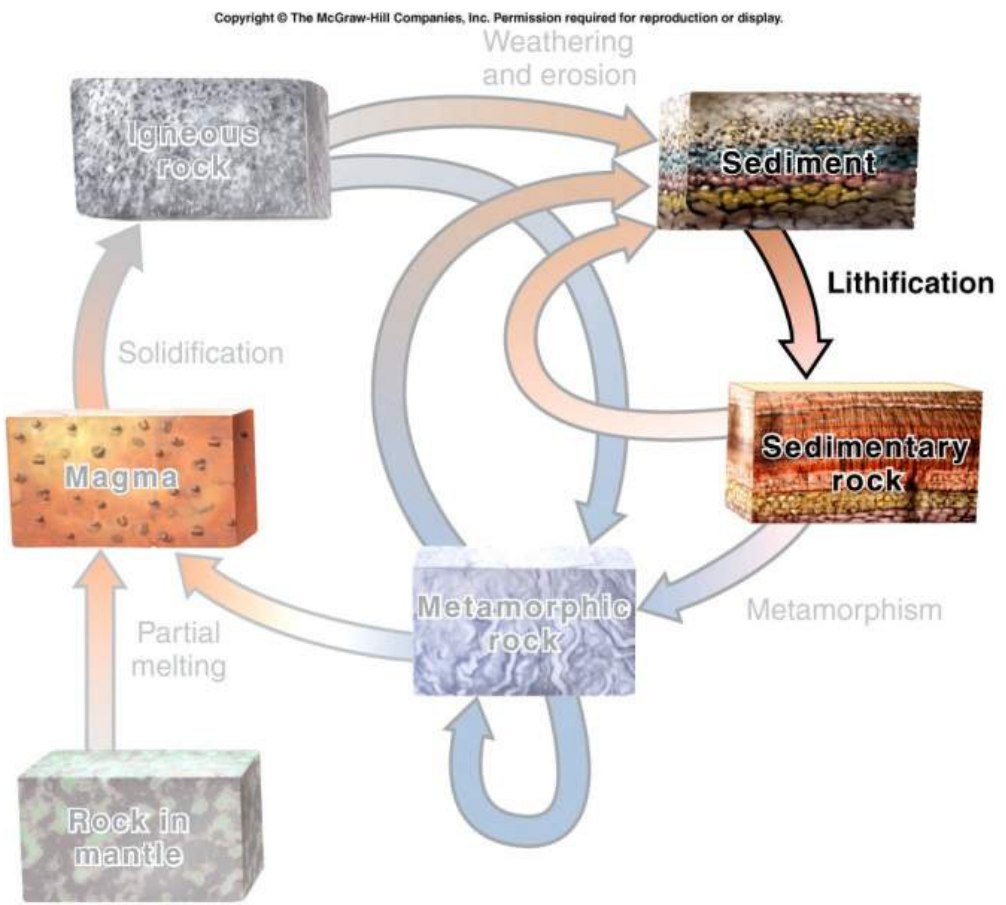
Sediment and sedimentary rocks

- *Sediment*
- From sediments to sedimentary rocks (transportation, deposition, preservation and lithification)
- Types of sedimentary rocks (clastic, chemical and organic)
- Sedimentary structures (bedding, cross-bedding, graded bedding, mud cracks, ripple marks)
- Interpretation of sedimentary rocks

Sediment

- *Sediment* - loose, solid particles originating from:
  - Weathering and erosion of pre-existing rocks
  - Chemical precipitation from solution, including secretion by organisms in water



Relationship to Earth's Systems

- *Atmosphere*
  - Most sediments produced by weathering in **air**
  - Sand and dust transported by **wind**
- *Hydrosphere*
  - **Water** is a primary agent in sediment production, transportation, deposition, cementation, and formation of sedimentary rocks
- *Biosphere*
  - **Oil**, the product of partial decay of **organic materials**, is found in sedimentary rocks

Sediment

- Classified by *particle size*
  - Boulder - >256 mm
  - Cobble - 64 to 256 mm
  - Pebble - 2 to 64 mm
  - Sand - 1/16 to 2 mm
  - Silt - 1/256 to 1/16 mm
  - Clay - <1/256 mm

Table 6.1

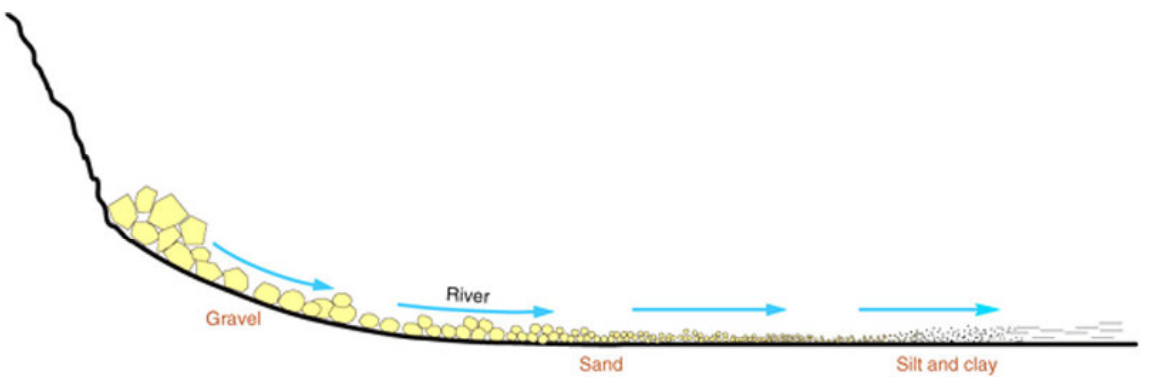
Sediment Particles and Clastic Sedimentary Rocks

Diameter (mm)	Sediment		Sedimentary Rock
256	Boulder	Gravel	**Breccia** (angular particles) or **conglomerate** (rounded particles)
64	Cobble		
2	Pebble		
1/16	Sand		**Sandstone**
1/256	Silt	"Mud"	Siltstone (mostly silt)
	Clay		**Shale** or mudstone (mostly clay)

Sandstone and shale are quite common; the others are relatively rare.

From Sediment to Sedimentary Rock

- *Transportation*
  - Movement of sediment away from its source, typically by water, wind, or ice
  - *Rounding* of particles occurs due to abrasion during transport
  - *Sorting* occurs as sediment is separated according to grain size by transport agents, especially running water
  - Sediment size decreases with increased transport distance

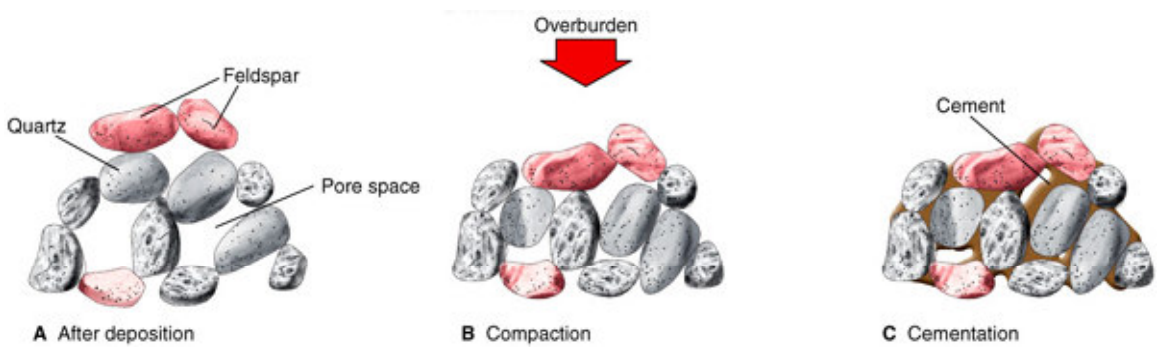


From Sediment to Sedimentary Rock

- *Deposition*
  - Settling and coming to rest of transported material
  - Accumulation of chemical or organic sediments, typically in water
  - *Environment of deposition* is the location in which deposition occurs
    - Deep sea floor
    - Beach
    - Desert dunes
    - River channel
    - Lake bottom

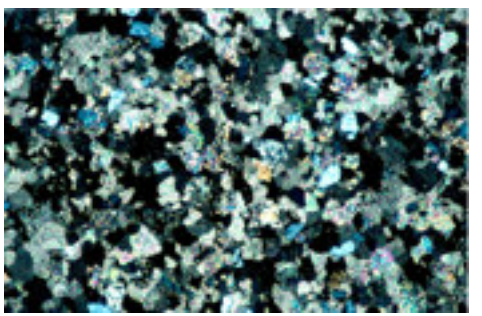
From Sediment to Sedimentary Rock

- *Preservation*
  - Sediment must be preserved, as by burial with additional sediments, in order to become a sedimentary rock
- *Lithification*
  - General term for processes converting loose sediment into sedimentary rock
  - Combination of *compaction* and *cementation*



Types of Sedimentary Rocks

- *Clastic sedimentary rocks*
  - Most common sedimentary rock type
  - Form from cemented sediment grains that come from pre-existing rocks
- *Chemical sedimentary rocks*
  - Have crystalline textures
  - Form by precipitation of minerals from solution
- *Organic sedimentary rocks*
  - Accumulate from remains of organisms



Clastic Sedimentary Rocks

- *Breccia and Conglomerate*
  - *Coarse-grained clastic* sedimentary rocks
  - Sedimentary **breccia** composed of coarse, *angular rock fragments* cemented together
  - **Conglomerate** composed of *rounded gravel* cemented together

Clastic Sedimentary Rocks

- *Sandstone*
  - *Medium-grained clastic* sedimentary rock
  - Types determined by composition
    - *Quartz sandstone* - >90% quartz grains
    - *Arkose* - mostly feldspar and quartz grains
    - *Graywacke* - sand grains surrounded by dark, fine-grained matrix, often clay-rich

Clastic Sedimentary Rocks

- *Shale*
  - Fine-grained clastic sedimentary rock
  - Splits into thin layers (*fissile*)
  - Silt- and clay-sized grains
  - Sediment deposited in lake bottoms, river deltas, floodplains, and on deep ocean floor

Clastic Sedimentary Rocks

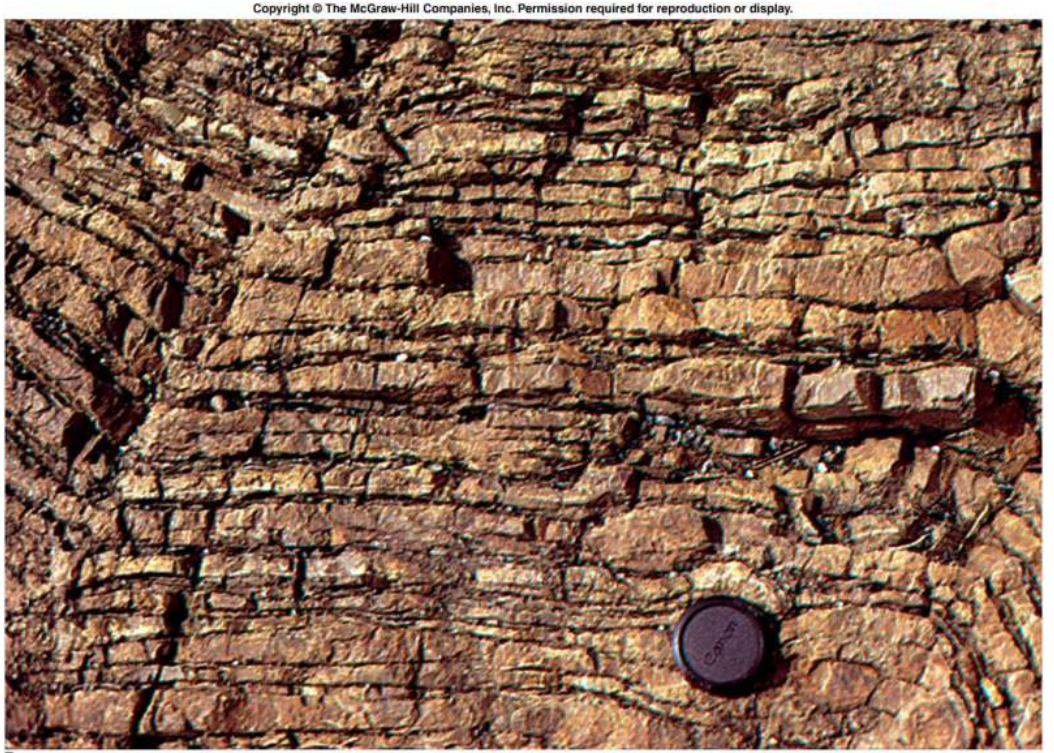
- *Siltstone*
  - Slightly coarser-grained than shales
  - Lacks fissility
- *Claystone*
  - Predominantly clay-sized grains; non-fissile
- *Mudstone*
  - Silt- and clay-sized grains; massive/blocky

Chemical Sedimentary Rocks

- *Carbonates*
  - Contain CO_3 as part of their chemical composition
  - *Limestone* is composed mainly of *calcite*
    - Most are *biochemical*, but can be *inorganic*
    - Often contain easily recognizable fossils
    - Chemical alteration of limestone in Mg-rich water solutions can produce *dolomite*

Chemical Sedimentary Rocks

- *Chert*
  - Hard, compact, fine-grained, formed almost entirely of silica
  - Can occur as layers or as lumpy nodules within other sedimentary rocks, especially limestones



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Chemical Sedimentary Rocks

Evaporites

- Form from evaporating saline waters (lake, ocean)
- Common examples are rock gypsum, rock salt

Organics in Sedimentary Rocks

- *Coal*
  - Sedimentary rock forming from compaction of partially decayed plant material
  - Organic material deposited in water with low oxygen content (i.e., stagnant)
- *Oil and natural gas*
  - Originate from organic matter in marine sediment
  - Subsurface "cooking" can change organic solids to oil and natural gas
  - Can accumulate in porous overlying rocks

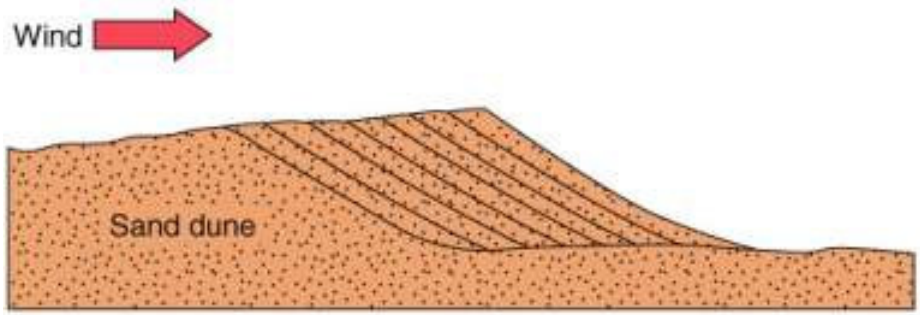
Sedimentary Structures

- *Sedimentary structures*
  - Features within sedimentary rocks produced during or just after sediment deposition
  - Provide clues to how and where deposition of sediments occurred
  - *Bedding*
  - *Cross-bedding*
  - *Graded bedding*
  - *Mud cracks*
  - *Ripple marks*

Sedimentary Structures

- *Bedding*
  - Series of visible layers within a rock
  - Most common sedimentary structure

- *Cross-bedding*
  - Series of thin, inclined layers within a horizontal bed of rock
  - Common in sandstones
  - Indicative of deposition in ripples, bars, dunes, deltas



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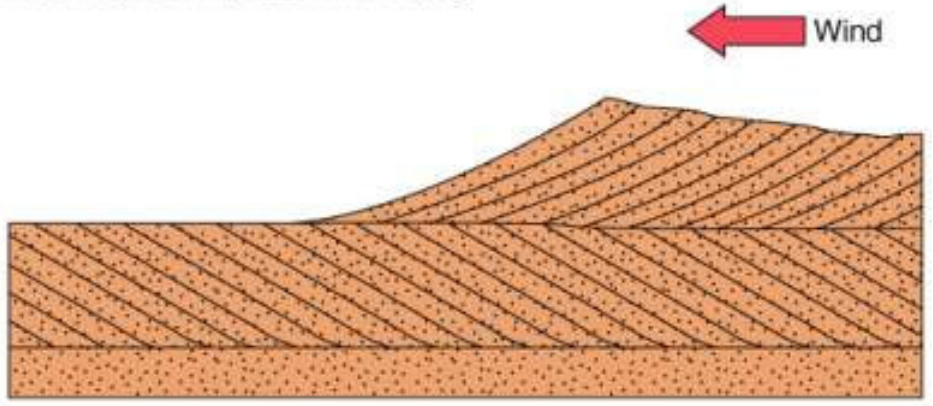

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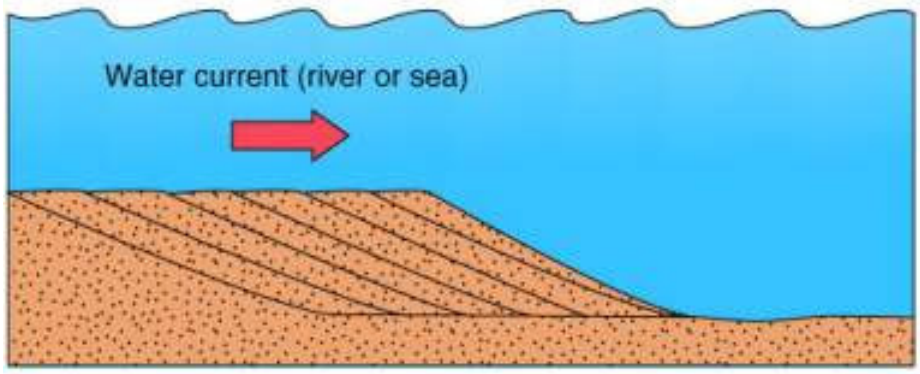

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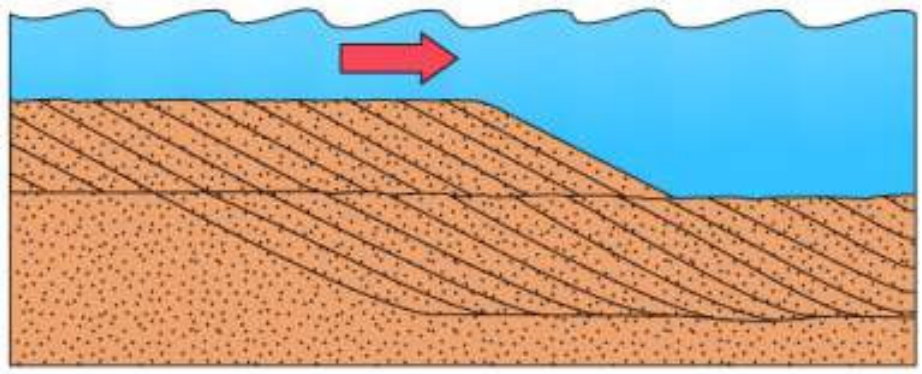


D

Sedimentary Structures

- *Graded bedding*
  - Progressive change in grain size from bottom to top of a bed

- *Mud cracks*
  - Polygonal cracks formed in drying mud

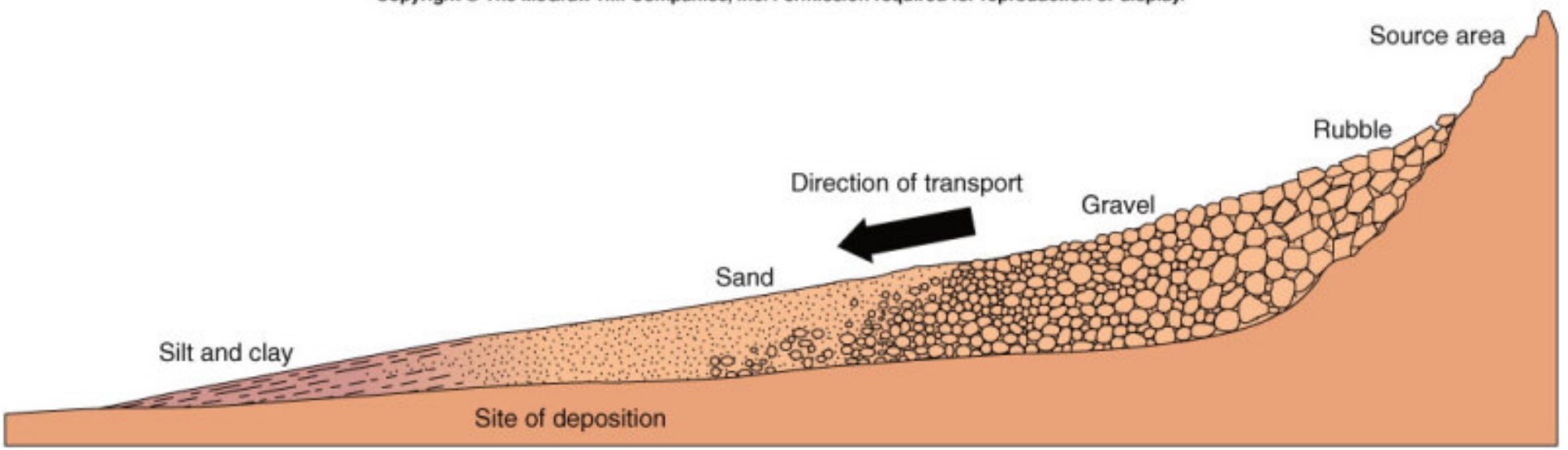
Sedimentary Structures

- *Ripple marks*
  - Small ridges formed on surface of sediment layer by moving wind or water
- *Fossils*
  - Traces of plants or animals preserved in rock
  - Hard parts (shells, bones) more easily preserved as fossils

Sedimentary Rock Interpretation

- Sedimentary rocks give important clues to geologic history of an area
- *Source area*
  - Locality that eroded and provided sediment
  - Sediment composition, shape, size and sorting are indicators of source rock type and relative location

Sedimentary Rock Interpretation



Sediment deposits often become thinner away from the source area, and sediment grains usually become finer and more rounded

Sedimentary Rock Interpretation

- *Depositional environment*
  - Location where sediment came to **rest**
  - Sediment characteristics and sedimentary structures (including fossils) are indicators

Sedimentary Rock Interpretation

- *Depositional environment*
  - Examples: glacial valleys, alluvial fans, river channels and floodplains, lakes, deltas, beaches, dunes, shallow marine, reefs, deep marine

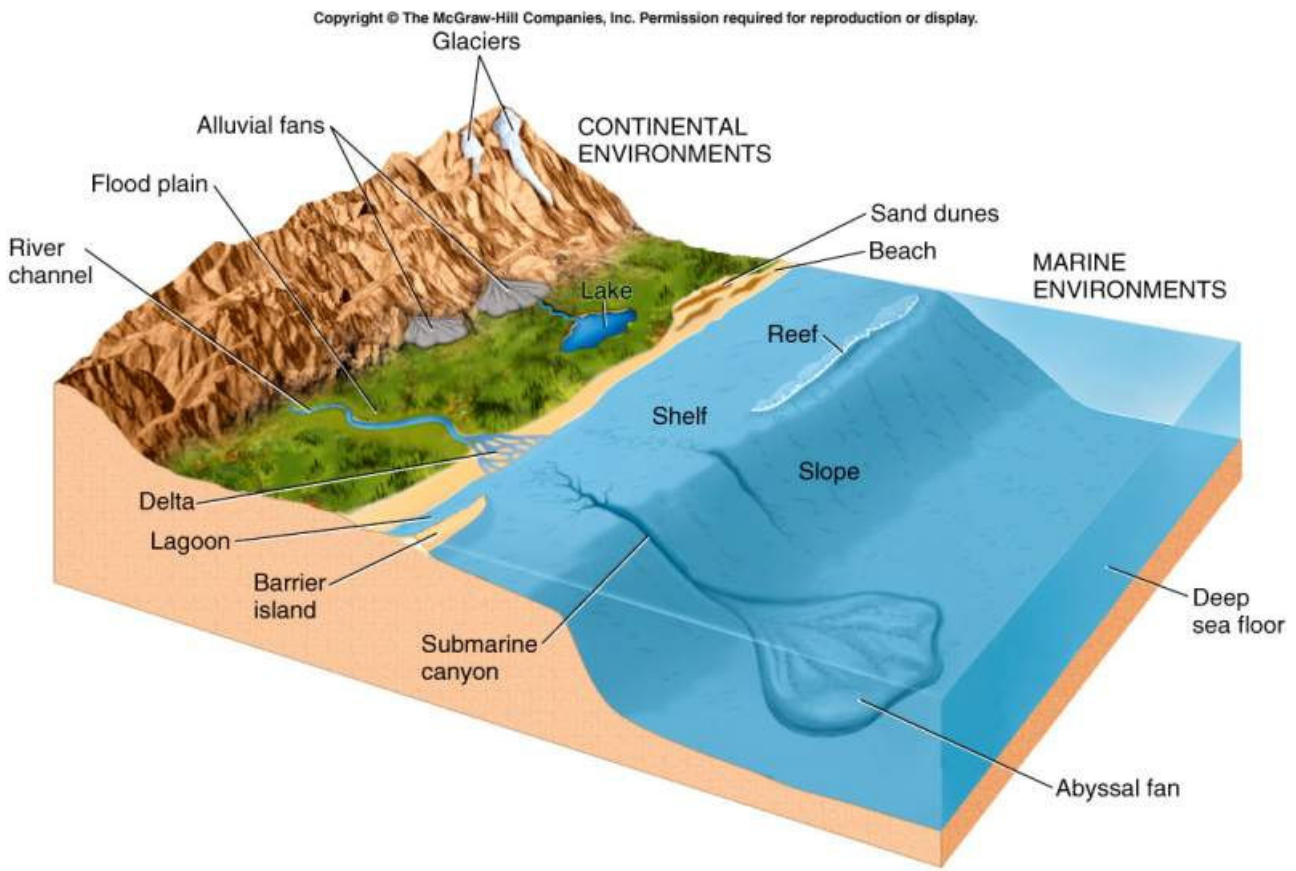


Plate Tectonics and Sedimentary Rocks

- Tectonic setting plays key role in the distribution of sedimentary rocks
- Occurrence of specific sedimentary rock types can be used to reconstruct past plate-tectonic settings
- Erosion rates and depositional characteristics give clues to each type of tectonic plate boundary

Plate Tectonics and Sedimentary Rocks

- Convergent boundary: Rapid erosion: coarse-grained clastic sediments are transported by streams and turbidity currents and are deposited in basins near mountains.

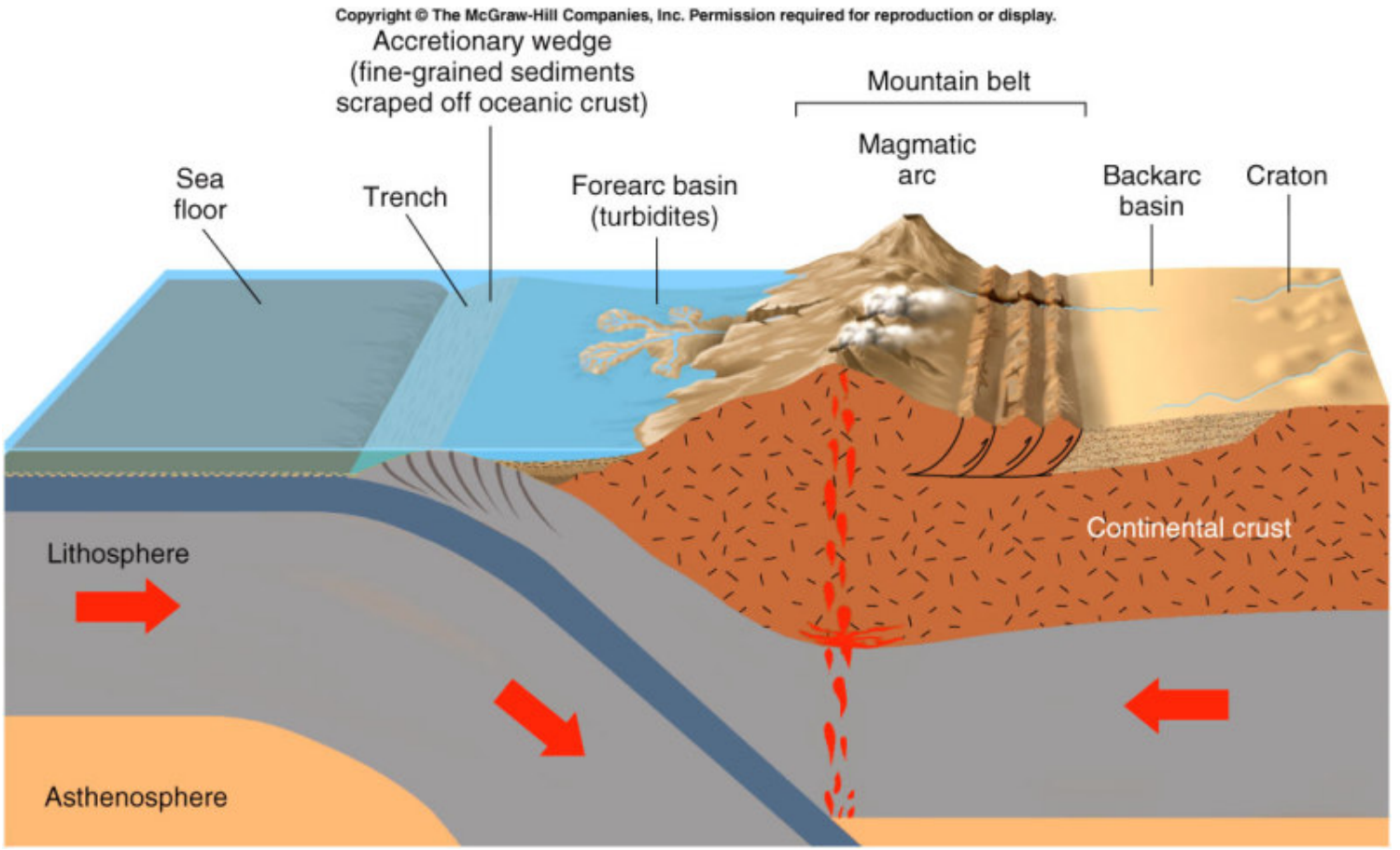
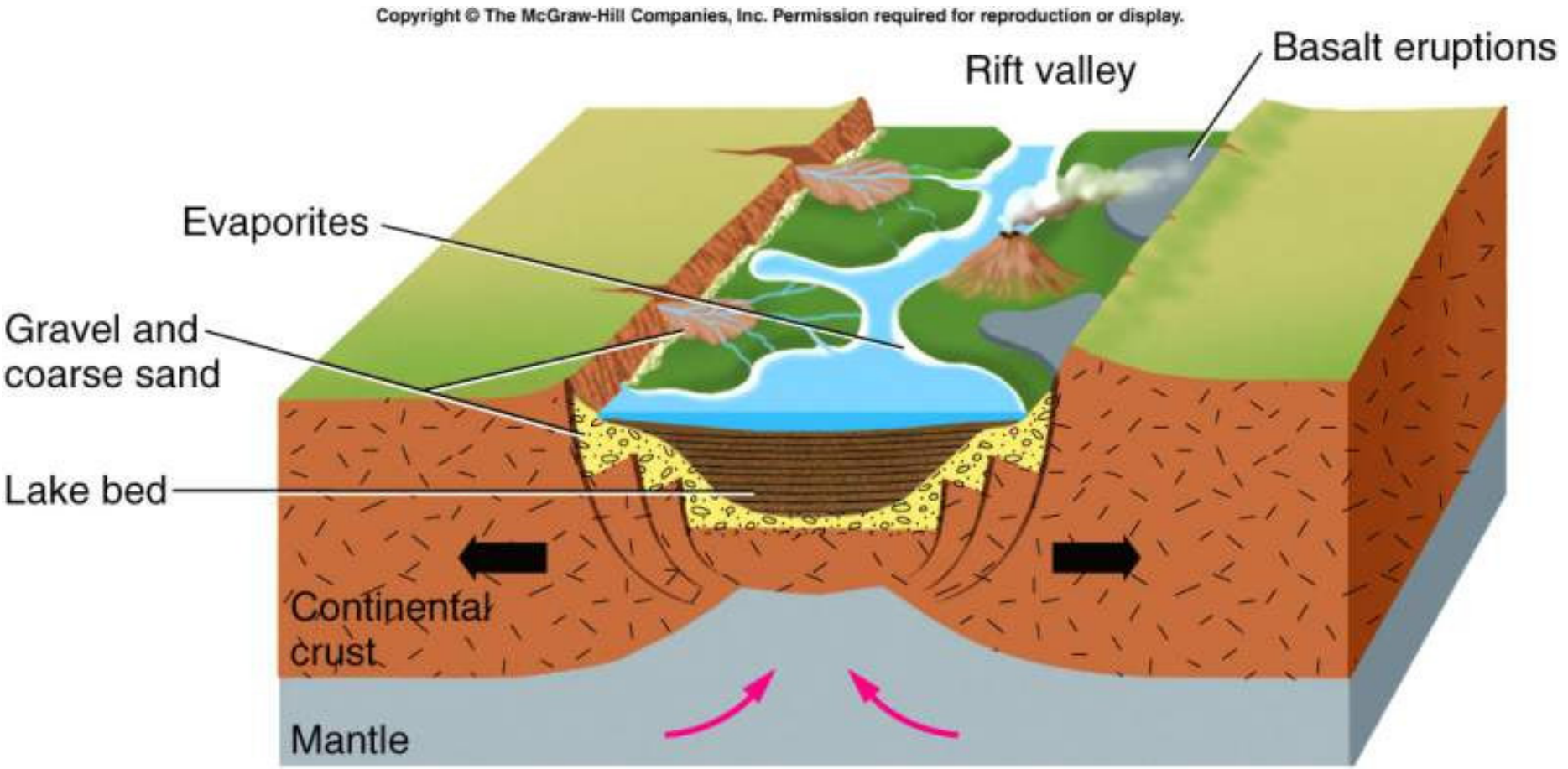


Plate Tectonics and Sedimentary Rocks

- Divergent boundary: thick wedges of gravel and coarse sand along fault-bounded margins of developing rift valley. Lake bed deposits and evaporate rocks are located on the floor of the rift valley.



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