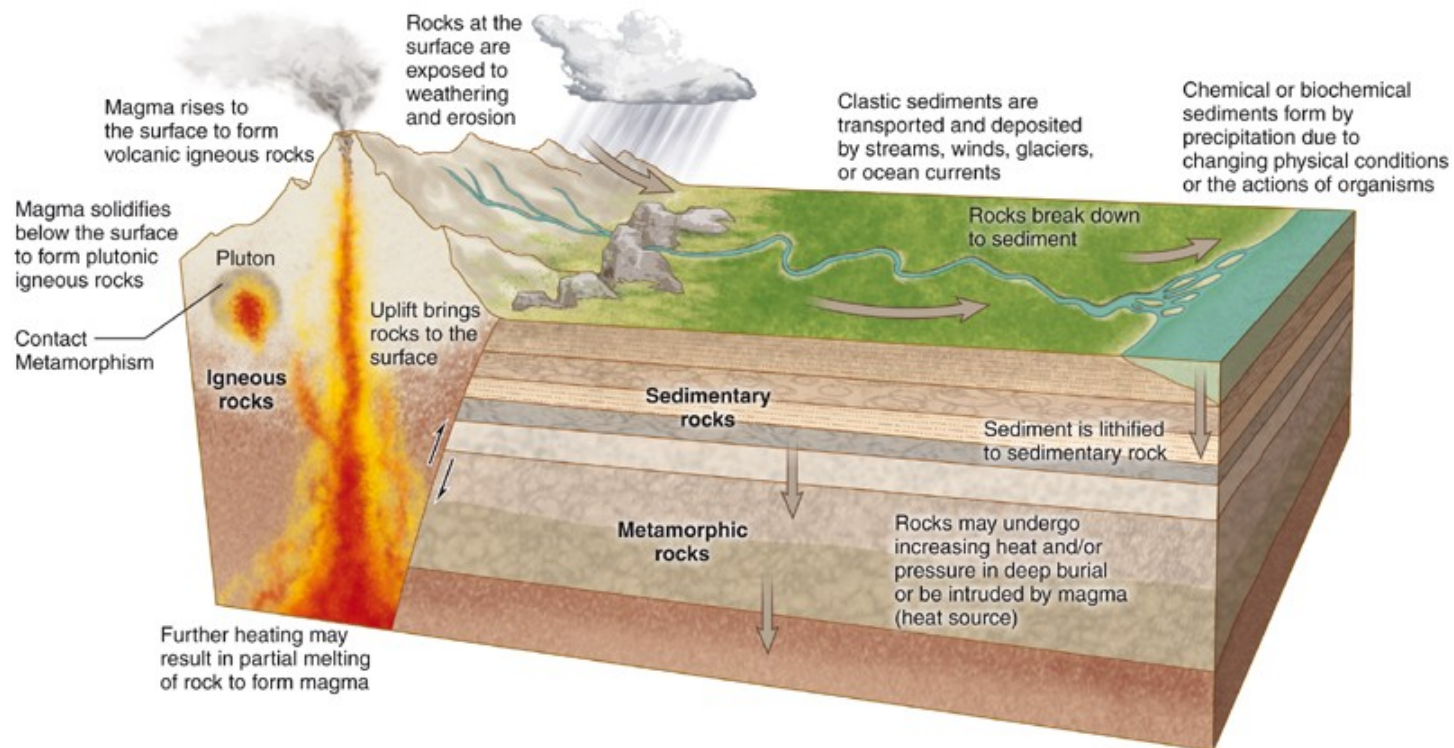
Contact vs. Regional Metamorphism

Characteristic	Rocks formed by	
	Contact metamorphism	Regional metamorphism
Form at temperatures above 200°C	X	X
May originally have been an igneous rock	X	X
Form as a result of increasing pressures		X
May surround plutonic igneous rocks	X	
Slate is an example		X
Form as a result of melting		
May underlie several adjacent states		X
Found in mountain belts	X	X
May originally have been a sedimentary rock	X	X
May contain a foliation		X
Marble is a possible example	X	X
Form on Earth's surface	X	
Limestone is an example		
May have originally been a metamorphic rock	X	X

The Rock Cycle and Mineral Resources

- Rock cycle links igneous, sedimentary, and metamorphic rocks together.
 - Any rock can become any other rock under the appropriate conditions.

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Rocks and Minerals Concepttest

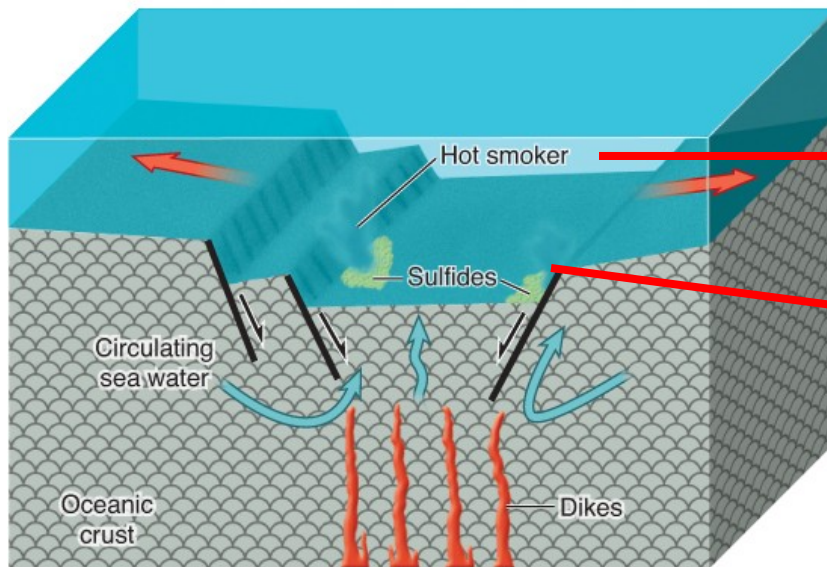
Cooking an egg could be seen as an analog for the formation of :

- A. Igneous rock.
- B. Sedimentary rock.
- C. Metamorphic rock.**

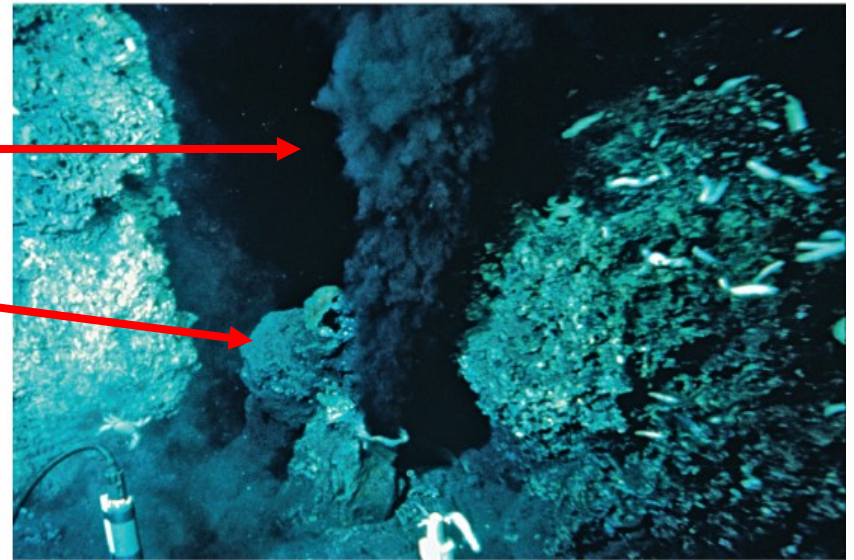
Mineral Resources

- Mineral resources result from specific geologic processes associated with formation of rocks.
 - Can result from chemical reactions driven by changing temperatures and movement of fluids through rocks.

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a.



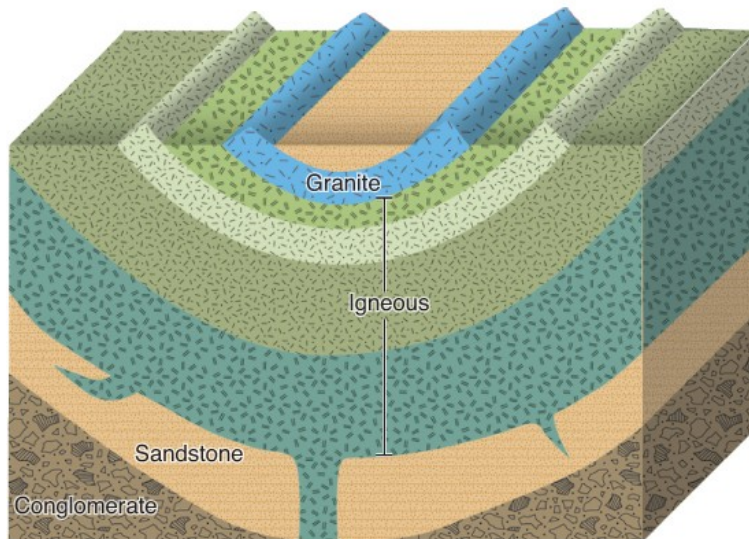
b.

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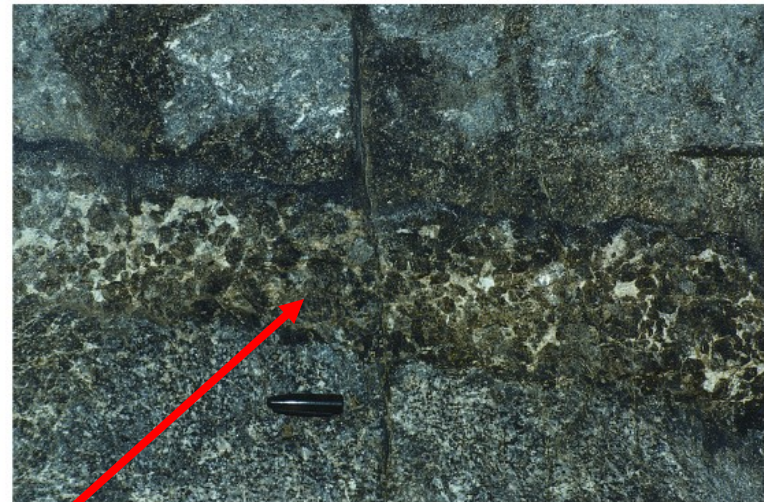
Mineral Resources

- Mineral resources result from specific geologic processes associated with formation of rocks.
 - Can result when minerals crystallize at different temperatures.

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a.



b.

© Stephen Reynolds

platinum

Rocks and Minerals Concept Map

Interactions between the earth system and rocks and minerals.

Some choices (Think of others):

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- C Sahara Dust carried by wind to Atlantic ocean
- D Evaporation of sea water → chemical sedimentary rock in Geosphere
- F Marine organisms extract calcium carbonate from the ocean
- H Formation of biochemical sedimentary rocks, (coal)
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- M Plants that form coal extract carbon in atmosphere
- N Burning fossil fuels releases carbon to atmosphere

