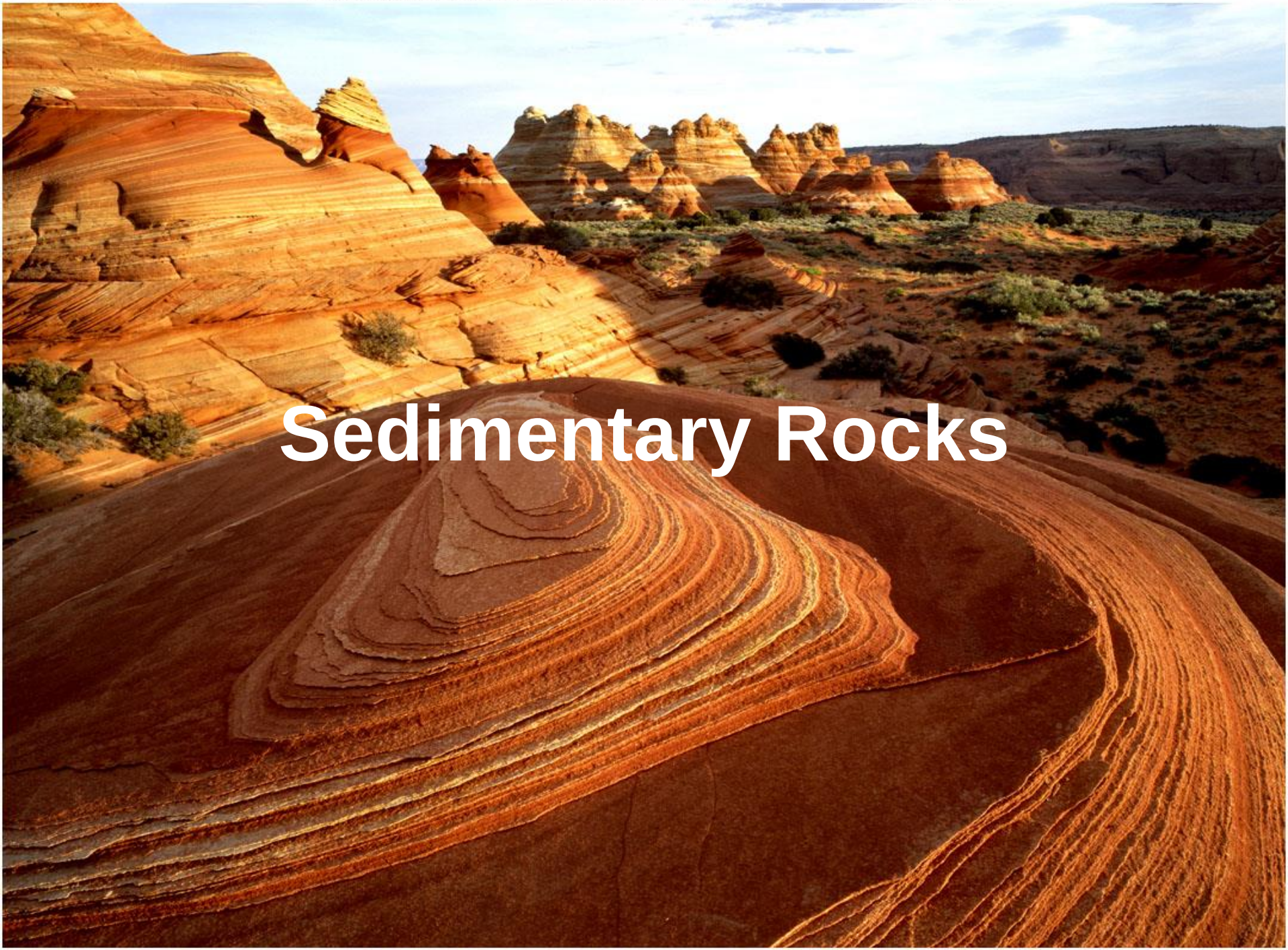


Sedimentary Rocks

Sedimentary Rocks

Sedimentary rocks are rocks that have formed from:

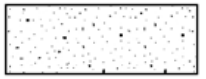
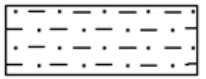
(1) *lithification* of any type of sediment,

(2) *precipitation* from solution, or

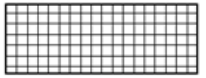
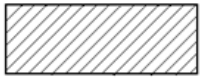
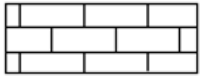
(3) *consolidation* of the remains of plants and animals.

Scheme for Sedimentary Rock Identification

INORGANIC LAND-DERIVED SEDIMENTARY ROCKS

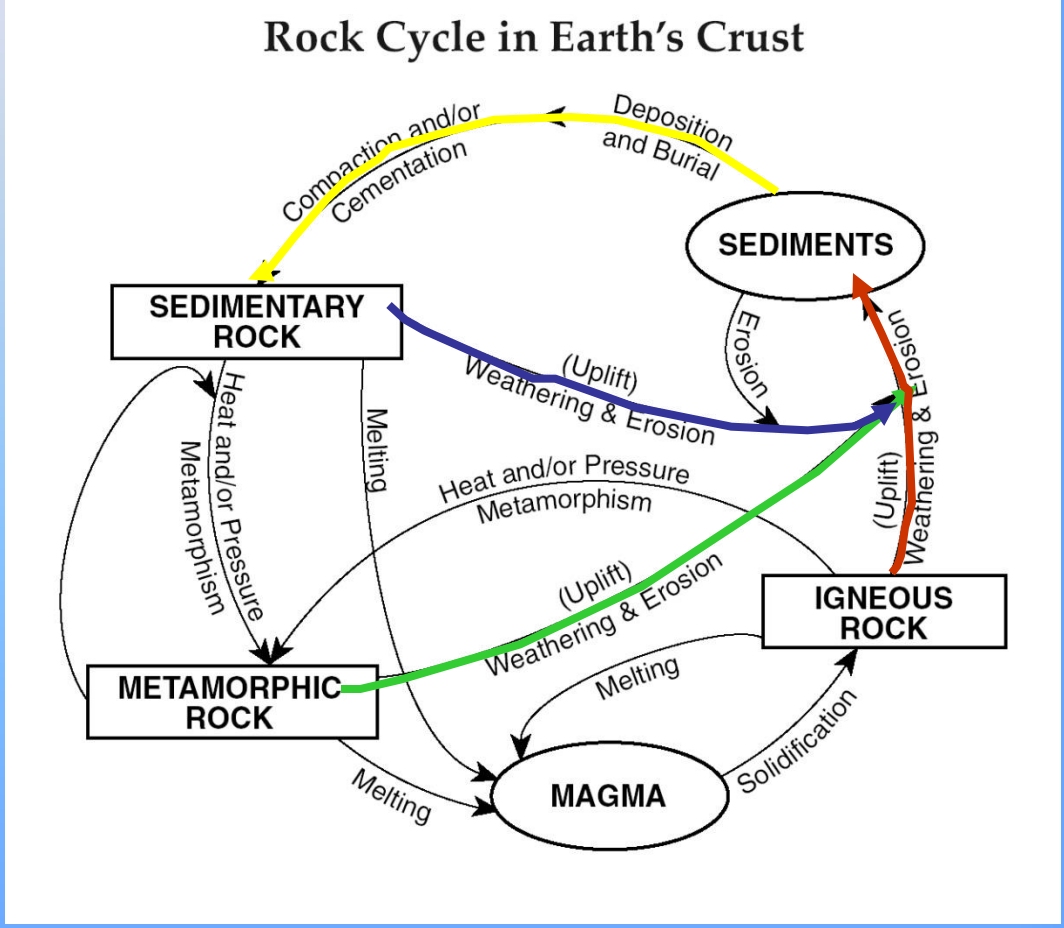
TEXTURE	GRAIN SIZE	COMPOSITION	COMMENTS	ROCK NAME	MAP SYMBOL
Clastic (fragmental)	Pebbles, cobbles, and/or boulders embedded in sand, silt, and/or clay	Mostly quartz, feldspar, and clay minerals; may contain fragments of other rocks and minerals	Rounded fragments	**Conglomerate**	
			Angular fragments	**Breccia**	
	Sand (0.006 to 0.2 cm)		Fine to coarse	**Sandstone**	
	Silt (0.0004 to 0.006 cm)		Very fine grain	**Siltstone**	
	Clay (less than 0.0004 cm)		Compact; may split easily	**Shale**	

CHEMICALLY AND/OR ORGANICALLY FORMED SEDIMENTARY ROCKS

TEXTURE	GRAIN SIZE	COMPOSITION	COMMENTS	ROCK NAME	MAP SYMBOL
Crystalline	Fine to coarse crystals	Halite	Crystals from chemical precipitates and evaporites	**Rock salt**	
		Gypsum		**Rock gypsum**	
		Dolomite		**Dolostone**	
Crystalline or bioclastic	Microscopic to very coarse	Calcite	Precipitates of biologic origin or cemented shell fragments	**Limestone**	
Bioclastic		Carbon	Compacted plant remains	**Bituminous coal**	

A. **Sediment**: The collective term for loose, solid particles that originate from:

- **weathering** and **erosion** of preexisting rocks.
- Chemical precipitation from solution, including secretion by organisms in water



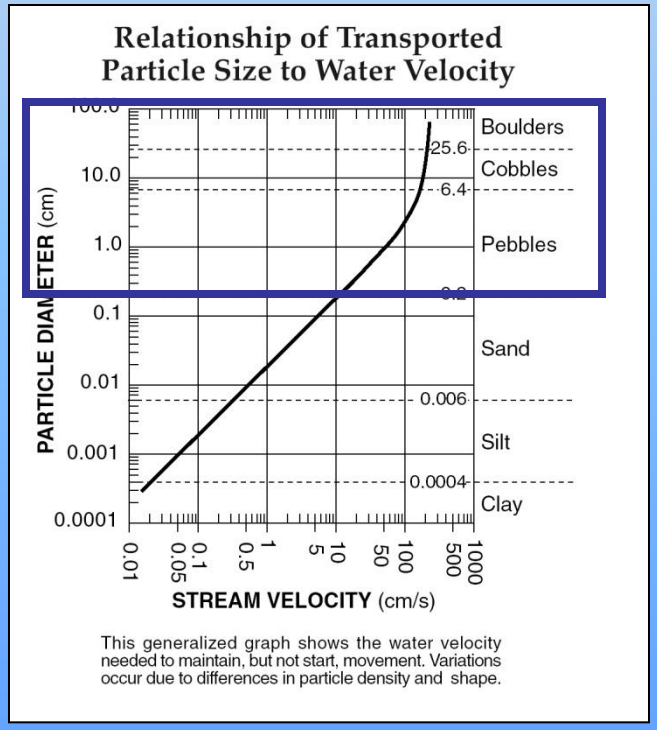
1. Types of Sediment

a) **Gravel** rounded particles coarser than 2 mm in diameter.

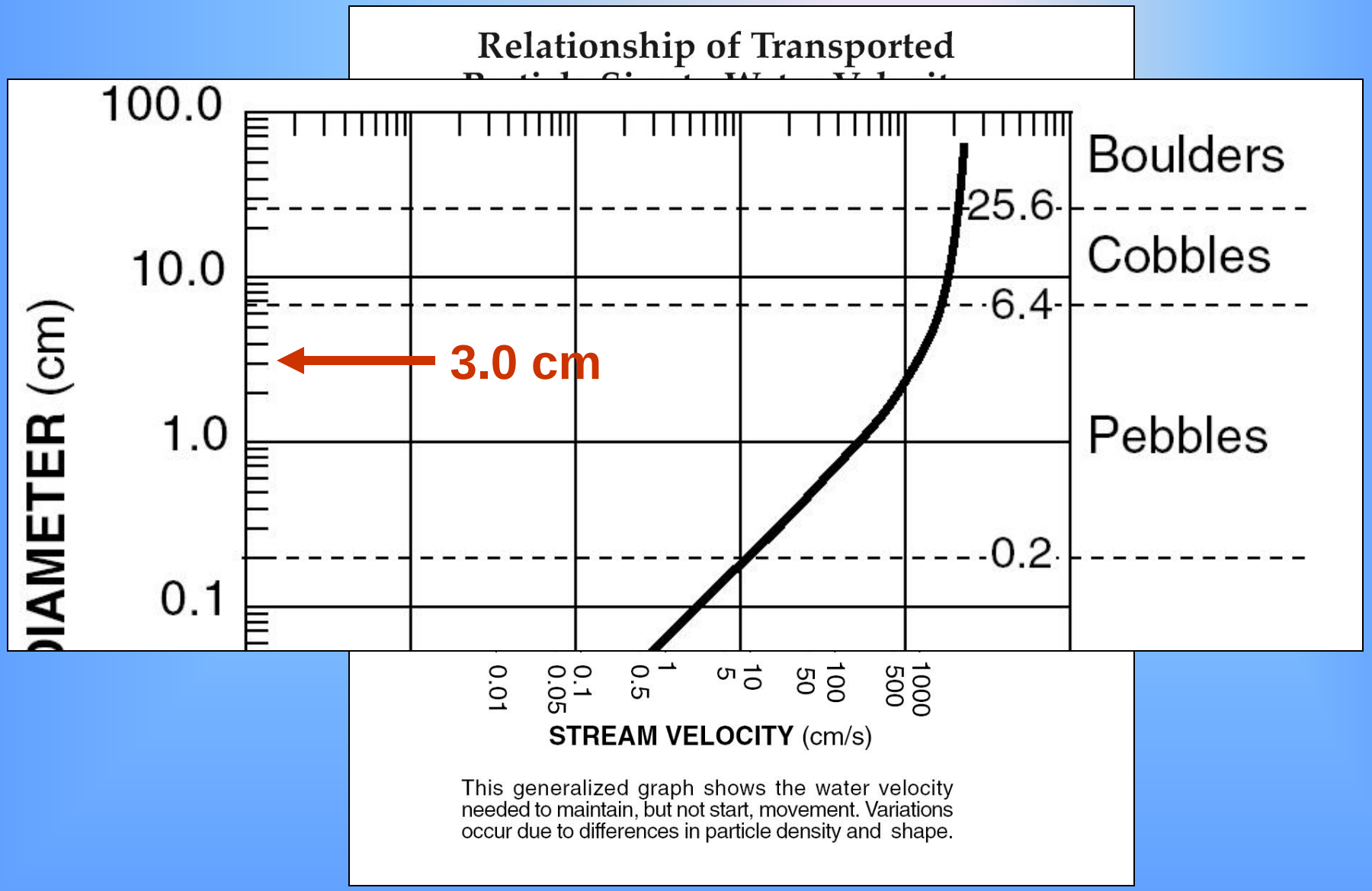
i **Pebbles**: Range from 2 to 64 mm

i **Cobbles**: Range from 64 to 256 mm

iii: **Boulders**: Coarser than 256 mm



Note the nonlinear vertical and horizontal scales



Rubble

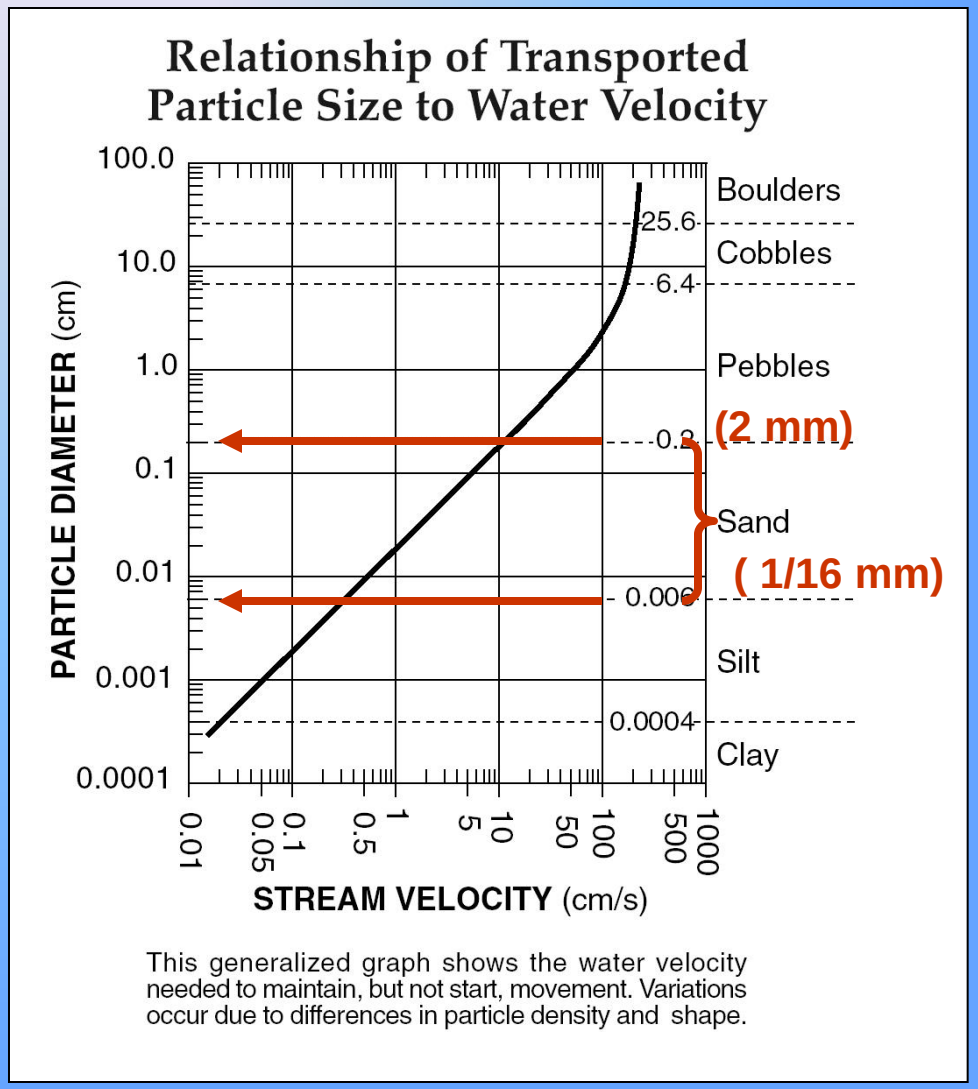
- **Angular fragments larger than 2 mm in diameter are called _*rubble*_.**

Types of Sediment

b) **Sand** grains:

i. 1/16 mm to 2 mm

ii. Feels gritty between the fingers



Varieties of Sand

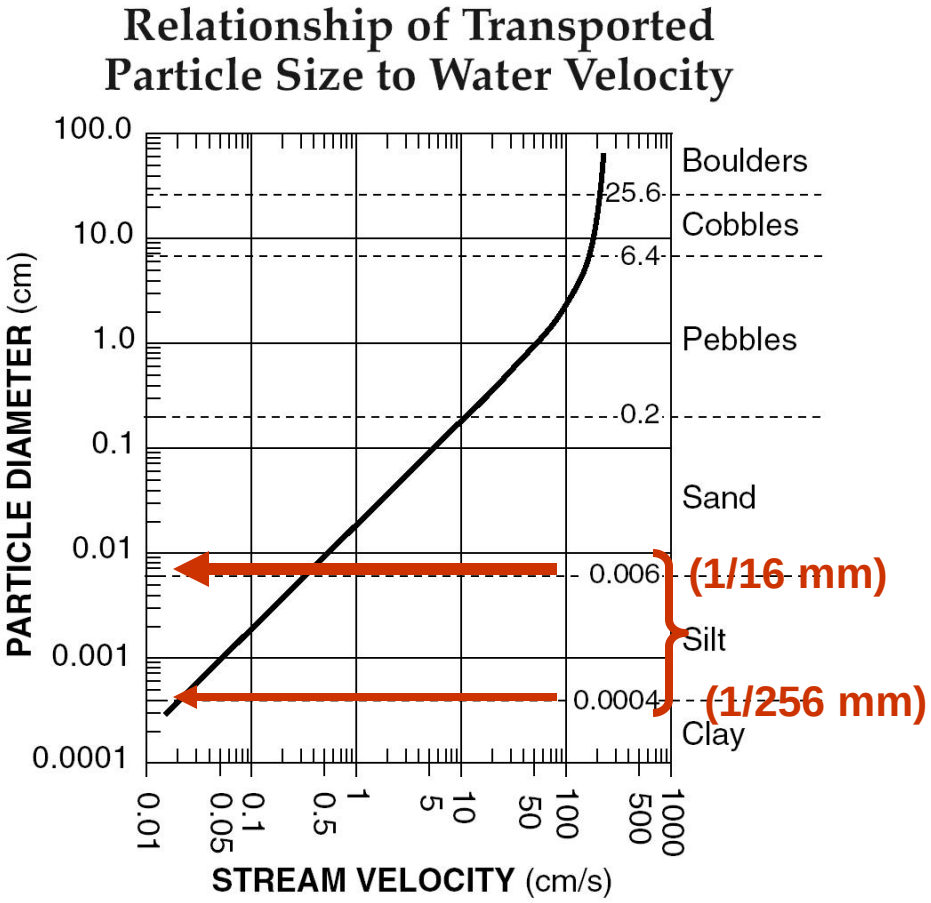
- **The term *sand* only refers to a *size range*.**
- **Sand can be composed of a variety of minerals, depending upon the parent rock that was weathered and eroded.**
- **Sand can also be composed of organic matter such as**
  - **Shells**
  - **Algae**
  - **Broken pieces of coral**

http://www.paccd.cc.ca.us/instadmn/physcidv/geol_dp/dndougla/SAND/VSCIndex.htm

Types of Sediment

c) **Silt** grains:

i. 1/256 mm to 1/16 mm
ii. Too small to see without magnification
iii. Doesn't feel gritty between fingers but feels gritty between teeth.



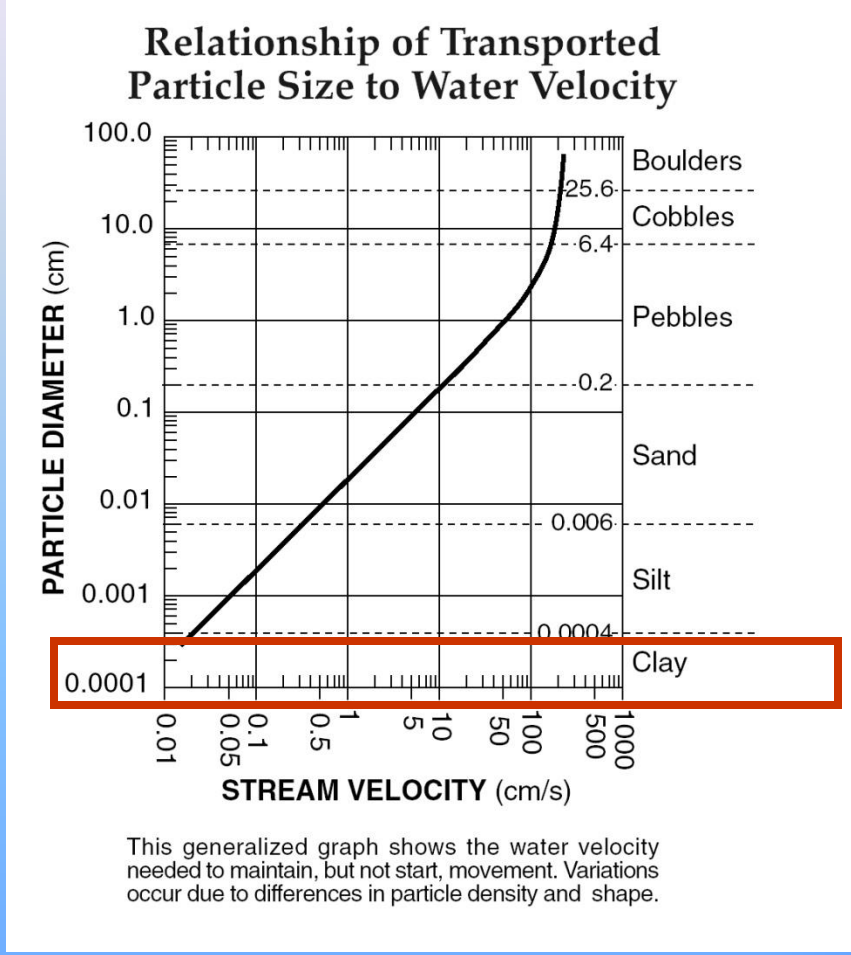
Types of Sediment

d) **Clay**

i. The finest sediment

i. Less than 1/256 mm

☞ **Mud** is the term used for wet silt or clay.

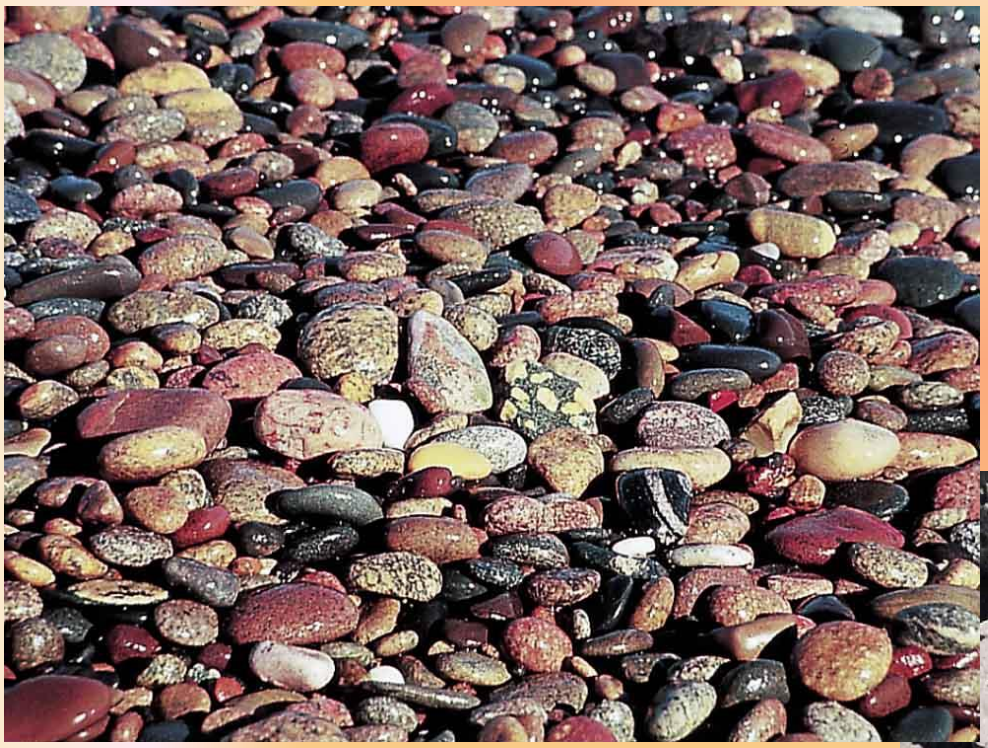


Transportation of Sediment

a) **Rounding**: The grinding away of sharp edges and corners of sand and gravel as rivers, glaciers, or waves cause particles to hit and scrape against one another.

b) **Sorting**: The process by which sediment grains are selected and separated according to: (1) size, (2) density, or (3) shape.

Rounding and Sorting

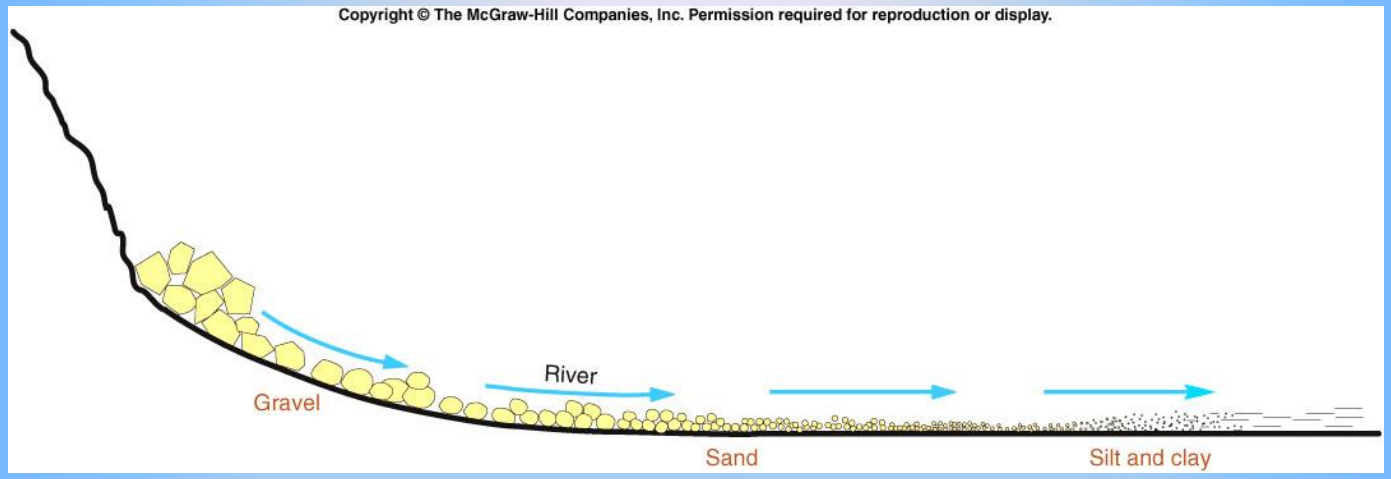


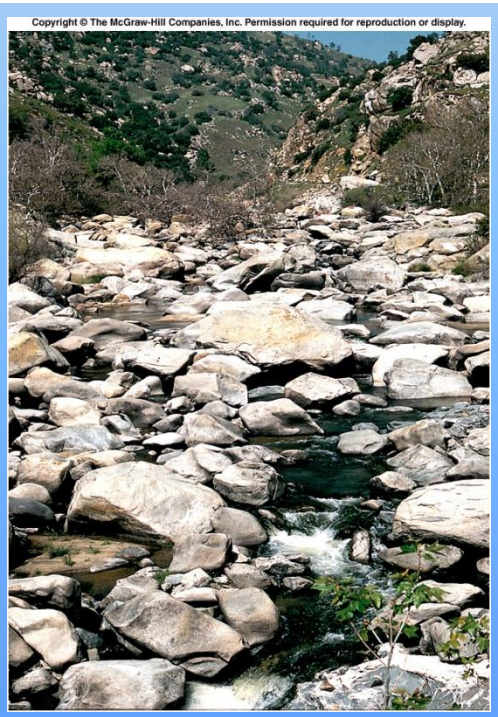
- A deposit
  - of well rounded
  - and well sorted gravel

- Angular, poorly sorted gravel

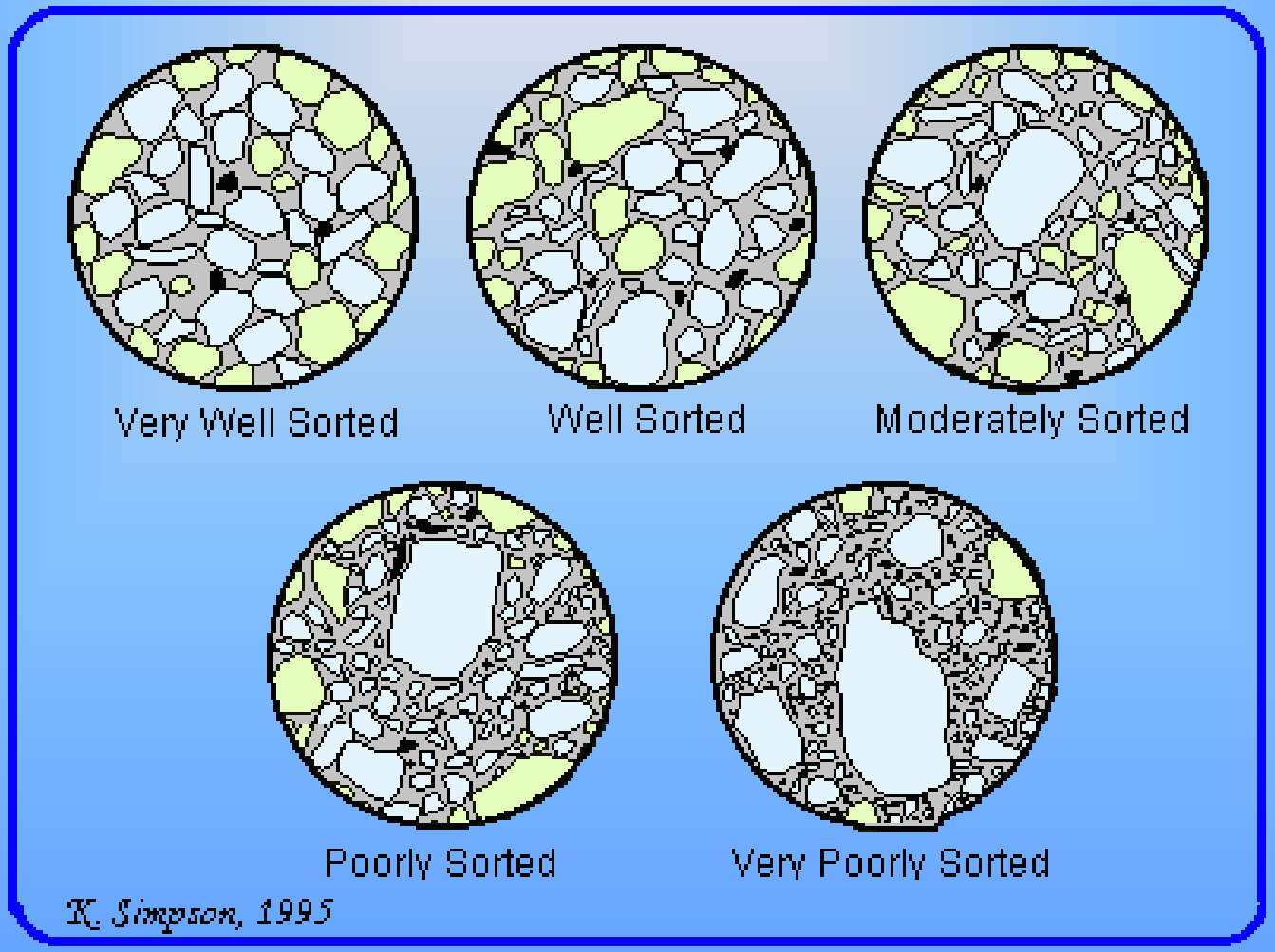
Rounding Due to Abrasion

Sorting by a Stream





Degrees of Sorting



3. Deposition

a) When transported material settles.

b) Also includes organic and biological extraction of sediment from solution

c) Factors that affect rate of deposition:
If all other factors are equal

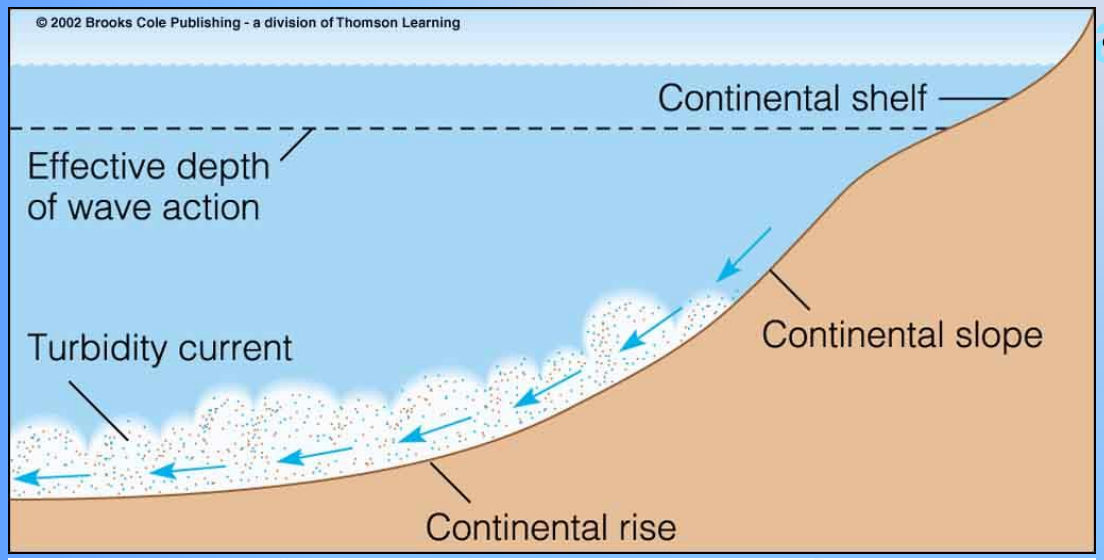
i. Sediment Size: **Larger sizes settle at a faster rate.**

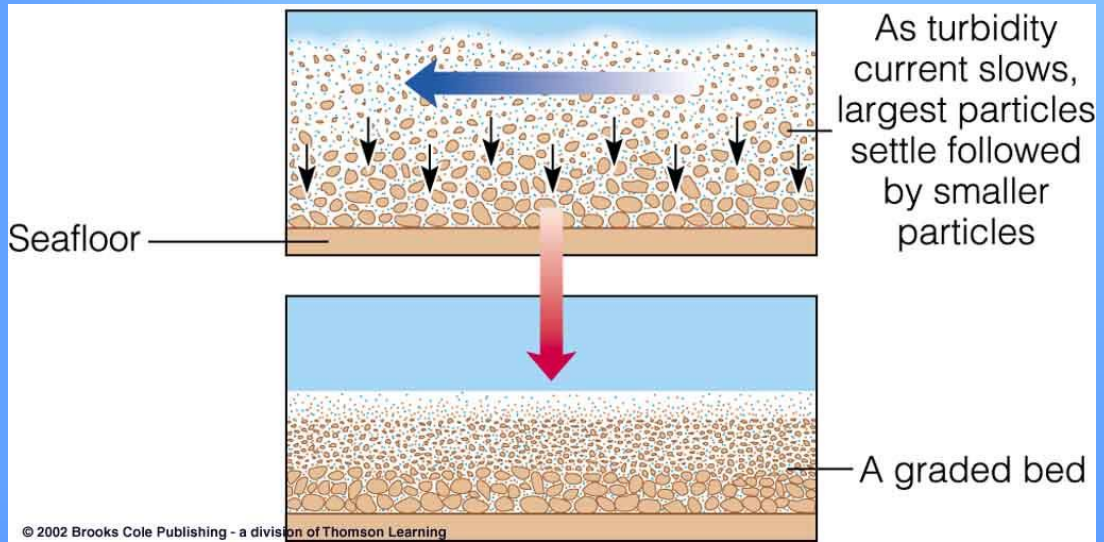
ii. Sediment Density: **Denser particles settle faster.**

iii. Sediment Shape: **Spherical particles settle faster**

Graded Bedding

- Some beds show an upward gradual decrease





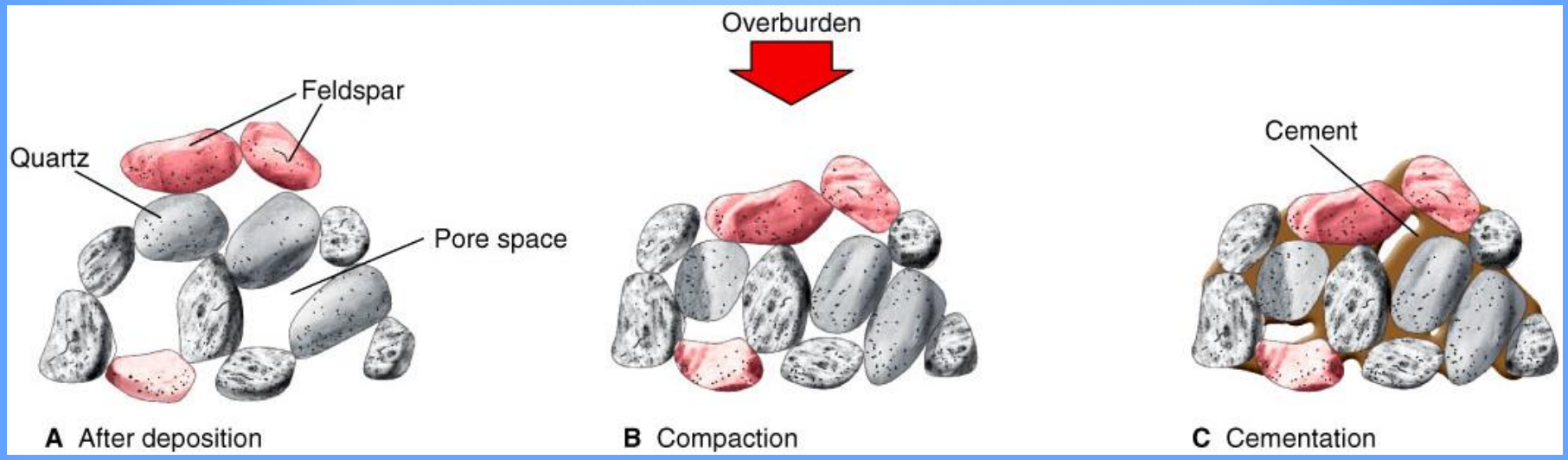
- Graded bedding is common in **turbidity current** deposits
  - which form when sediment-water mixtures flow along the seafloor
    - the largest particles settle out
    - then smaller ones

4. **Lithification**: The general term for a group of processes that convert loose sediment into rock.

a) Processes of lithification:

i. **Compaction**: Weight of overlying sediment (overburden) packs loose sediment grains tightly together

ii. **Cementation**: Precipitation of cement around sediment grains binds them into a firm, coherent rock.



Cementation

a) Pore space is **reduced**.

b) Common cements include:

i. Calcium carbonate (**calcite**)

ii. Silica: **SiO_2**

iii. **Iron Oxide, clay minerals** (less common)

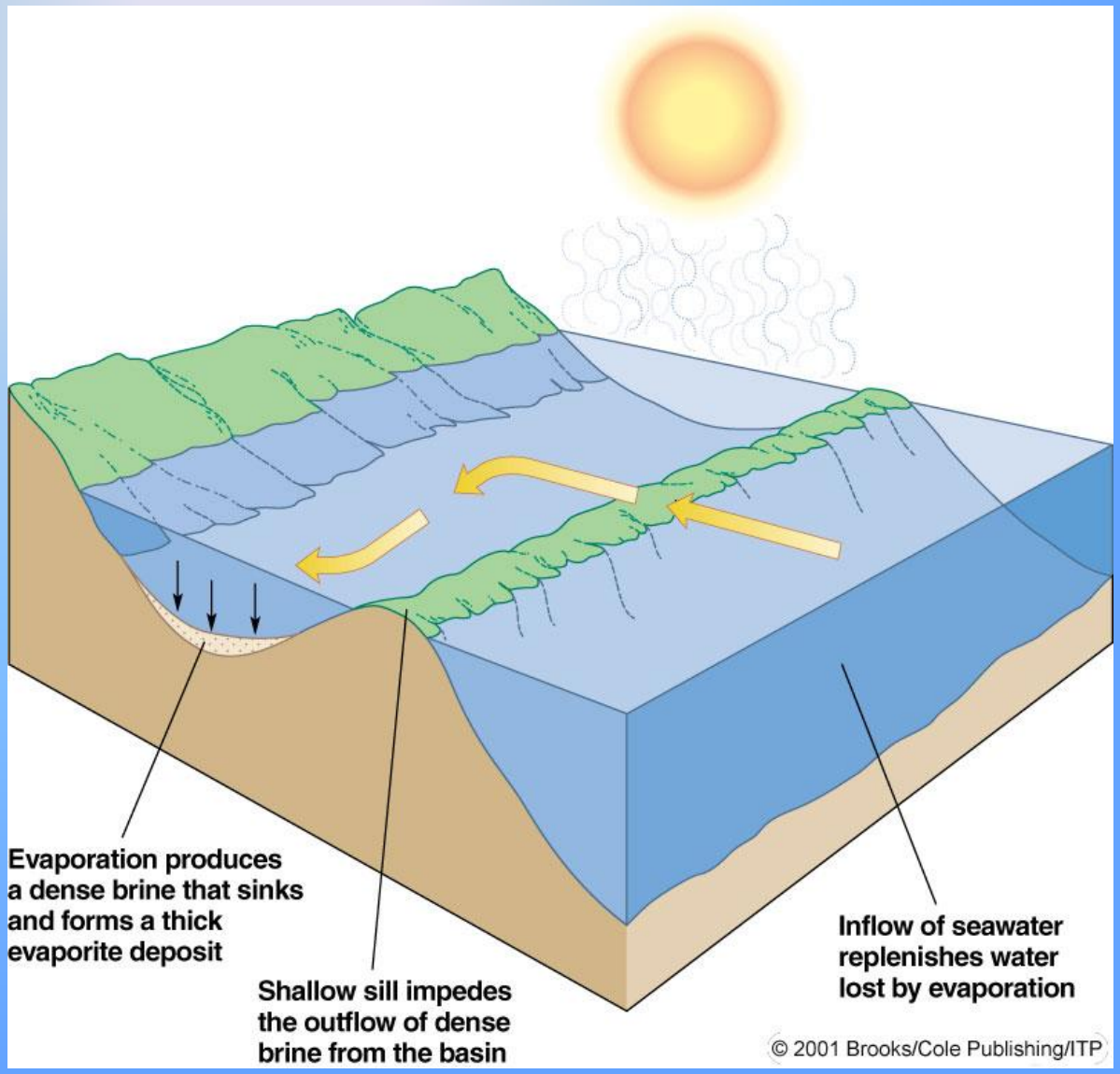
iii. Crystallization

- Minerals may precipitate from solution without passing through the loose sediment stage

Silled (Barred) Basin Model

- **Silled Basin Model** for evaporite sedimentation by direct precipitation from seawater

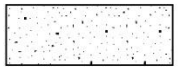
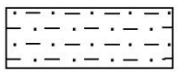
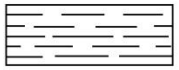
- Vertical scale is greatly exaggerated



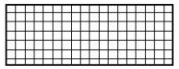
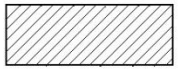
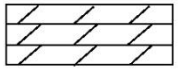
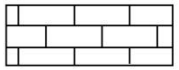
B. Types of Sedimentary Rocks

Scheme for Sedimentary Rock Identification

INORGANIC LAND-DERIVED SEDIMENTARY ROCKS

TEXTURE	GRAIN SIZE	COMPOSITION	COMMENTS	ROCK NAME	MAP SYMBOL
Clastic (fragmental)	Pebbles, cobbles, and/or boulders embedded in sand, silt, and/or clay	Mostly quartz, feldspar, and clay minerals; may contain fragments of other rocks and minerals	Rounded fragments	**Conglomerate**	
			Angular fragments	**Breccia**	
	Sand (0.006 to 0.2 cm)		Fine to coarse	**Sandstone**	
	Silt (0.0004 to 0.006 cm)		Very fine grain	**Siltstone**	
	Clay (less than 0.0004 cm)		Compact; may split easily	**Shale**	

CHEMICALLY AND/OR ORGANICALLY FORMED SEDIMENTARY ROCKS

TEXTURE	GRAIN SIZE	COMPOSITION	COMMENTS	ROCK NAME	MAP SYMBOL
Crystalline	Fine to coarse crystals	Halite	Crystals from chemical precipitates and evaporites	**Rock salt**	
		Gypsum		**Rock gypsum**	
		Dolomite		**Dolostone**	
Crystalline or bioclastic	Microscopic to very coarse	Calcite	Precipitates of biologic origin or cemented shell fragments	**Limestone**	
Bioclastic		Carbon	Compacted plant remains	**Bituminous coal**	

B. Types of Sedimentary Rocks

1. **Clastic** Sedimentary Rocks (from land-derived or terrigenous sediments)

   a) A sedimentary rock is said to have a **clastic** texture when it consists of sediment grains bound by cement into a rigid framework.

      i. Pore spaces are not completely filled.

      ii. Rock fragments can be identifiable pieces of rock, or individual mineral grains.

      iii. Clay minerals are also considered fragments.

Clastic Sedimentary Rocks

b) Clastic sedimentary rocks are classified by the **size** of the particles they contain.

Scheme for Sedimentary Rock Identification

INORGANIC LAND-DERIVED SEDIMENTARY ROCKS					
TEXTURE	**GRAIN SIZE**	**COMPOSITION**	**COMMENTS**	**ROCK NAME**	**MAP SYMBOL**
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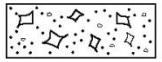
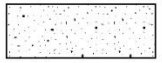
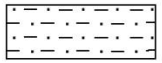
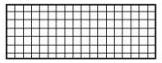
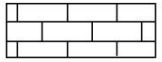
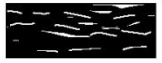
			Angular fragments	**Breccia**	
	Sand (0.006 to 0.2 cm)		Fine to coarse	**Sandstone**	
	Silt (0.0004 to 0.006 cm)		Very fine grain	**Siltstone**	
	Clay (less than 0.0004 cm)		Compact; may split easily	**Shale**	

CHEMICALLY AND/OR ORGANICALLY FORMED SEDIMENTARY ROCKS					
TEXTURE	**GRAIN SIZE**	**COMPOSITION**	**COMMENTS**	**ROCK NAME**	**MAP SYMBOL**
Crystalline	Fine to coarse crystals	Halite	Crystals from chemical precipitates and evaporites	**Rock salt**	
		Gypsum		**Rock gypsum**	
		Dolomite		**Dolostone**	
Crystalline or bioclastic	Microscopic to very coarse	Calcite	Precipitates of biologic origin or cemented shell fragments	**Limestone**	
Bioclastic		Carbon	Compacted plant remains	**Bituminous coal**	

i. Conglomerate : Cemented rounded gravel

Scheme for Sedimentary Rock Identification

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TEXTURE	GRAIN SIZE	COMPOSITION	COMMENTS	ROCK NAME	MAP SYMBOL
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	Sand (0.006 to 0.2 cm)			Breccia	
	Silt (0.0004 to 0.006 cm)			Sandstone	
	Clay (less than 0.0004 cm)			Siltstone	
				Shale	

ii. **Breccia**: Distinguished from conglomerate by angular fragments and is not common.

Scheme for Sedimentary Rock Identification

INORGANIC LAND-DERIVED SEDIMENTARY ROCKS					
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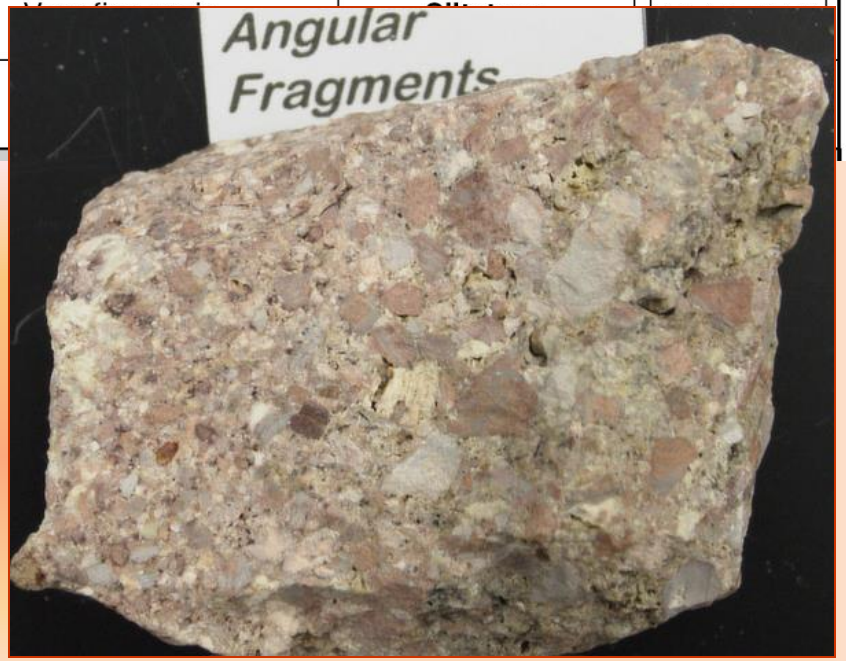
	Pebbles, cobbles, and/or boulders embedded in sand, silt, and/or clay	Mostly quartz, feldspar, and	Rounded fragments	**Conglomerate**	
			Angular fragments	**Breccia**	
			Fine to coarse	**Sandstone**	



iii. Sandstone

a) Medium grained

b) **Matrix**: The fine-grained silt and clay found in spaces between the sand grains and makes up a substantial volume of the rock.

Scheme for Sedimentary Rock Identification

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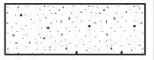
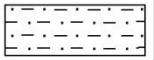
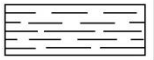
	Sand (0.006 to 0.2 cm)		Fine to coarse	**Sandstone**	
	Silt (0.0004 to 0.006 cm)		Very fine grain	**Siltstone**	
	Clay (less than 0.0004 cm)		Compact; may split easily	**Shale**	

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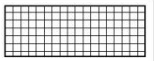
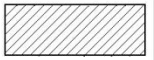
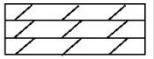
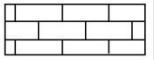
Crystalline	Fine to coarse crystals	Halite	Crystals from chemical precipitates and evaporites	**Rock salt**	
		Gypsum		**Rock gypsum**	
		Dolomite		**Dolostone**	
Crystalline or bioclastic	Microscopic to very coarse	Calcite	Precipitates of biologic origin or cemented shell fragments	**Limestone**	
Bioclastic		Carbon	Compacted plant remains	**Bituminous coal**	

c) Types of Sandstone

- **Quartz Sandstone**

- More than 90% of the grains are quartz
- Sand grains have been transported great distances.
- Well rounded

- Less resistant minerals have weathered away

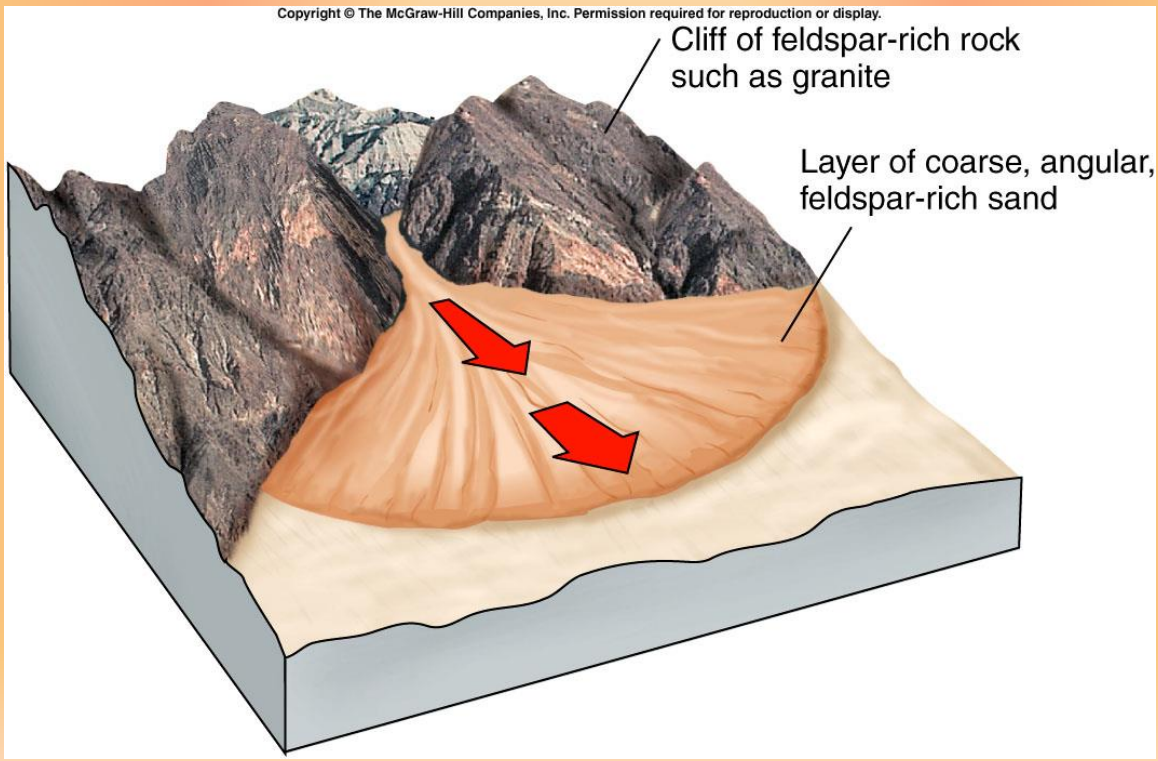
- **Arkose Sandstone**

- More than 25% feldspar

B

- Most grains are Coarse and granular

Arkose Sandstone

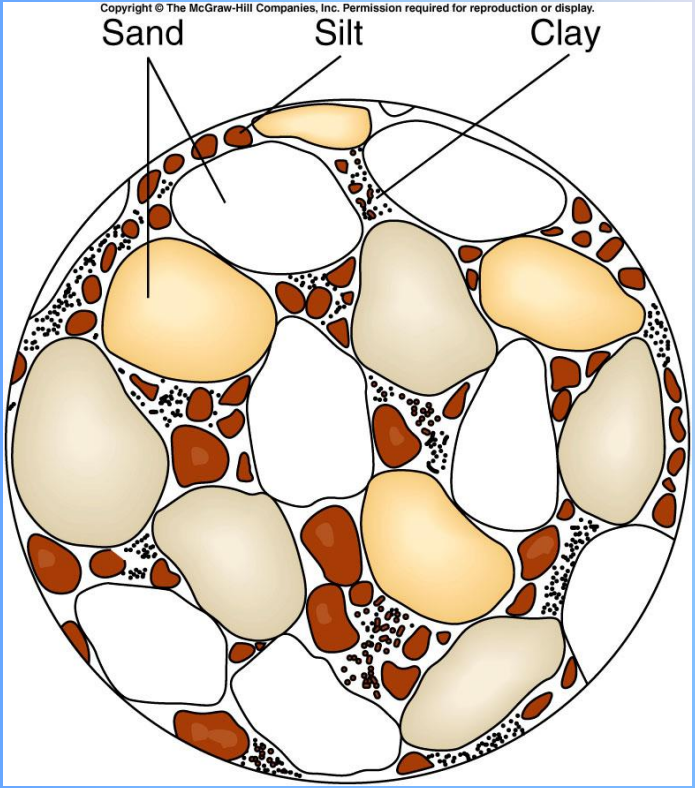


- Feldspar-rich sand accumulates from rapid erosion of granite.
- Feldspar is eroded and deposited before it can weather into clay minerals.

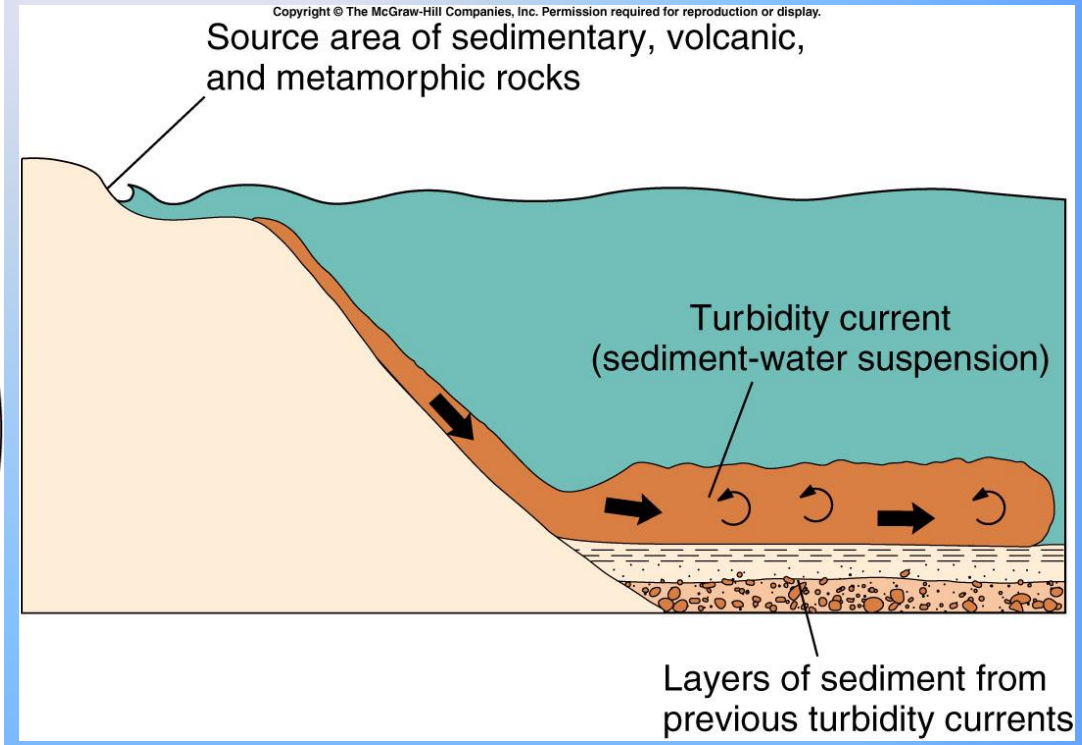
- **Graywacke** (“gray-whacky”)

- Grains surrounded by a dark, fine-grained matrix (more than 15% of rock’s volume)
- Called a “dirty” sandstone

Graywacke Sandstone



Poorly sorted sand surrounded by a matrix of silt and clay



Dense sediment-laden water is heavier than the clear water beneath which it flows.

iv. **Siltstone**: Composed mostly of silt grains and does not split into thin layers or laminations.

Scheme for Sedimentary Rock Identification

SEDIMENTARY ROCKS					
				COMMENTS	ROCK NAME	MAP SYMBOL
				Rounded fragments	Conglomerate	
				Angular		
				Fine to c		
				Compac easily		
				FORM		
				co		
Crystalline	Fine to coarse crystals	Halite	Cryst chem precip and e			
		Gypsum				
		Dolomite				
Crystalline or bioclastic	Microscopic to very coarse	Calcite	Precipitat origin or c fragments			
Bioclastic		Carbon	Compact plant rem			

v. Shale

Scheme for Sedimentary Rock Identification

ANIC LAND-DERIVED SEDIMENTARY ROCKS

	COMPOSITION	COMMENTS	ROCK NAME	MAP SYMBOL
	Mostly quartz, feldspar, and clay minerals; may contain fragments of other rocks and minerals	Rounded fragments	**Conglomerate**	
		Angular fragments	**Breccia**	
		Fine to coarse	**Sandstone**	
		Very fine grain	**Siltstone**	
Clay (less than 0.0004 cm)		Compact; may split easily	**Shale**	

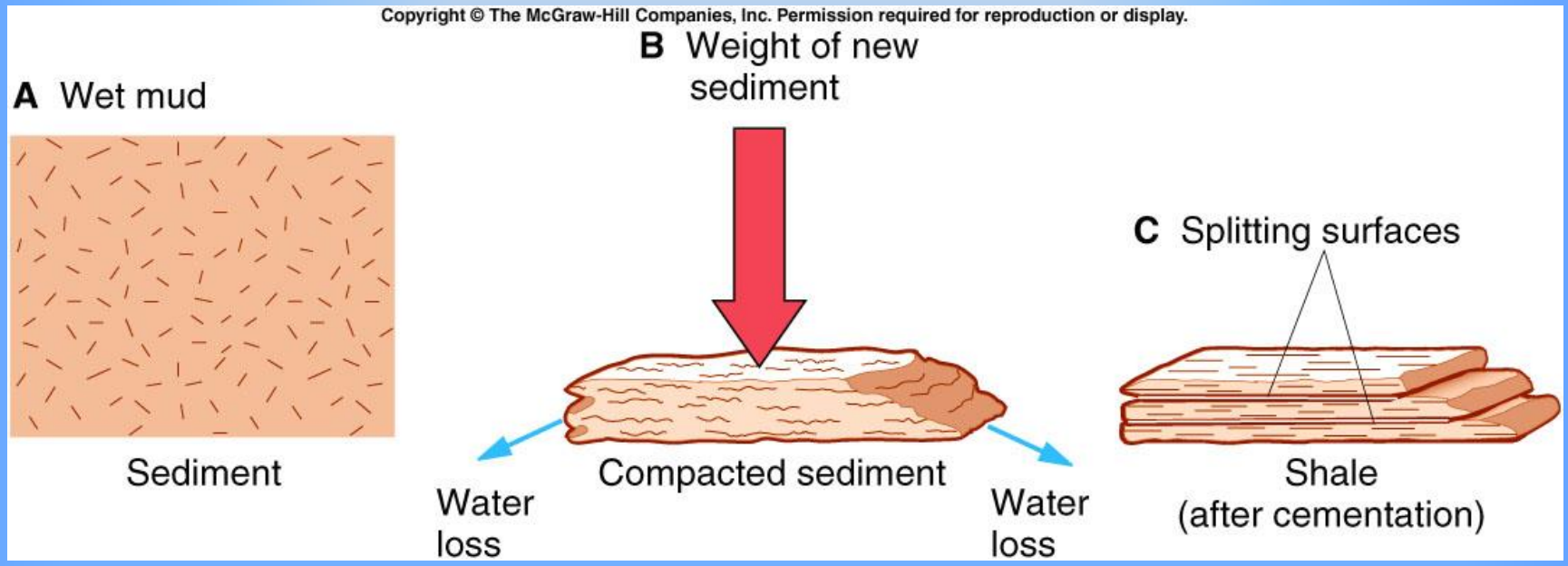
CHEMICALLY AND/OR ORGANICALL

TEXTURE	GRAIN SIZE	COMPOSITION		MAP SYMBOL
Crystalline	Fine to coarse crystals	Halite		
		Gypsum		
		Dolomite		
Crystalline or bioclastic	Microscopic to very coarse	Calcite		
Bioclastic		Carbon	plant remains	

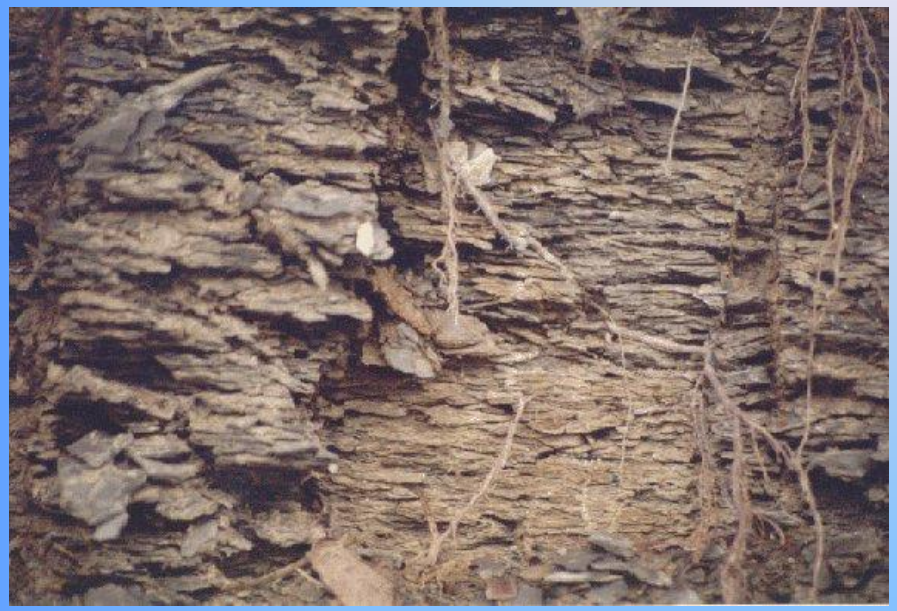
Shale

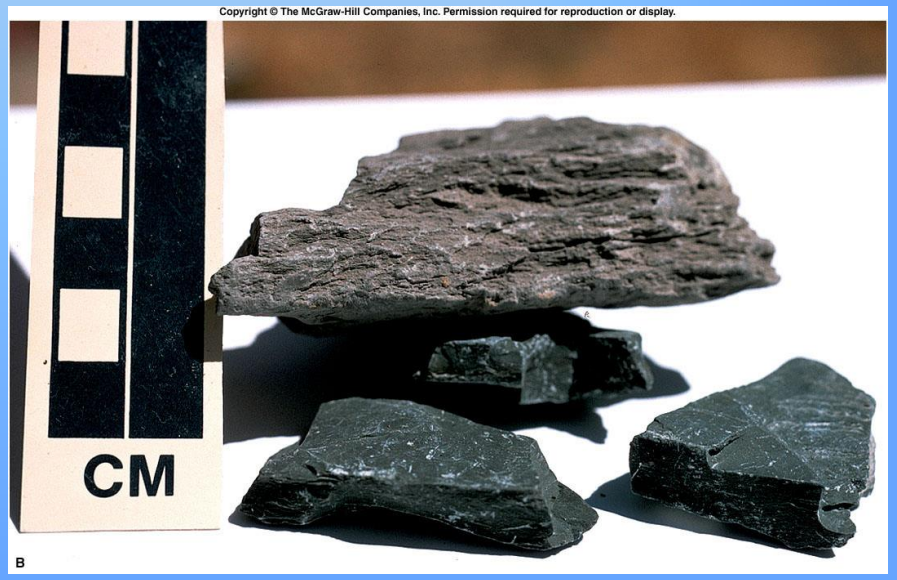
a) Fine-grained

b) Noted for **fissility** (splitting into thin layers).



Fissile Shale





Shale

c) Actually contains both silt and clay. Because clay is 2/3 the volume, it is often classified by its smallest sized particles (as in the *Earth Science Reference Tables*)

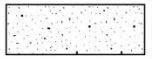
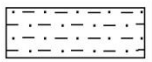
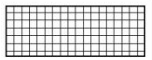
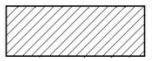
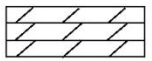
d) **Claystone** is rock composed of predominantly clay-sized particles.

e) **Mudstone** contains both silt and clay. It has the same feel as shale but *lacks its fissility.*

2. Chemical Sedimentary Rocks

Rocks formed by inorganic chemical processes
Referred to as *Crystalline* rocks in the ESRT.

Scheme for Sedimentary Rock Identification

INORGANIC LAND-DERIVED SEDIMENTARY ROCKS					
TEXTURE	**GRAIN SIZE**	**COMPOSITION**	**COMMENTS**	**ROCK NAME**	**MAP SYMBOL**
Clastic (fragmental)	Pebbles, cobbles, and/or boulders embedded in sand, silt, and/or clay	Mostly quartz, feldspar, and clay minerals; may contain fragments of other rocks and minerals	Rounded fragments	**Conglomerate**	
			Angular fragments	**Breccia**	
	Sand (0.006 to 0.2 cm)		Fine to coarse	**Sandstone**	
	Silt (0.0004 to 0.006 cm)		Very fine grain	**Siltstone**	
	Clay (less than 0.0004 cm)		Compact; may split easily	**Shale**	
CHEMICALLY AND/OR ORGANICALLY FORMED SEDIMENTARY ROCKS					
TEXTURE	**GRAIN SIZE**	**COMPOSITION**	**COMMENTS**	**ROCK NAME**	**MAP SYMBOL**
Crystalline	Fine to coarse crystals	Halite	Crystals from chemical precipitates and evaporites	**Rock salt**	
		Gypsum		**Rock gypsum**	
		Dolomite		**Dolostone**	
Crystalline or bioclastic	Microscopic to very coarse	Calcite	Precipitates of biologic origin or cemented shell fragments	**Limestone**	
Bioclastic		Carbon	Compacted plant remains	**Bituminous coal**	

- Formed from **precipitation** of minerals from water.
- All have a **crystalline** texture.

a) **Evaporites**

a) Examples **Gypsum, rock salt**

b) Formed from evaporating seawater or from a saline lake.

b) **Carbonates**

Contain **CO_3** as part of their chemical composition. The two main types of carbonates are **limestone** and **dolostone**.

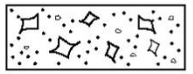
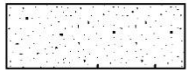
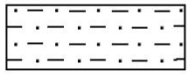
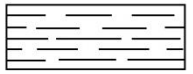
i. Limestones formed Inorganically

- Since most limestones are formed either directly or indirectly by the action of living things, and because limestones formed *completely as a result of inorganic chemical process* do not make up a great volume of sedimentary rocks, they are not included as a separate category (chemical limestones) in the *Earth Science Reference Tables*.

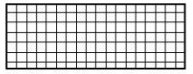
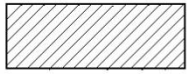
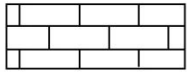
- However, limestone can be precipitated directly as the result of inorganic processes and are included in the group of chemically formed sedimentary rocks by many geologists.

Scheme for Sedimentary Rock Identification

INORGANIC LAND-DERIVED SEDIMENTARY ROCKS

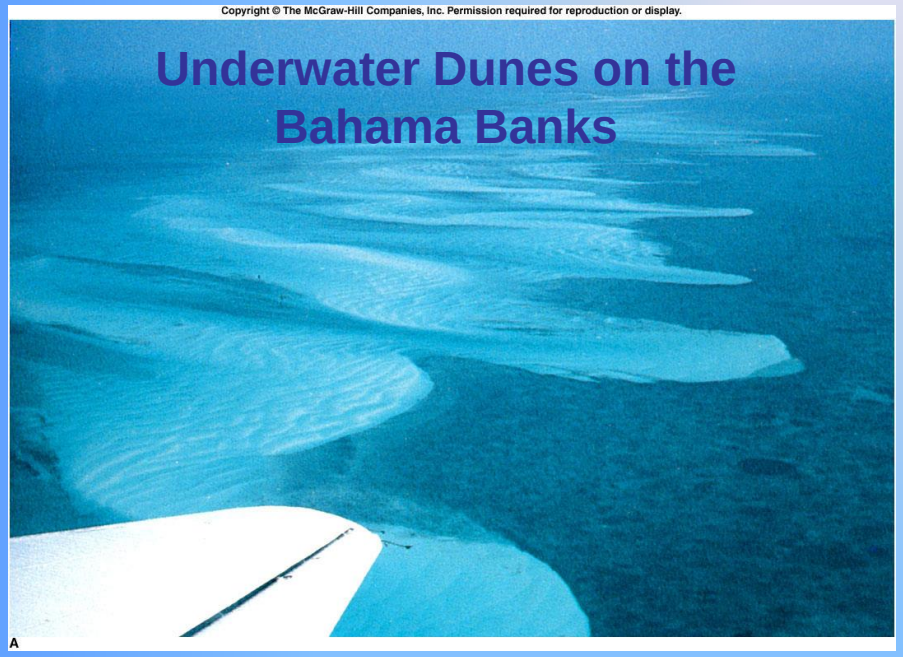
TEXTURE	GRAIN SIZE	COMPOSITION	COMMENTS	ROCK NAME	MAP SYMBOL
Clastic (fragmental)	Pebbles, cobbles, and/or boulders embedded in sand, silt, and/or clay	Mostly quartz, feldspar, and clay minerals; may contain fragments of other rocks and minerals	Rounded fragments	**Conglomerate**	
			Angular fragments	**Breccia**	
	Sand (0.006 to 0.2 cm)		Fine to coarse	**Sandstone**	
	Silt (0.0004 to 0.006 cm)		Very fine grain	**Siltstone**	
	Clay (less than 0.0004 cm)		Compact; may split easily	**Shale**	

CHEMICALLY AND/OR ORGANICALLY FORMED SEDIMENTARY ROCKS

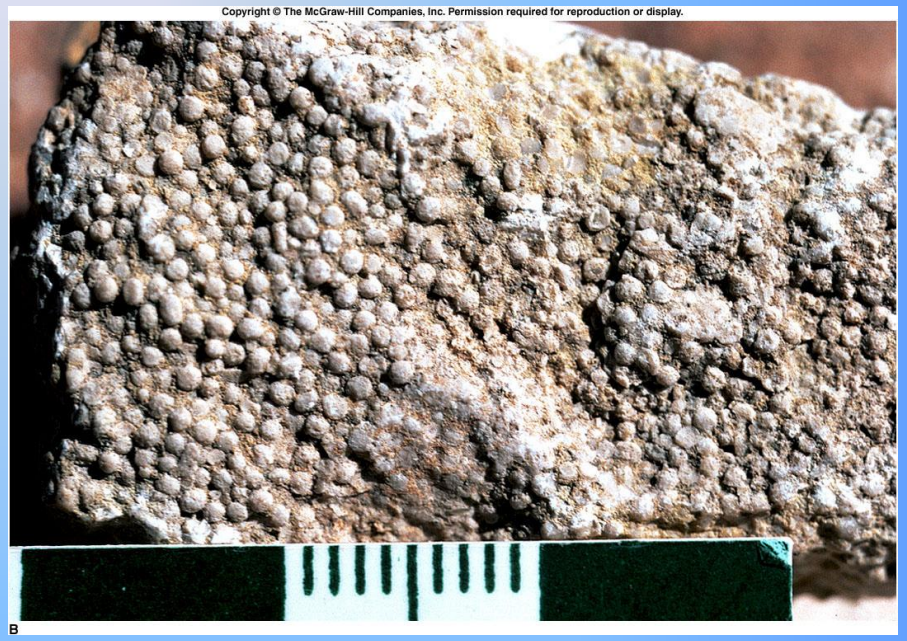
TEXTURE	GRAIN SIZE	COMPOSITION	COMMENTS	ROCK NAME	MAP SYMBOL
Crystalline	Fine to coarse crystals	Halite	Crystals from chemical precipitates and evaporites	**Rock salt**	
		Gypsum		**Rock gypsum**	
		Dolomite		**Dolostone**	
Crystalline or bioclastic	Microscopic to very coarse	Calcite	Precipitates of biologic origin or cemented shell fragments	**Limestone**	
Bioclastic		Carbon	Compacted plant remains	**Bituminous coal**	

- **Types of Limestone formed by inorganic chemical processes include:**

Oolitic Limestone



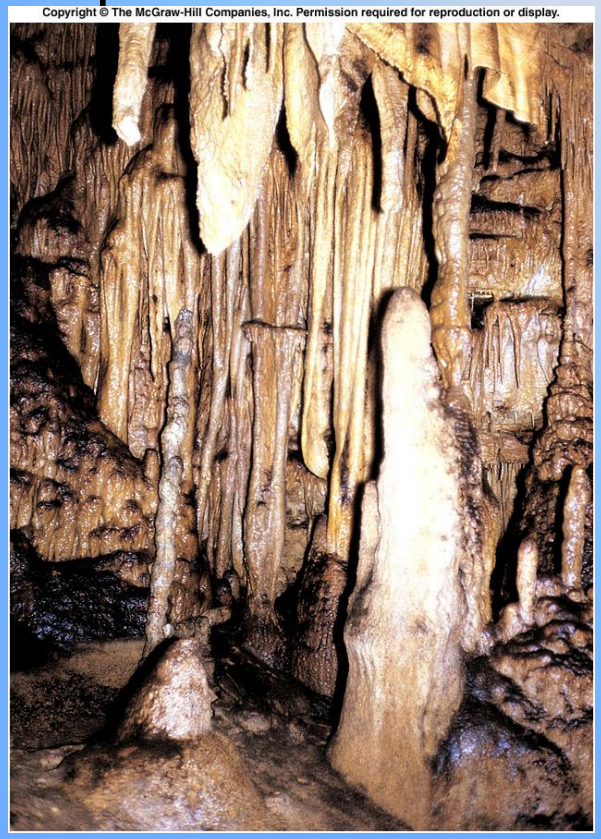
Aerial Photograph



- Cementation of small sand-sized calcite spheres precipitated directly from seawater
- Tidal currents and wave action rolls them back resulting in a nearly spherical shape as the grow.

Travertine (Chemical Limestone)

- Forms from fresh water in caves and in hot springs when droplets of carbonate-rich water lose CO_2.

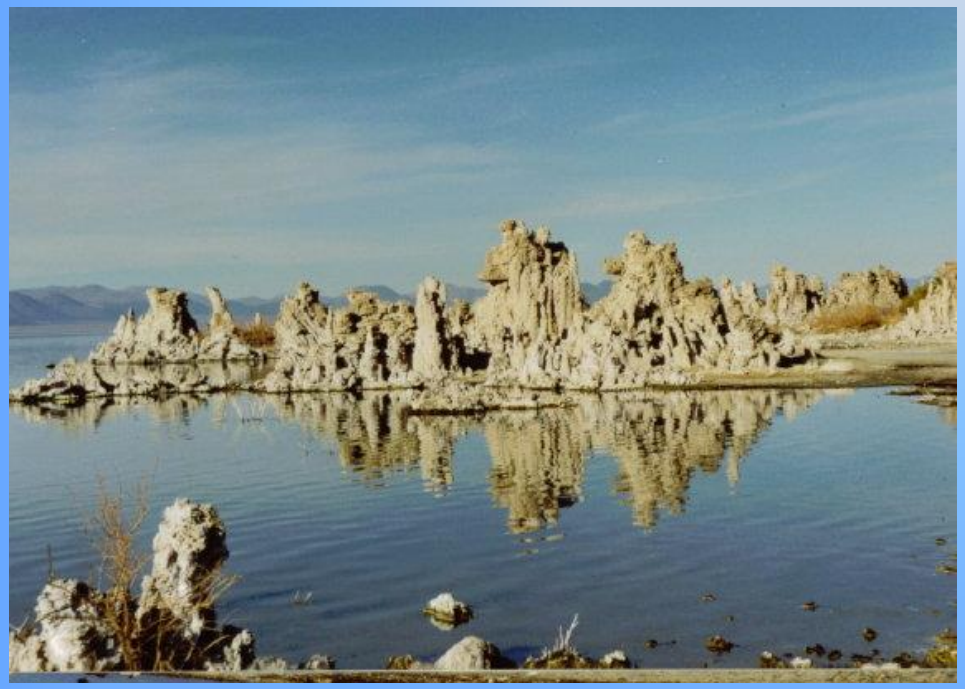


Great Onyx Cave
Kentucky

Mammoth Hot Spring
Yellow Stone National Park

Tufa (Chemical Limestone)

- Precipitated in the fresh water of a continental spring or lake



Tufa at Mono Lake, California

ii. **Dolostone** (also called *dolomite*)

a. Forms from limestone as calcium in calcite is partially replaced by magnesium as water solutions move through the limestone.

Mg^{++} + $2\ CaCO_3$ ⟶ $CaMg(CO_3)_2$ + Ca^{++}

Magnesium in solution ***calcite*** ***dolomite*** ***calcium in solution***

b. Mg-rich brines from surface evaporation trickle through existing limestone layers.

c. Chemical reactions at the boundary between seawater and fresh underground water.

3. Bioclastic (Organically formed) Sedimentary Rocks)

a) Limestones (Biochemical)

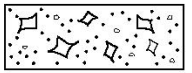
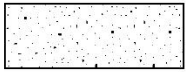
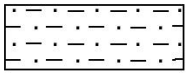
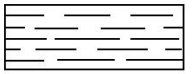
i. These are carbonate rocks (contain CO_3 as part of their chemical composition)

ii. Precipitated through the actions of organisms (such as algae and corals) on continental shelves in warm, shallow water.

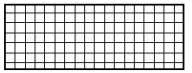
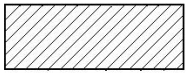
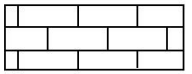
iii. These rocks have a crystalline texture and contain fossil remains of the organisms still in their growth positions.

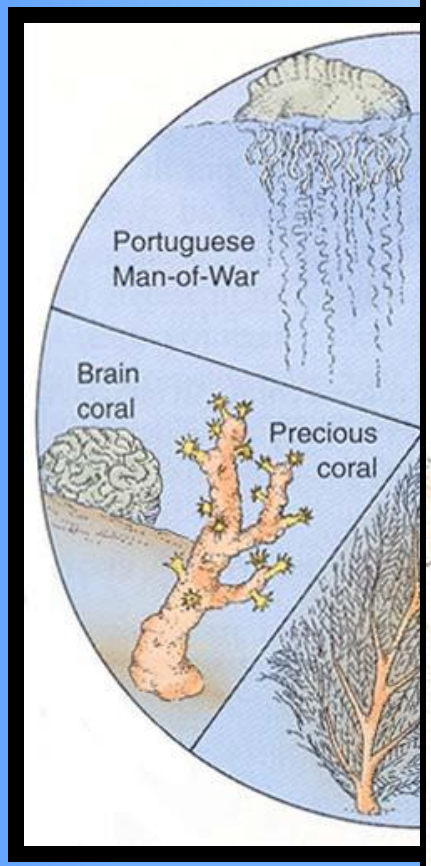
Scheme for Sedimentary Rock Identification

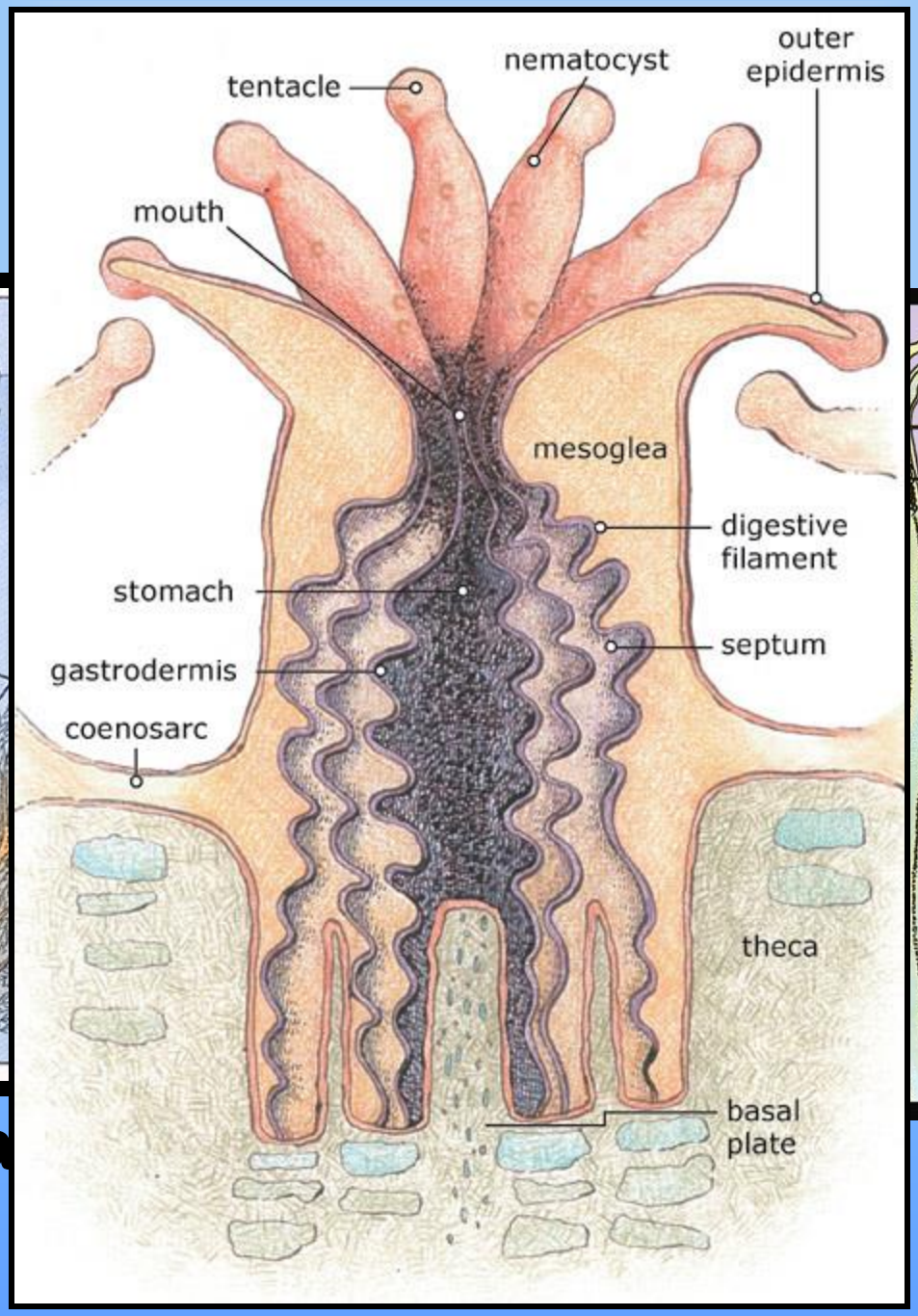
INORGANIC LAND-DERIVED SEDIMENTARY ROCKS

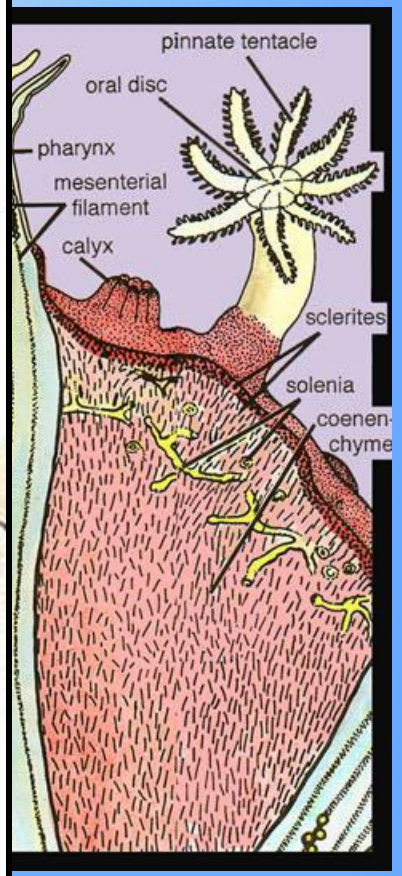
TEXTURE	GRAIN SIZE	COMPOSITION	COMMENTS	ROCK NAME	MAP SYMBOL
Clastic (fragmental)	Pebbles, cobbles, and/or boulders embedded in sand, silt, and/or clay	Mostly quartz, feldspar, and clay minerals; may contain fragments of other rocks and minerals	Rounded fragments	**Conglomerate**	
			Angular fragments	**Breccia**	
	Sand (0.006 to 0.2 cm)		Fine to coarse	**Sandstone**	
	Silt (0.0004 to 0.006 cm)		Very fine grain	**Siltstone**	
	Clay (less than 0.0004 cm)		Compact; may split easily	**Shale**	

CHEMICALLY AND/OR ORGANICALLY FORMED SEDIMENTARY ROCKS

TEXTURE	GRAIN SIZE	COMPOSITION	COMMENTS	ROCK NAME	MAP SYMBOL
Crystalline	Fine to coarse crystals	Halite	Crystals from chemical precipitates and evaporites	**Rock salt**	
		Gypsum		**Rock gypsum**	
		Dolomite		**Dolostone**	
Crystalline or bioclastic	Microscopic to very coarse	Calcite	Precipitates of biologic origin or cemented shell fragments	**Limestone**	
Bioclastic		Carbon	Compacted plant remains	**Bituminous coal**	


Portuguese
Man-of-War
Brain
coral
Precious
coral

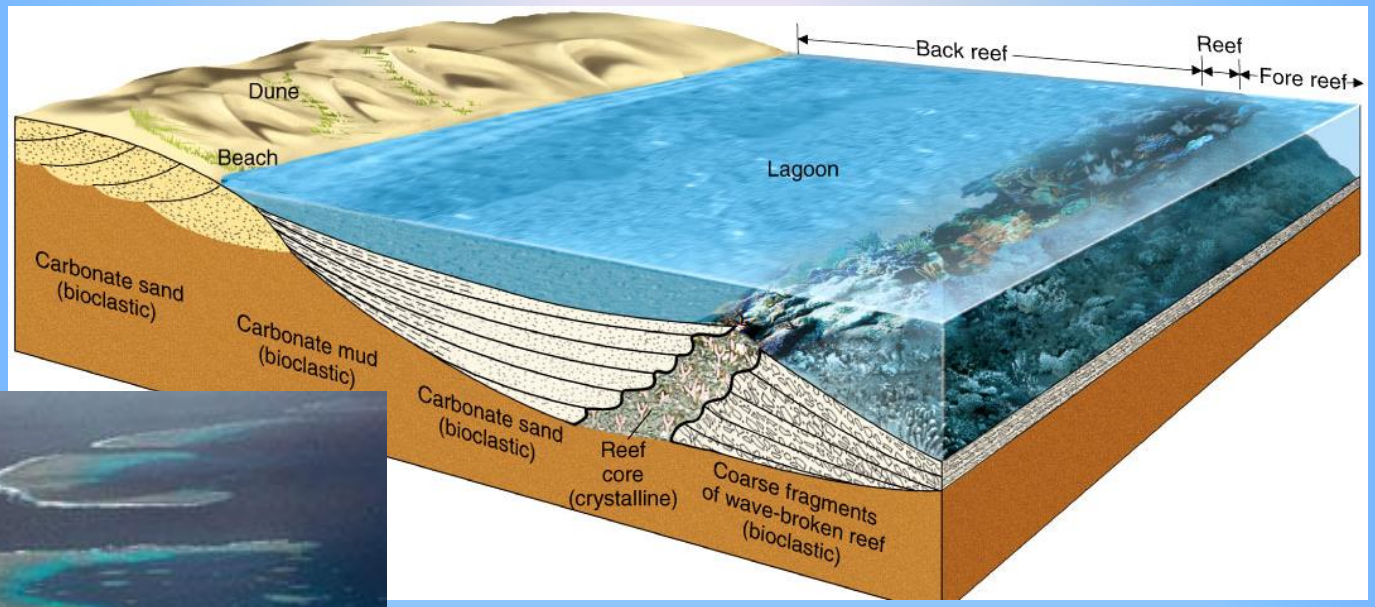

tentacle
nematocyst
outer
epidermis
mouth
mesoglea
digestive
filament
stomach
septum
gastrodermis
coenosarc
theca
basal
plate


pinnate tentacle
oral disc
pharynx
mesenterial
filament
calyx
sclerites
solenia

Cnida

Coral Limestone

Barrier Reefs



Great Barrier Reef
Australia

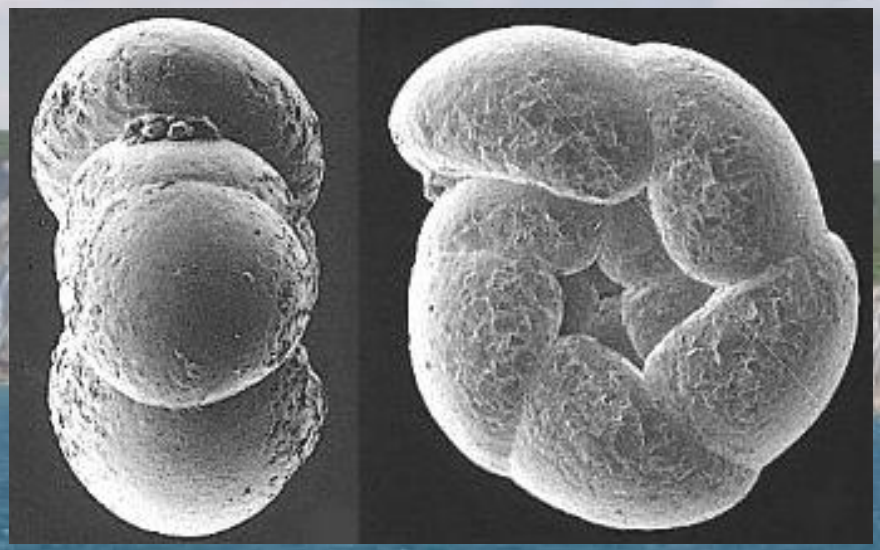
b) Limestones (Skeletal)

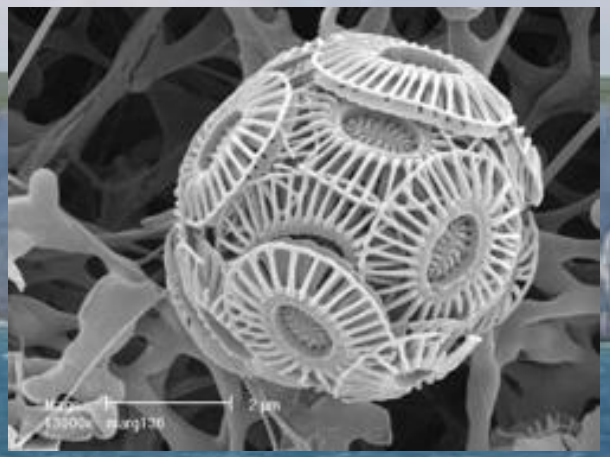
- Formed from wave-broken fragments of shells, corals, and algae.
  i. **Coquina**: Coarse-grained with recognizable fossils shell fragments

ii. **Chalk**: Fine-grained, light colored, and porous from **microscopic** marine organisms (plankton).

White Cliffs of Dover
Kent, England

Coccolithophorids (Coccoliths)

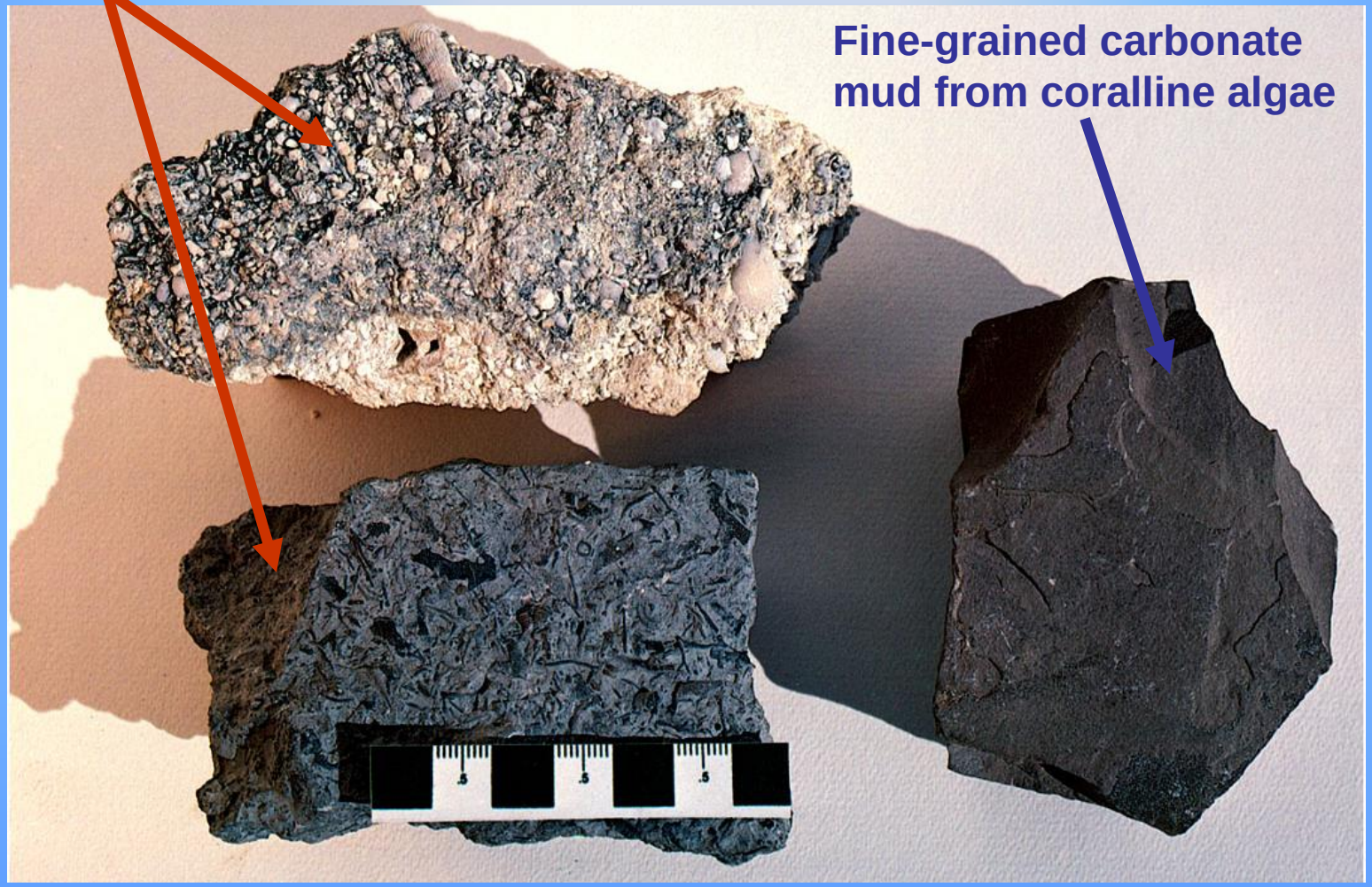




- Primary constituent of chalk in the White Cliffs of Dover
- Calcareous platelets
- Secreted by yellow-green algae
- Extremely small

Bioclastic Limestone

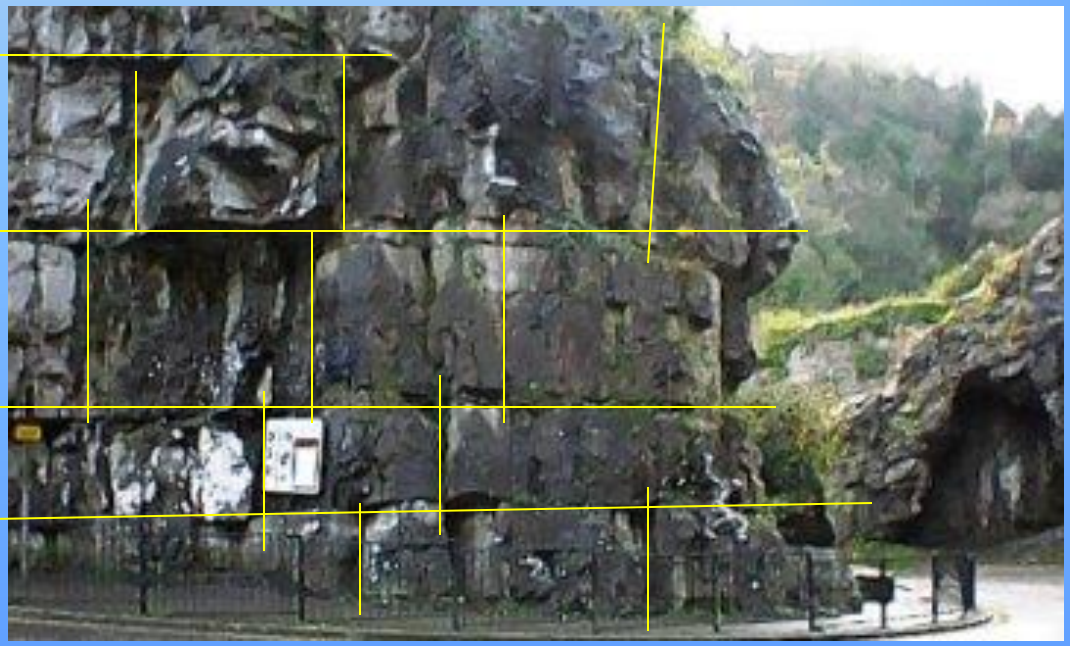
Coarse-grained with
shell and coral fragments



Limestone

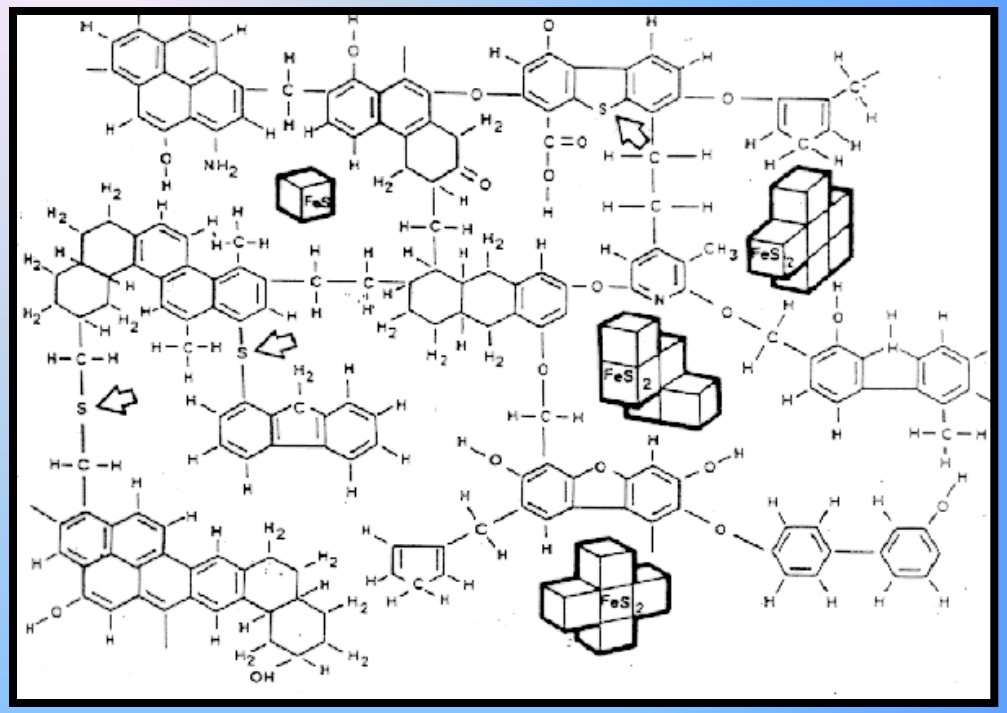
- Limestone ridge in the Canadian Rockies

- Limestone in France



c. Coal

Bituminous Coal

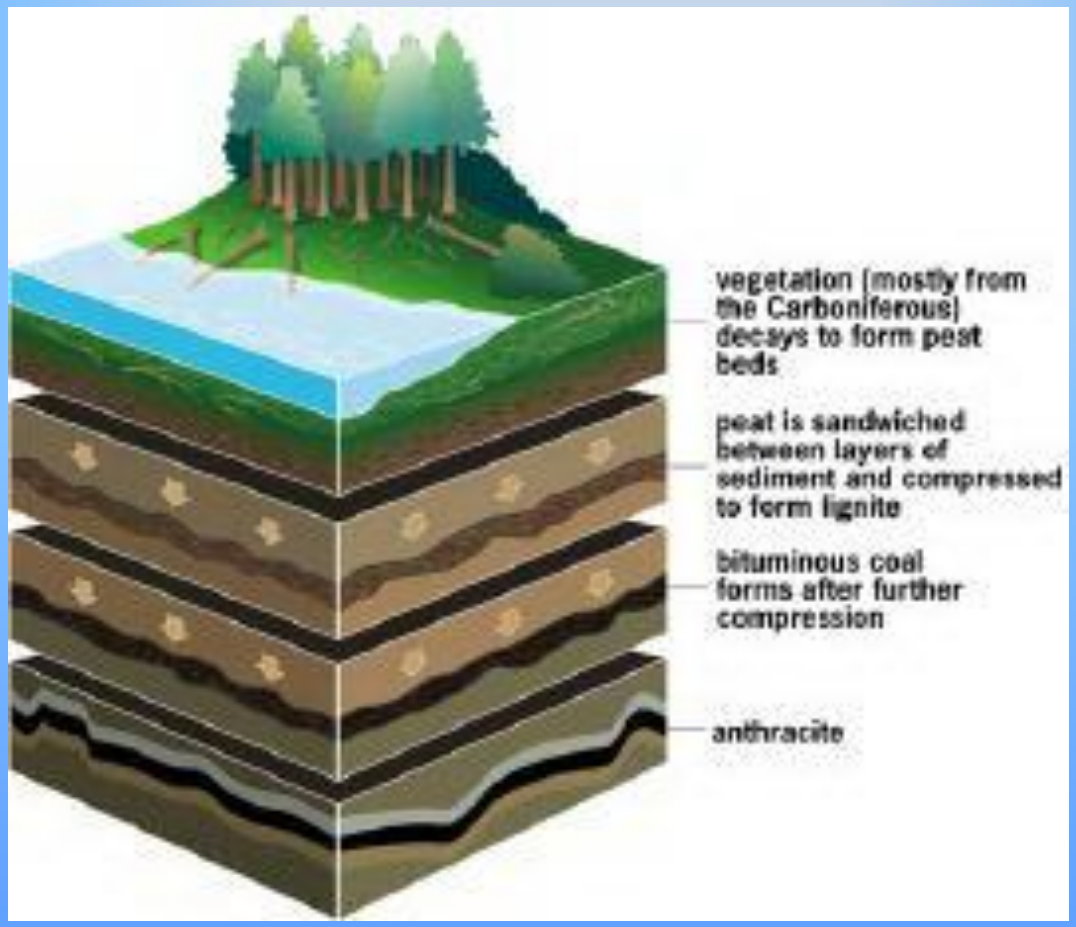


Representative structure of bituminous Coal showing sulfur linkages and the presence of iron pyrite FeS_2

- Forms from the compaction of plant material that has not completely decayed.

Coal Formation

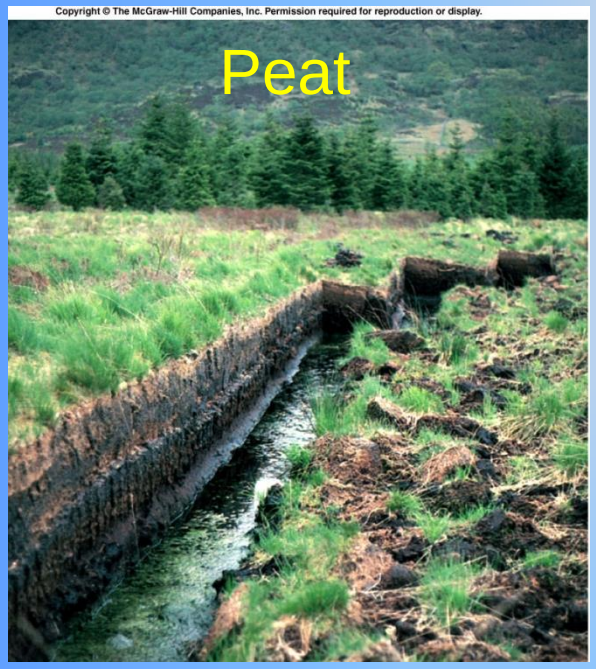
- **Environment of deposition: Shallow swamps in a temperate or tropical climate that have rapid plant growth and water with a low oxygen content.**

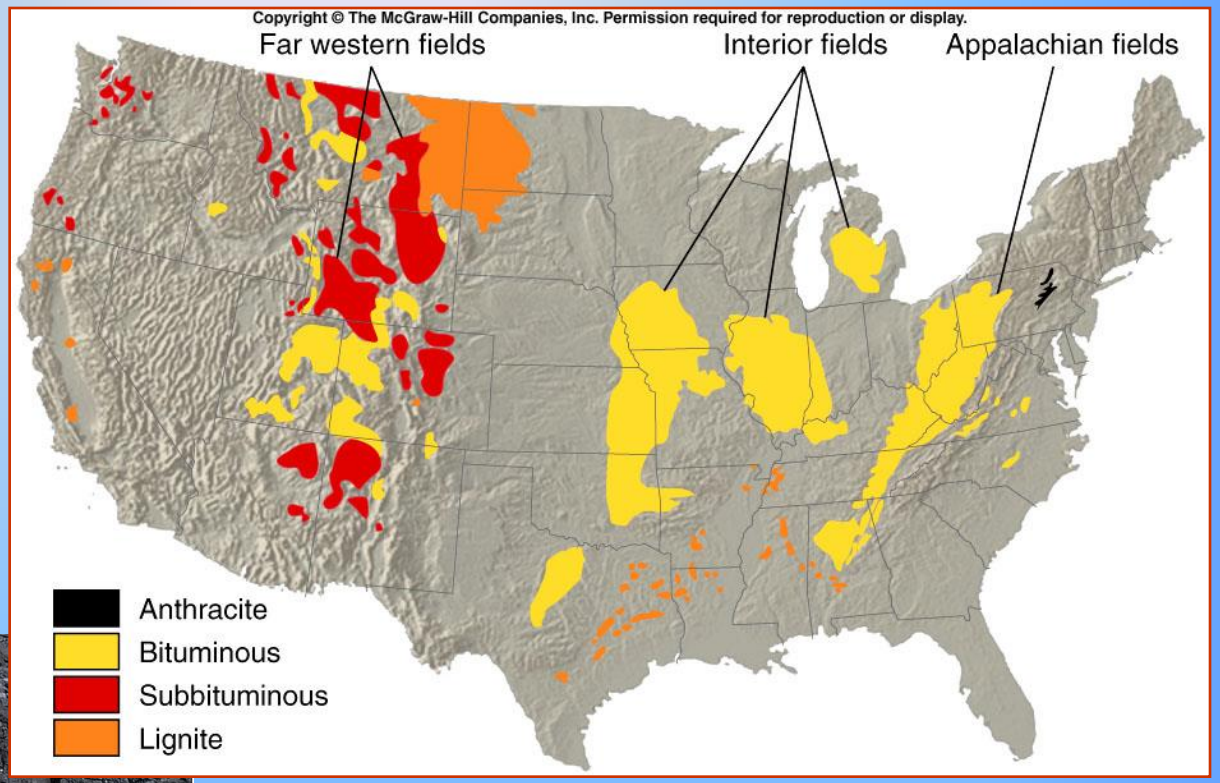


Variations of Coal

ii Several … of original plant material and the degree of compaction (peat, lignite, bituminous). Anthracite is a metamorphic grade of coal

Coal

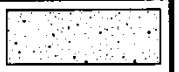




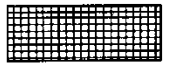
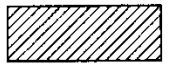
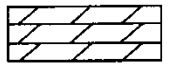
Identifying Sedimentary Rocks

Scheme for Sedimentary Rock Identification

INORGANIC LAND-DERIVED SEDIMENTARY ROCKS

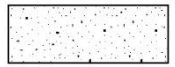
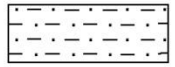
TEXTURE	GRAIN SIZE	COMPOSITION	COMMENTS	ROCK NAME	MAP SYMBOL
Clastic (fragmental)	Pebbles, cobbles, and/or boulders embedded in sand, silt, and/or clay	Mostly quartz, feldspar, and clay minerals; may contain fragments of other rocks and minerals	Rounded fragments	Conglomerate	
			Angular fragments	Breccia	
	Sand (0.2 to 0.006 cm)		Fine to coarse	Sandstone	
	Silt (0.006 to 0.0004 cm)		Very fine grain	Siltstone	
	Clay (less than 0.0004 cm)		Compact; may split easily	Shale	

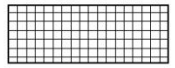
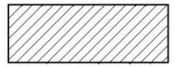
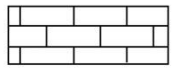
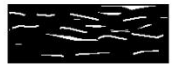
CHEMICALLY AND/OR ORGANICALLY FORMED SEDIMENTARY ROCKS

TEXTURE	GRAIN SIZE	COMPOSITION	COMMENTS	ROCK NAME	MAP SYMBOL
Crystalline	Varied	Halite	Crystals from chemical precipitates and evaporites	Rock Salt	
	Varied	Gypsum		Rock Gypsum	
	Varied	Dolomite		Dolostone	
Bioclastic	Microscopic to coarse	Calcite	Cemented shell fragments or precipitates of biologic origin	Limestone	
	Varied	Carbon	From plant remains	Coal	

Identifying Sedimentary Rocks

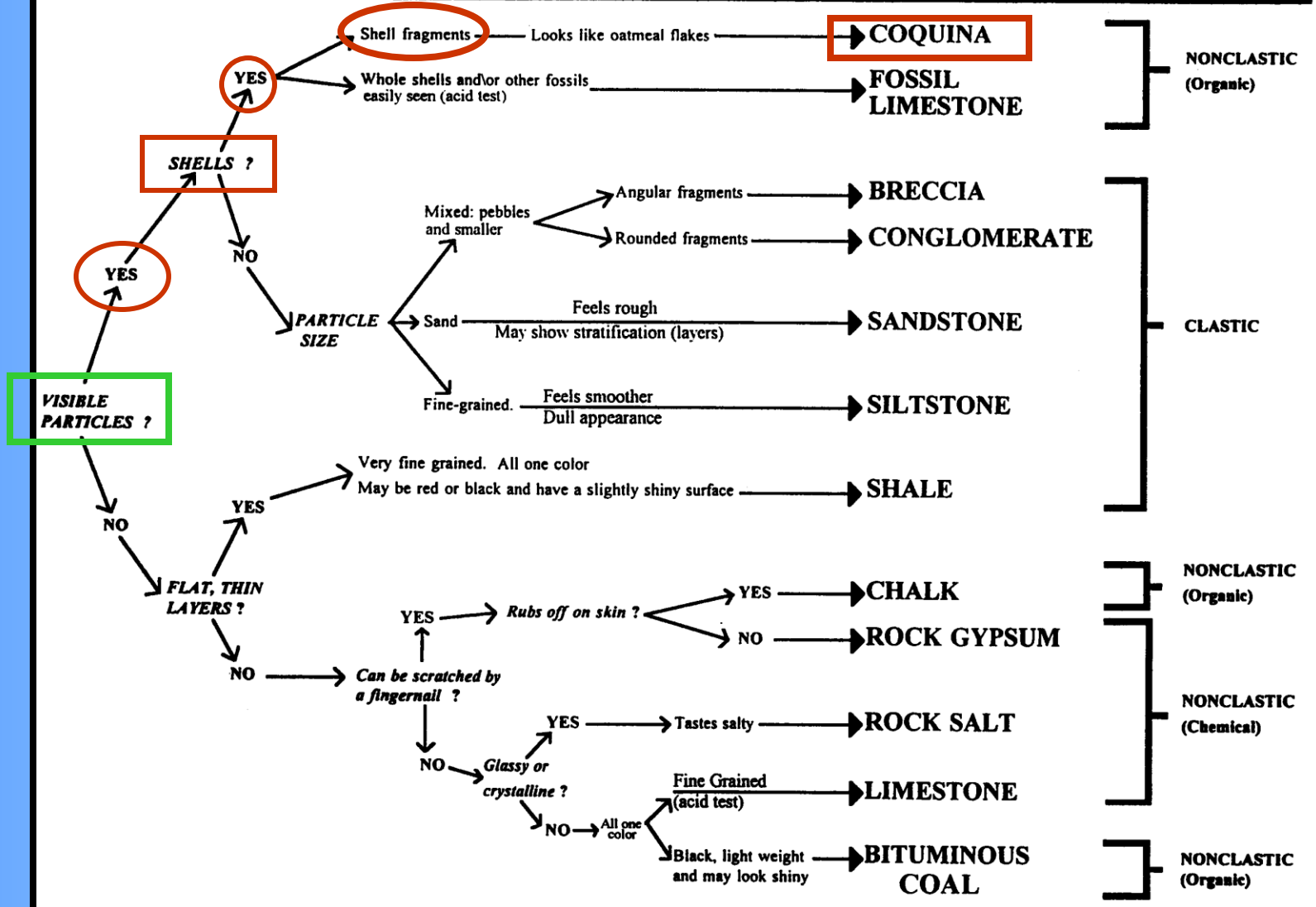
Scheme for Sedimentary Rock Identification

INORGANIC LAND-DERIVED SEDIMENTARY ROCKS					
TEXTURE	**GRAIN SIZE**	**COMPOSITION**	**COMMENTS**	**ROCK NAME**	**MAP SYMBOL**
Clastic (fragmental)	Pebbles, cobbles, and/or boulders embedded in sand, silt, and/or clay	Mostly quartz, feldspar, and clay minerals; may contain fragments of other rocks and minerals	Rounded fragments	**Conglomerate**	
			Angular fragments	**Breccia**	
	Sand (0.006 to 0.2 cm)		Fine to coarse	**Sandstone**	
	Silt (0.0004 to 0.006 cm)		Very fine grain	**Siltstone**	
	Clay (less than 0.0004 cm)		Compact; may split easily	**Shale**	

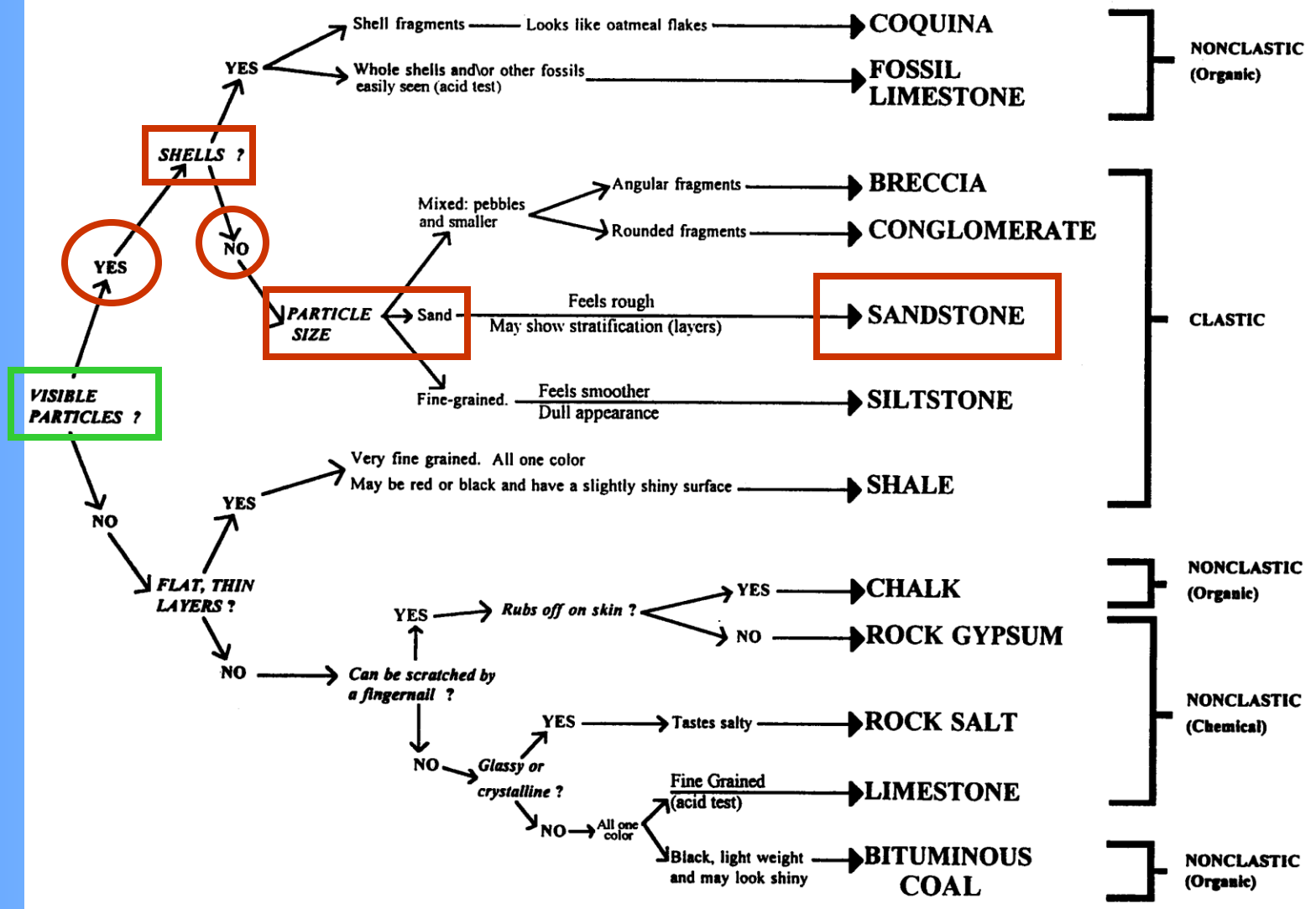
CHEMICALLY AND/OR ORGANICALLY FORMED SEDIMENTARY ROCKS					
TEXTURE	**GRAIN SIZE**	**COMPOSITION**	**COMMENTS**	**ROCK NAME**	**MAP SYMBOL**
Crystalline	Fine to coarse crystals	Halite	Crystals from chemical precipitates and evaporites	**Rock salt**	
		Gypsum		**Rock gypsum**	
		Dolomite		**Dolostone**	
Crystalline or bioclastic	Microscopic to very coarse	Calcite	Precipitates of biologic origin or cemented shell fragments	**Limestone**	
Bioclastic		Carbon	Compacted plant remains	**Bituminous coal**	

Considered "Nonclastic"

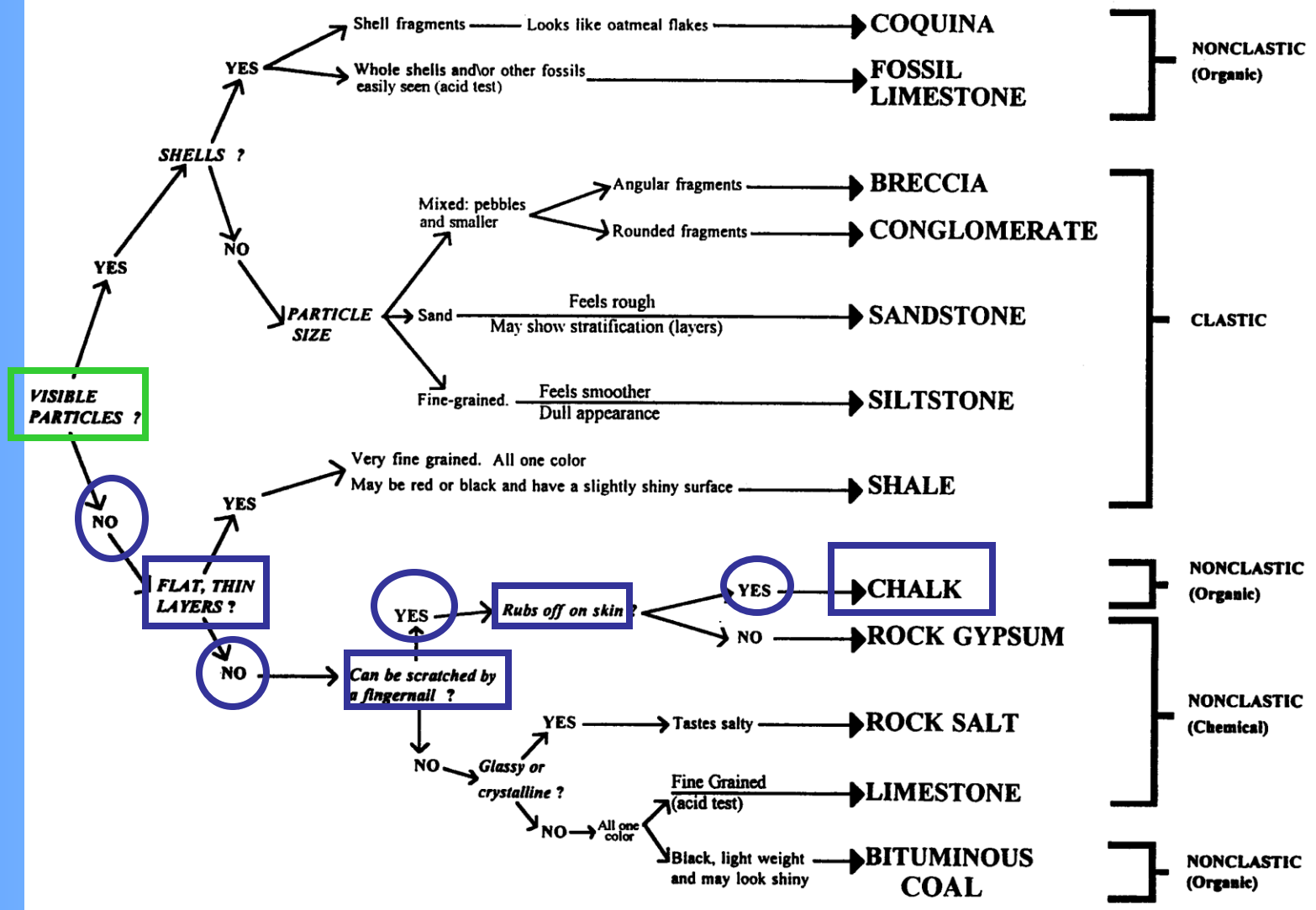
SEDIMENTARY ROCK IDENTIFICATION



SEDIMENTARY ROCK IDENTIFICATION



SEDIMENTARY ROCK IDENTIFICATION



C. Sedimentary Structures

- Features found within sedimentary rock

- Usually form during or shortly after deposition

1. Significance

    a) Important because they provide clues of past environments and methods of sediment transportation.

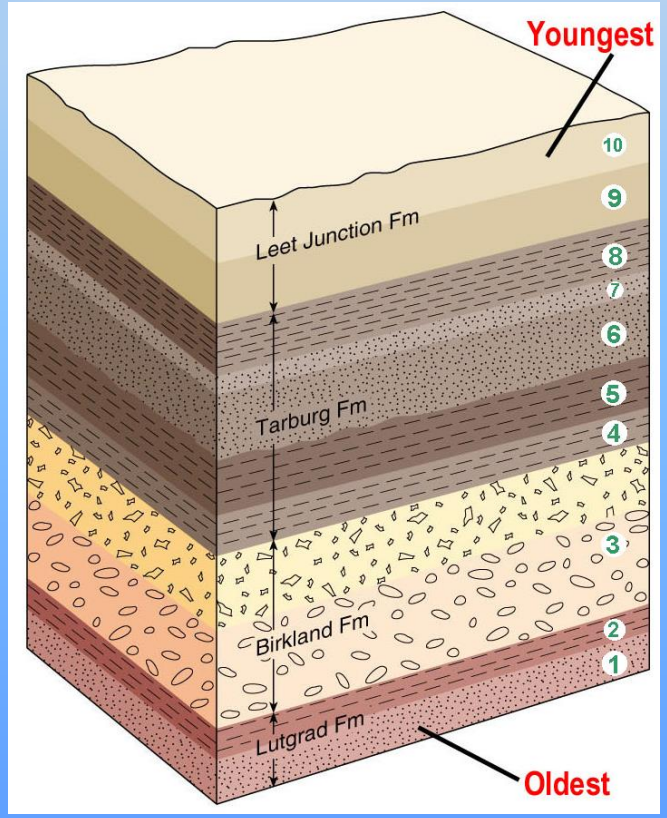
    b) May reveal the upward direction of deposition allowing for interpretation of the geometry of folded and faulted rocks in tectonically active regions.

2. Types of Sedimentary Structures

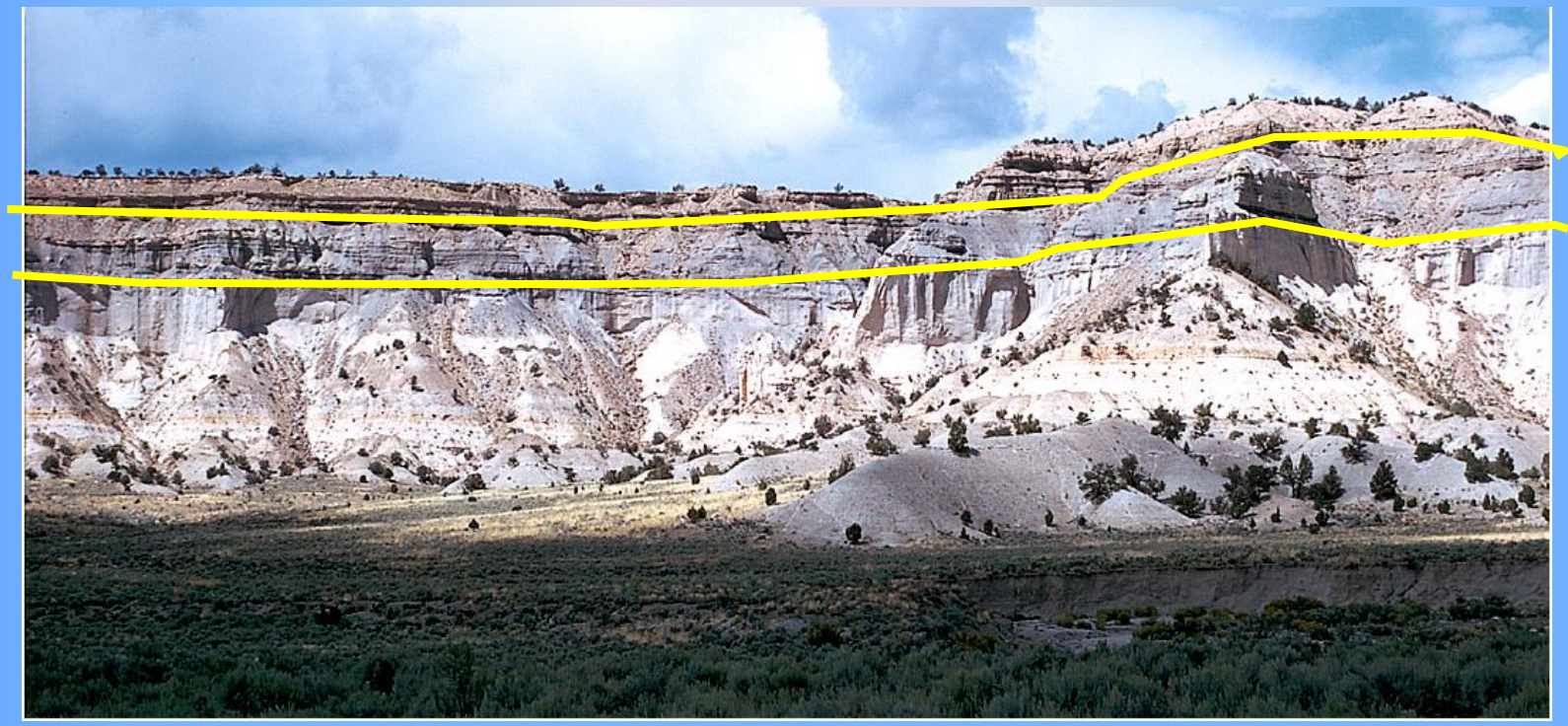
Also Referred to as *Primary Structures*

a) **Bedding**: A series of visible layers within a rock

i **Most are originally deposited as horizontal layers (Principle of Original Horizontality), and the oldest layers is usually on the bottom with the layers becoming younger upward (Principle of Superposition)**



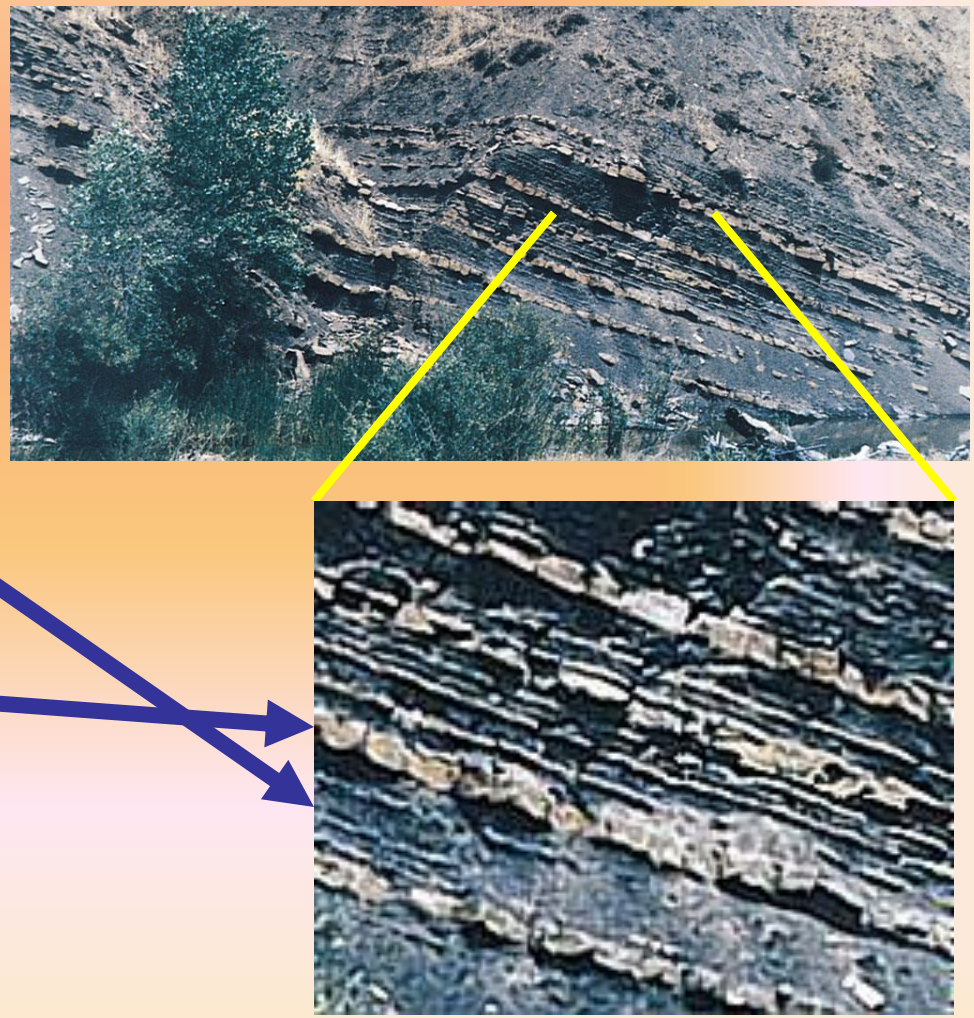
ii. **Bedding planes**: **Nearly flat surface of deposition separating two layers of rock.**



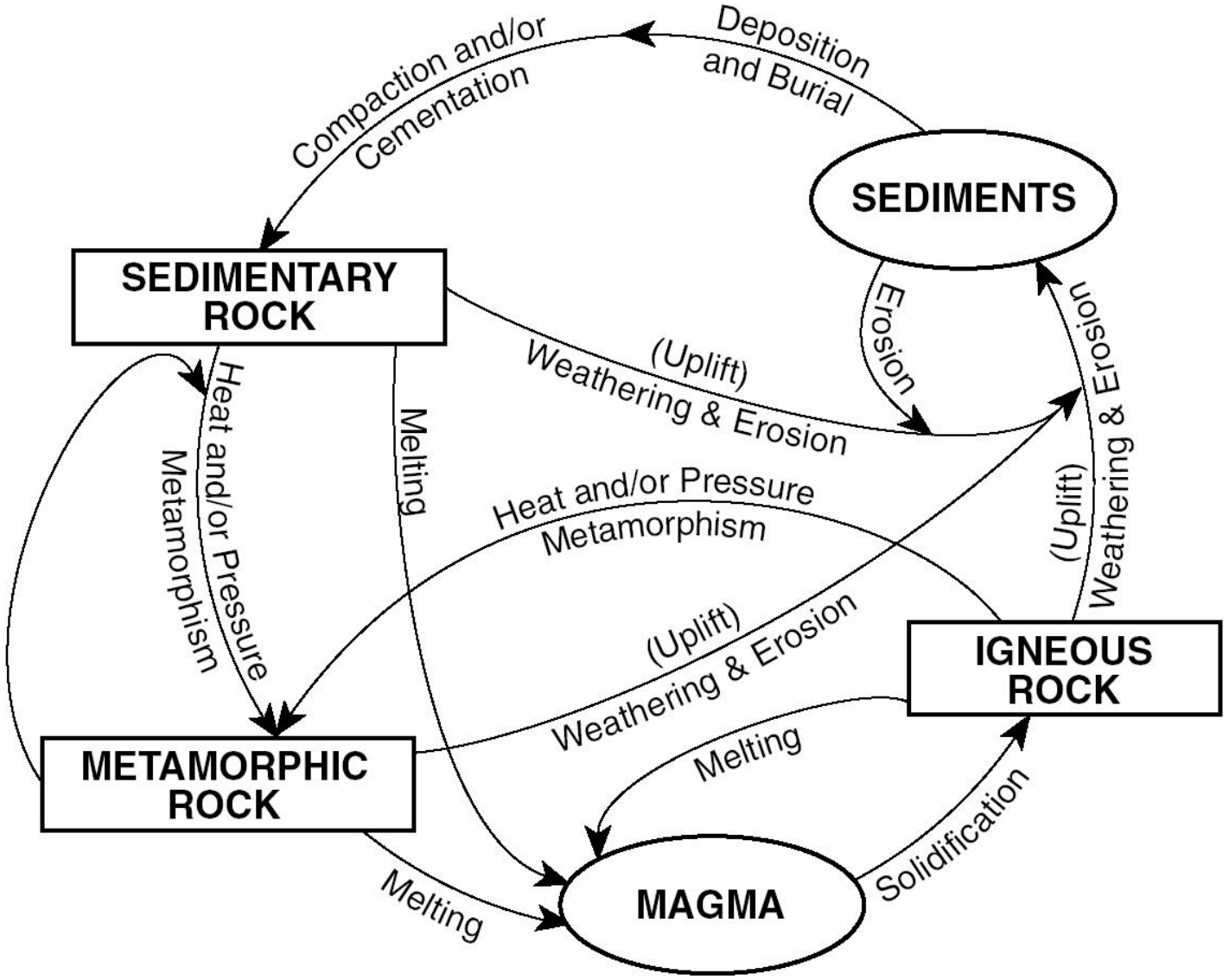
- **Contact**: The boundary surface between two different rock types or ages of rock. These are usually *bedding planes*.

Bedding

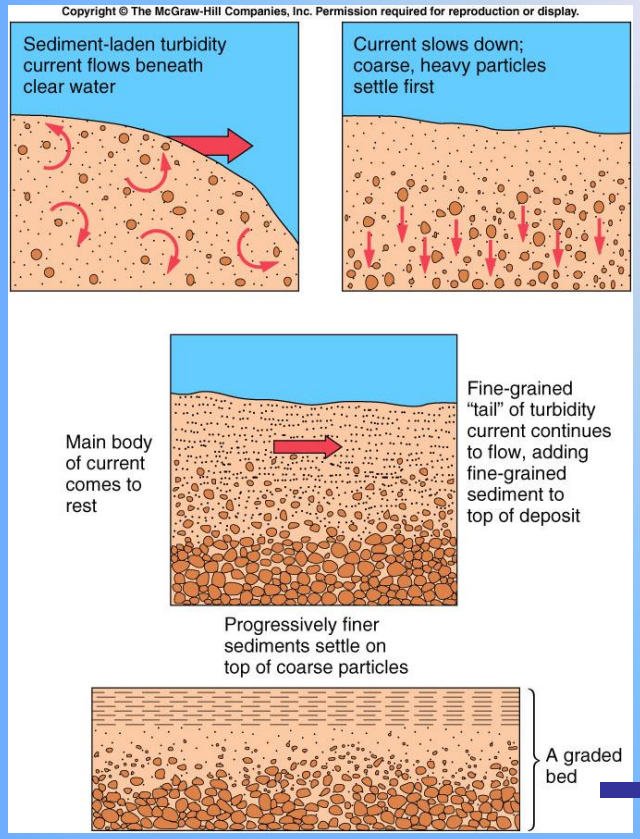
- Sedimentary rocks generally have bedding or stratification
  - Individual layers less than 1 cm thick are ***laminations***
    - common in mudrocks
  - ***Beds*** are thicker than 1 cm
    - common in rocks with coarser grains

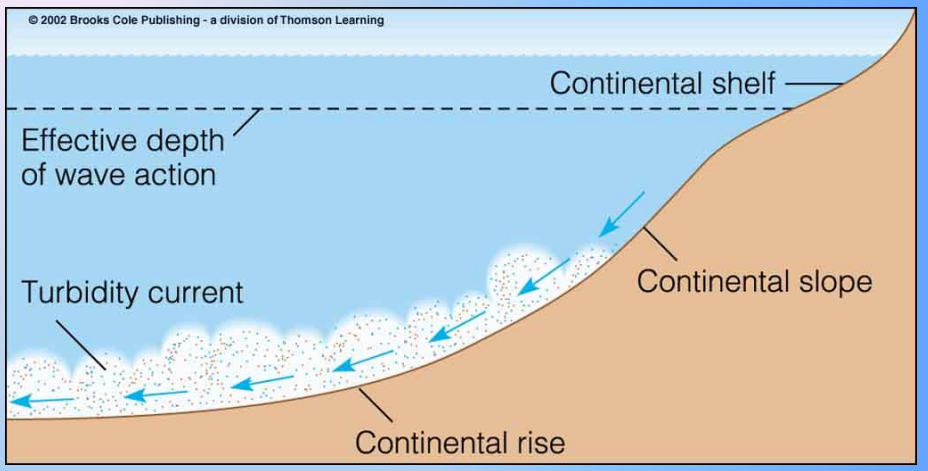


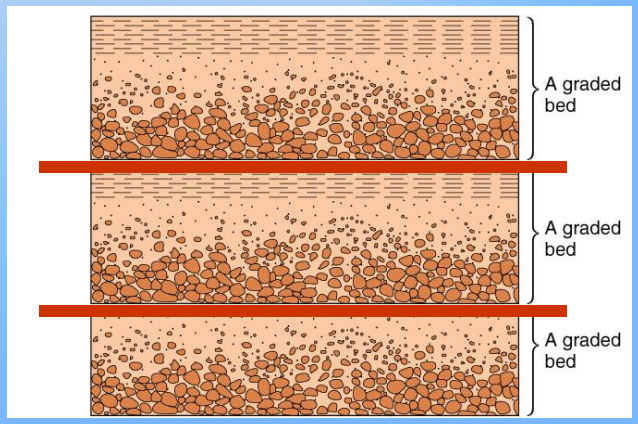
Rock Cycle in Earth's Crust



b. Graded Beds







i A layer with a **vertical** change in particle size (coarse to fine at the top).

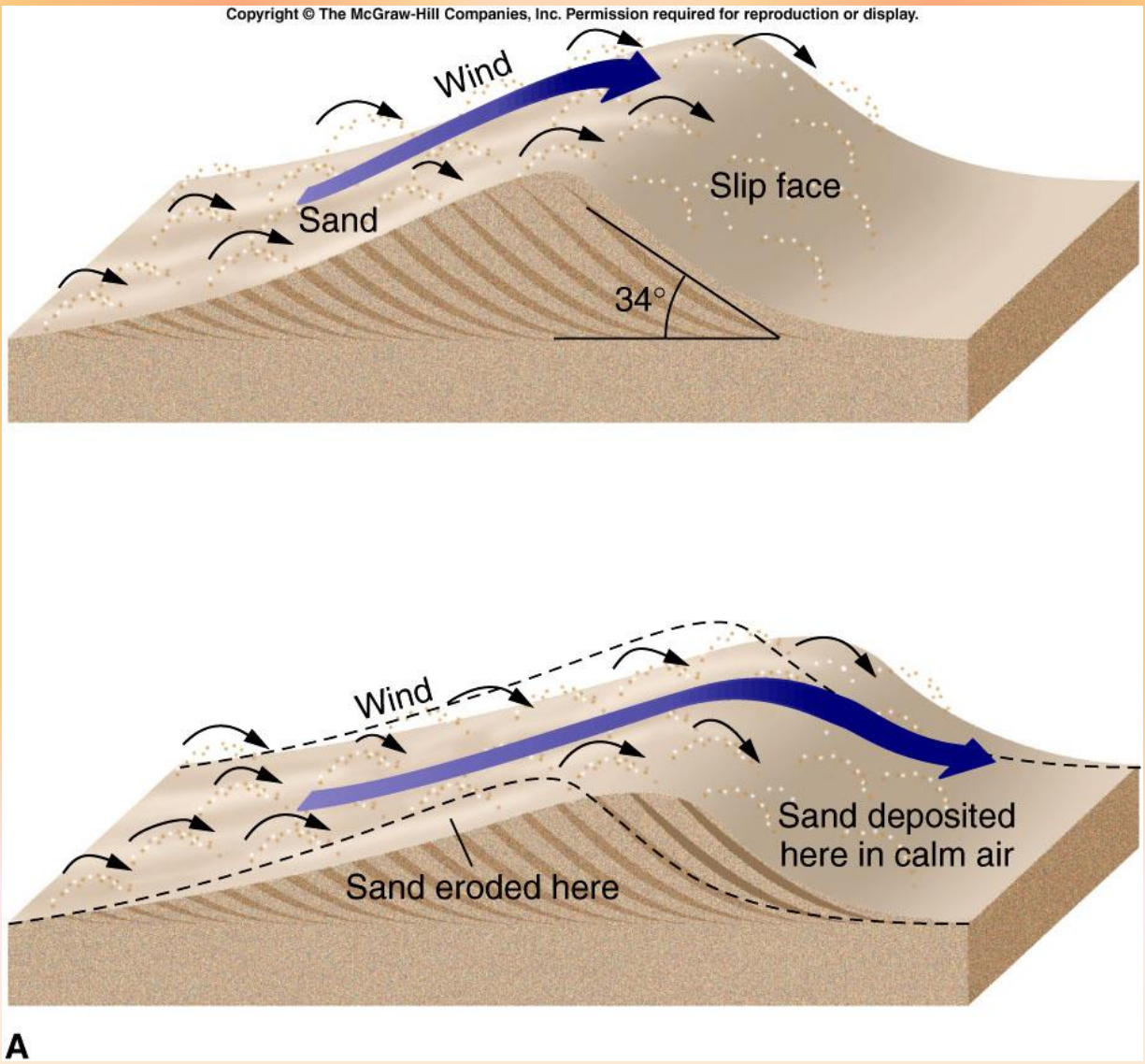
ii Most likely to occur in a **turbidity current**.

Graded Beds

c) Cross-Bedding

- A series of thin, inclined layers within a larger bed of rock.
- These layers form a distinct angle to the horizontal.
- Most common in sandstone

Cross-Bedding from Wind-Blown Sand

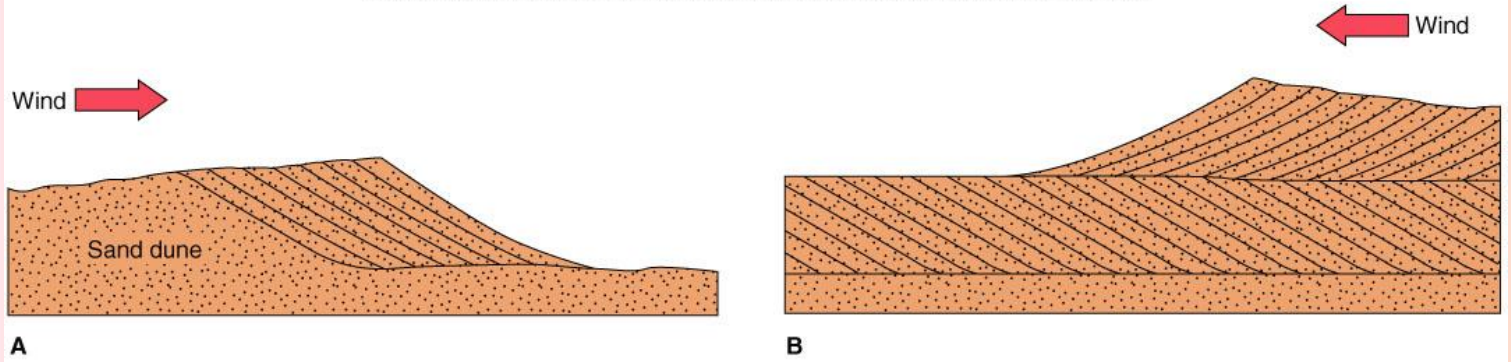


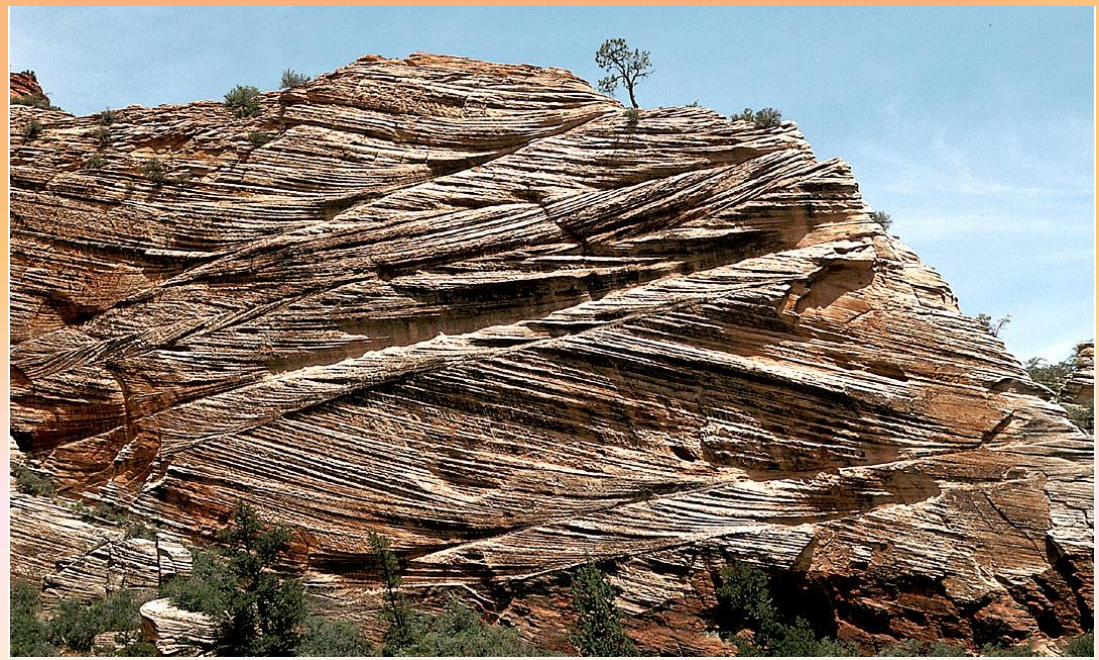
Sand Dunes

Coastal Dunes

Desert Dunes

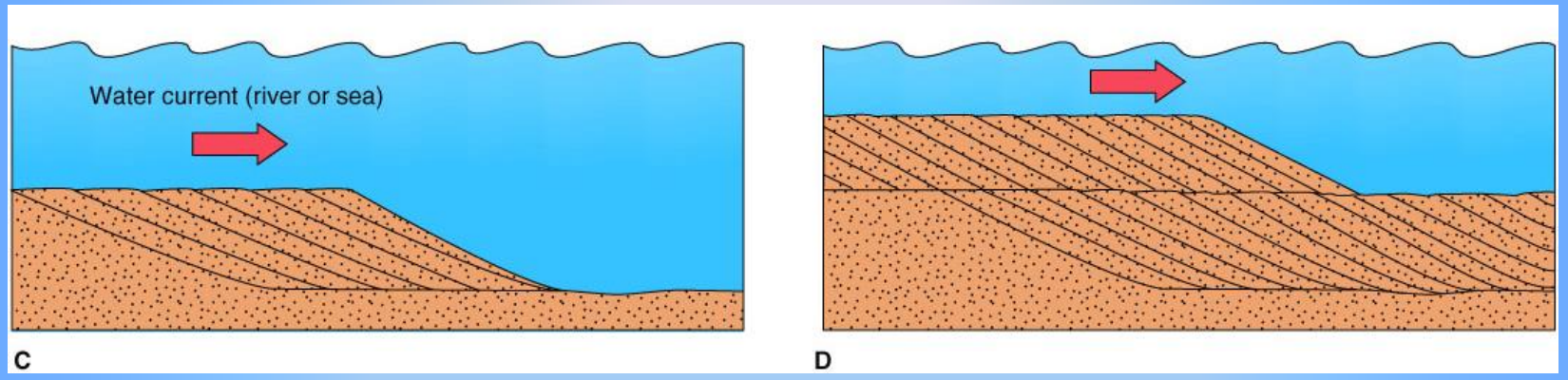
Cross-Bedding in Dunes

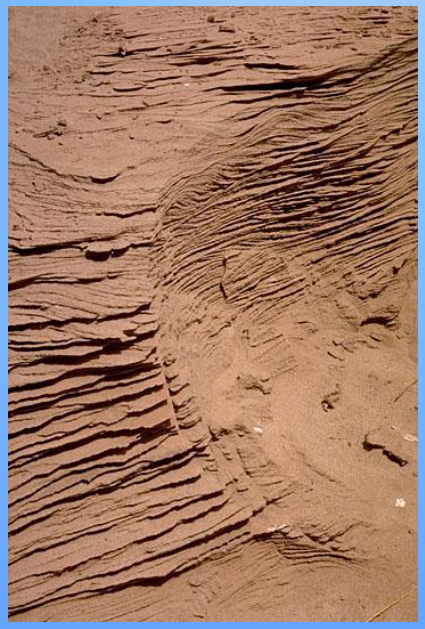




Zion National Park, UT

Cross-Bedding from a Water Current





d) Mudcracks

Mudcracks in recently dried mud

- Polygonal cracks formed in very fine-grained sediment as it dries.
- Only form in environments where sediment is exposed above water.
  - Tidal Flats
  - Lake bottoms as the lake dries up
  - Flood deposited sediment
  - Desert floors after rainfall

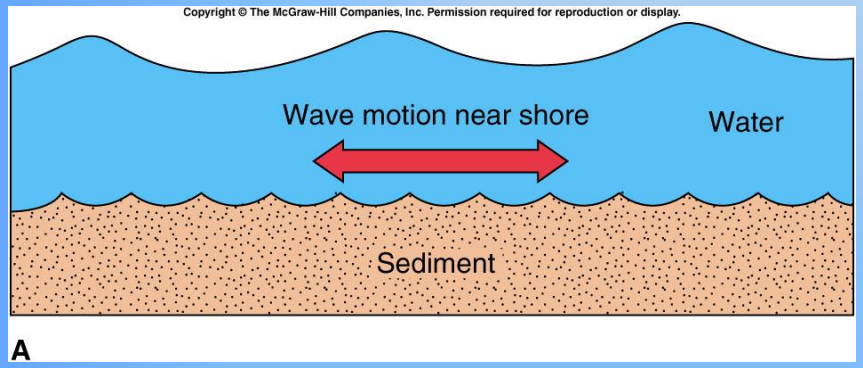
Mudcracks in Rocks

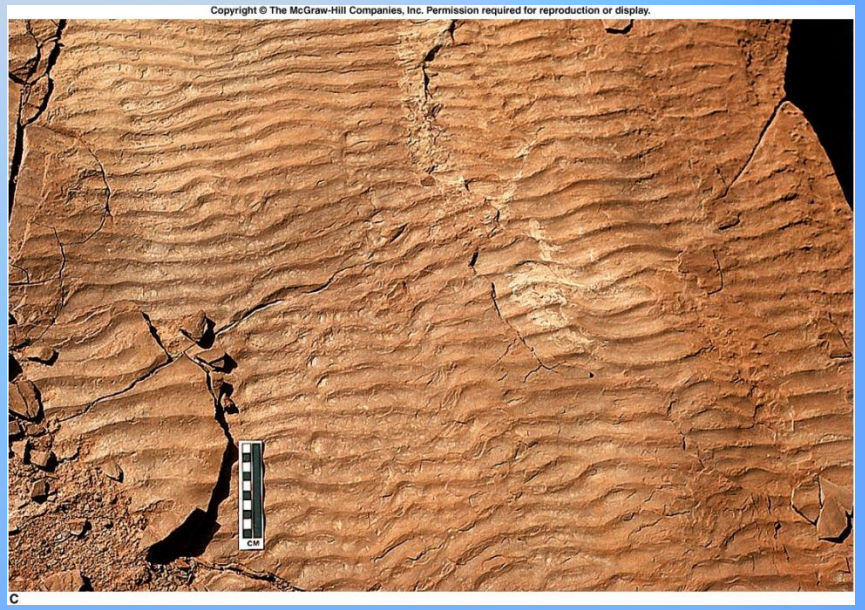
The cracks usually fill with sediment

e) **Ripple Marks**

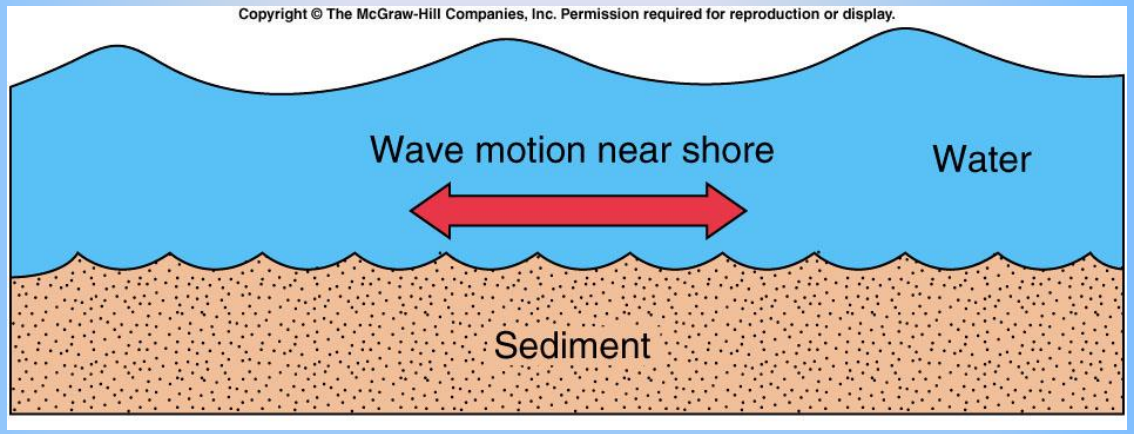
Small ridges formed on the surface of sediment by moving wind or water.

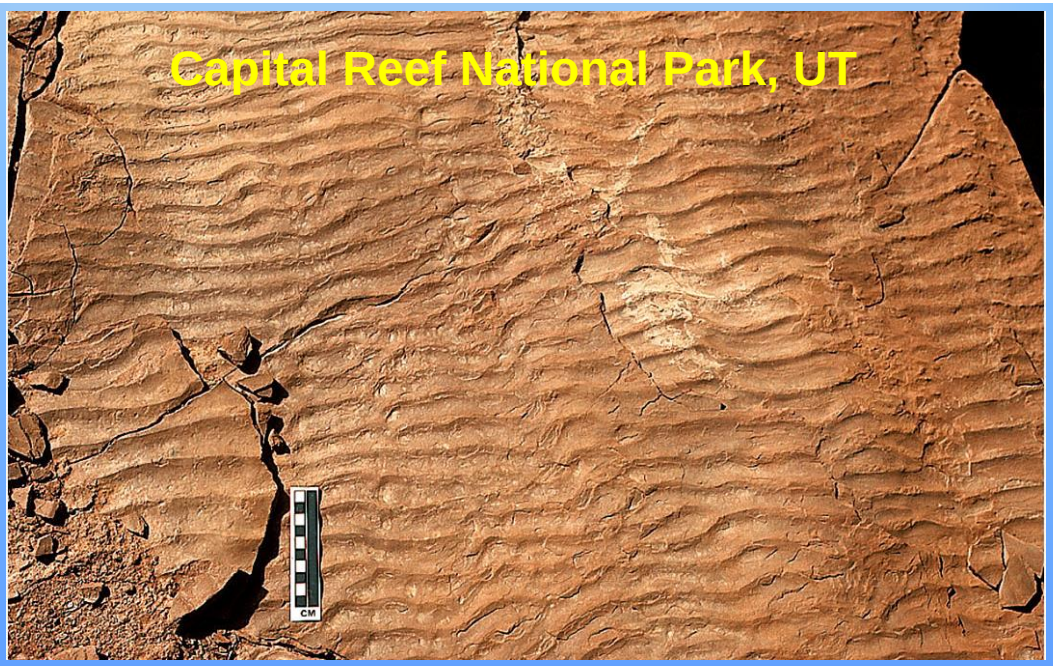
e) Ripple Marks



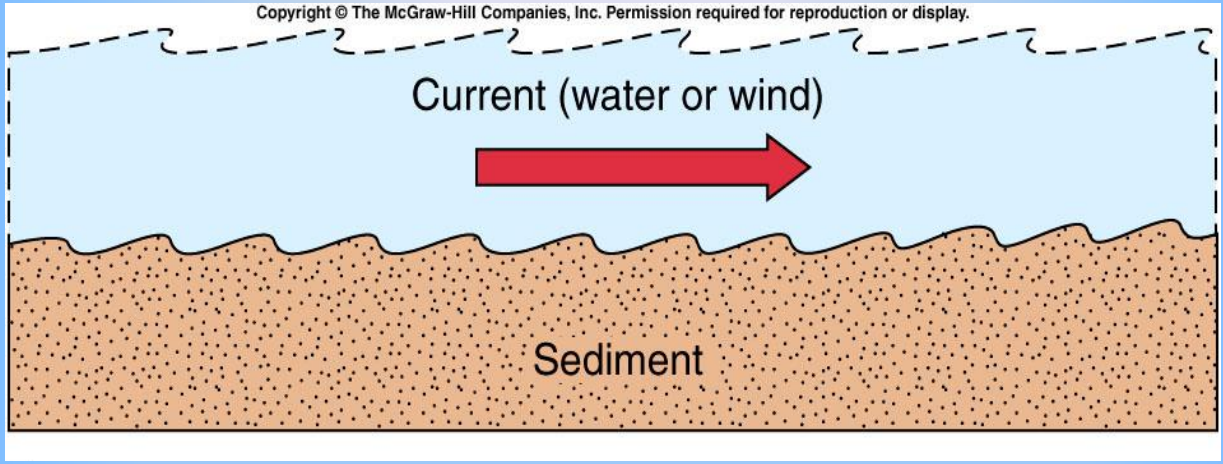


Wave-Caused Ripple Marks (Symmetrical)





Current-Caused Ripple Marks (Asymmetrical)



Current Ripples in a tidal flat (Baja, CA)

100 million-yr old ripples in sandstone (San Juan Basin, NM)

f) **Fossils**

Any traces of plants or animals preserved in a rock

Body Fossils – Unaltered Remains

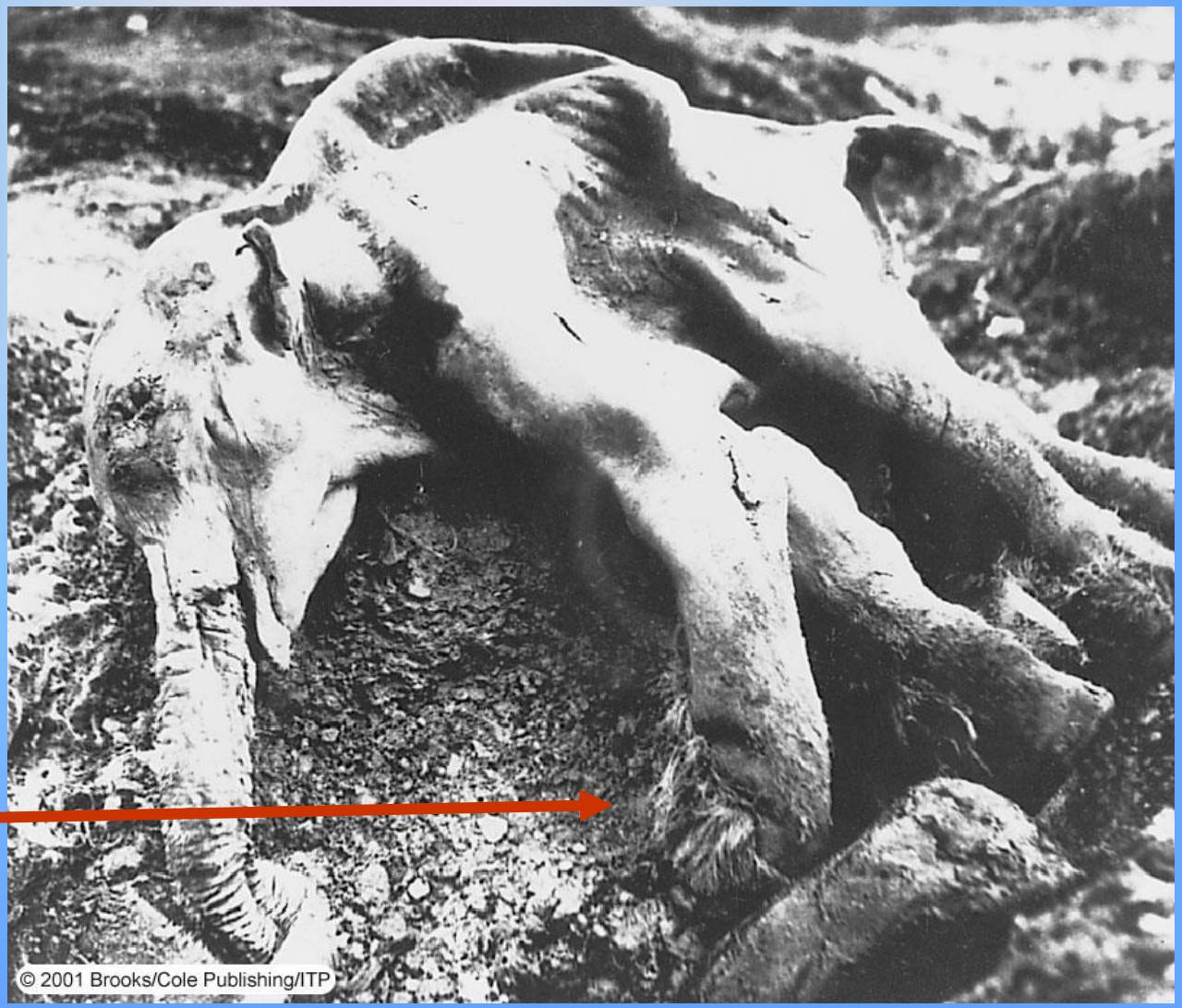
Insects in Amber

Preservation in Tar

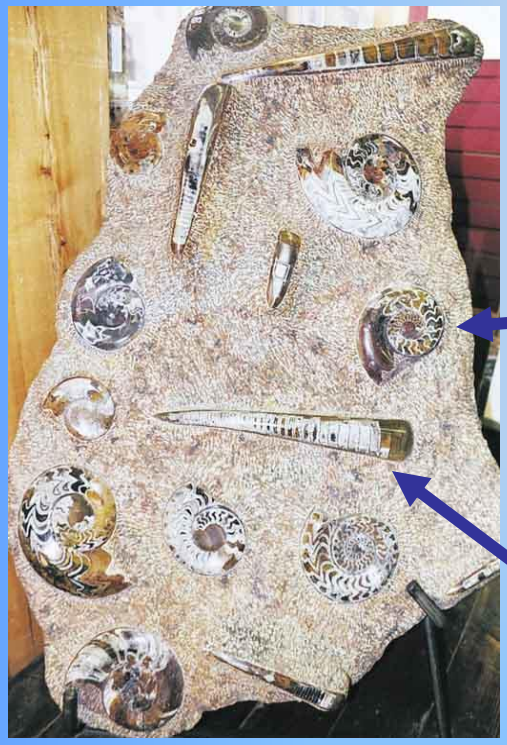
- Body fossils may be preserved as
  - *unaltered remains*,
    - meaning they retain
    - their original composition and structure,
    - by freezing, mummification, in amber, in tar

Body Fossils – Unaltered Remains

- 40,000-year-old frozen baby mammoth
- Found in Siberia in 1971
- It is 1.15 m long and 1.0 m tall
- It had a hairy coat
- Hair around the feet is still visible



Body Fossils



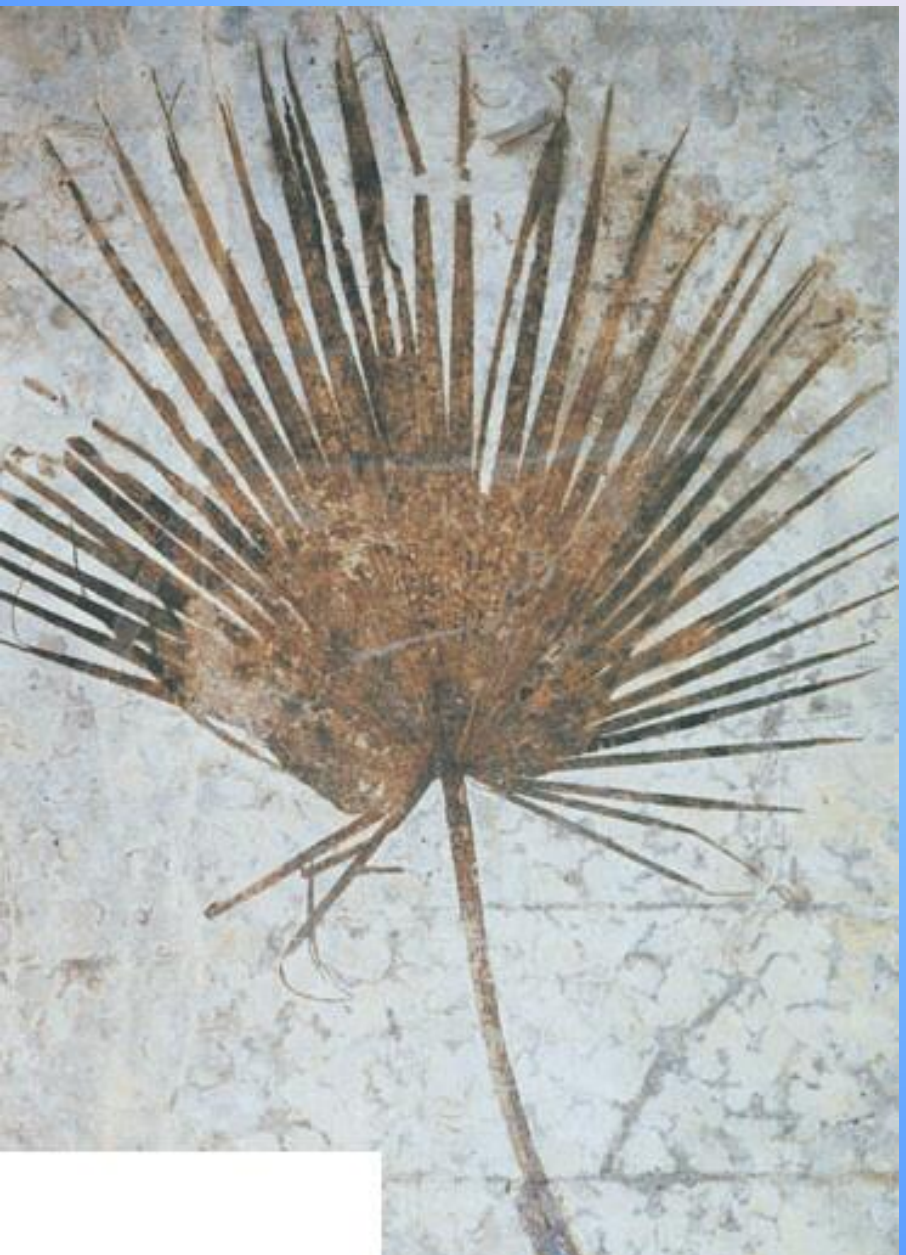
Extinct relatives of the Modern squid

Altered Remains

- Petrified tree stump
  - in Florissant Fossil Beds National Monument, Colorado
- Volcanic mudflows
  - 3 to 6 m deep
  - covered the lower parts
  - of many trees at this site

Petrified Wood
Painted Desert, AZ

Unaltered Remains



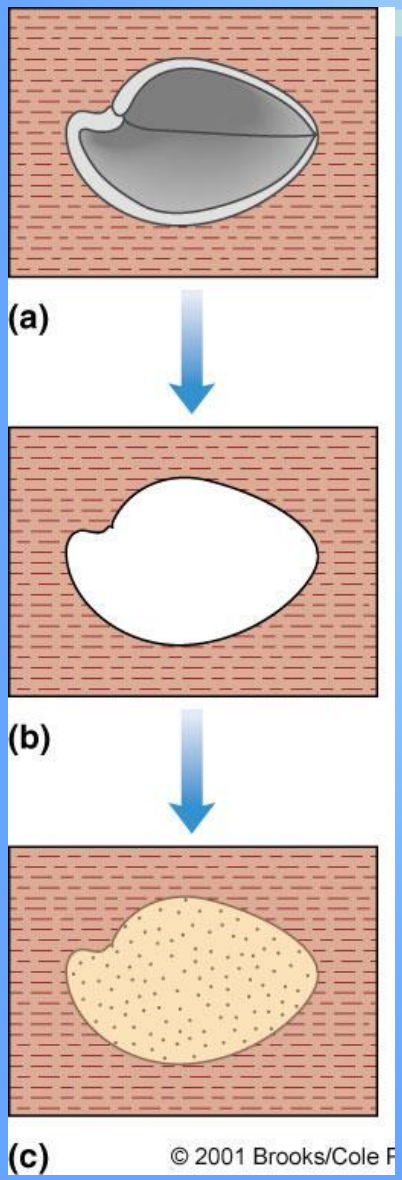
- Carbon film of a palm frond

- Carbon film of an insect

Molds and Casts

- **Molds** form
  - when buried remains leave a cavity
- **Casts** form
  - if material fills in the cavity

Mold and Cast



Step a: burial of a shell

Step b: dissolution leaving a cavity, a mold

Step c: the mold is filled by sediment forming a cast

Trace Fossils

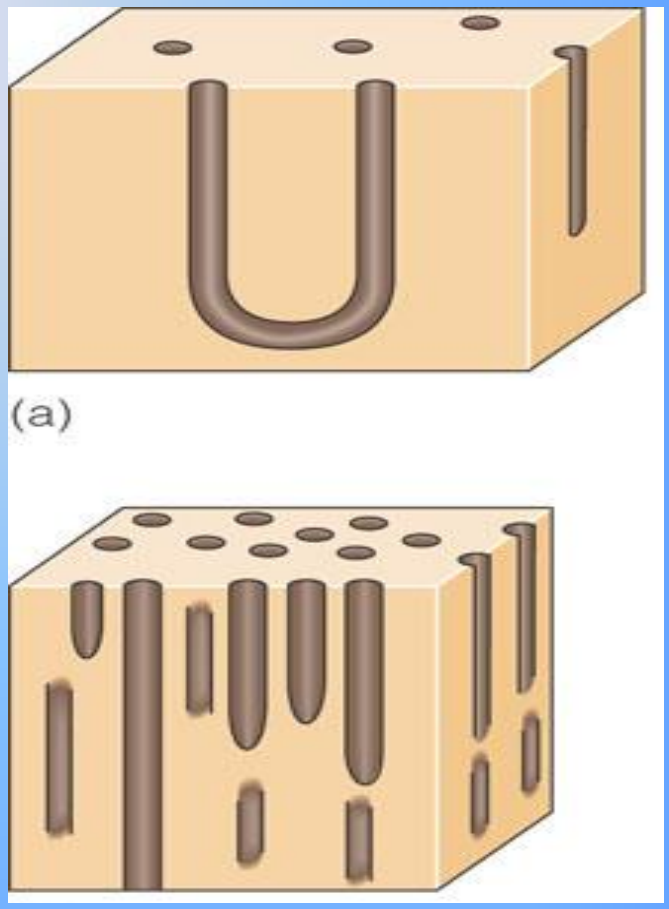
- Footprints
- Burrows
- Trails
- Fossilized “dung”

Trace Fossils

- Fossilized feces (coprolite)
  - of a carnivorous mammal
- Specimen measures about 5 cm long
  - and contains small fragments of bones

Dinosaur Trackways

Burrows

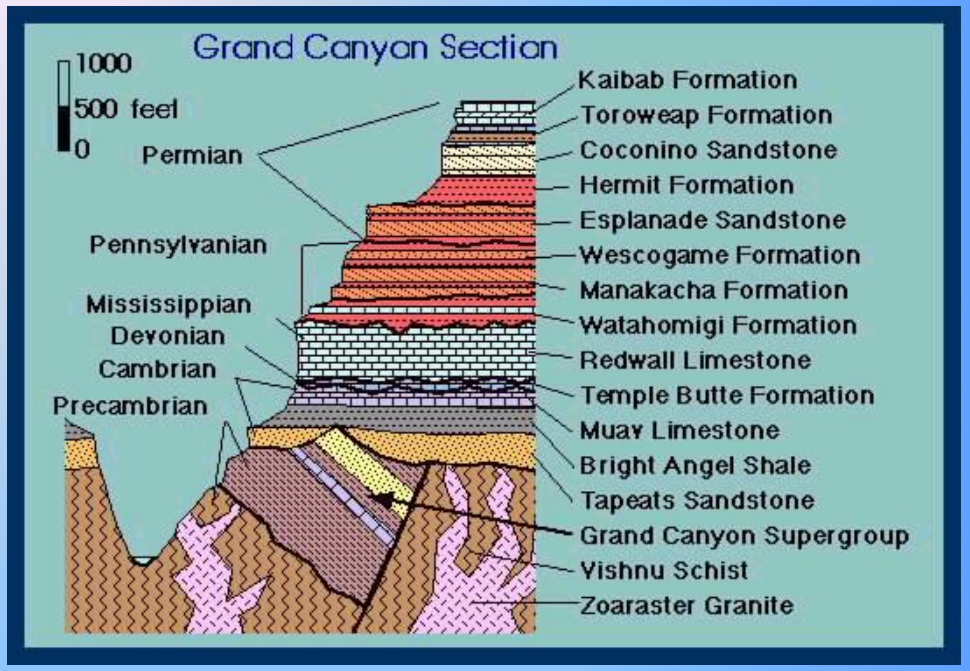


- Vertical, dark-colored areas in this rock are sediment-filled burrows

D. Formations

Rock Units of the Paleozoic Section in Grand Canyon National Park, Arizona

System	Group	Formation	Member
Permian		Kaibab	
		Toroweap	
	Hermit	Coconino	
		Hermit Shale	
Pennsylvanian		Supai	
Mississippian		Redwall Limestone	Horseshoe Mesa
			Mooney Falls
			Thunder Springs
			Whitmore Wash
Devonian		Temple Butte	
Cambrian	Tonto	Muav Limestone	
		Bright Angel Shale	
		Tapeats Sandstone	



1. A body of rock of considerable thickness with characteristics that distinguish it from adjacent rock units.

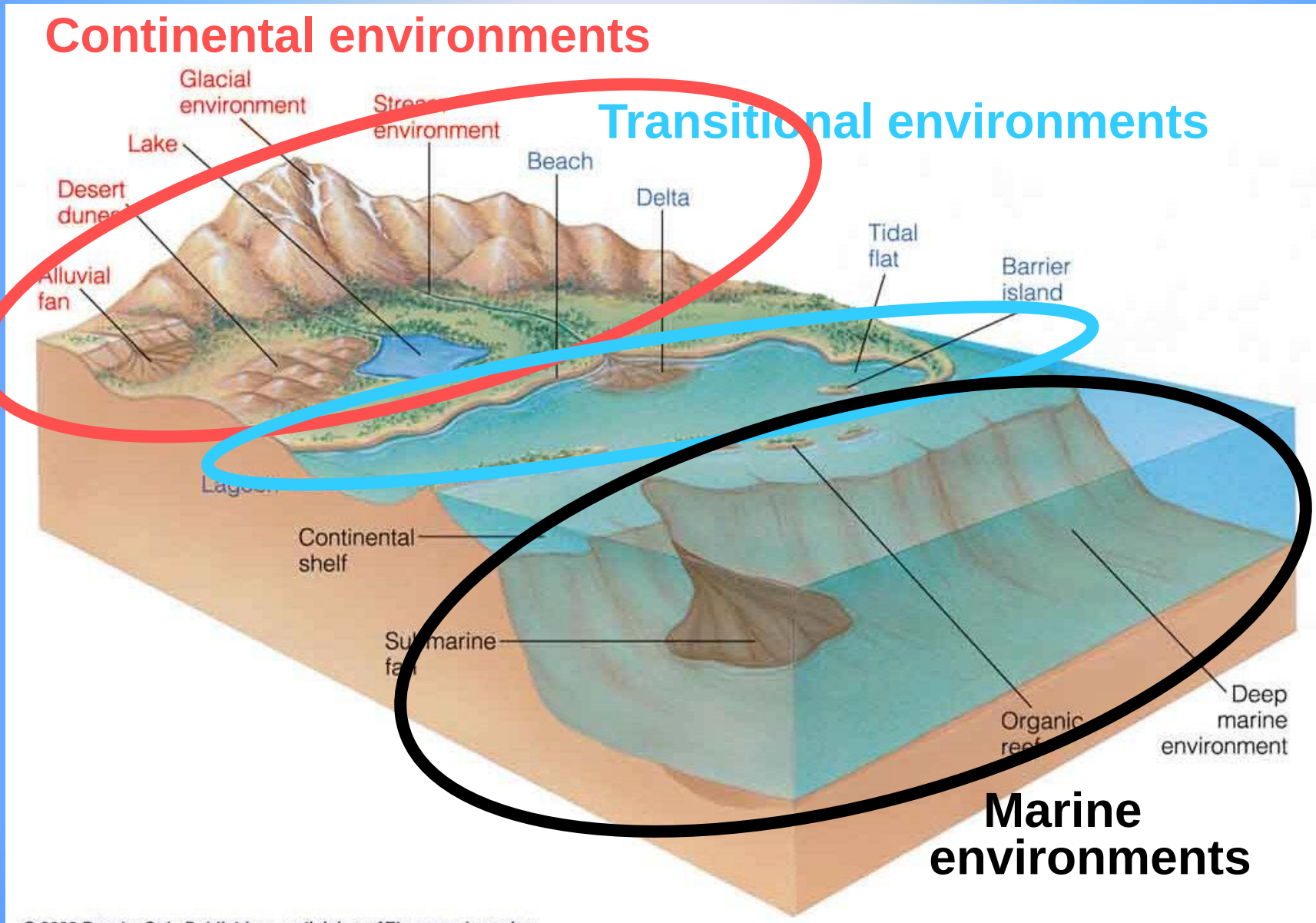
2. Usually composed of one or more sedimentary rock beds.

3. Often based on rock type.
   - Criterion for distinguishing and naming a formation is some visible characteristic that makes it recognizable. For example:
   - A sequence of limestone beds may have different fossils in the lower half than in the upper half.
   - It would be divided into two formations based on the fossil content.

Environments of Deposition

- Depositional environments
  - Anywhere sediment accumulates
  - Especially a particular area
    - where a distinctive kind of deposit originates from physical, chemical, and biological processes
- Three broad areas of deposition include
  - ***Continental***
  - ***Transitional (shallow marine)***
  - ***Deep Marine***

Depositional Environments



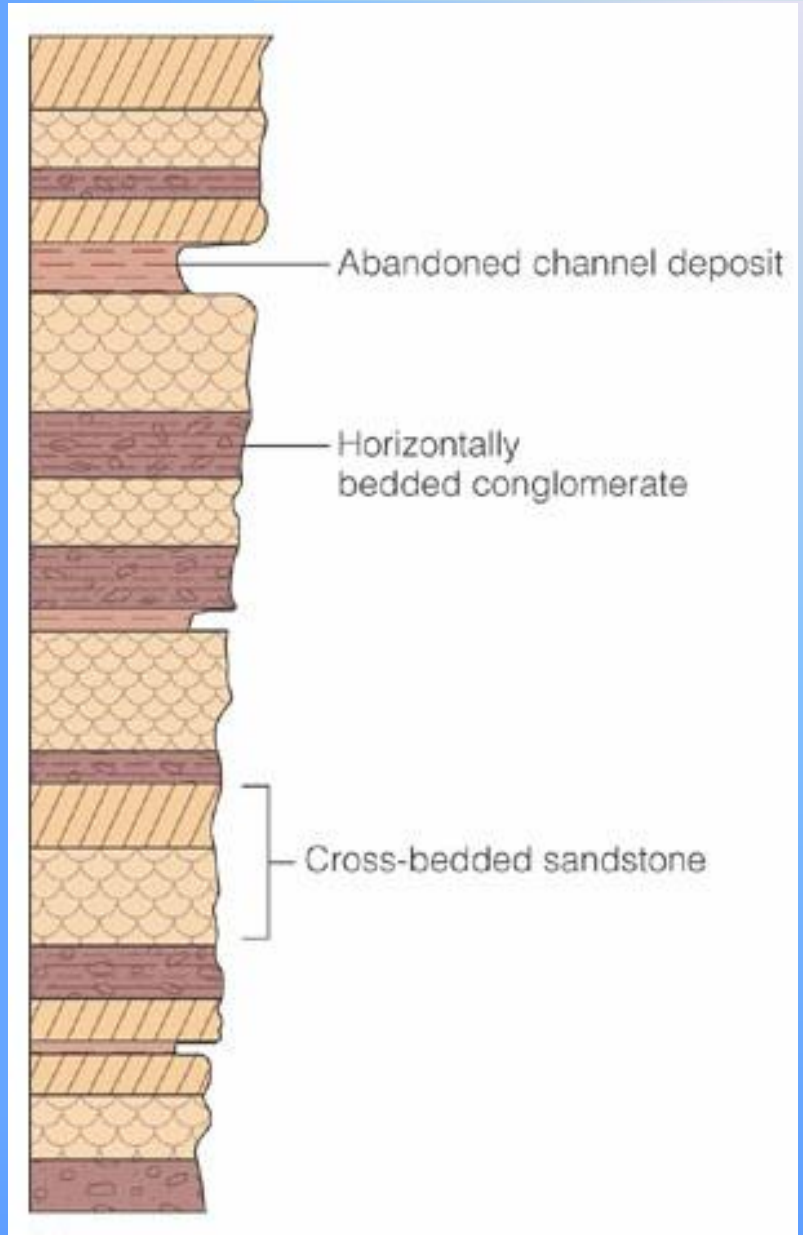
Continental Environments

- Deposition on continents (on land) might take place in
  - fluvial systems (rivers and streams)
  - deserts
  - areas covered by and adjacent to glaciers
- Deposits in each of these environments
  - possess combinations of features that allow us to differentiate among them

Braided Stream

- The deposits of braided streams are mostly
  - gravel and cross-bedded sand with subordinate mud

Braided Stream Deposits



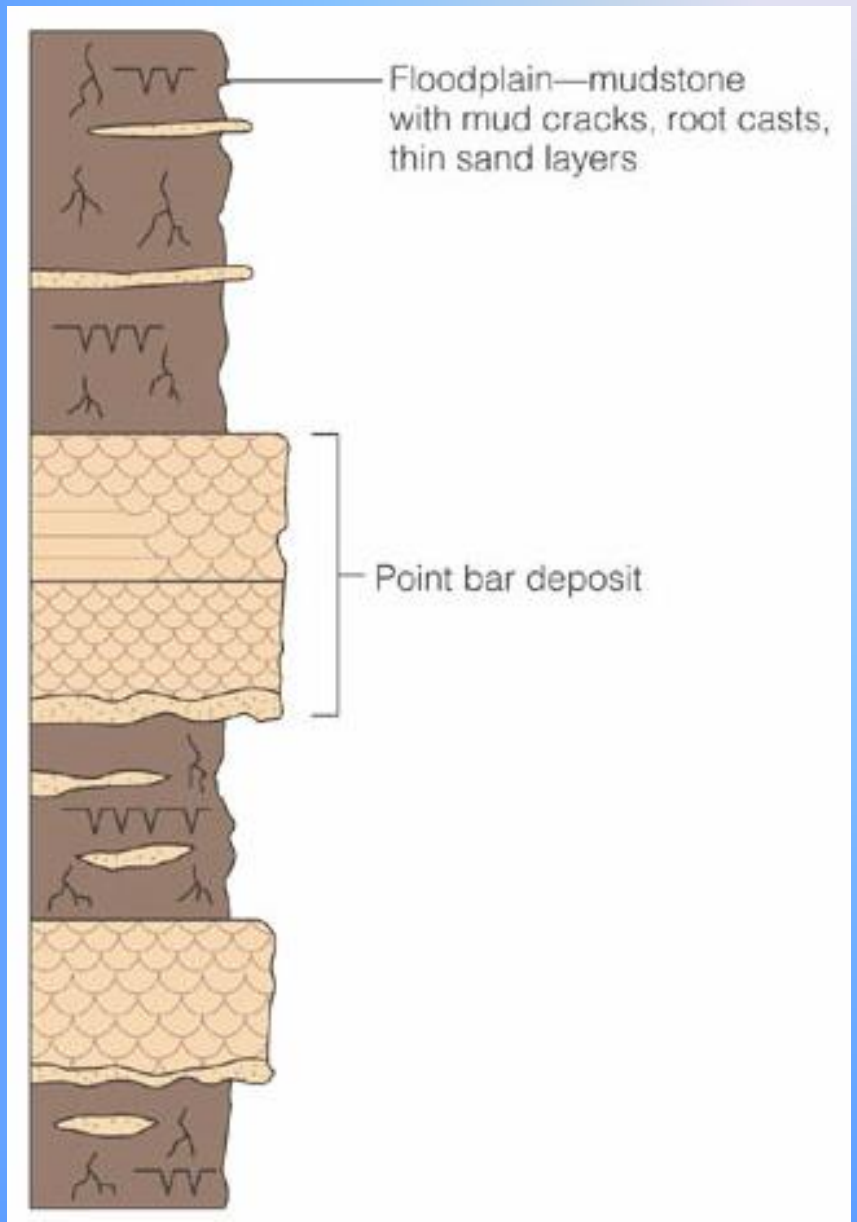
- Braided stream deposits consist of
  - conglomerate
  - cross-bedded sandstone
  - but mudstone is rare or absent

Meandering Stream

- Meandering stream deposits

  - Mostly fine-grained floodplain
  - Sediments with subordinate sand bodies

Meandering Stream Deposits

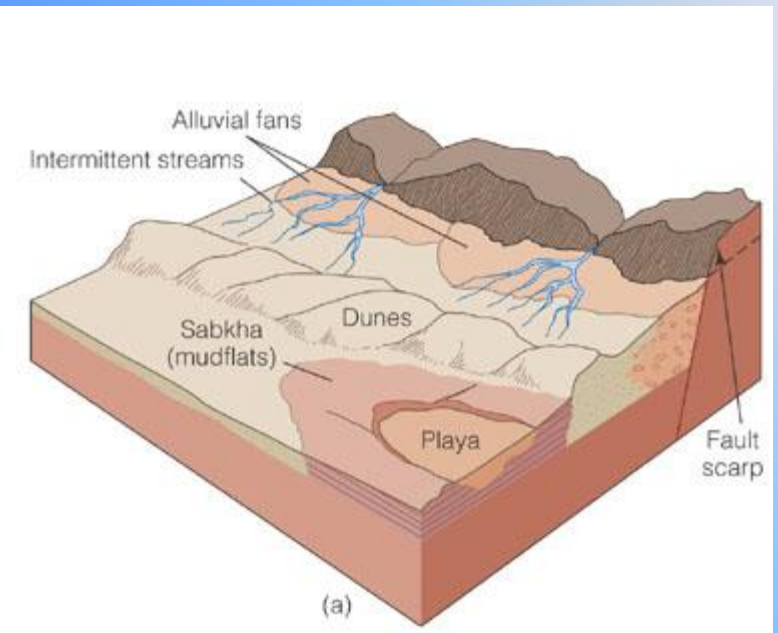


- In meandering stream deposits,
  - mudstone deposited in a floodplain is common
  - sandstones are point bar deposits
  - channel conglomerate is minor

Desert Environments

- Desert environments contain an association of features found in
  - sand dune deposits,
  - alluvial fan deposits,
  - and playa lake deposits
- Windblown dunes are typically composed
  - of well-sorted, well-rounded sand
  - with cross-beds meters to tens of meters high
  - land-dwelling plants and animals make up any fossils

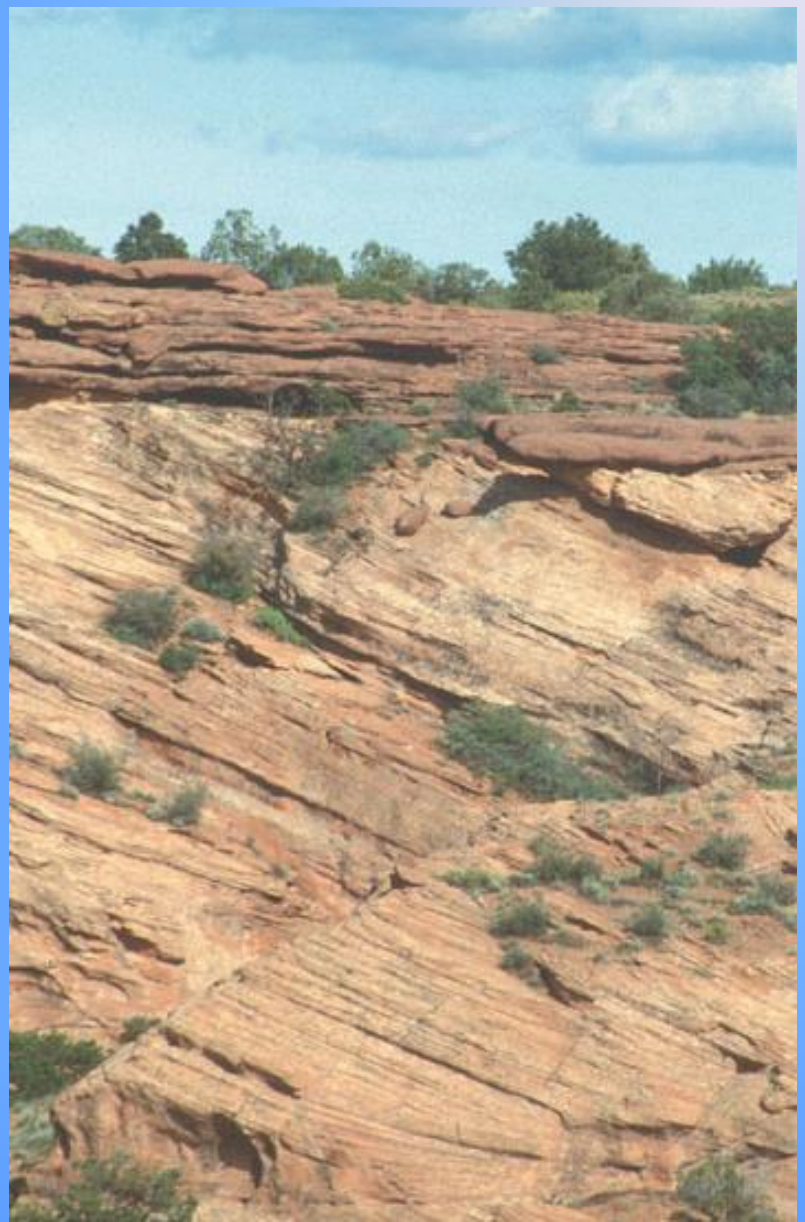
Associations in Desert Basin




(b)

- A desert basin showing the association
  - of alluvial fan,
  - sand dune,
  - and playa lake deposits
- In the photo,
  - the light colored area in the distance
  - is a playa lake deposit in Utah

Dune Cross-Beds

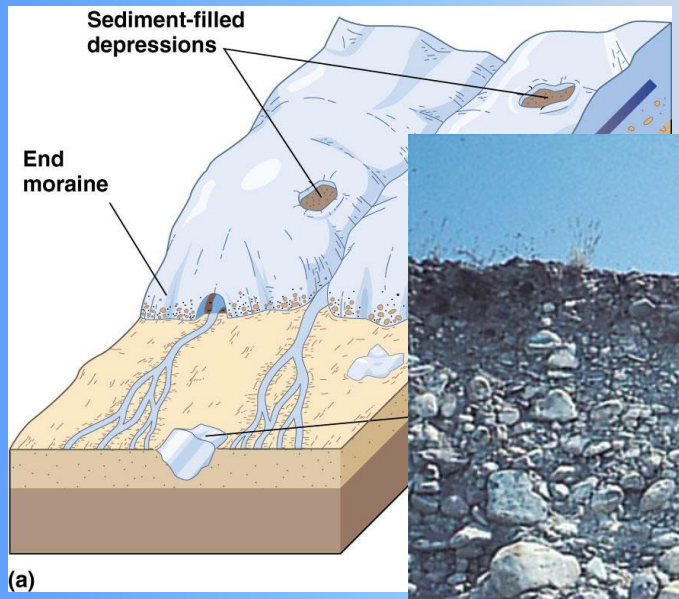


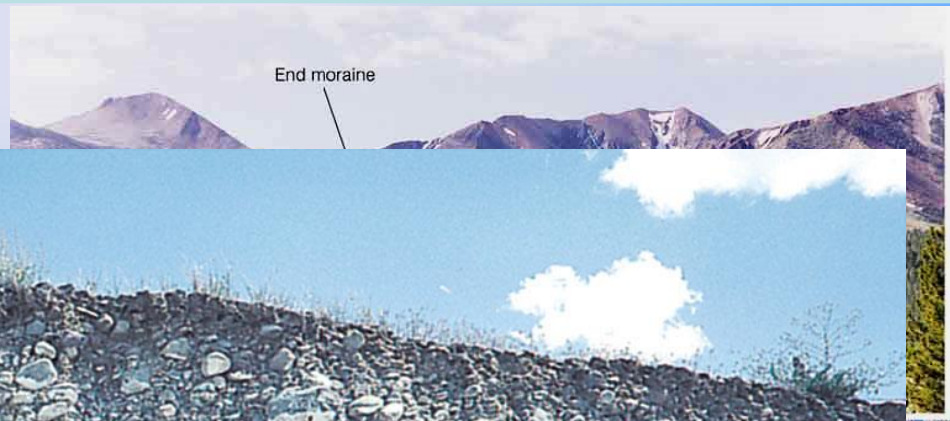
- Large-scale cross-beds
  - in a Permian-aged
  - wind-blown dune deposit in Arizona

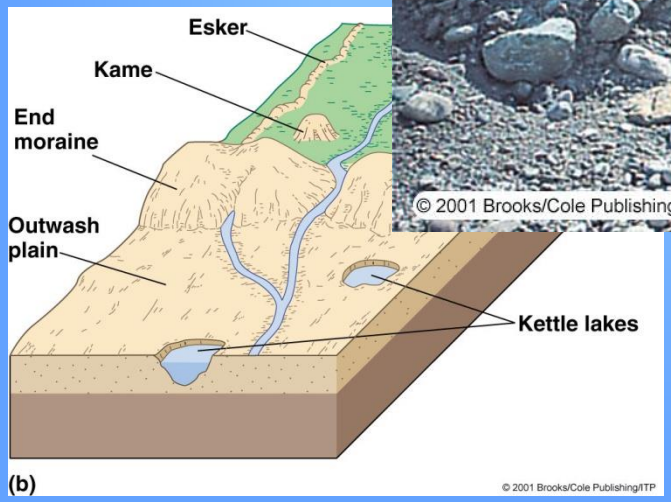
Glacial Environments

- All sediments deposited in
  - glacial environments are collectively called drift
- **Till** is poorly sorted, nonstratified drift
  - deposited directly by glacial ice
  - mostly in ridge-like deposits called ***moraines***
- **Outwash** is sand and gravel deposited
  - by braided streams issuing from melting glaciers

Moraines and Till





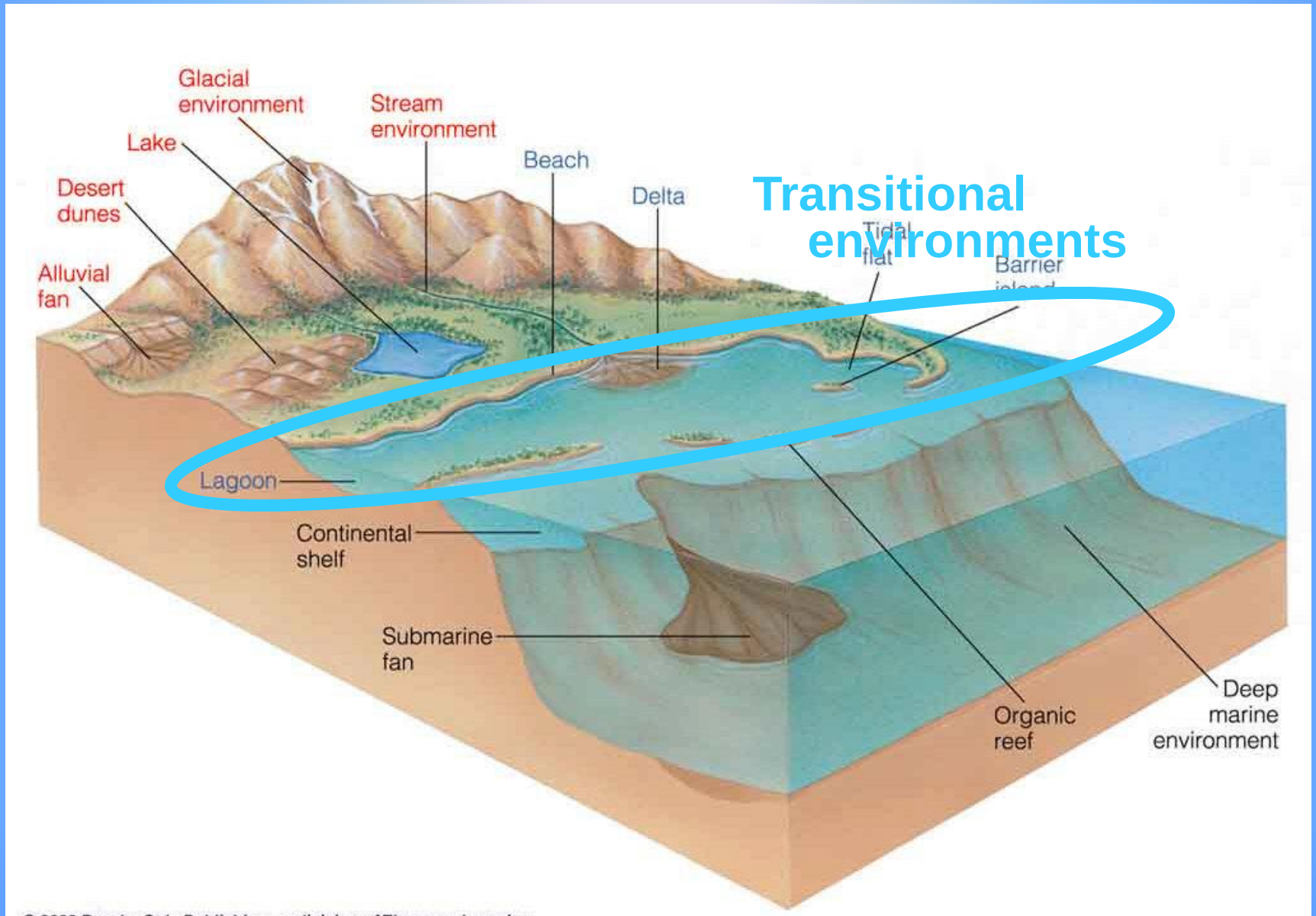


- Origin of glacial drift
- Moraines and poorly sorted till

Shallow Marine – Transitional Environments

- Environments include with both marine and continental processes
- Transitional environments include
  - deltas
  - beaches
  - barrier islands and lagoons
  - tidal flats

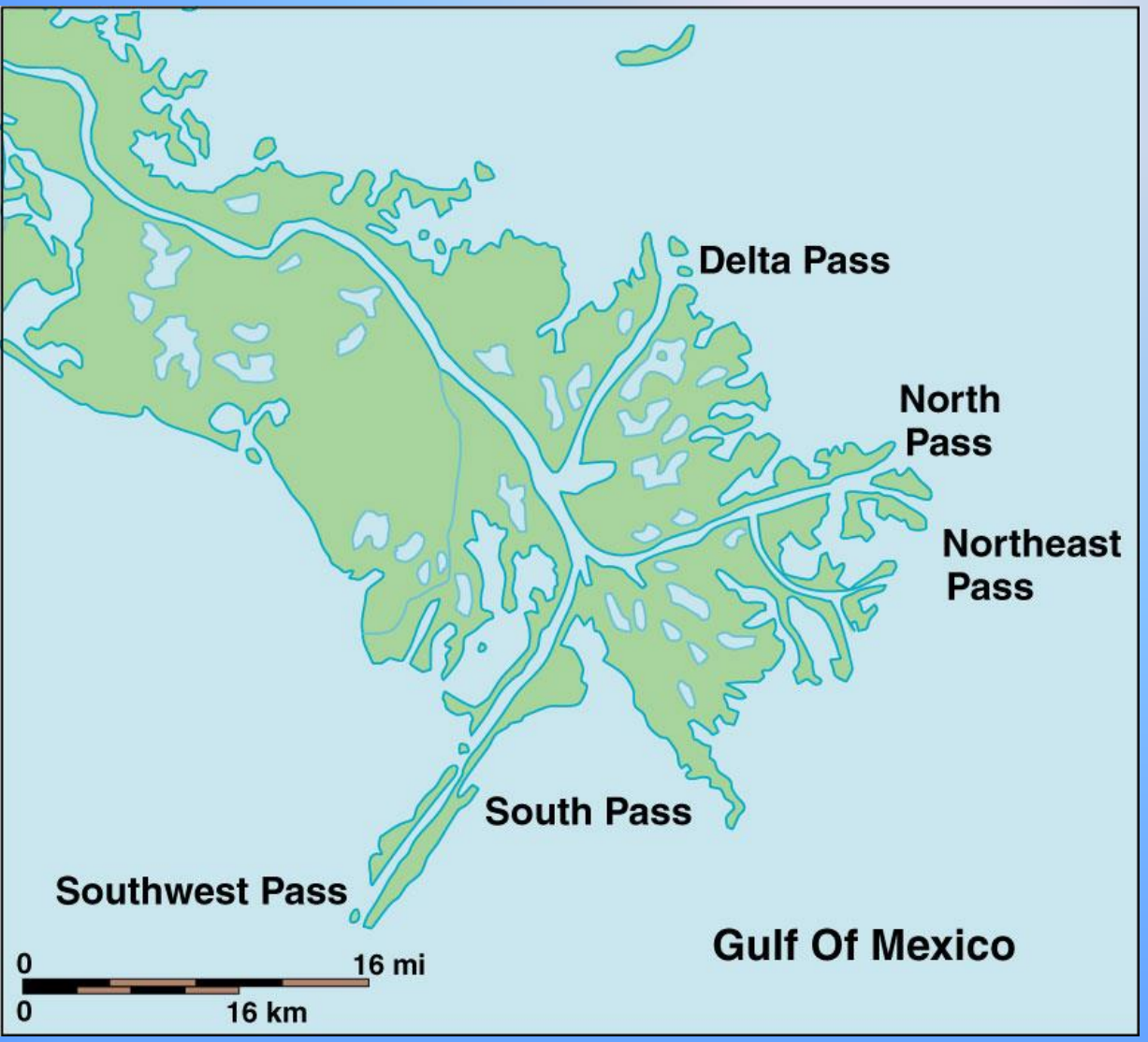
Transitional Environments



Marine Deltas

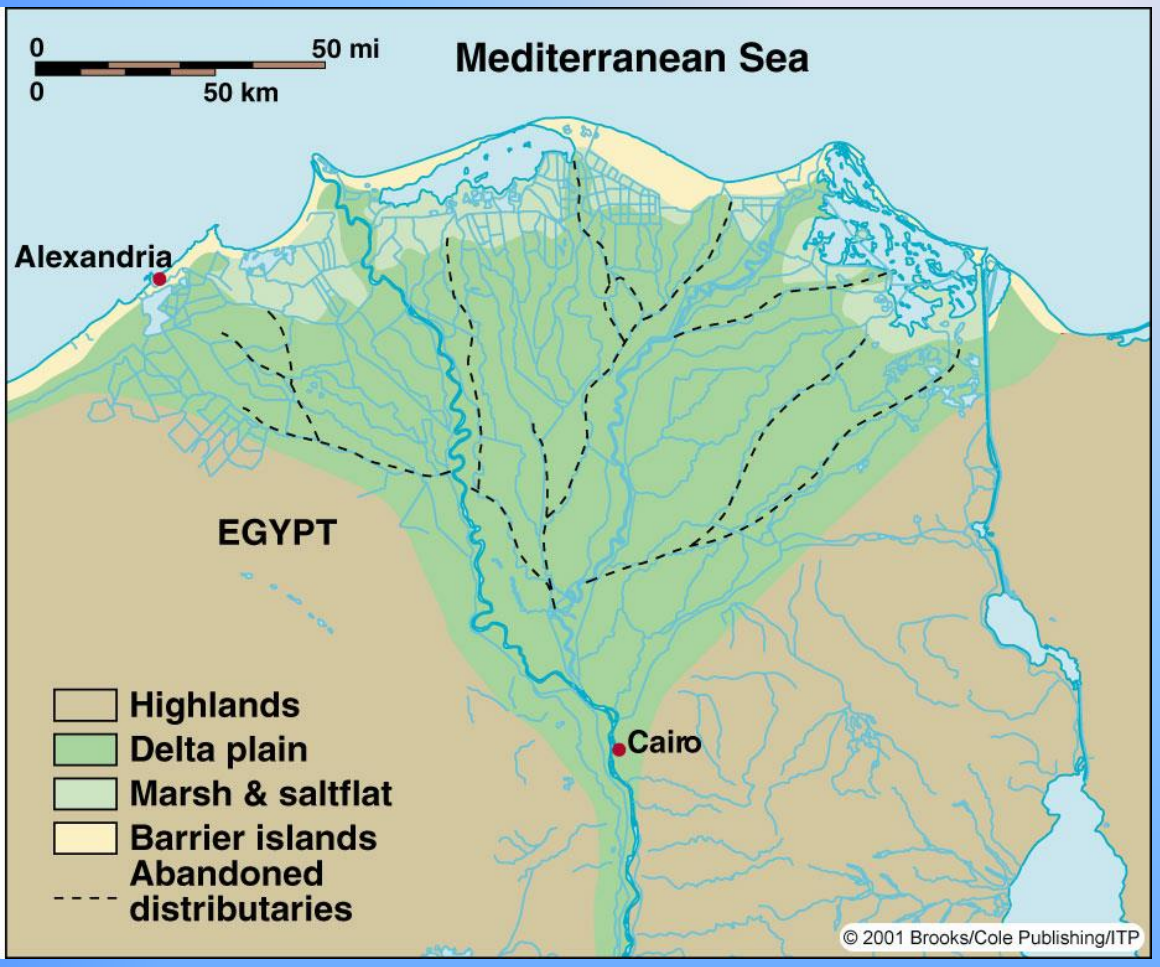
- When fluvial (stream) processes prevail
  - a stream/river-dominated delta results
- Strong wave action
  - produces a wave dominated delta
- Tidal influences
  - result in tide-dominated deltas

Stream/River-Dominated Deltas



- Stream/river-dominated deltas
  - have long distributary channels
  - extending far seaward
  - Mississippi River delta

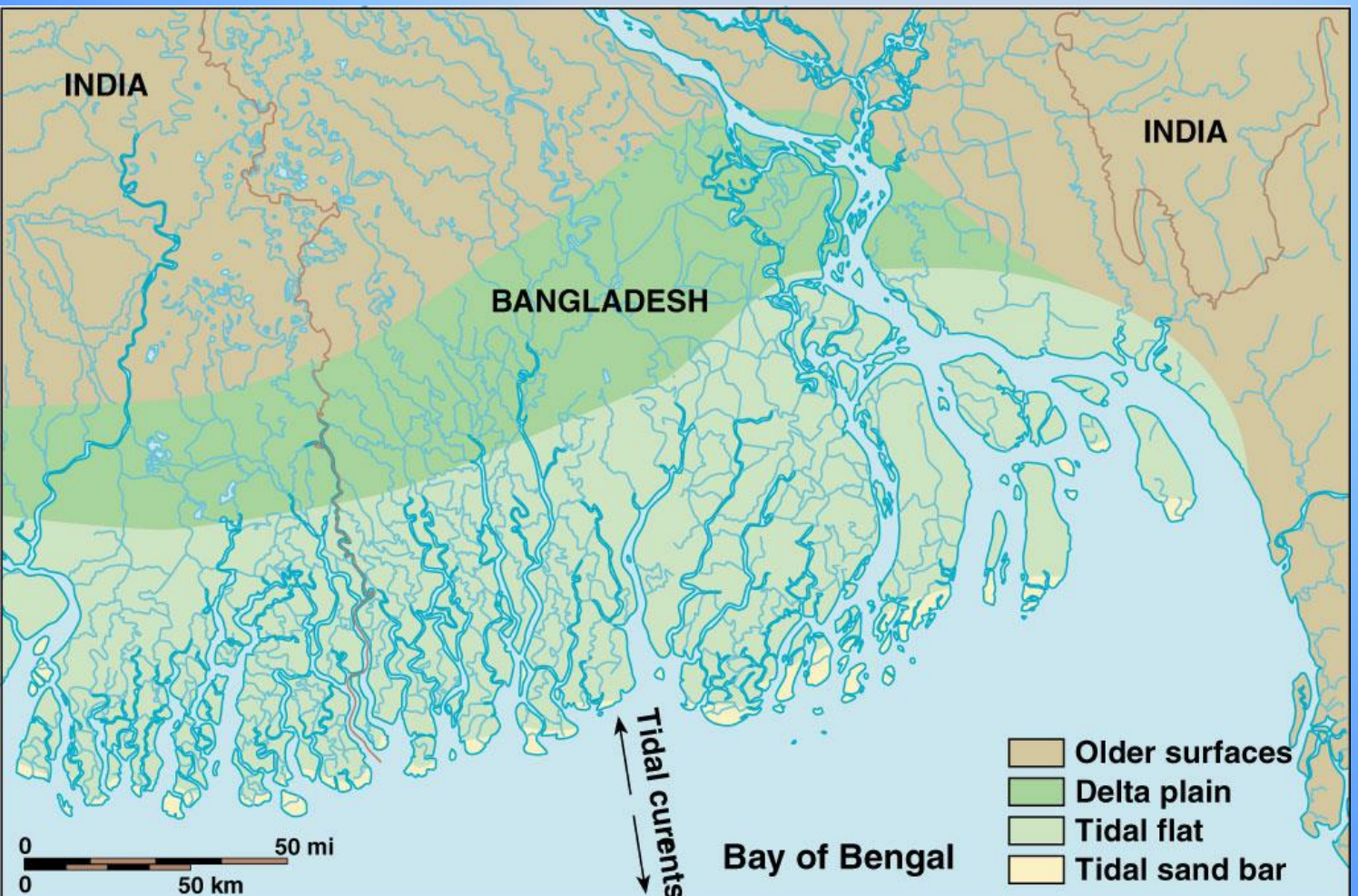
Wave-Dominated Deltas



- Wave-dominated deltas
  - such as the Nile Delta of Egypt
  - also have distributary channels
  - but their seaward margin is modified by wave action

Tide-Dominated Deltas

- Tide-Dominated Deltas,
  - such as the Ganges-Brahmaputra delta



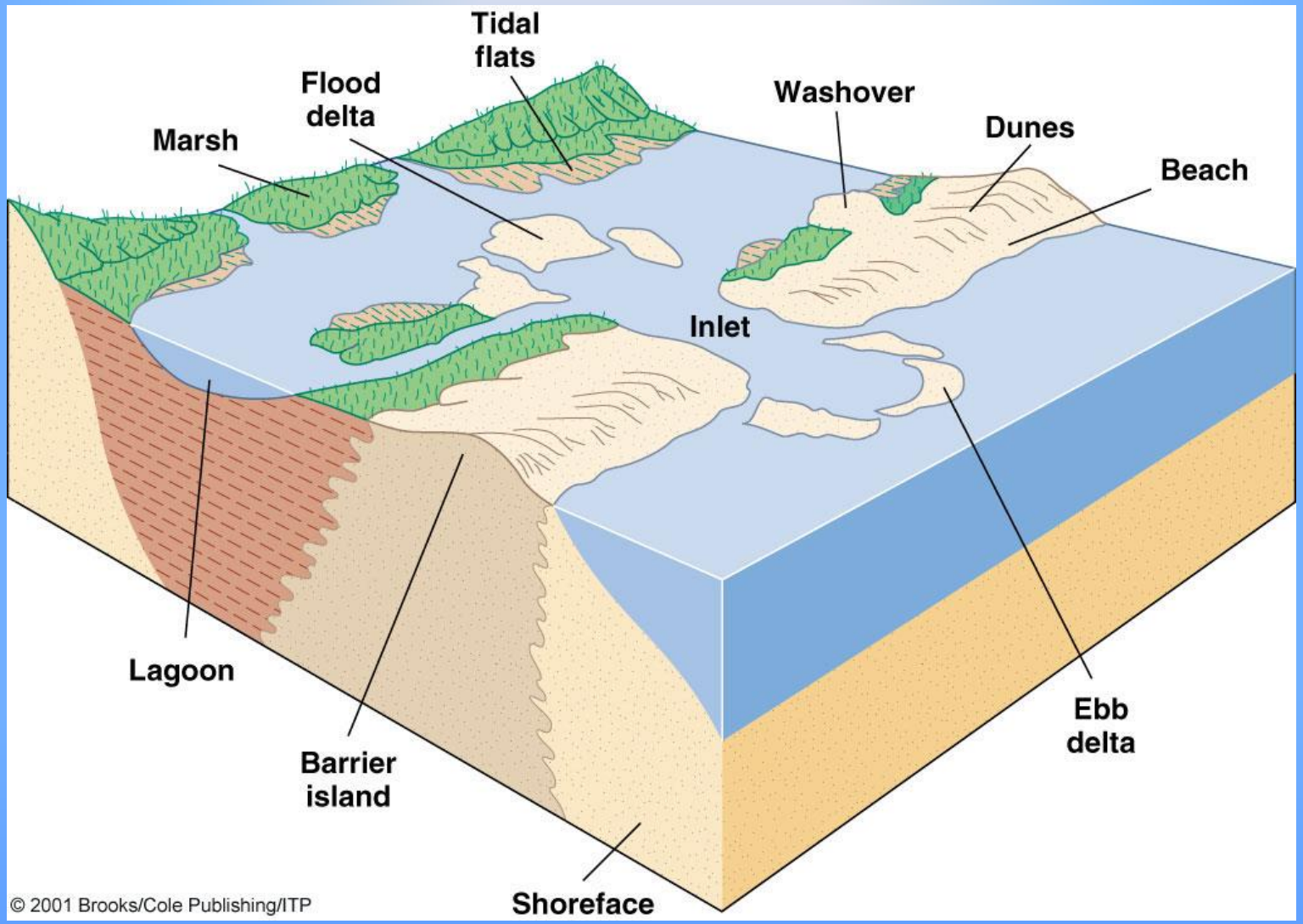
  - tidal sand bodies
  - along the direction of tidal flow

Barrier Islands

- On broad continental margins
  - with abundant sand, long **barrier islands** lie offshore
  - separated from the mainland by a lagoon
- Barrier islands are common along the Gulf
  - and Atlantic Coasts of the United States
- Many ancient deposits formed in this environment

Barrier Island Complex

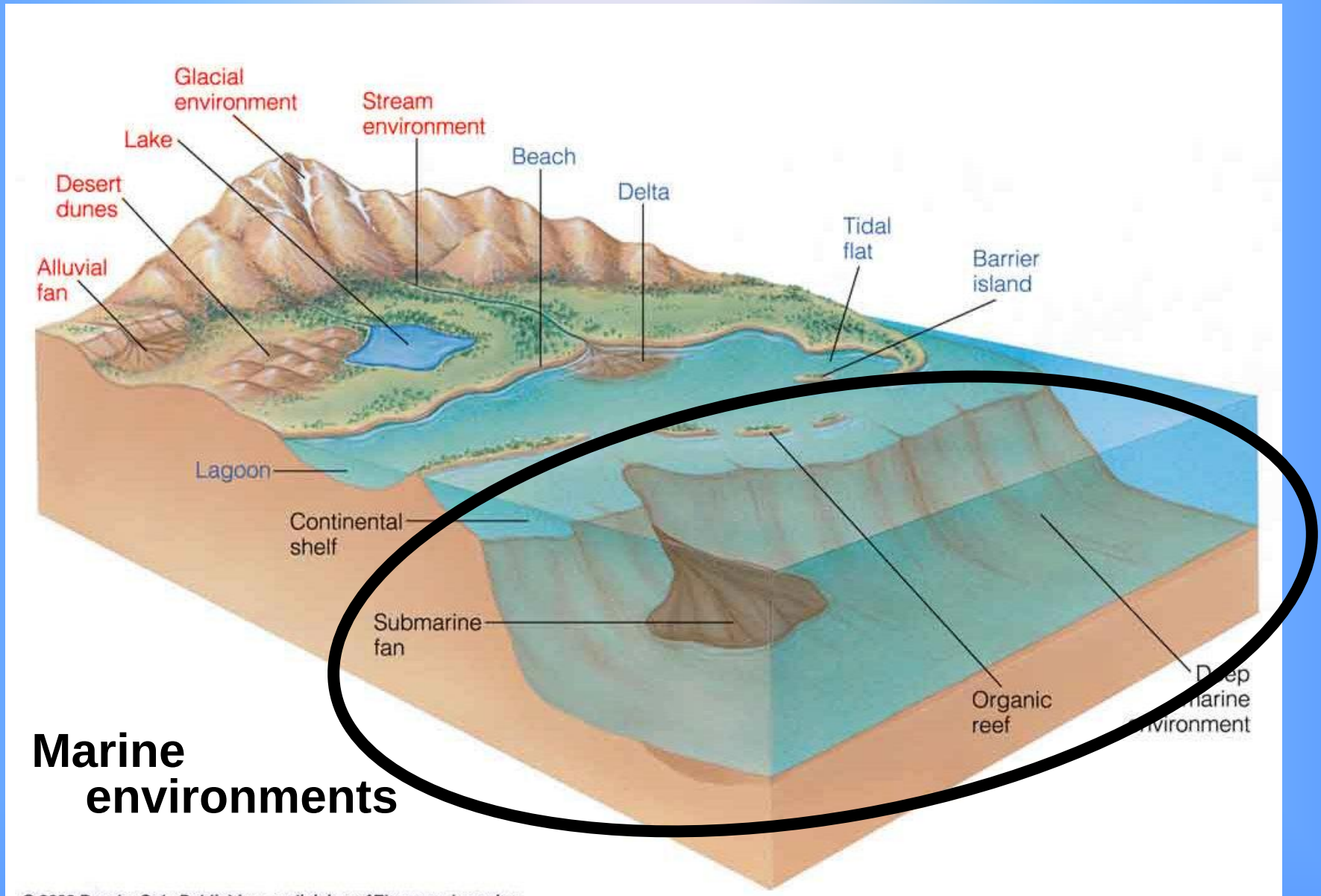
- Subenvironments of a barrier island complex



Marine Environments

- Marine environments include:
  - continental shelf
  - continental slope
  - continental rise
  - deep-seafloor

Marine Environments



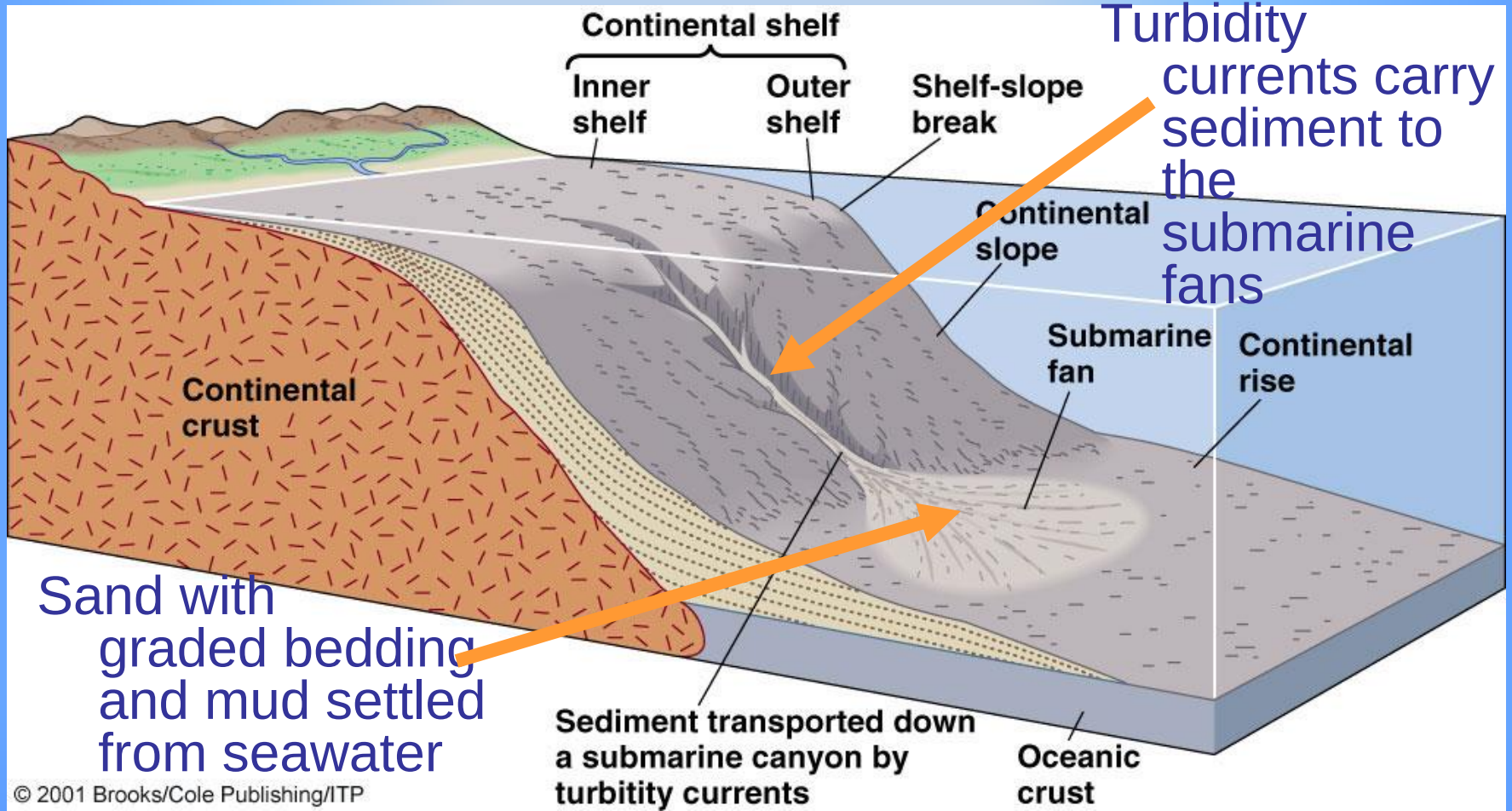
Marine environments

Slope and Rise

- The low-energy part of the shelf
  - has mostly mud with marine fossils,
  - and interfingers with inner-shelf sand
- Much sediment derived from the continents
  - crosses the continental shelf
  - and is funneled into deeper water
  - through ***submarine canyons***
- It eventually comes to rest
  - on the continental slope and continental rise
  - as a series of overlapping submarine fans

Detrital Marine Environments

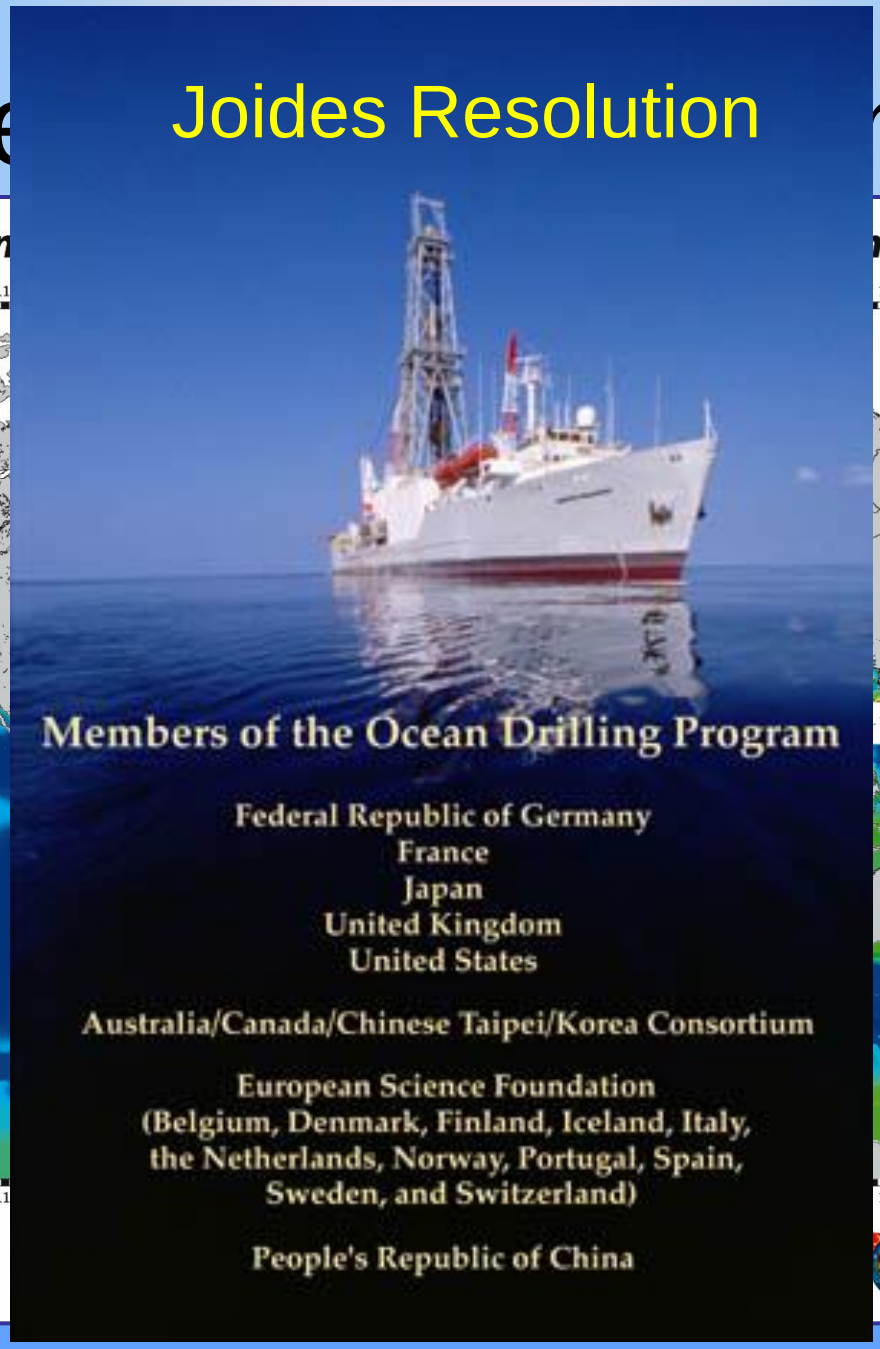
- Shelf, slope and rise environments
- The main avenues of sediment transport
  - across the shelf are submarine canyons



Deep Sea

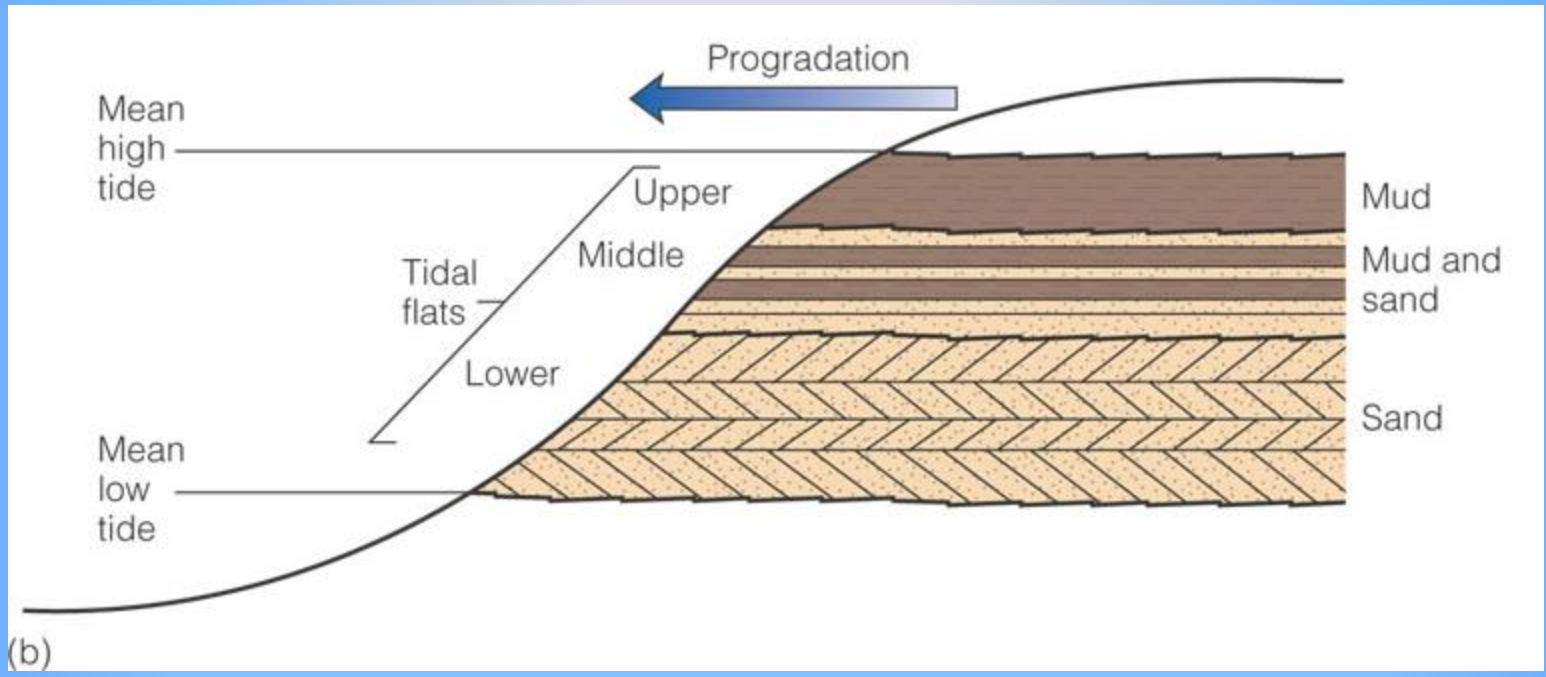
- Beyond the continental rise
- The seafloor is nearly completely covered by fine-grained deposits
    - No sand and gravel
    - No sediment near mid-ocean ridges
- The main sources of sediment are:
  - windblown dust from continents or oceanic islands
  - volcanic ash
  - shells of microorganisms dwelling in surface waters of the ocean

Joides Resolution



End !! ☺

Tidal Flats



- Tidal-flat deposits showing a prograding shoreline
  - Notice the distinctive cross-beds
  - that dip in opposite directions
  - How could this happen?

Reefs – Carbonate Platforms