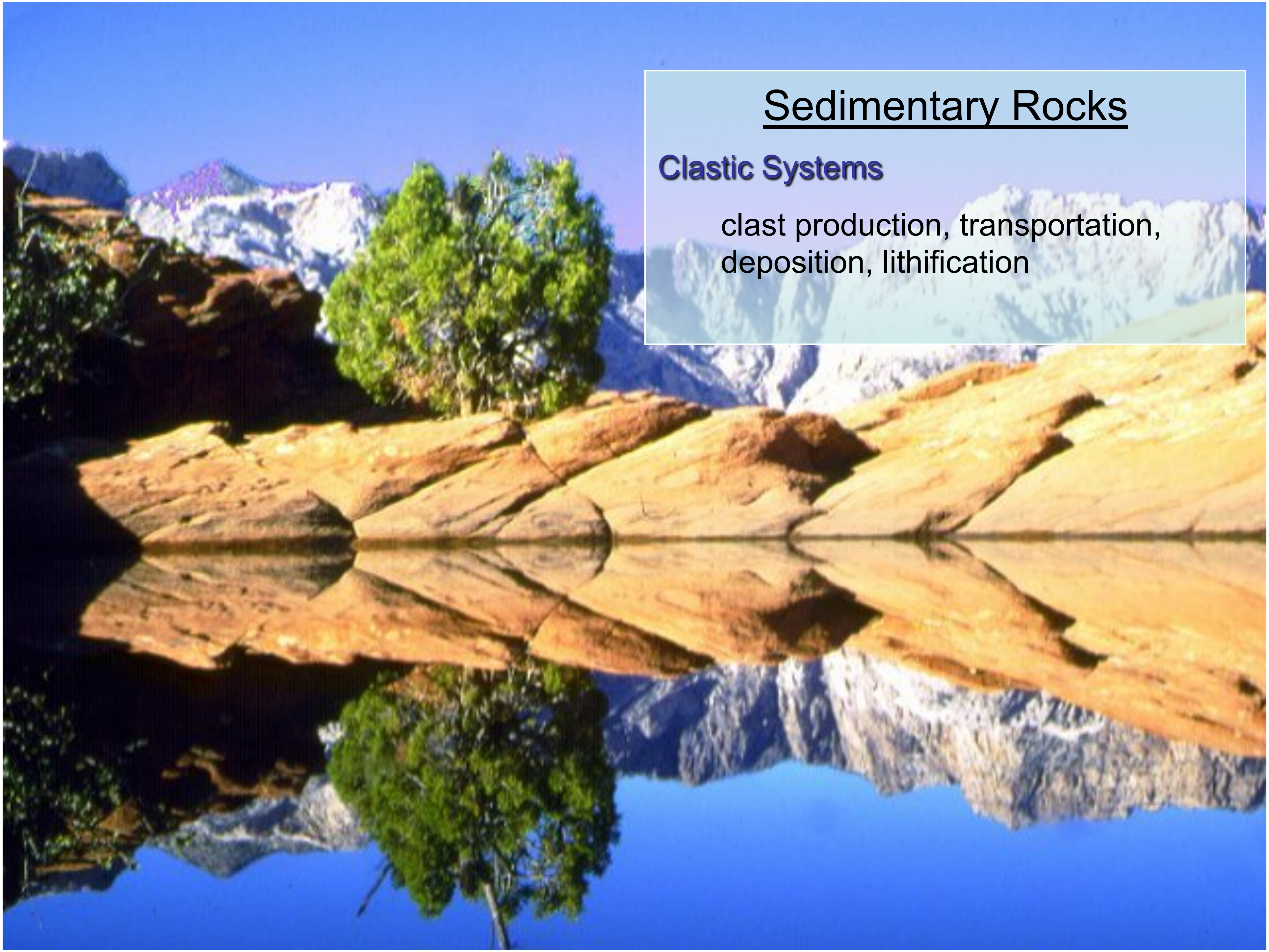
Sedimentary Rocks

Clastic Systems

clast production, transportation, deposition, lithification



Rock Types

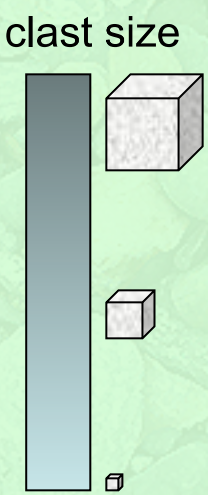
Pressure (relative to surface)	Rock Types	**Temperature** (relative to surface)
varies	**Igneous Rocks** Minerals crystallize from cooling magma originating within Earth	hot enough to melt rock
normal	**Sedimentary Rocks** Formed by processes at or near Earth surface	normal
high	**Metamorphic Rocks** Changes brought about by applying pressure and heat to pre-existing rocks	varies, NOT hot enough to melt rock

Sedimentary Rocks and Processes

Clastic	Non-Clastic
Sediments are derived from fragments of pre-existing rocks (clasts).	*All sedimentary rocks not composed of clasts*
Categorized primarily by clast size	Categorized primarily by composition

Clastic Sedimentary Rocks

e.g., conglomerate, breccia, sandstone, siltstone, shale

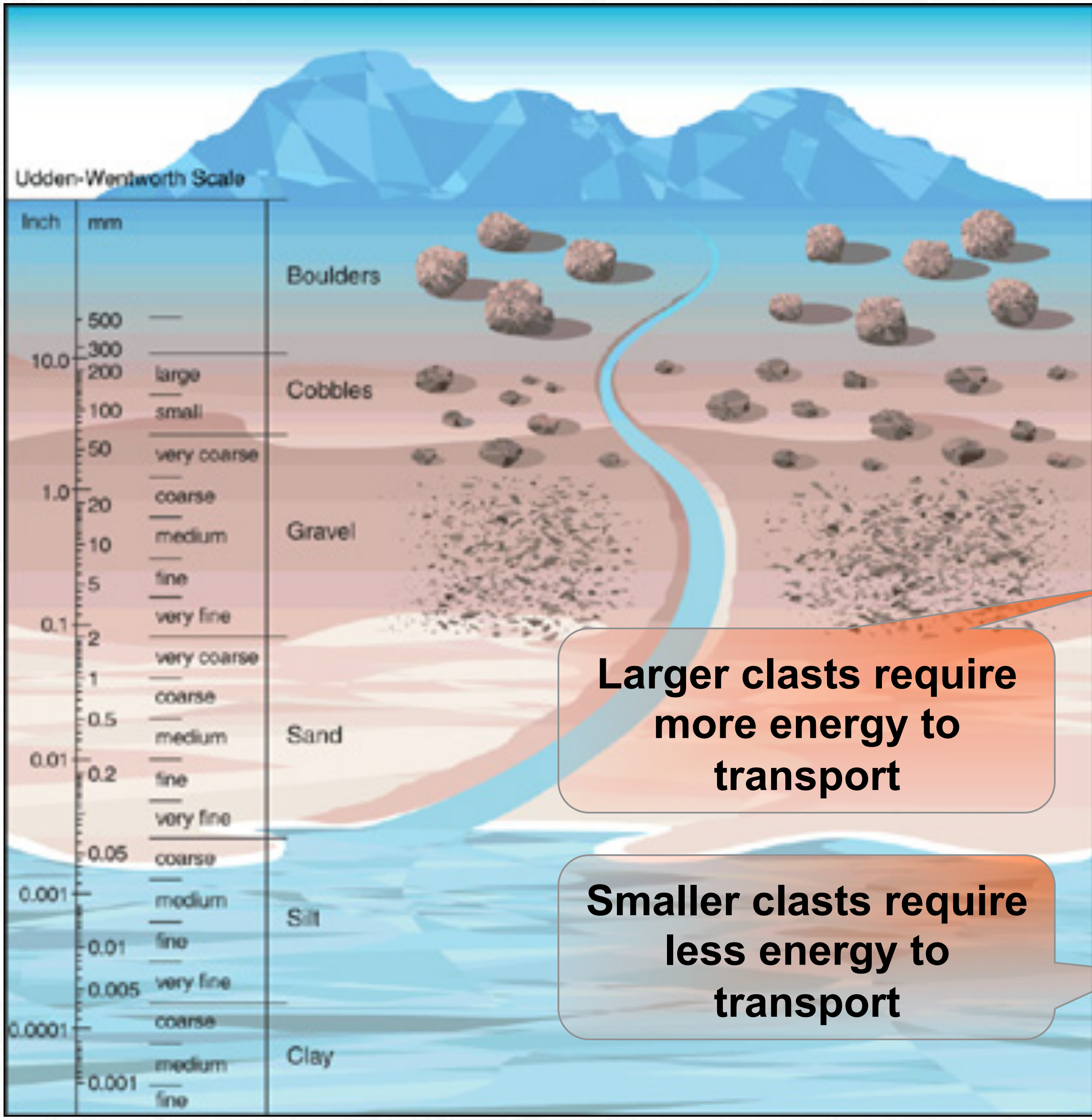


Formed from clasts (bits and pieces of pre-existing rocks). The major processes in clastic rock formation are:

- Weathering of clasts from pre-existing rock
- Transport of clasts
- Deposition of clasts
- Lithification of clasts

Weathering processes continue to alter the clasts until deposition. In general, both physical and chemical weathering tend to make clasts smaller and rounder.

Sorting of clasts by size occurs mostly during transportation.



Larger clasts require more energy to transport

Smaller clasts require less energy to transport

Sedimentary clasts are classified by **grain size** (the size of the individual clasts) using the Wentworth Scale:

Wentworth Scale

Boulders

Cobbles

Gravel (pebbles)

Sand

Silt

Clay

http://www.glossary.oilfield.slb.com/

Clastic Sedimentary Rocks

Transportation - movement of clasts from the source area to a depositional basin

Both physical and chemical weathering continue during transportation, altering the chemical composition and physical appearance of the clasts.

Modes of Transport:

Mass wasting

Wind

Ice

Water

Clast Sorting

The farther the clasts have traveled from the source, the more well sorted they tend to be.

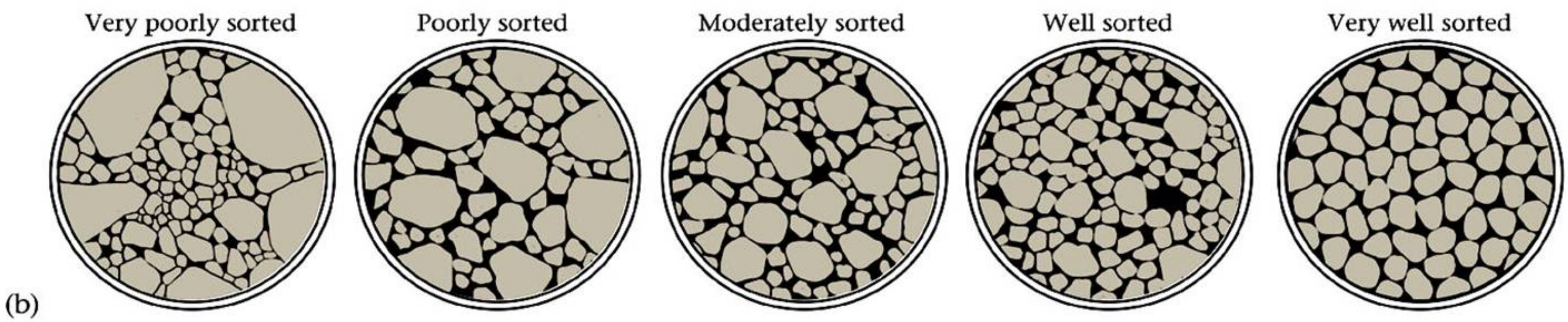


FIGURE 7.18

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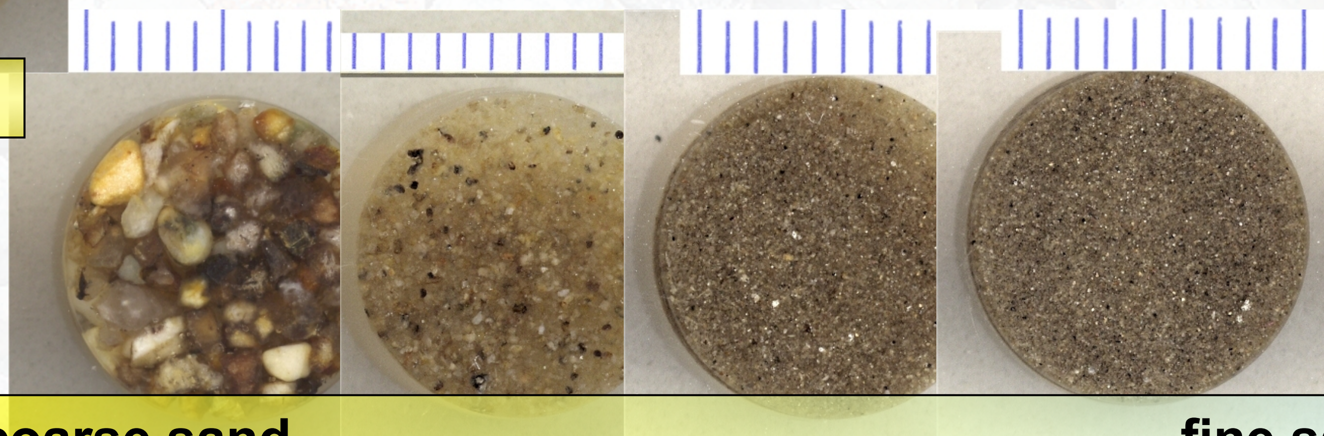
Clast Size Comparisons

gravel



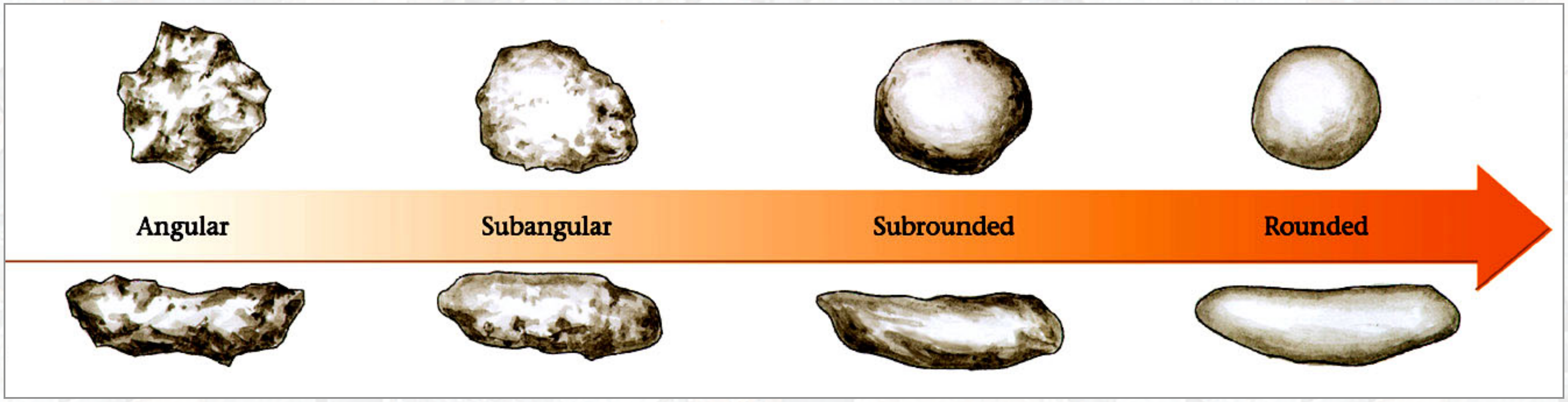
coarse sand — fine sand

silt and clay

Large clasts require more energy to transport than small clasts. Smaller clasts tend to be transported greater distances than larger clasts.

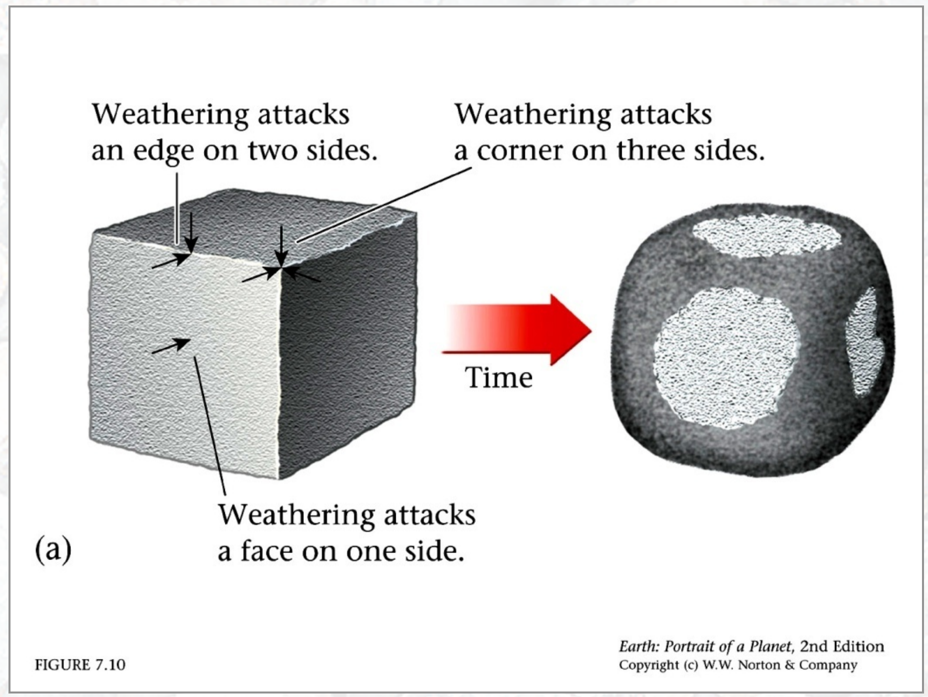
http://www.brookes.ac.uk/geology/8320/8320welc.html

Clast Rounding



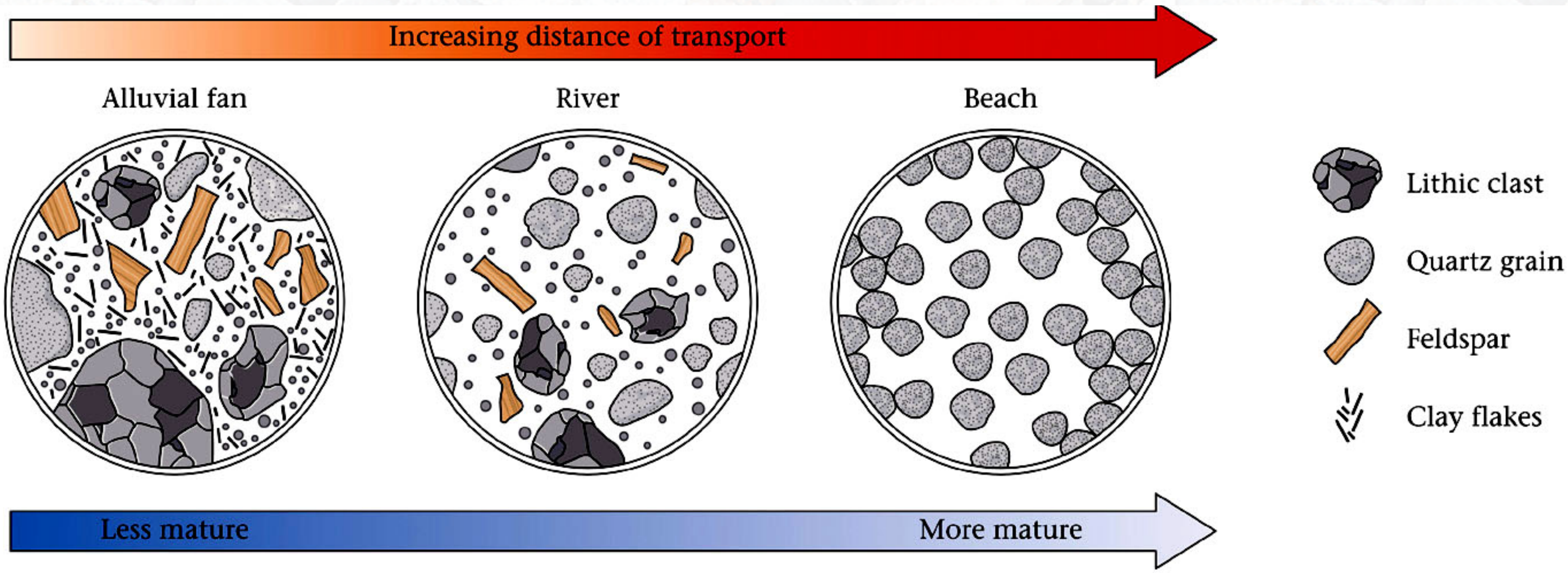
As clasts are rolled around during transportation, sharp corners tend to be knocked off, and the clasts become more rounded the farther they are transported.

Angular grains are usually found only near the source rock.



Clast Composition

As clasts are transported, weathering breaks down unstable minerals. Increasing transportation distance thus results in a clastic deposit with mostly minerals that are stable on the surface of the earth (e.g., quartz and clay).



Eolian Transportation – Work of the Wind

Dust storm approaching Stratford, Texas: Dust bowl surveying in Texas

(f)

FIGURE 7.19

Strong winds can move enormous amounts of sediment, however, the clasts wind can move over long distances tend to be small and dry.

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Fluvial Systems

Movement of clasts by flowing water

http://www.picture-newsletter.com/flood/index.htm

Sediment Load: sediment being transported by a stream

- Suspended load - sediment carried in water column, kept aloft by turbulence
- Dissolved load - ions in solution
- Bed Load – sediment moving along bottom of stream.

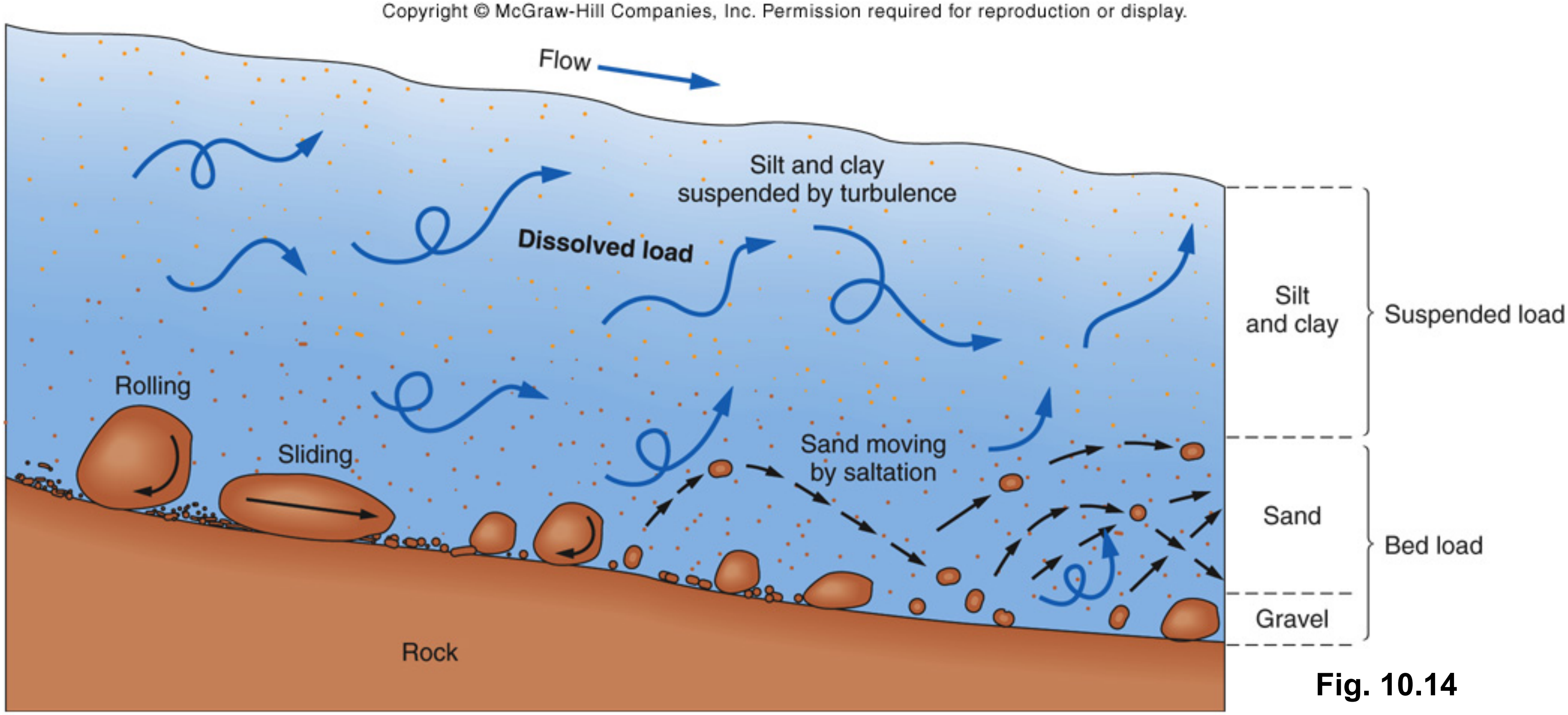

Fig. 10.14

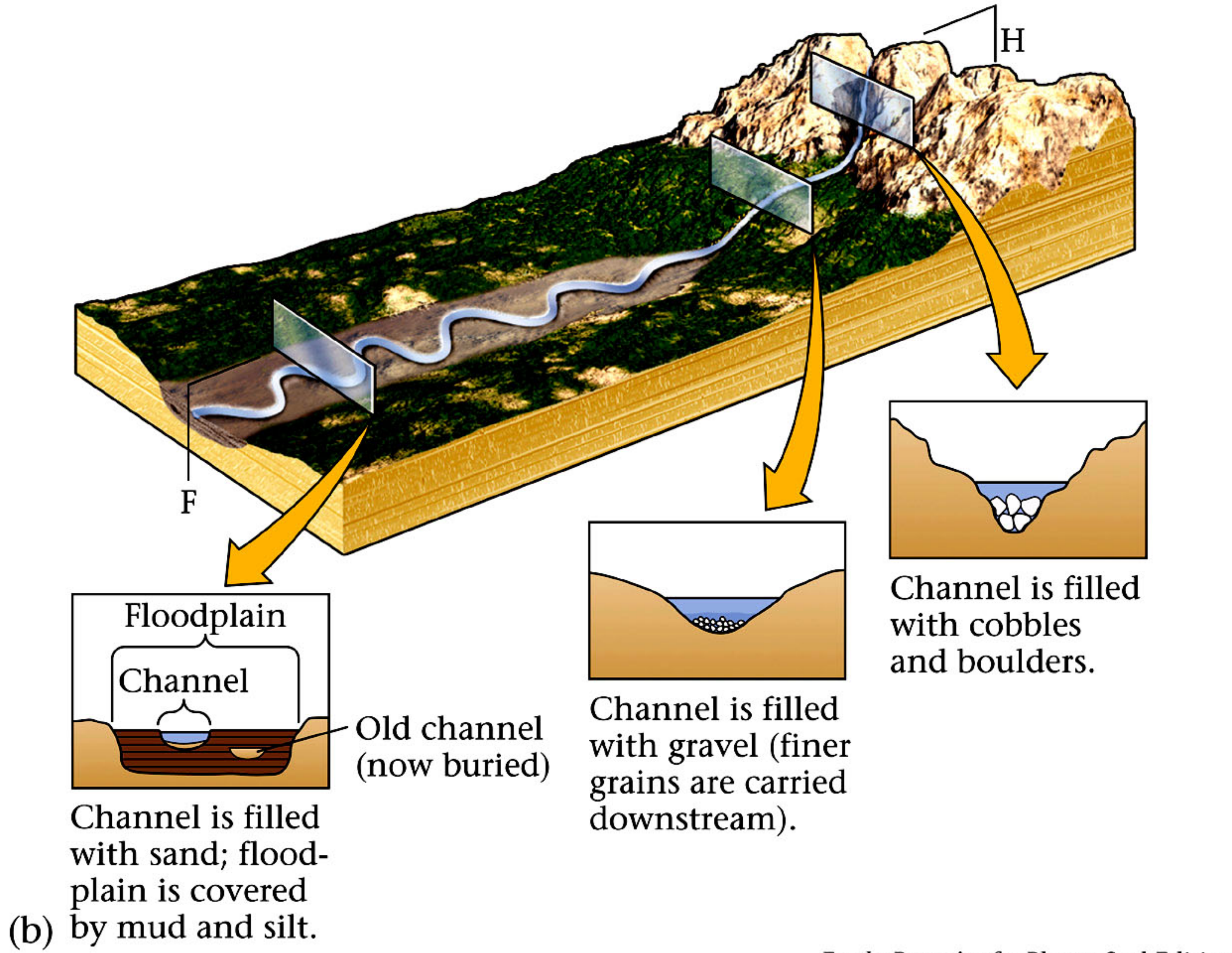

FIGURE 7.33

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http://www.gatlinburg-tennessee.com/press/photo.html?category_id=31

Deposition of Clasts

When the transportation medium (air, water, ice, etc.) has too little energy to carry a certain size of clasts, those clasts are *deposited*.

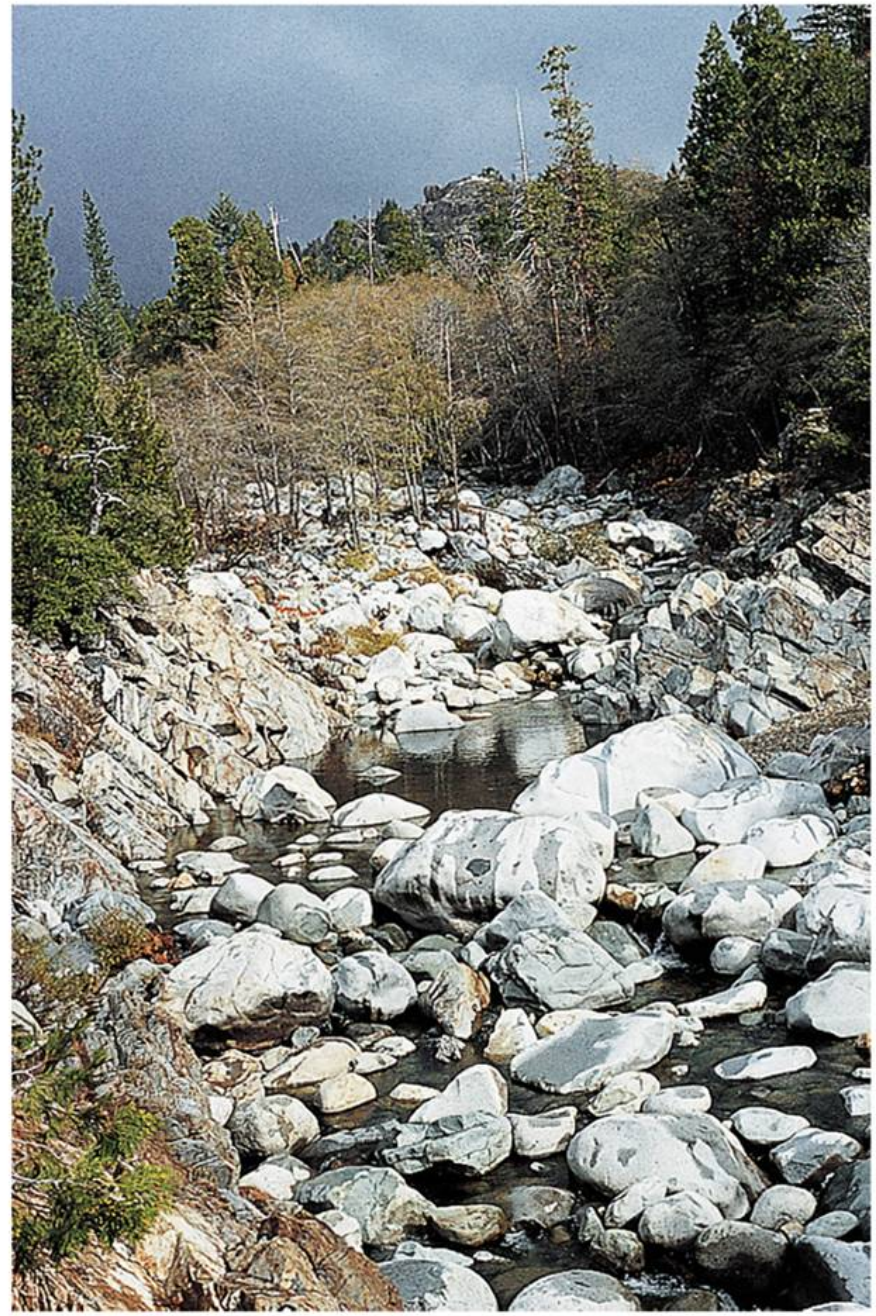
Reminder: It takes more energy to transport larger clasts!

Proximal Depositional Environments

Near the source rock, the clasts have not experienced much physical or chemical weathering.

These areas contain poorly rounded and poorly sorted clasts.

Clasts composed of chemically unstable minerals (e.g., feldspar) are most common close to the source rock.



Distal Depositional Environments

Clasts experience both chemical and physical weathering as they are transported. Thus, the further they have traveled from the source the more altered the clasts are.

Distal areas contain well rounded and well sorted clasts. Large clasts (e.g., boulders) are rare (they have either been left upstream, or have weathered into smaller clasts).

Clasts composed of chemically unstable minerals (e.g., feldspar) are very rare in distal settings. Clay minerals derived from feldspars are common.

Depositional Environments

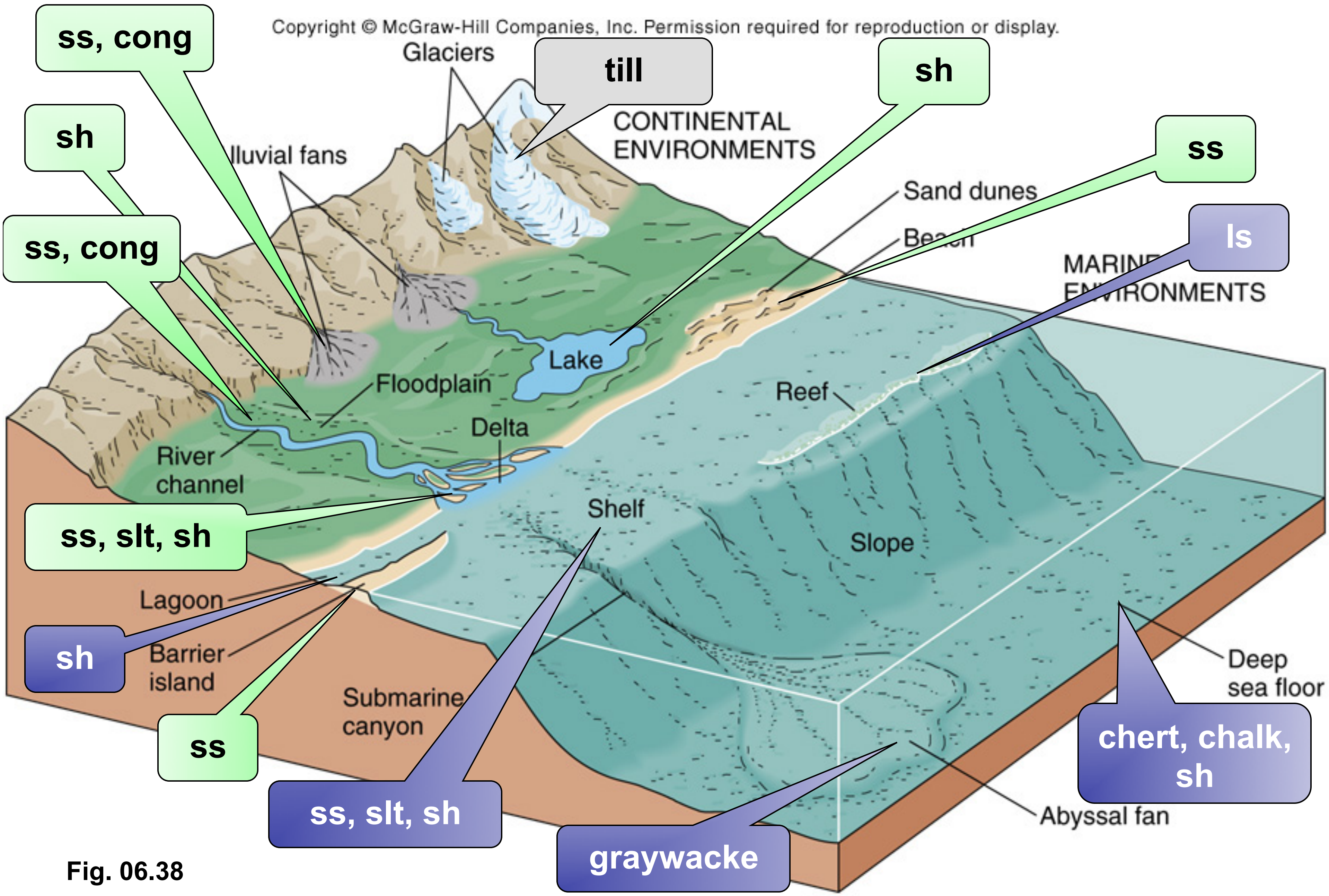
- **Glacial**: Unsorted mixture of sediment from clay to boulder (till)
- **Alluvial fan**: River deposited sediment at the base of a mountain on flat plains, usually in arid regions. Layers of widely different grains size (sandstone, conglomerate)
- **River Channel**: Elongate deposits of sand and gravel along a river or stream (sandstone, conglomerate)

Depositional Environments

- **Flood Plain:** Broad, flat plain adjacent to streams. Collects fine-grain sediment during floods (shale)
- **Lake**: Thin-bedded fine-grain sediment (shale); evaporites in arid environments
- **Delta**: Formed as rivers/streams enter lake or ocean, dropping sediment load due to decreasing energy (cross-bedded sandstone, siltstone, shale)

Depositional Environments

- **Beach, Barrier Island, Dune**: Usually well-sorted quartz sandstone, deposited by wind or water
- **Lagoon**: Semi-enclosed body of water between barrier island and mainland. Collects fine-grain sediment (shale)
- **Shallow Marine Shelves**: Broad shallow shelves near beaches (sandstone, siltstone, shale)



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ss, cong
Glaciers
till
sh
CONTINENTAL ENVIRONMENTS
sh
lluvial fans
ss, cong
Sand dunes
ss
ls
MARINE ENVIRONMENTS
Lake
Floodplain
Reef
Delta
River channel
ss, slt, sh
Shelf
Slope
Lagoon
sh
Barrier island
Submarine canyon
ss
Deep sea floor
chert, chalk, sh
ss, slt, sh
graywacke
Abyssal fan

Fig. 06.38

Lithification

Transformation of a pile of sediment into sedimentary rock.

Compaction – The weight of overlying sediment presses sediment together. Especially important for clay-sized particles.

Cementation - Minerals precipitate in pore spaces between clasts.

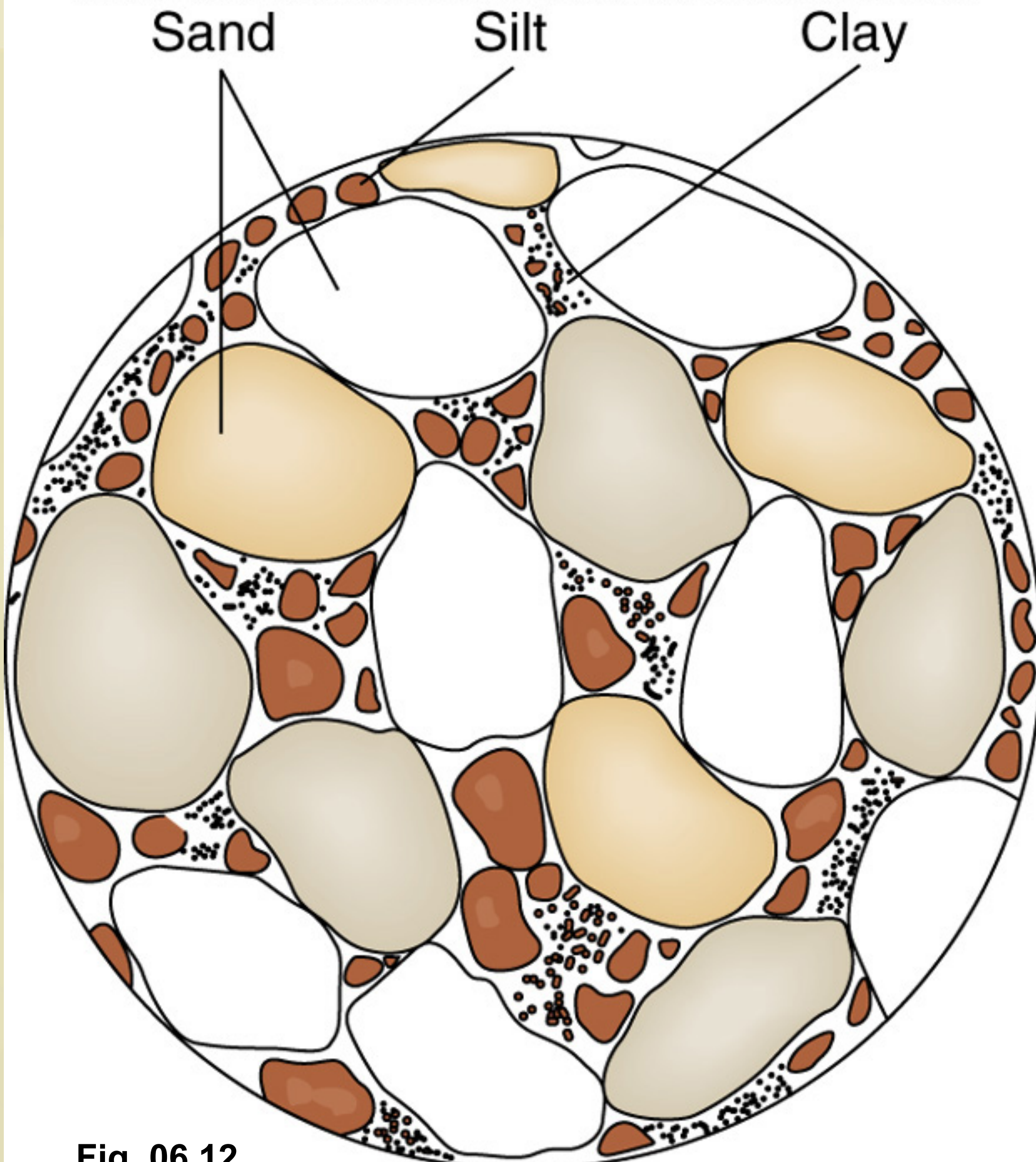
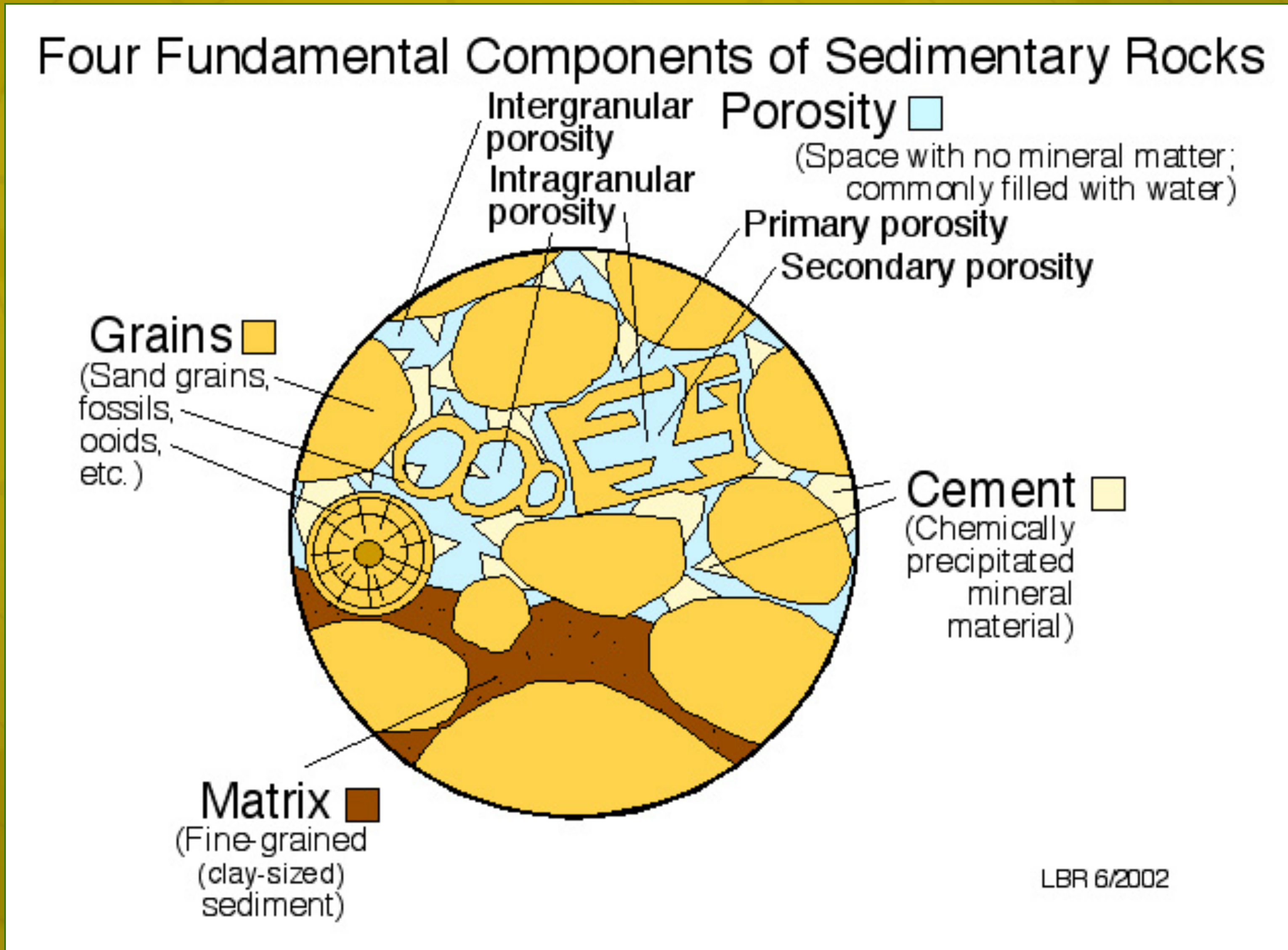


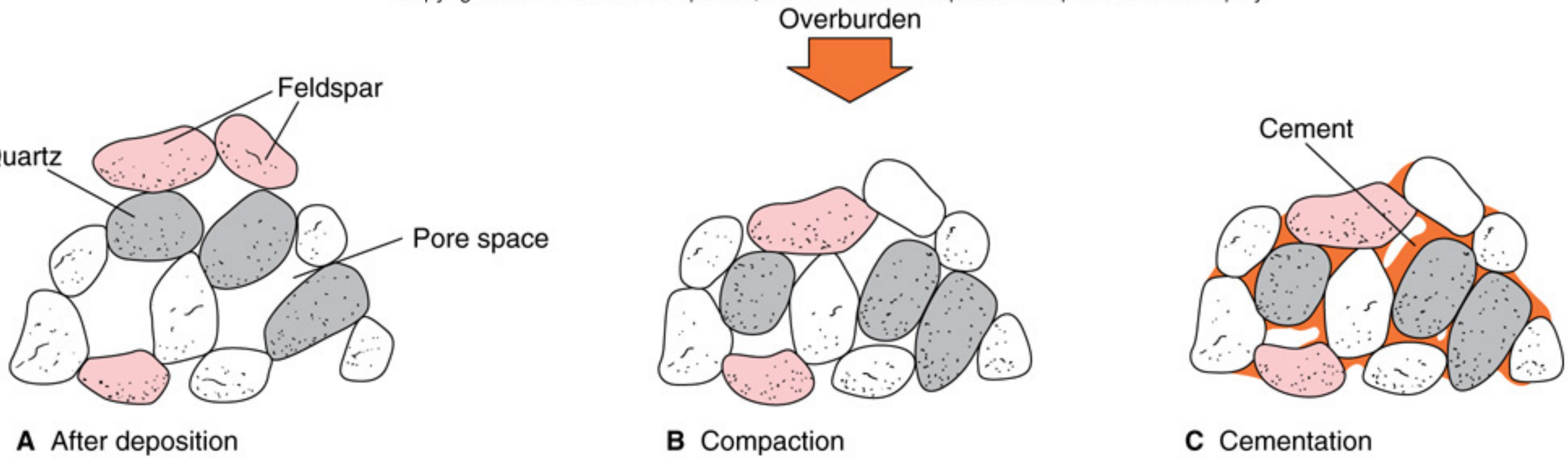
Fig. 06.12

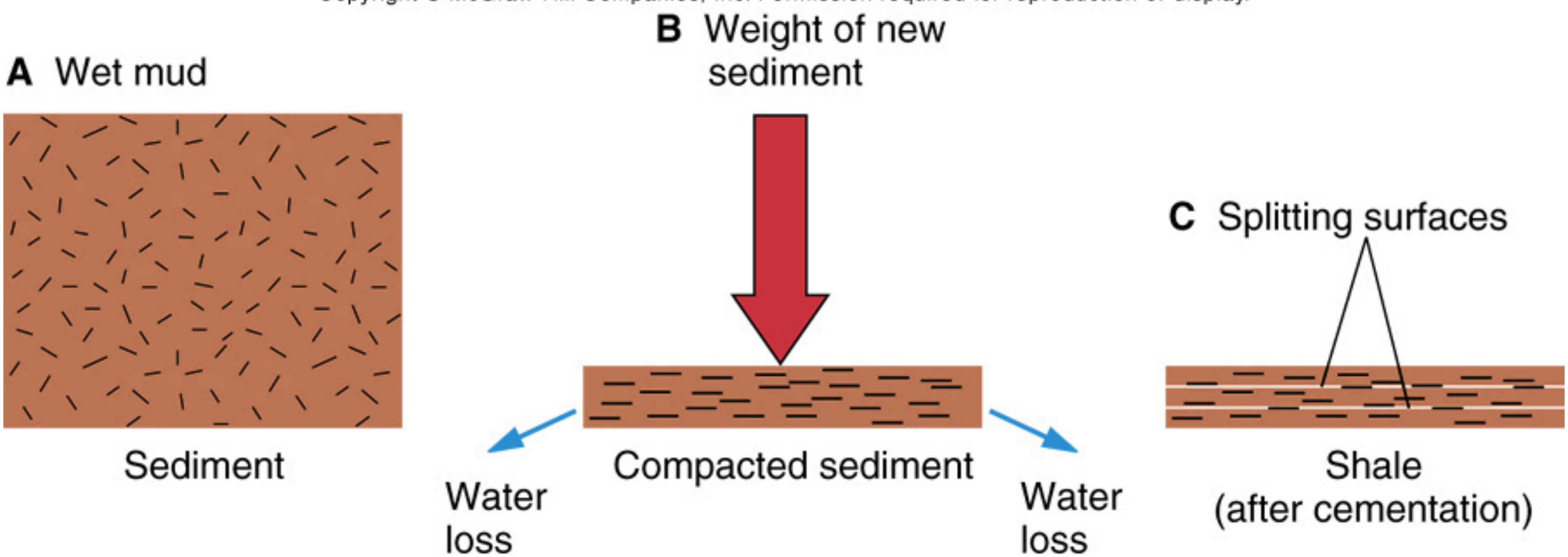
Newly deposited sediment generally has a lot of "pore space" (the volume that is not filled with sediment).

This pore space is filled with either air or water, and the reduction of the open space occurs as lithification progresses.



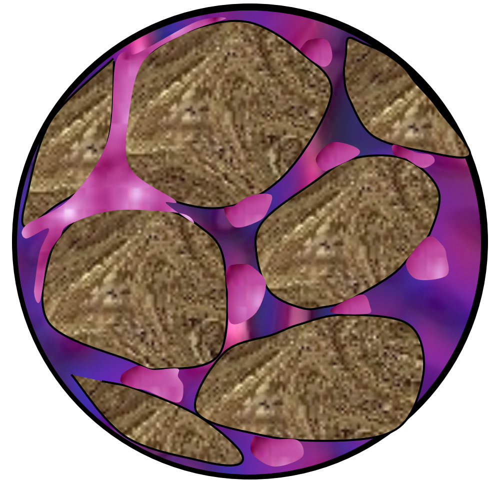
http://www.gly.uga.edu/railsback/GeologicalDiagrams1.html

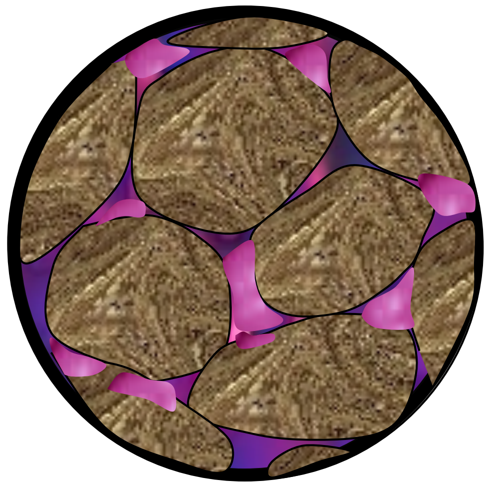

Overburden
Feldspar
Quartz
Pore space
Cement
A After deposition
B Compaction
C Cementation


A Wet mud
B Weight of new sediment
C Splitting surfaces
Sediment
Water loss
Compacted sediment
Water loss
Shale
(after cementation)

Compaction – reduction of pore space due to crowding

Cementation – reduction of pore space due mineral growth





Cementation *and* Compaction