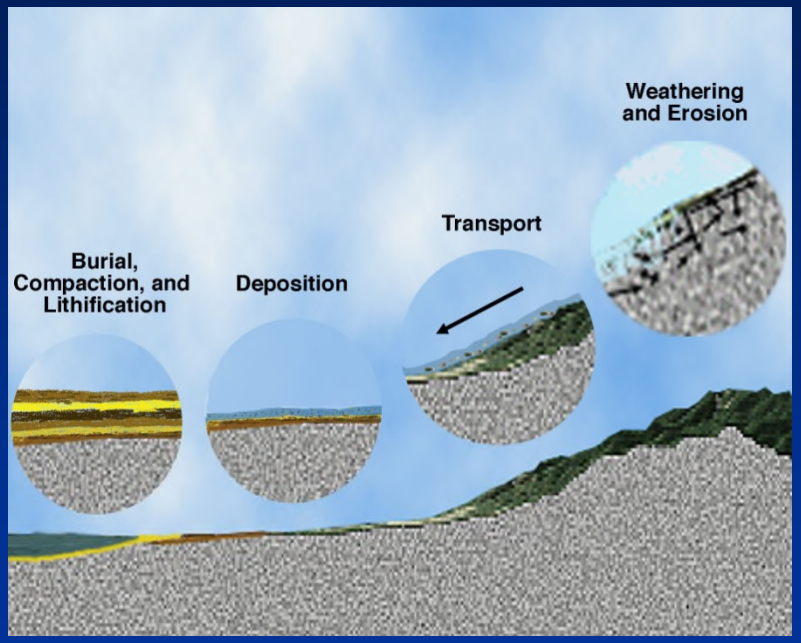
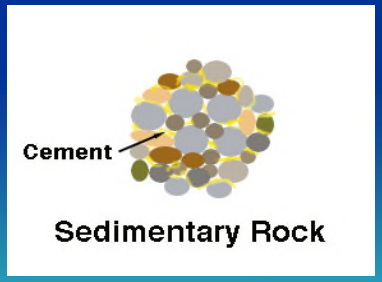
Sedimentary Rocks

Origin, Properties and Identification

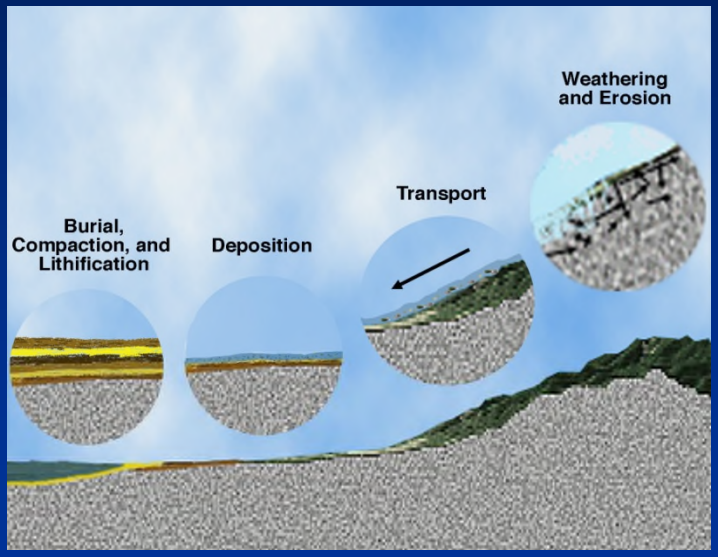


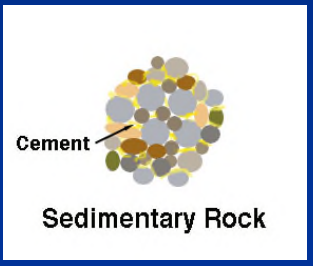


Physical Geology – GEOL 100

Ray Rector - Instructor

Sedimentary Rock Origin and Identification Lab





Pre-Lab Internet Link Resources

1) http://www.rockhounds.com/rockshop/rockkey/index.html

2) http://earthsci.org/education/teacher/basicgeol/sed/sed.html#top

Major Sedimentary Concepts

1) Sedimentary rocks form by depositing, compaction, and cementing of sediment grains, and/or precipitation of crystals from an aqueous solution
2) The type of sedimentary rock formed is controlled by two factors: **1)** type of sediment and **2)** depositional environment
3) The ***five primary depositional environments*** of sedimentation worldwide are **1)** lakes and river systems, **2)** alluvial fans and deserts, **3)** shorelines, **4)** continental margins (shelves, slopes and rises) , and **5)** deep ocean floor.
4) Source rock, climate, weathering, erosion, and deposition conditions control the nature of the deposited sediments, and hence the types of sedimentary rocks that form at each of the five sedimentary sites described above.
5) Sedimentary rocks formed by cementing of clastic grains are called ***detrital*** rocks.
6) Sedimentary rocks formed by the precipitation and/or cementing of shell, skeleton, or plant material are called ***biochemical*** rocks.
7) Sedimentary rocks formed by the precipitation and cementing of material directly from an aqueous solution like seawater are called ***chemical*** rocks**.**
8) Identification of sedimentary rocks based on two criteria:
   - ✓ **Texture**
   - ✓ **Composition**

Sedimentary Rocks in The Rock Cycle

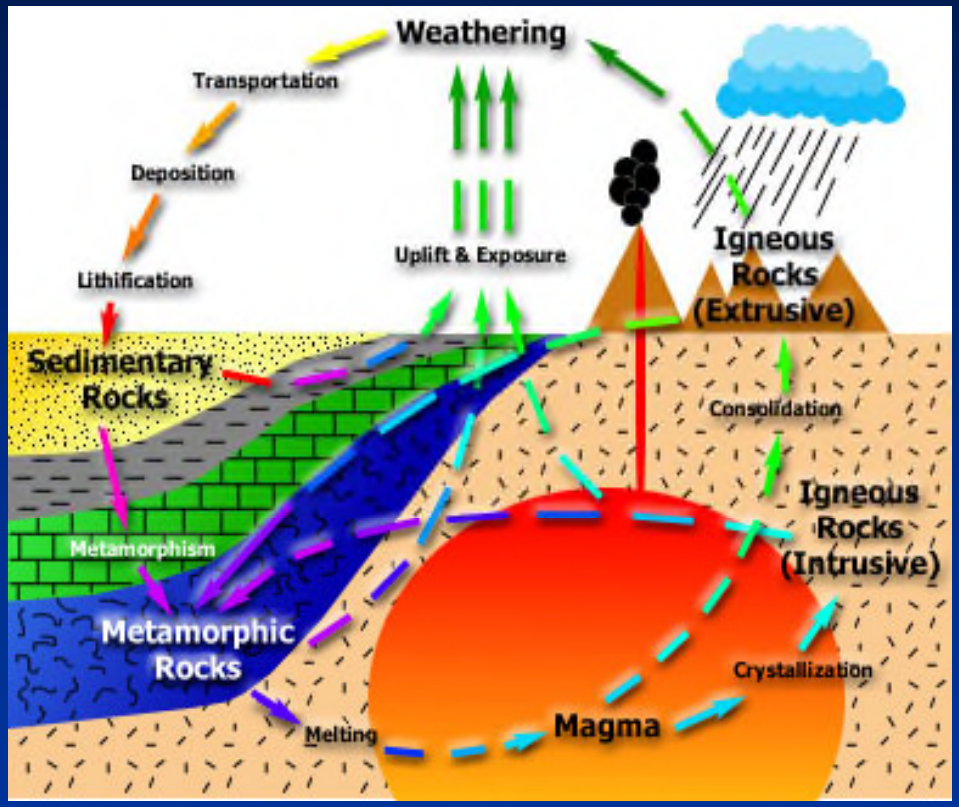
Key Points:

1) Part of rock cycle involving materials, conditions and processes *at or near Earth's surface*

2) Begins with weathering of uplifted, exposed rock

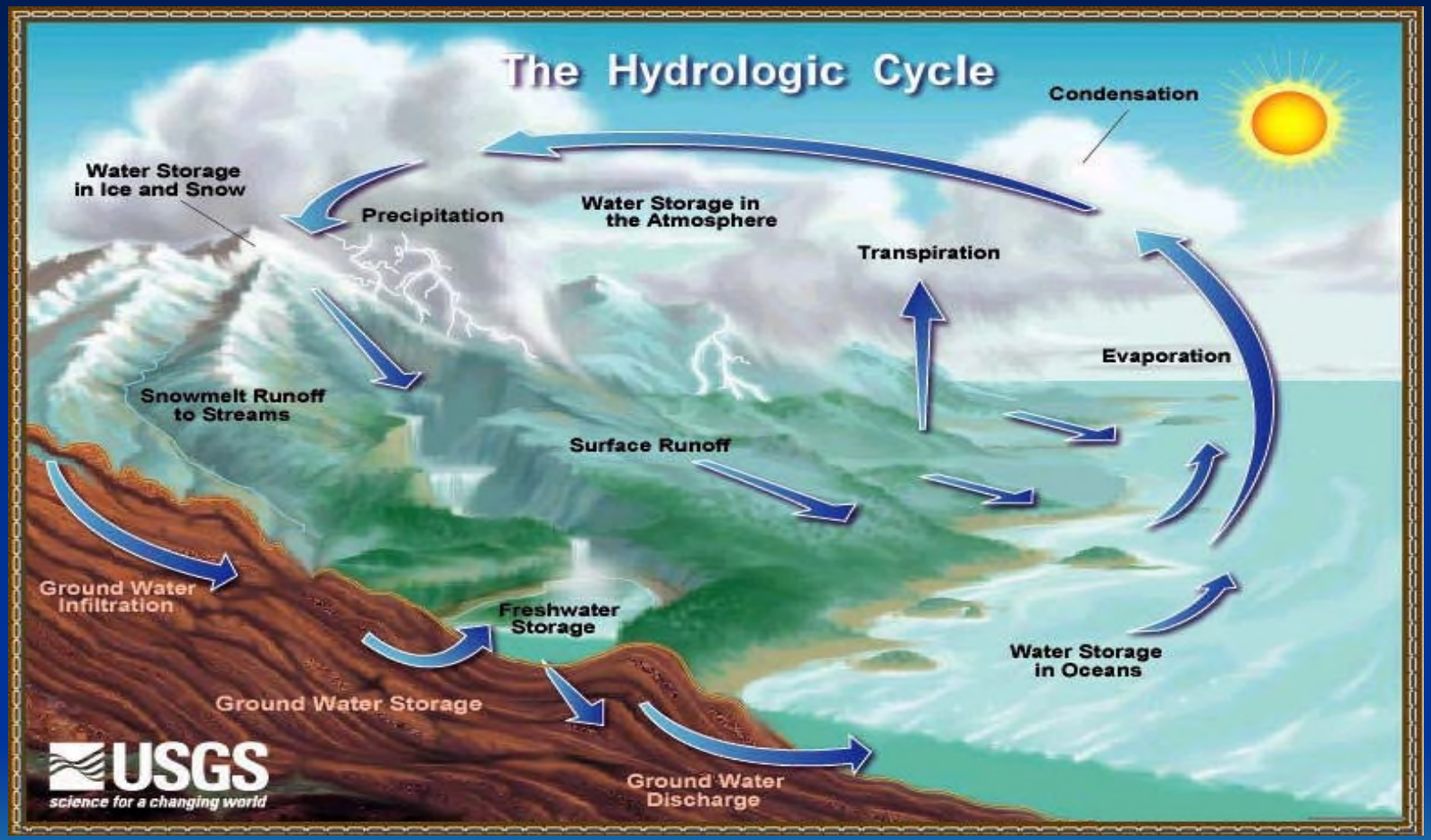
3) Continues with the erosion (removal and transportation) of weathered sediment

4) Finishes with the deposition and lithification of sediment



The Rock Cycle

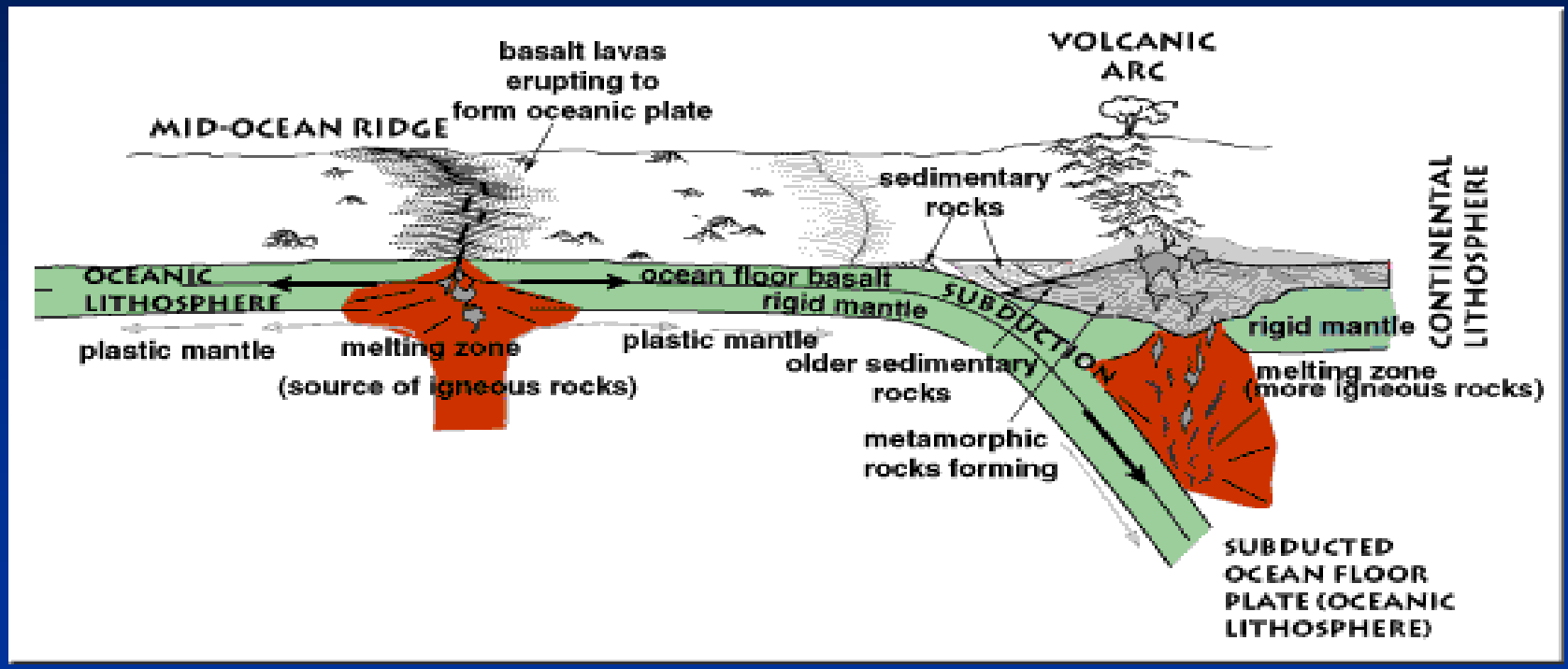
Water Cycle = Mother Sedimentary



1) **Agents** = Sun, Water, Air and Gravity

2) **Processes** = Weathering, Erosion and Deposition

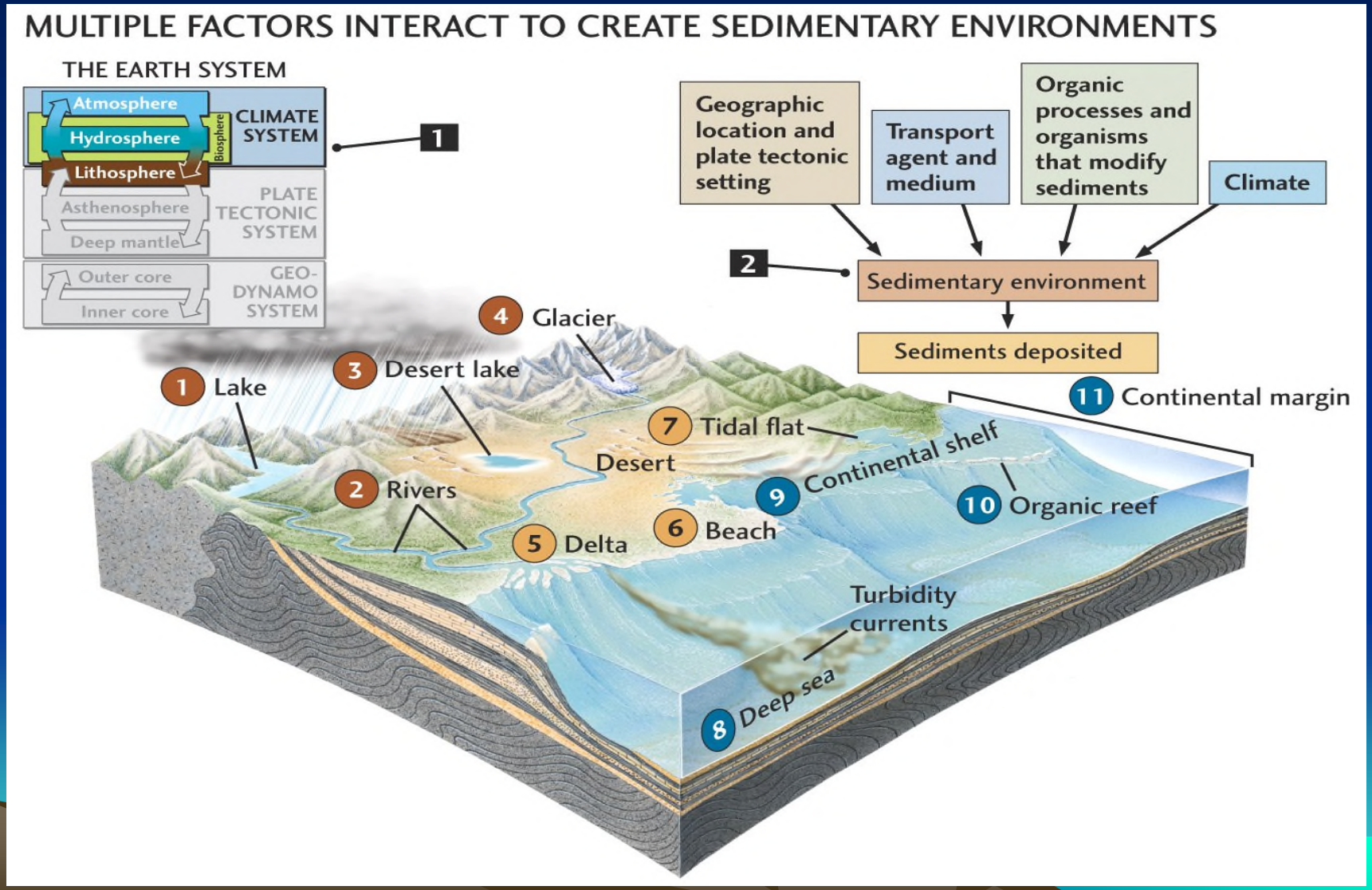
Tectonic Environments and Sedimentary Rock Formation



1) ***Source regions*** for sediments are primarily convergent plate boundaries

2) ***Depositional sites*** for sediments are primarily the edges of ocean basins

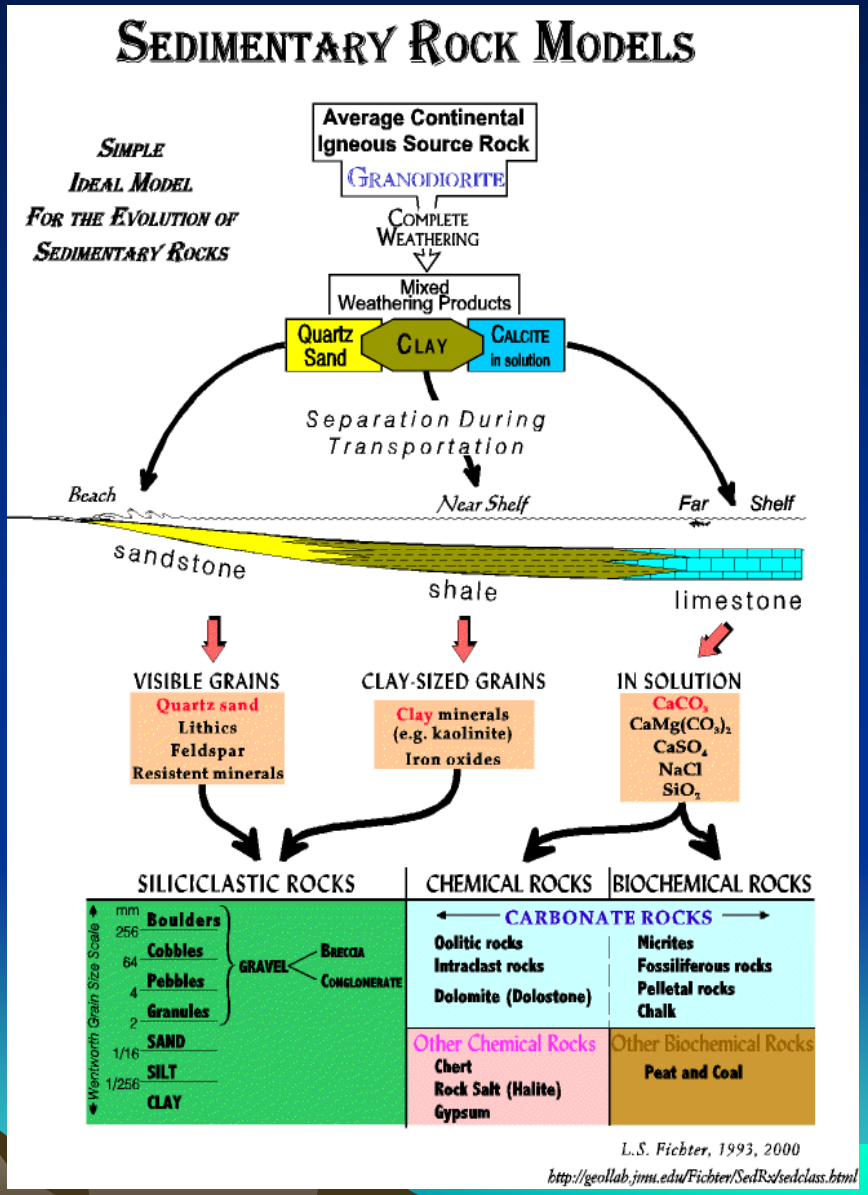
Sedimentary Environments Where Sedimentary Rocks Form



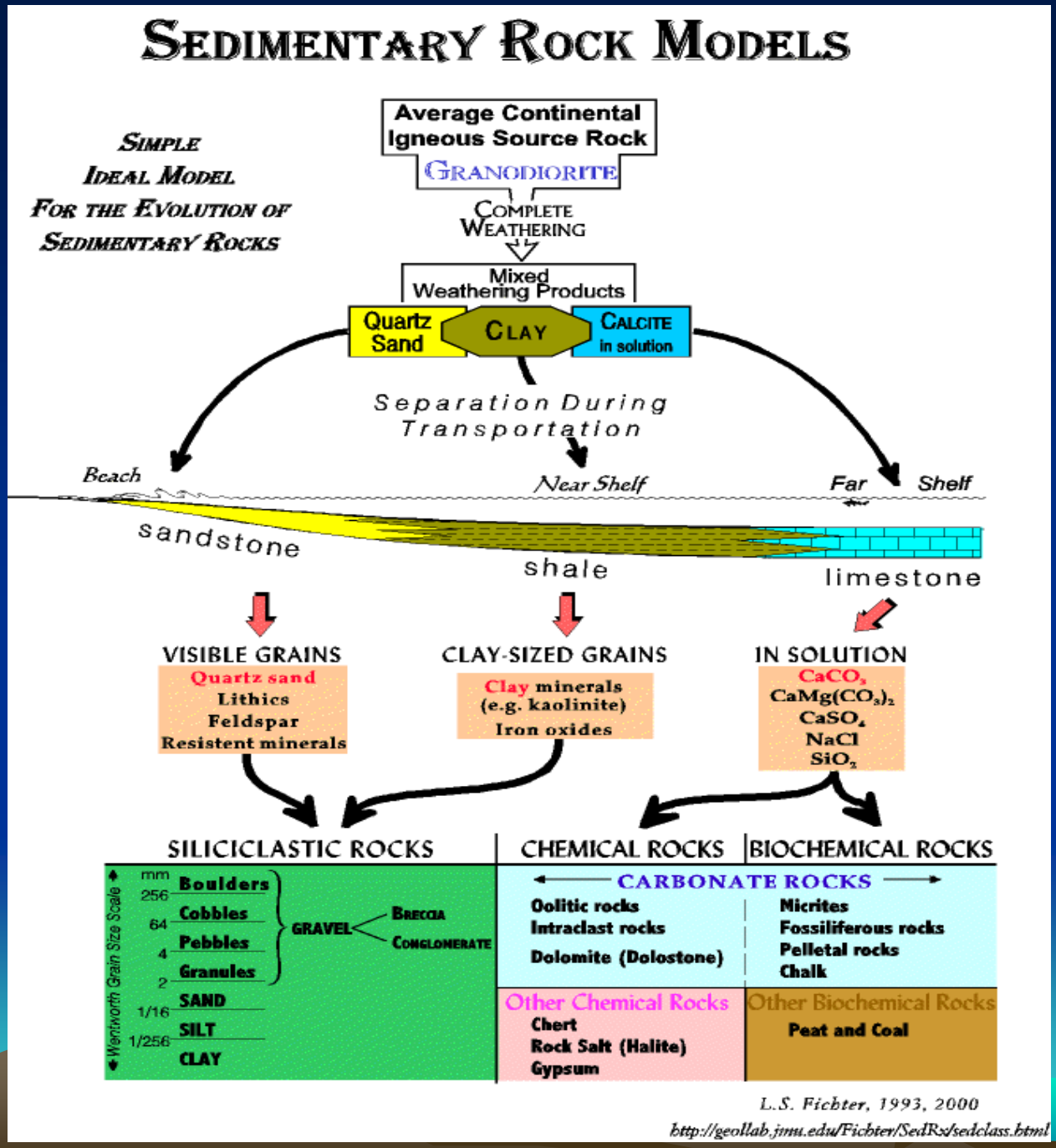
Origin of Sedimentary Rocks

Sedimentary rocks generated by a sequence of surface and near-surface processes including the following: weathering, erosion (removal/transport), deposition, burial, compaction, and cementation (lithification) of sediments.

The weathering, erosion, and lithification processes produce an abundance of quartz-, clay- and carbonate-rich sediments, which ultimate form three major types of sedimentary rocks.

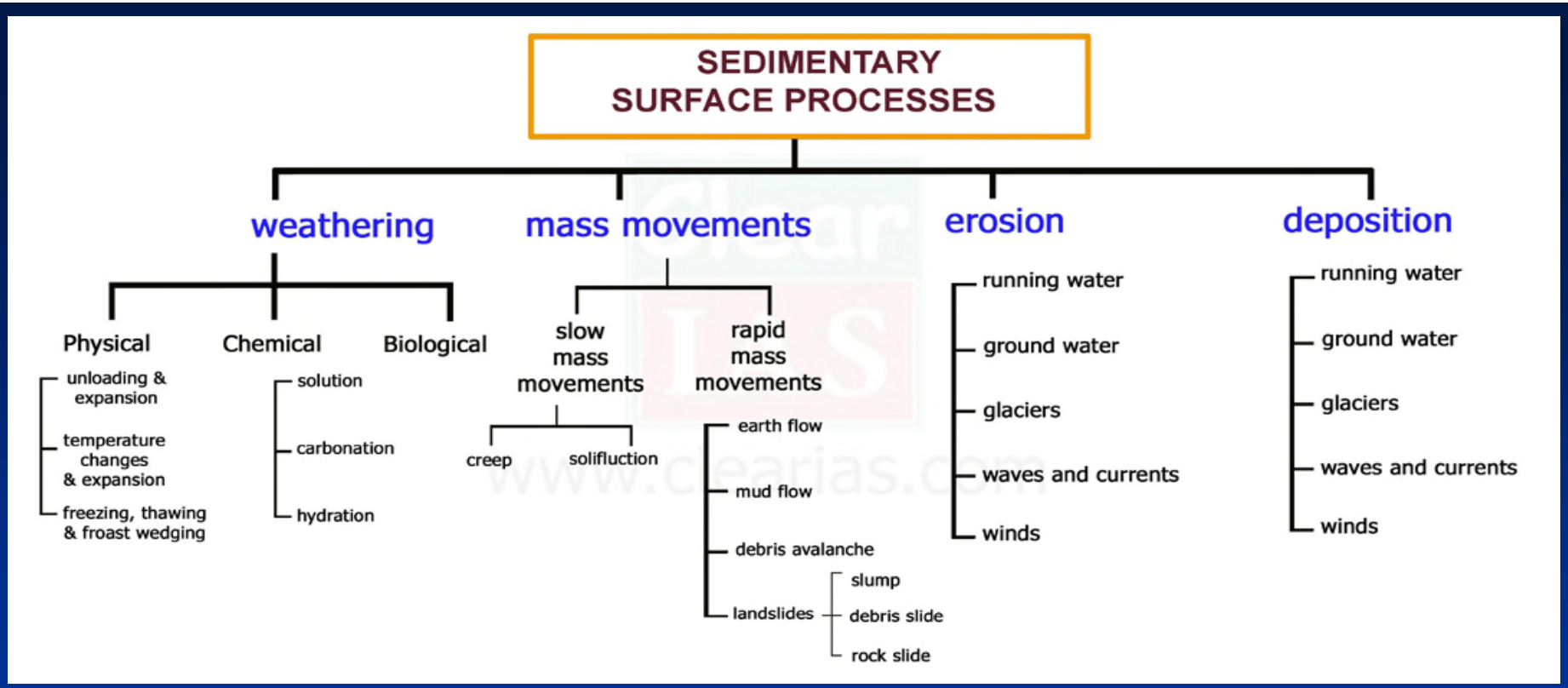


Sedimentary Rock Models



L.S. Fichter, 1993, 2000

http://geollab.jmu.edu/Fichter/SedRx/sedclass.html



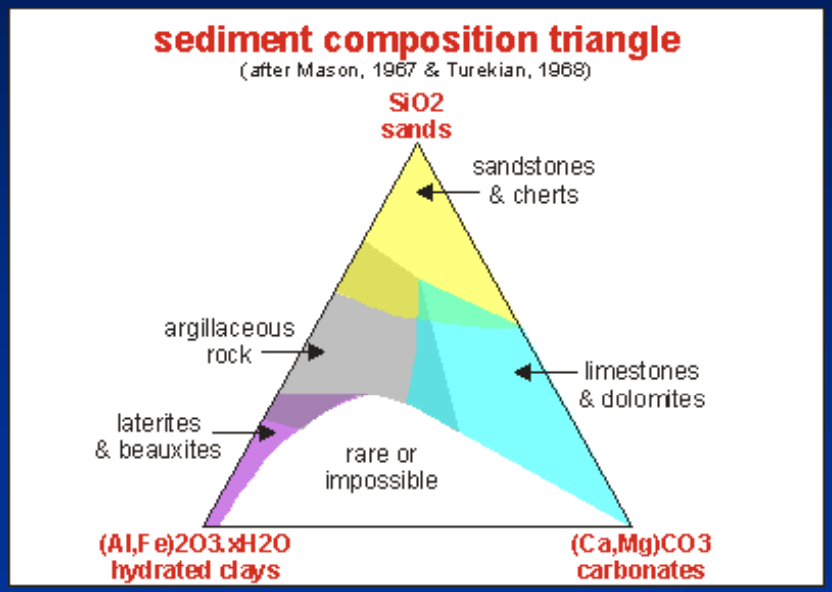
1) Weathering breaks down rock mechanically and chemically into mineral sediment grains and dissolved mineral ions

2) Mass movement and erosion removes and transports sediment and dissolved materials to sites of b y a transport medium such as moving water to a site of deposition

3) Deposition occurs where sediment settles out of a transport medium onto the ground surface to collect over time

Sediment Composition Classification

Three Most Common Sediment Types Forming Sedimentary Rock



Sediments Type Chart

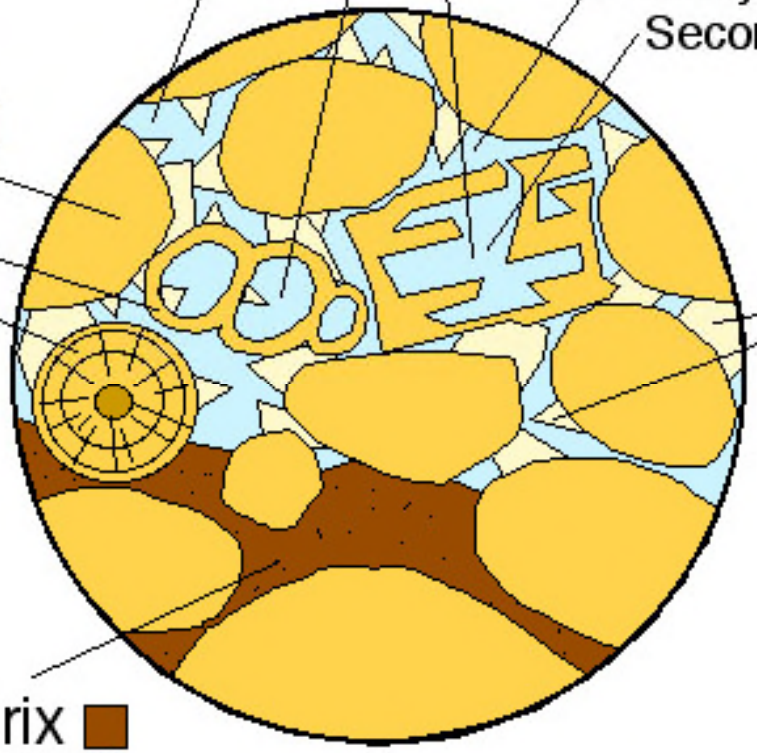
Sediment Mineral Types

- ✓ Quartz Silts & Sands
- ✓ Clays
- ✓ Carbonates

Sediment Rock Types

- ✓ Siltstone, Sandstone & Chert
- ✓ Shales & Mudstones
- ✓ Limestones & Dolostones

Four Fundamental Components of Sedimentary Rocks



Porosity
(Space with no mineral matter; commonly filled with water)

Intergranular porosity

Intragranular porosity

Primary porosity

Secondary porosity

Grains
(Sand grains, fossils, ooids, etc.)

Cement
(Chemically precipitated mineral material)

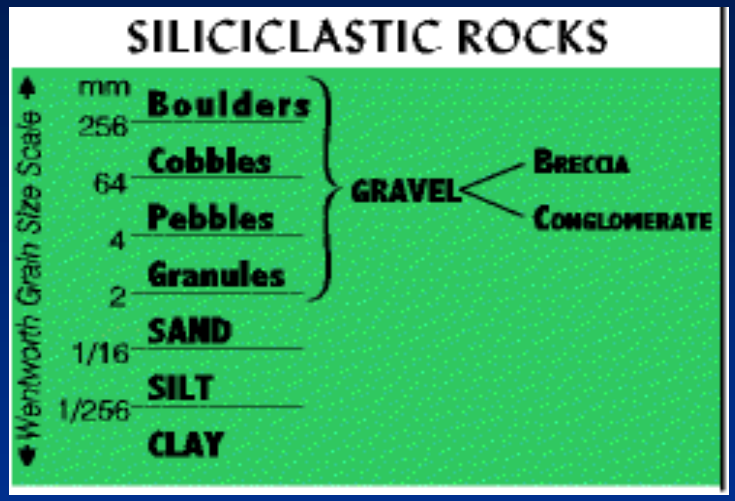
Matrix
(Fine-grained (clay-sized) sediment)

LBR 6/2002

Three Major Groups of Sedimentary Rocks

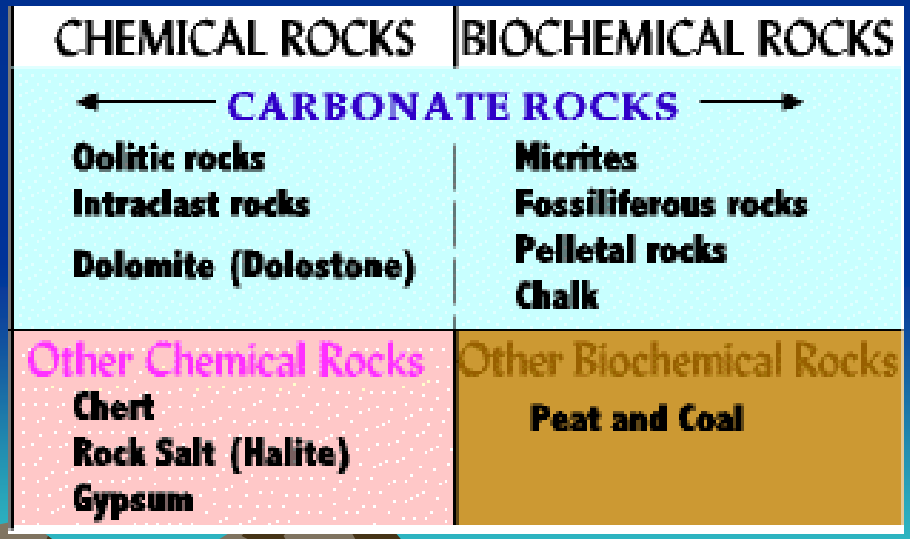
1) Siliciclastic

- ✓ Breccia and Conglomerate
- ✓ Sandstone
- ✓ Siltstone
- ✓ Shale



2) Biochemical

- ✓ Limestone and Coal
- ✓ Biogenic origin
- ✓ Clastic and Crystalline



3) Chemical

- ✓ Chert, Rock Salt, and Gypsum
- ✓ Inorganic origin
- ✓ Crystalline

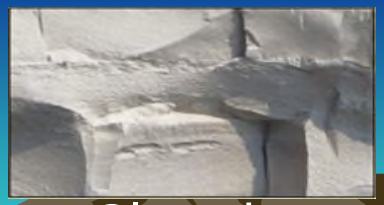
http://earthsci.org/mineral/mineral.html

Predominant Sediment Clast Types at Specific Depositional Settings

Gravel-size

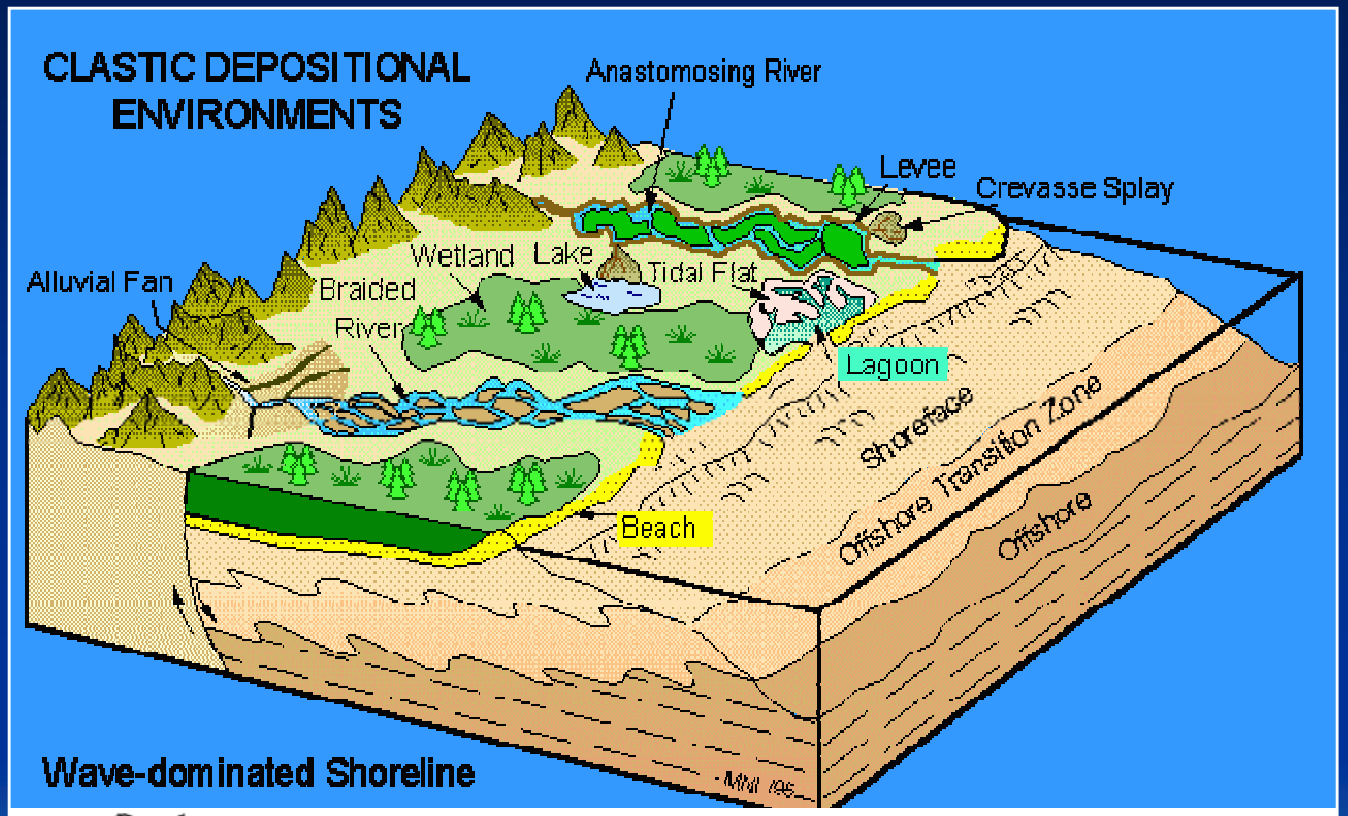
Sand-size

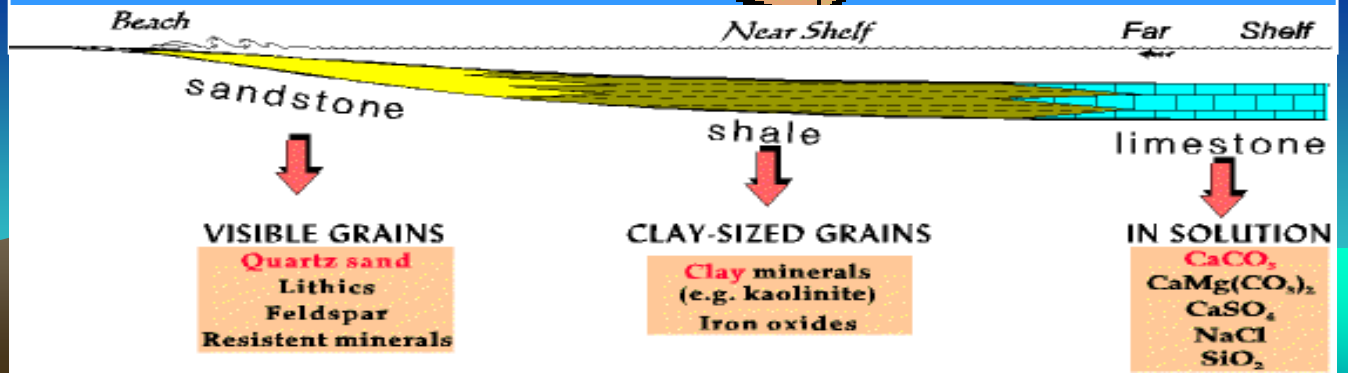
Silt-size



Clay-size

Clast Size





Sediment Clast Types

Clast Size

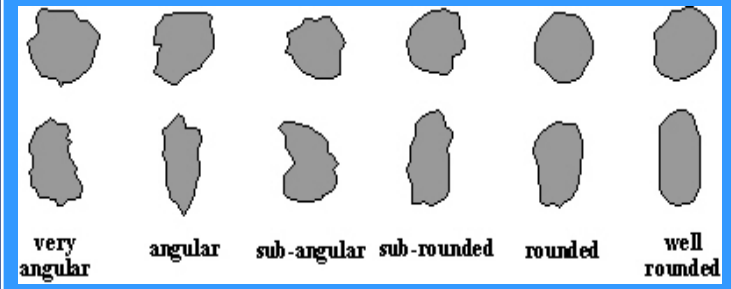
Gravel-size

Sand-size

Silt-size

Clay-size

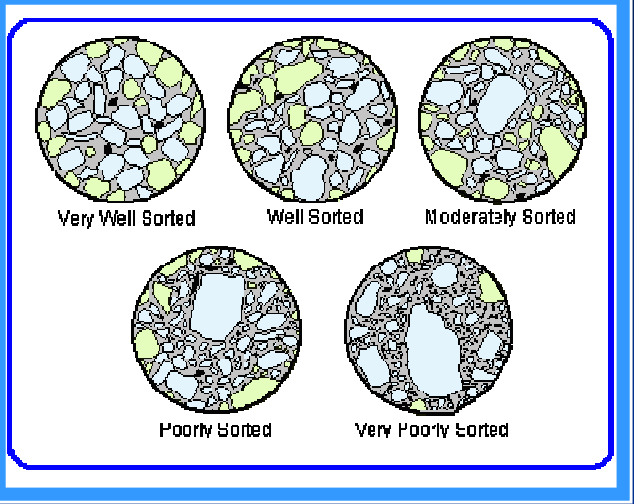
Clast Shape



Near-to-source

Far-from-source

Clast Sorting



1) **Clast size** is a function of transport time and medium
   - ✓ An indicator of depositional environment
2) **Clast shape** is a function of transport distance and time
   - ✓ An indicator of sediment “maturity”
3) **Clast sorting** is a function of transport medium
   - ✓ An indicator of depositional environment

Sedimentary Detrital Rock Textures

Breccia Texture:

- ✓ Very coarse-grained
- ✓ Angular fragments
- ✓ Deposits lose to source region

Conglomerate Texture:

- ✓ Very coarse-grained
- ✓ Rounded Fragments
- ✓ Deposits far from source reg

Sandstone Texture:

- ✓ Coarse to medium-grained
- ✓ Mostly quartz and feldspar
- ✓ Deposits in moving waters

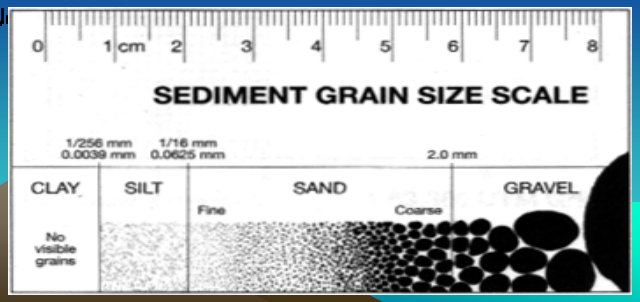
Siltstone texture:

- ✓ Fine-grained = silt-sized
- ✓ Mostly quartz and feldspar
- ✓Deposits in fairly quiet waters

Shale Texture:

- ✓ Very fine-grained = clay-sized
- ✓ Mostly clay
- ✓ Deposits in very quiet waters

Phi Units*	Size	Wentworth Size Class	Sediment/Rock Name
-8	256 mm	Boulders	Sediment: GRAVEL Rock: RUDITES: (conglomerates, breccias)
-6	64 mm	Cobbles	
-2	4 mm	Pebbles	
-1	2 mm	Granules	
0	1 mm	Very Coarse Sand	Sediment: SAND Rocks: SANDSTONES (arenites, wackes)
1	1/2 mm	Coarse Sand	
2	1/4 mm	Medium Sand	
3	1/8 mm	Fine Sand	
4	1/16 mm	Very Fine Sand	
8	1/256 mm	Silt	Sediment: MUD Rocks: LUTITES (mudrocks)
		Clay	



Sedimentary Biological & Chemical Types

Clastic and Crystalline

Sparite Texture:

- ✓ Coarse-grained crystalline
- ✓ Carbonate minerals
- ✓ Halite and Gypsum
- ✓ With or without fossils

Micrite Texture:

- ✓ Fine-grained crystalline
- ✓ Carbonate minerals
- ✓ With or without fossils

Coquina Texture:

- ✓ Coarse-grained
- ✓ Mostly shell material
- ✓ Carbonate minerals

Microcrystalline texture:

- ✓ Extremely fine-grained
- ✓ Smooth, massive looking
- ✓ Deposits in quiet waters
- ✓ Chert and Travertine

Fossiliferous Texture:

- ✓ Abundant fossils
- ✓ Either crystalline or clastic groundmass
- ✓ Usually carbonate rich

Sedimentary Rock Structures

Mud Cracks

Ripple Marks

Cross Bedding

Graded Bedding

Layering

Bioturbation

Sedimentary Rock Classification

- **A Three Step Process**

1) Find Texture

- ✓ Detrital? Crystalline
- ✓ Grain size?
- ✓ Shape?
- ✓ Fossils?

2) Find Rock Composition

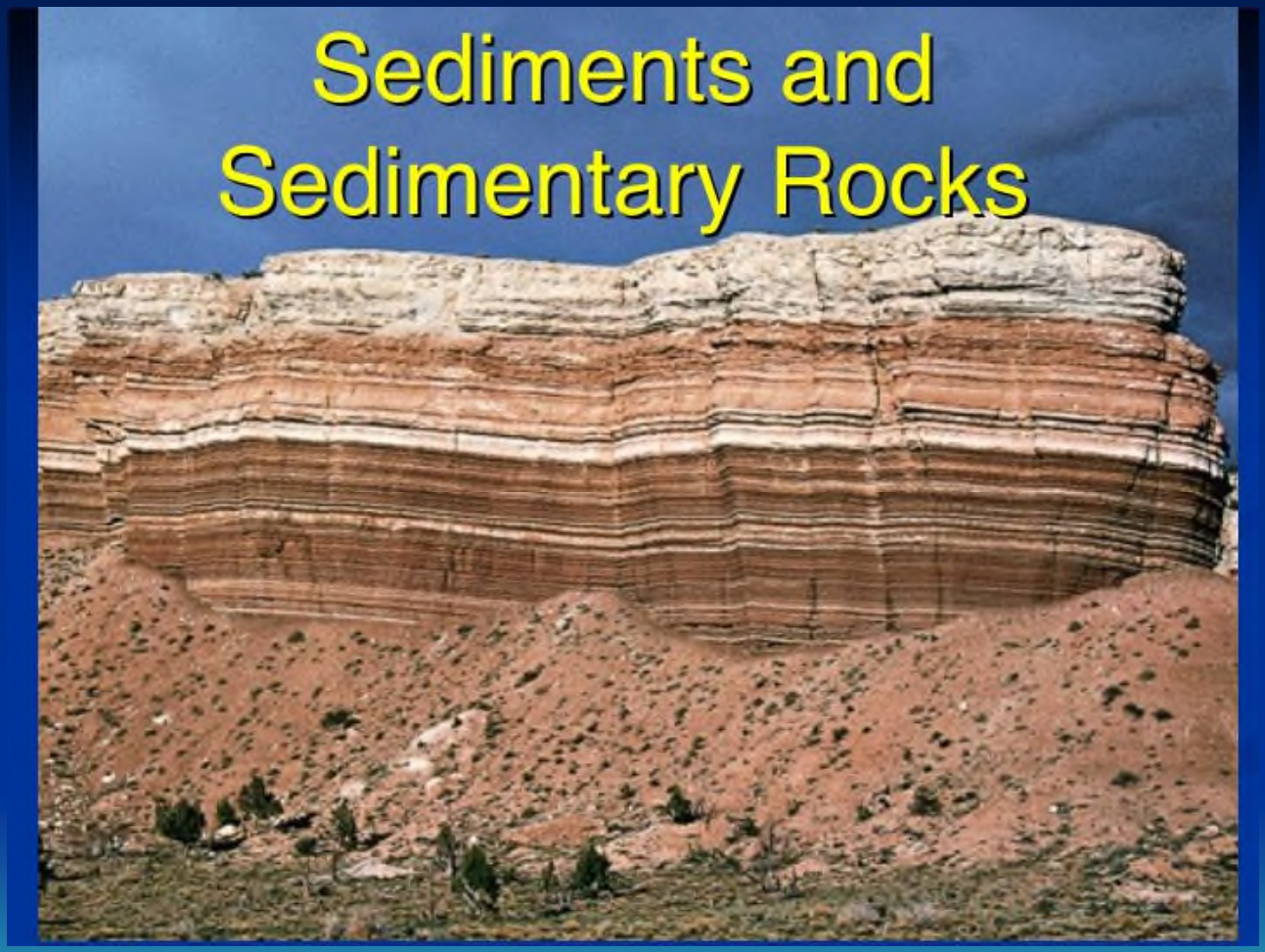
- ✓ Mineralogy?

3) Name the Rock

SEDIMENTARY ROCK ANALYSIS AND CLASSIFICATION

STEP 1: What is the rock's composition?		STEP 2: What are the rock's textural and other distinctive properties?			STEP 3: Rock Name(s)	
DETRITAL (CLASTIC)	Mainly rock fragments or mineral grains (quartz, feldspar, clay) weathered from other rocks	Mainly gravel (≥ 2 mm)		Rounded grains	CONGLOMERATE	
				Angular grains	BRECCIA	
		Mainly sand (1/16 – 2 mm)		Mostly quartz grains	QUARTZ SANDSTONE	SANDSTONE
				Mainly feldspar and quartz	ARKOSE	
				Sand is mixed with much silt and/or clay (mud)	GRAYWACKE	
		Mainly Mud (< 1/16 mm)	Mostly silt (1/256 – 1/16 mm)	Breaks into blocks or layers	SILTSTONE	MUDSTONE
			Mostly clay (< 1/256 mm)	Crumbles or breaks into blocks	CLAYSTONE	
				Fissile (splits easily)	SHALE	
BIOCHEMICAL: Mainly fossil shells or plant fragments	Mainly plant fragments or charcoal	Dull brown with visible plant fragments		Porous and easy to break apart the plant fragments	PEAT	
		Black		Dense and brittle or porous and sooty	BITUMINOUS COAL	
	Mainly fossil shells, shell fragments, or microfossils Effervesces in dilute HCl	Mostly visible shells and shell fragments cemented into a dense mass			CALCIRUDITE	LIMESTONE
		Mostly sand-sized fragments. May have a few larger shells.			CALCARENITE	
		Mostly very fine grained to microcrystalline mass of calcite and microfossils			MICRITE	
		Porous, poorly cemented mass of shells and shell fragments			COQUINA	
		Mostly very fine grained, earthy, chalky, light-colored mass of microfossils			CHALK	
CHEMICAL (INORGNIC): Chemically precipitated crystals	Mainly crystals of calcite or aragonite, $CaCO_3$ Effervesces in dilute HCl	Crystalline to microcrystalline bands of calcite crystals			TRAVERTINE	
		Spherical grains like tiny beads (< 2 mm) with concentric laminations			OOLITIC LIMESTONE	
	Mainly dolomite $CaMg(CO_3)_2$	Microcrystalline		Effervesces in dilute HCl only if powdered	DOLOSTONE	
	Mainly varieties of quartz, SiO_2 (chalcedony, flint, chert, opal, jasper, etc.)	Microcrystalline, conchoidal fracture		Scratches glass	CHERT	
	Mainly halite, NaCl	Crystals formed as inorganic chemical precipitates		Salty taste	ROCK SALT	
	Mainly gypsum, $CaSO_4 \cdot 2H_2O$	Crystals formed as inorganic chemical precipitates		Can be scratched with your fingernail	ROCK GYPSUM	
	Mostly iron-bearing minerals, like limonite and hematite	Amorphous or microcrystalline		Dark-colored, usually brown or red-gray	IRONSTONE	

Discussion and Examination



http://www.cobweb.net/~bug2/mineral.htm

http://www.rockhounds.com/rockshop/rockkey/index.html

http://www.union.edu/PUBLIC/GEODEPT/COURSES/geo-10/mineral.htm