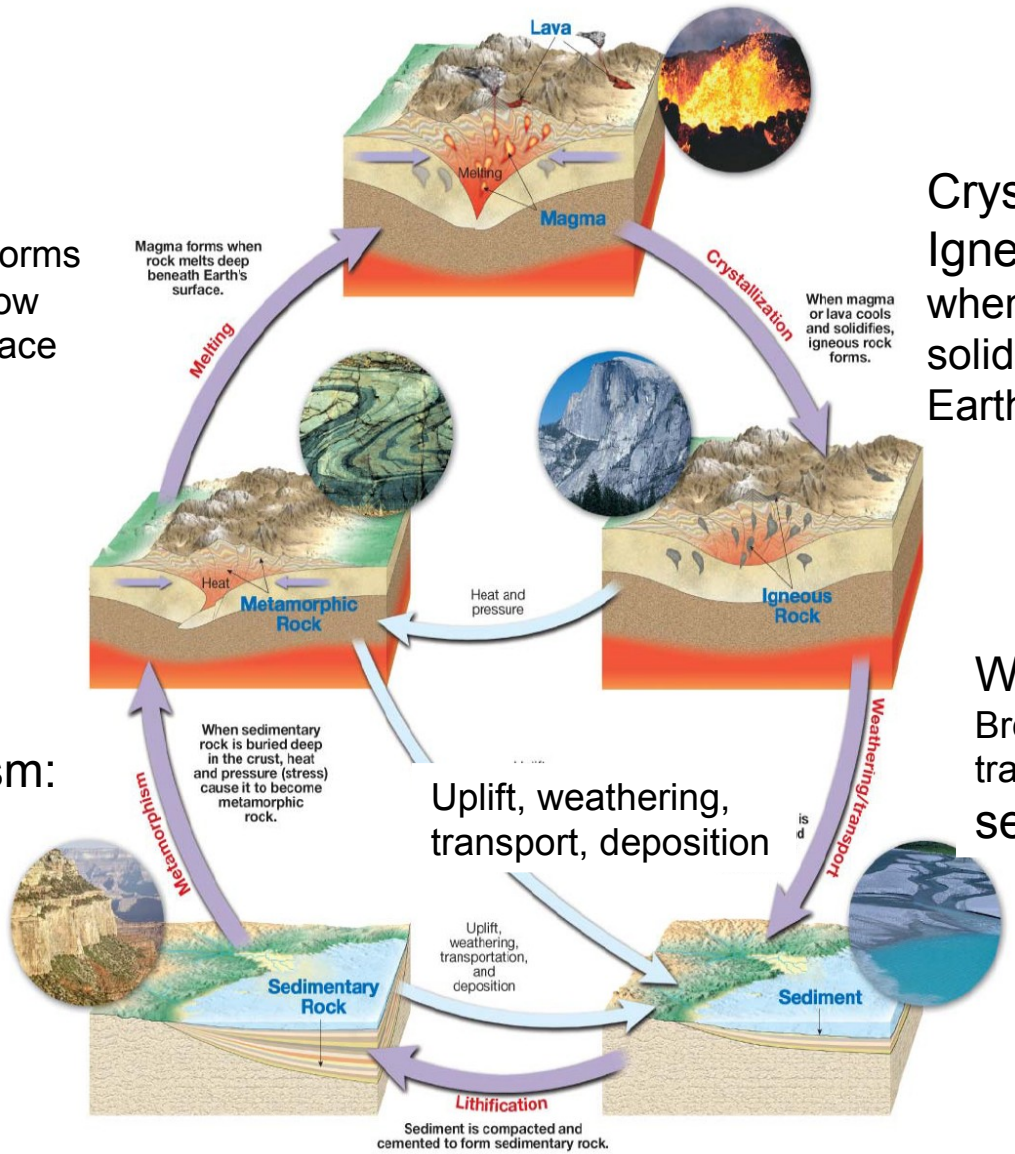
Chapter 7: Rocks and Minerals

1. Igneous Rocks
2. Sedimentary Rocks
3. Metamorphic Rocks
4. The Rock Cycle and Mineral Resources

Rock Cycle

Melting: forms magma below Earth's surface

Crystallization: Igneous rock forms when magma solidifies on or below Earth's surface

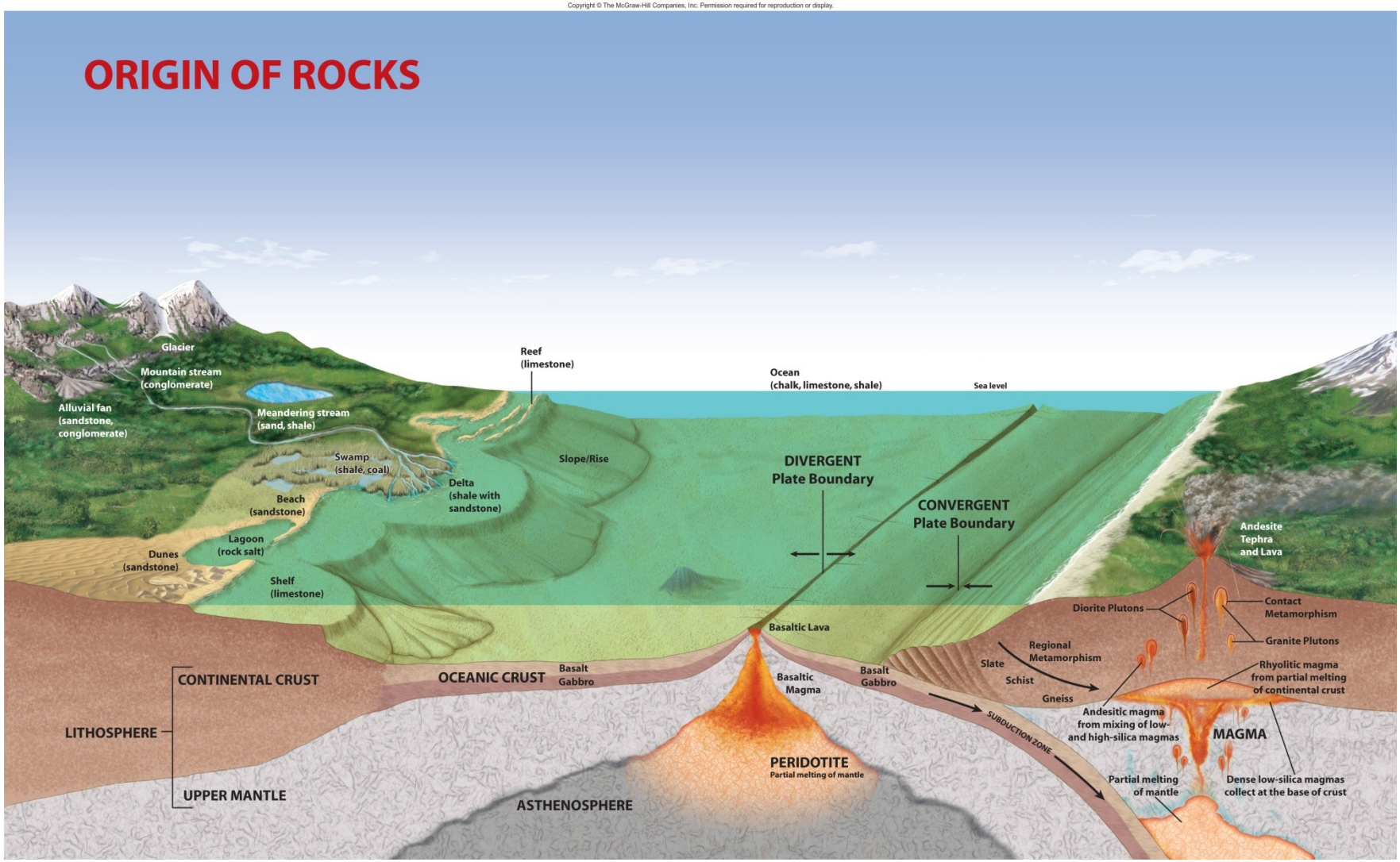


Metamorphism: Heat & Pressure

Weathering: Breaks down into transported sediment

Lithification: Compaction into Sedimentary Rock

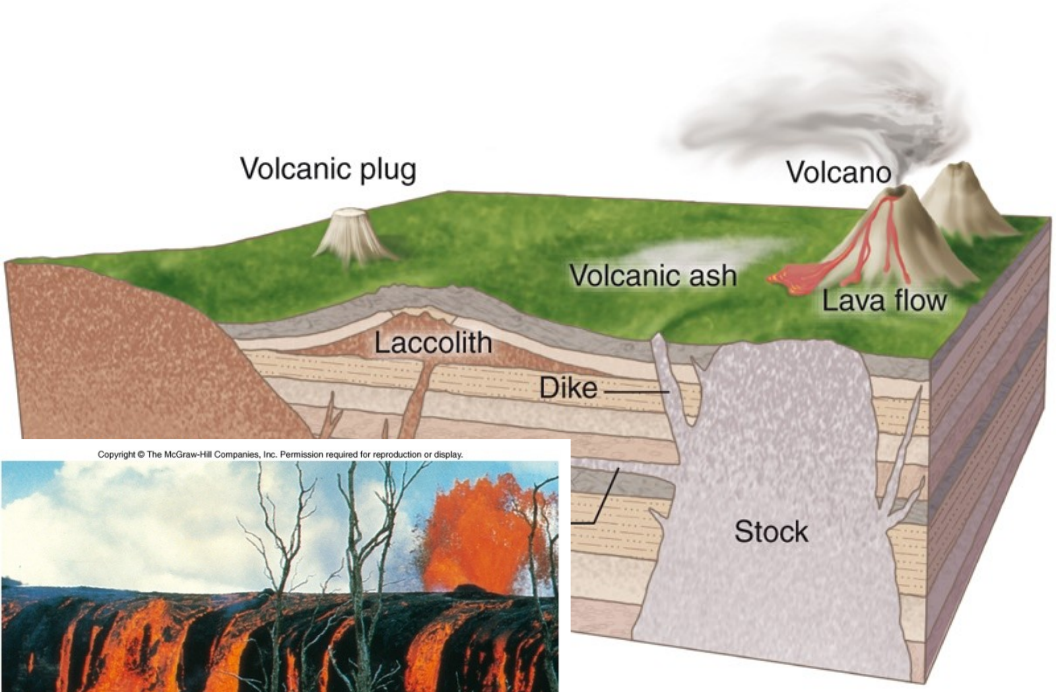
Igneous Rocks



Igneous Rocks

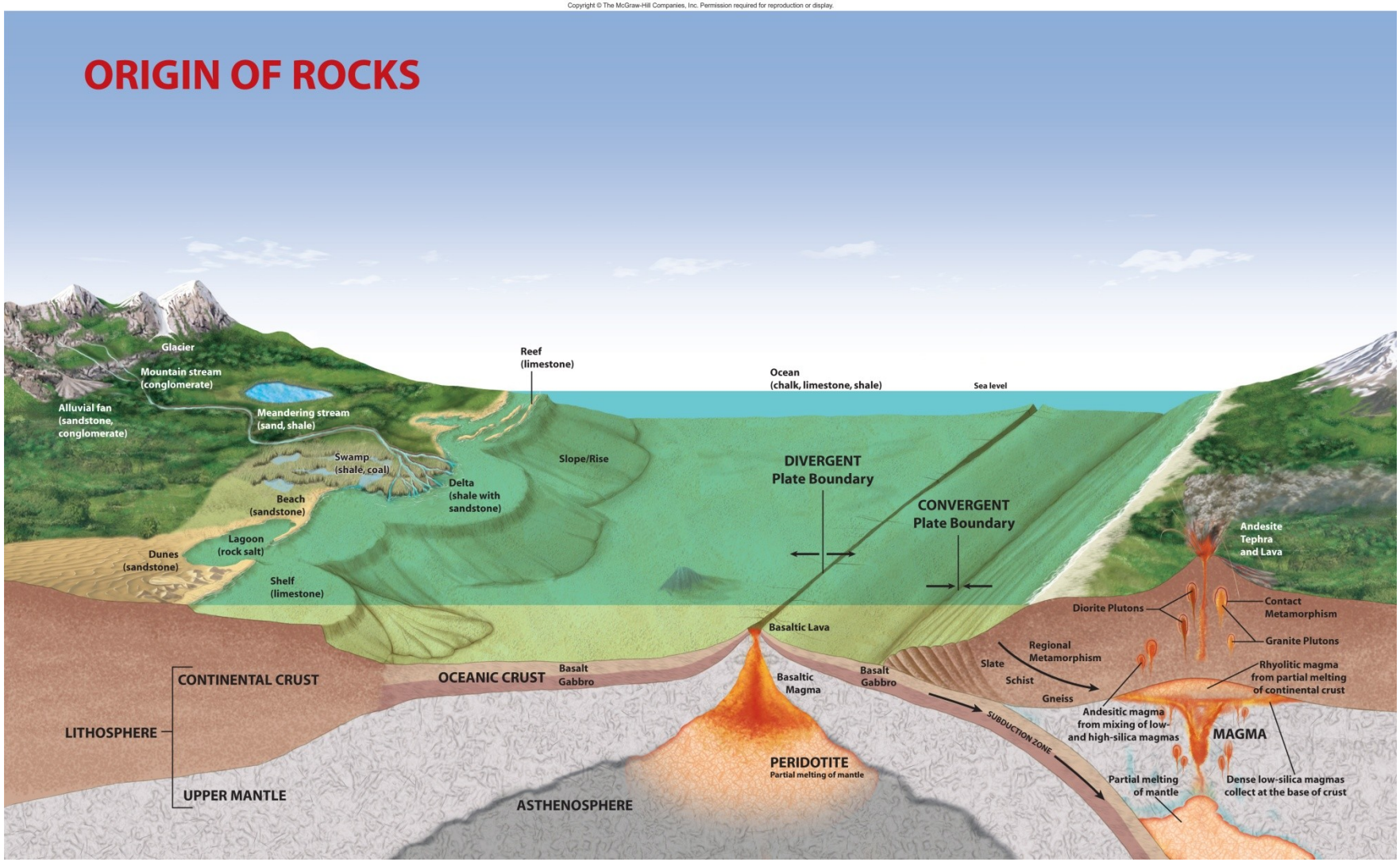
Two types of igneous rocks are classified based on texture and composition

The same magma can form both rock types

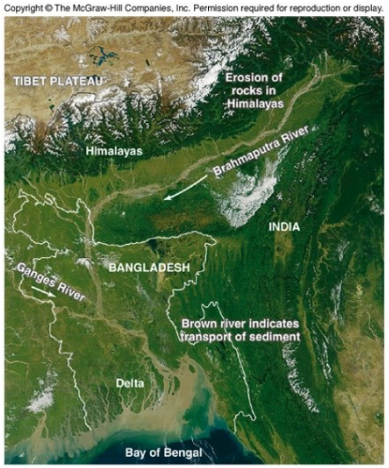


1. **Volcanic rocks** – form when magma rises to Earth's surface
   - Produces volcanoes, lava flows, tephra
   - Molten rock cools rapidly on surface,
2. **Plutonic rocks** – form when magma solidifies below Earth's surface
   - Produces **plutons** that remain hidden until exposed by erosion
   - Molten rock cools slowly

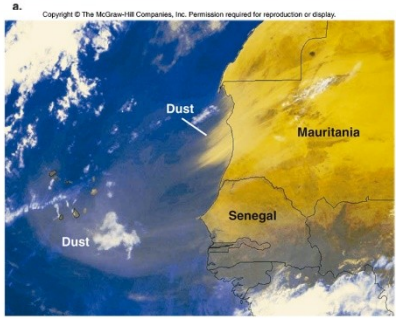
Sedimentary Rocks



Sedimentary Rocks



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



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

Sediments of different grain size

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)

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

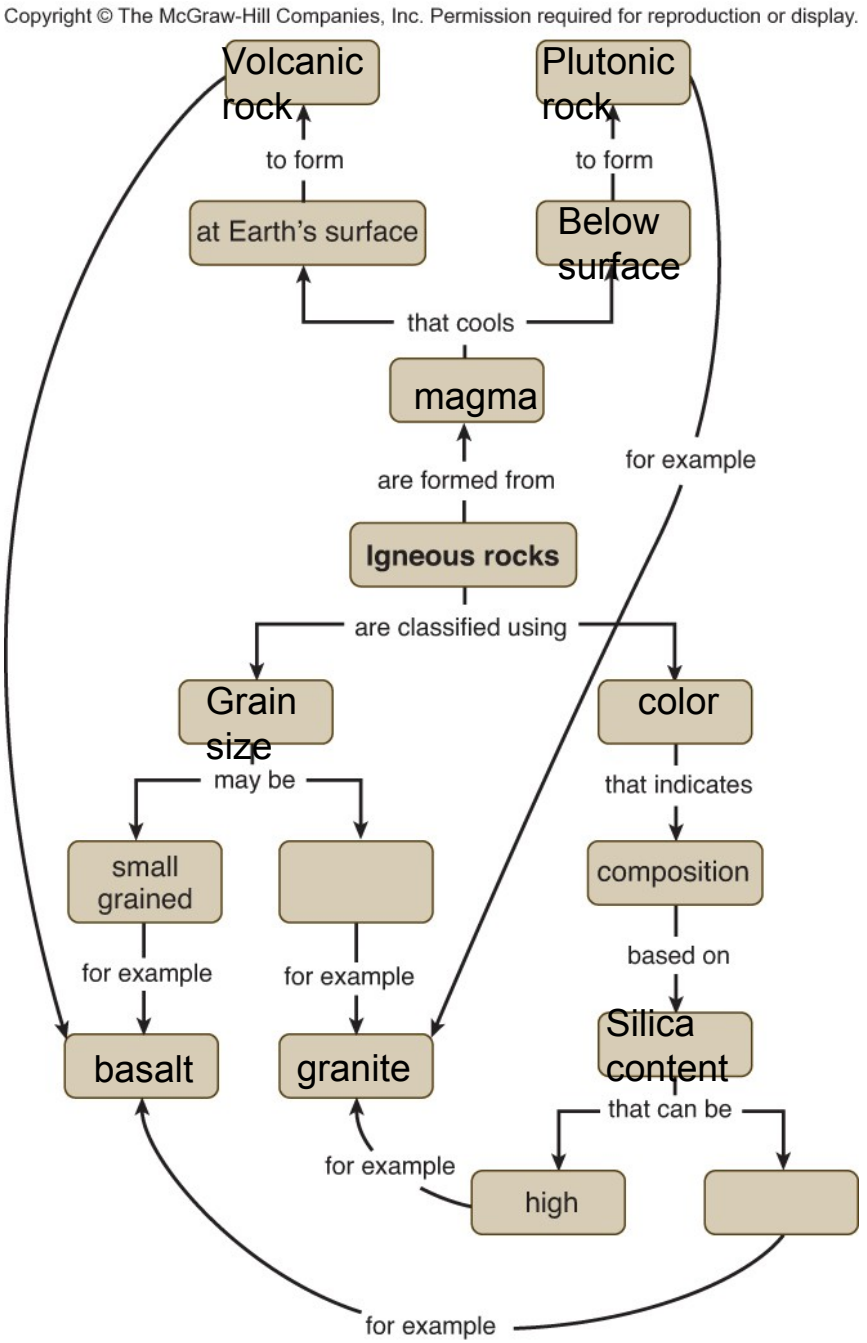
a.

b.

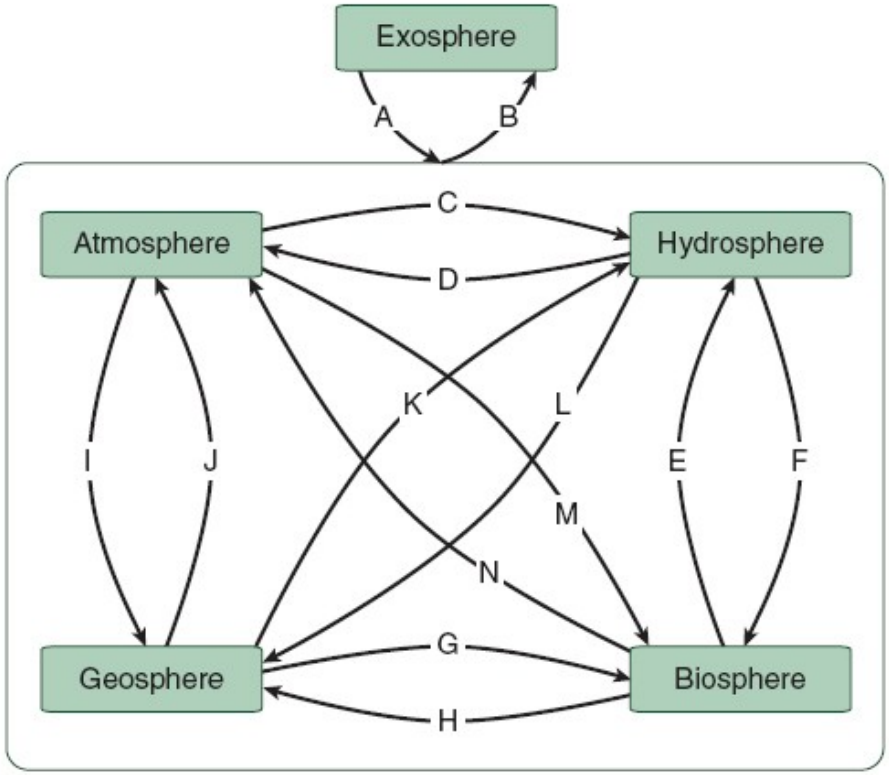
- BIOCHEMICAL:
- Link the biosphere and geosphere
- Form due to actions of living organisms that extract minerals or from the remains of dead organisms
- Limestone is a CHALK biochemical rock. made from microscopic (clay-sized) coccolithophore organisms
- . Chalk indicates specific marine conditions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

Rocks and Minerals Checkpoint 7.12

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



Rocks and Minerals Concept Map

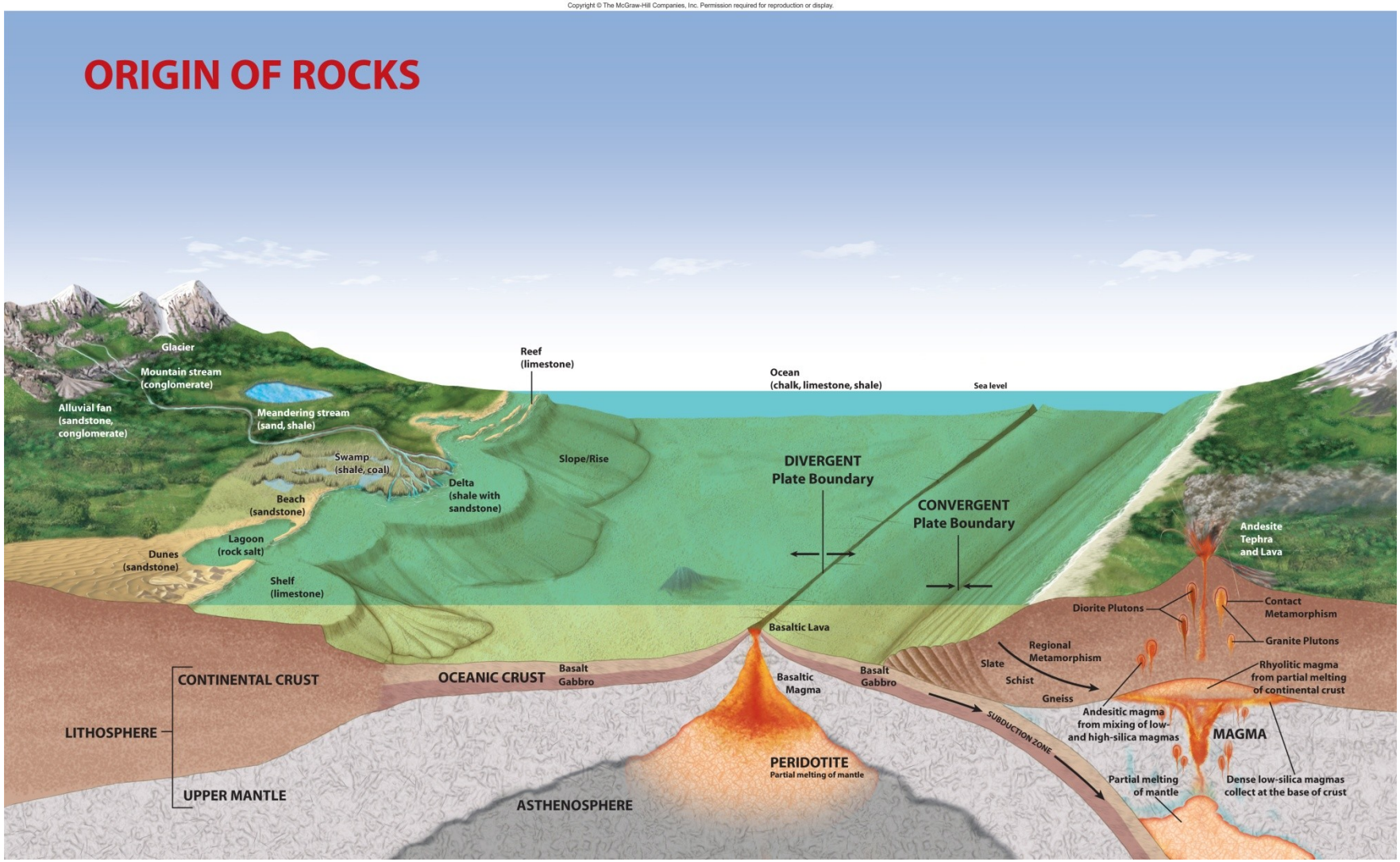


Interactions between the earth system and rocks and minerals.

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



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

a.

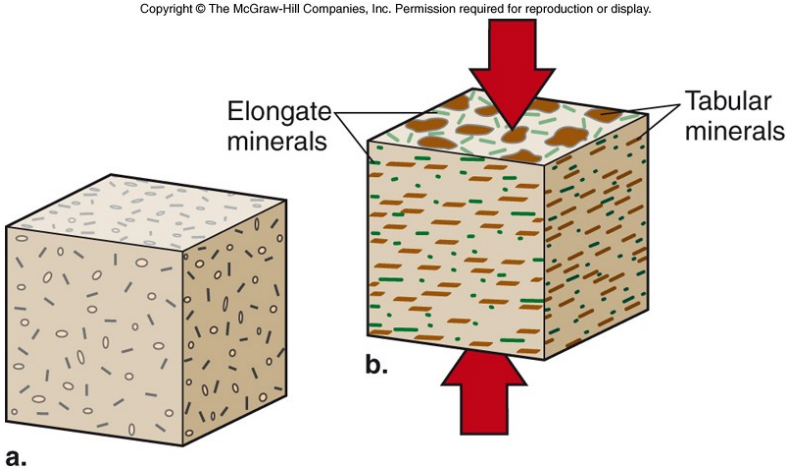
Marble (above) and limestone have similar composition but marble typically has a larger grain size

Metamorphic Rocks

Two types of **metamorphism**

2. Regional metamorphism

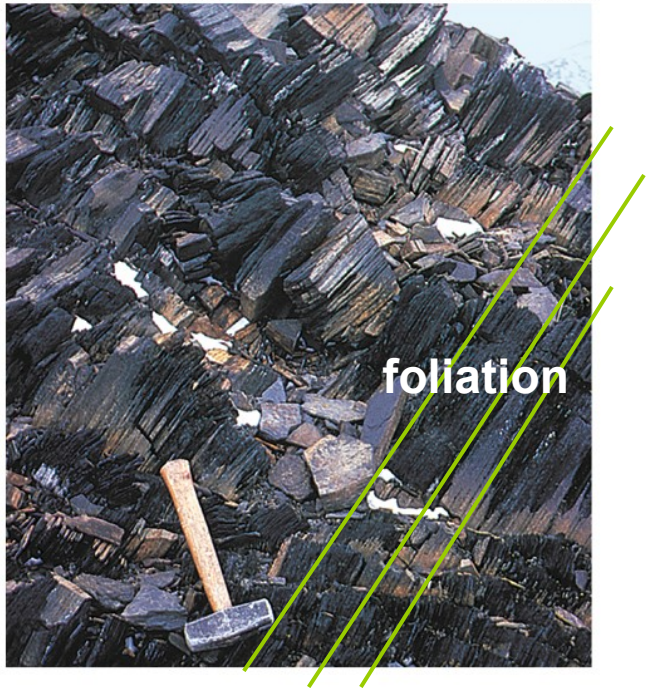
- Increased heat and pressure associated with associated with plate tectonic processes that form mountains
  - Increased pressures and temperatures cause tabular minerals to take on a preferred orientation, **foliation**, perpendicular to direction of pressure



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



a.

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

c.

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

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

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 Conceptest

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

A. **Contact metamorphism**

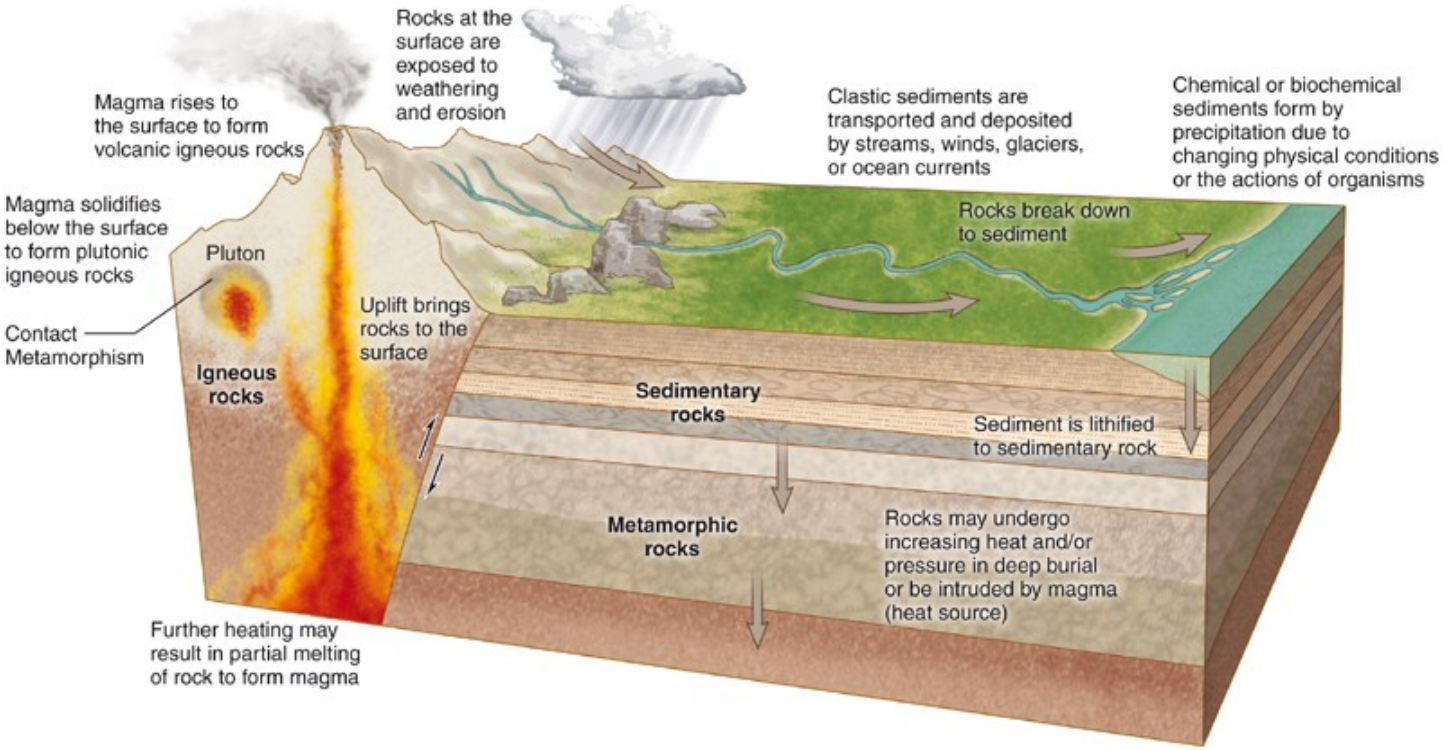
B. Regional metamorphism

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.



Rocks and Minerals Conceptest

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

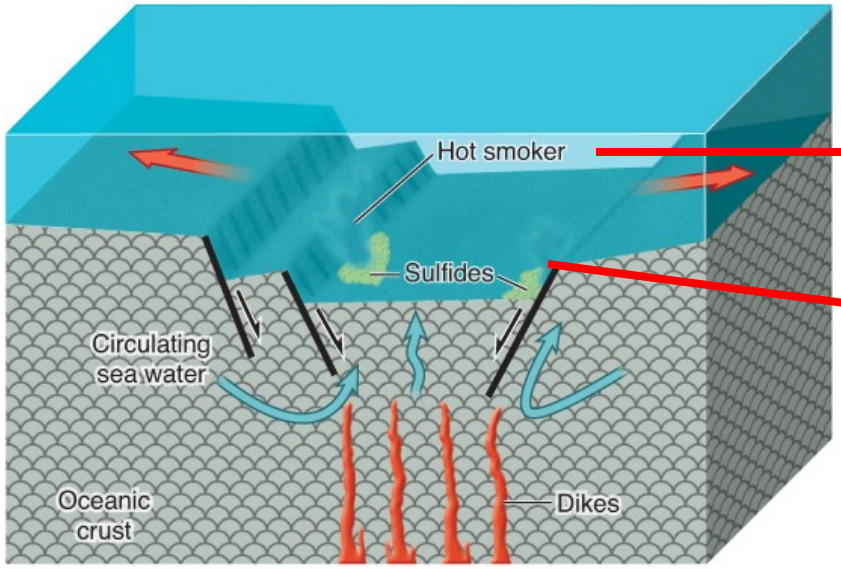
A. Igneous rock.

B. Sedimentary rock.

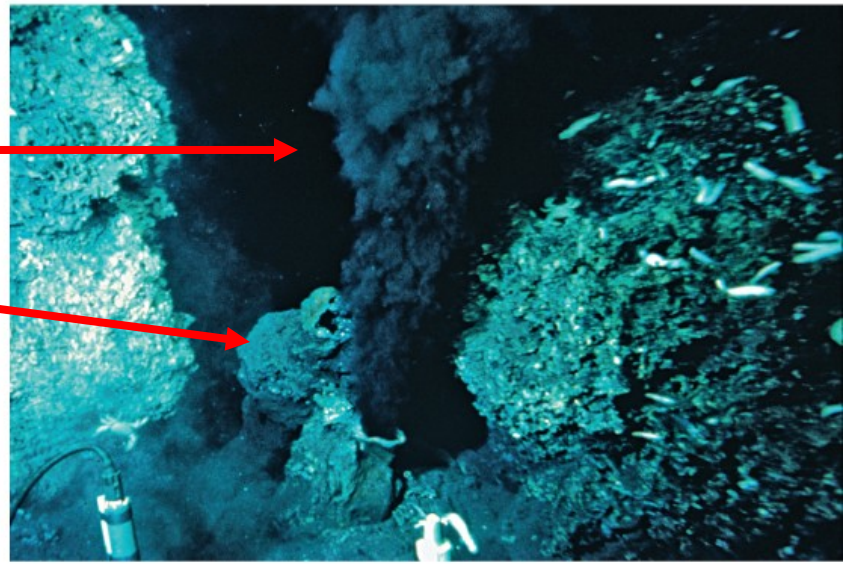
C. **Metamorphic rock.**

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.



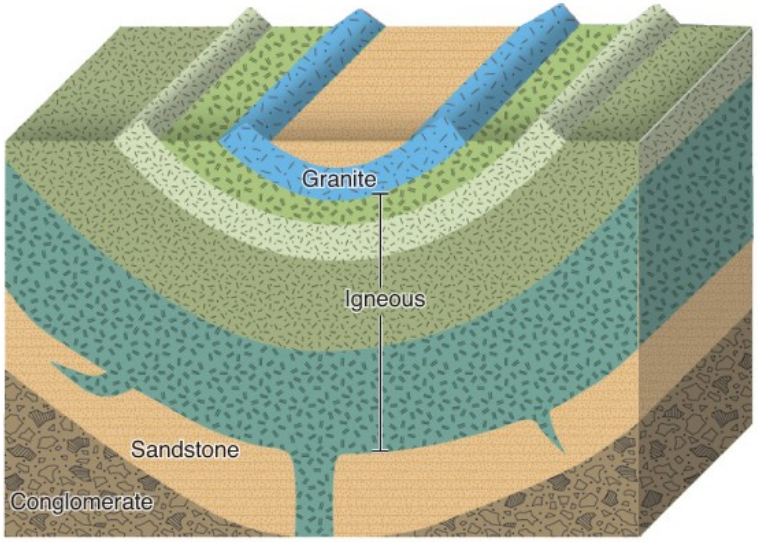
a.



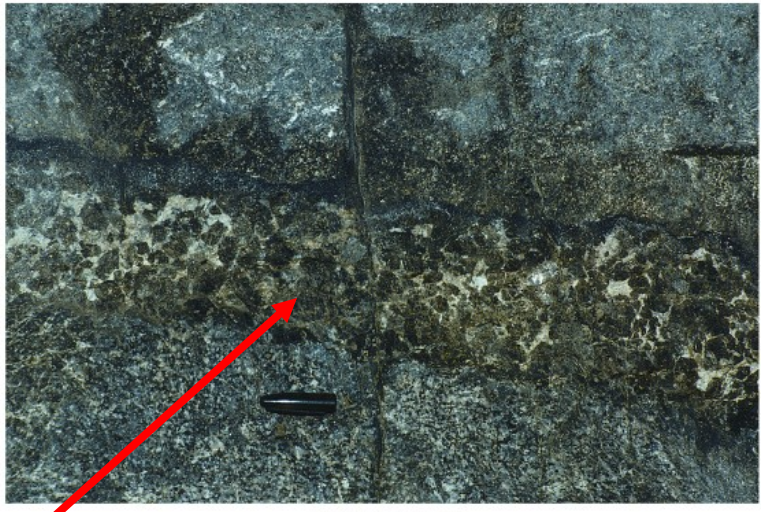
b. © W. R. Normak/USGS

Mineral Resources

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



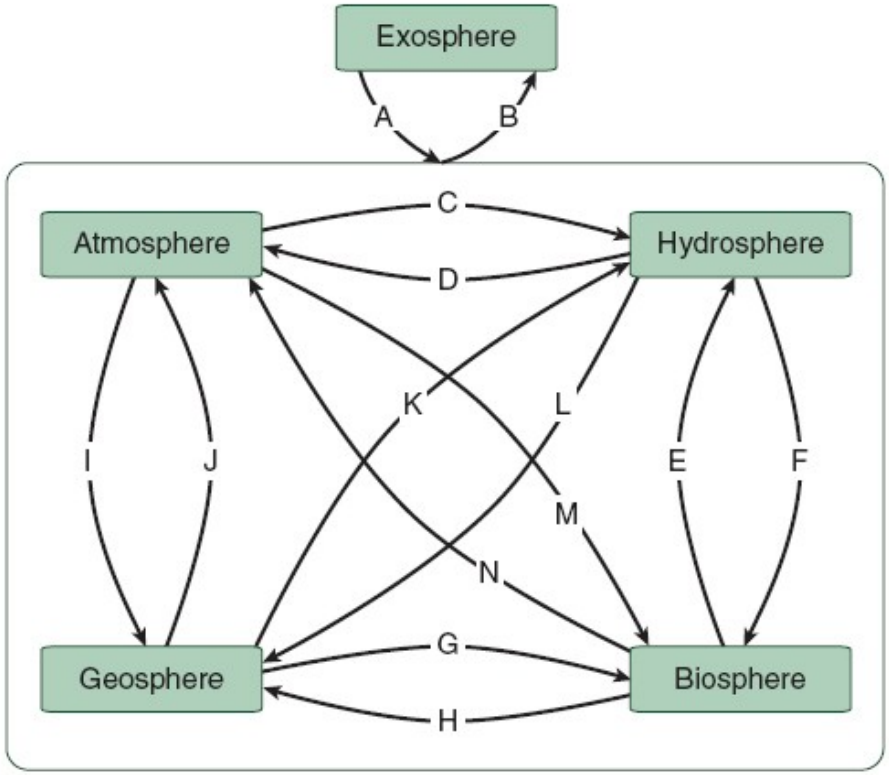
a.



b.

platinum

Rocks and Minerals Concept Map



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