Module 9
Sedimentary Rocks

SEDIMENTARY ROCKS

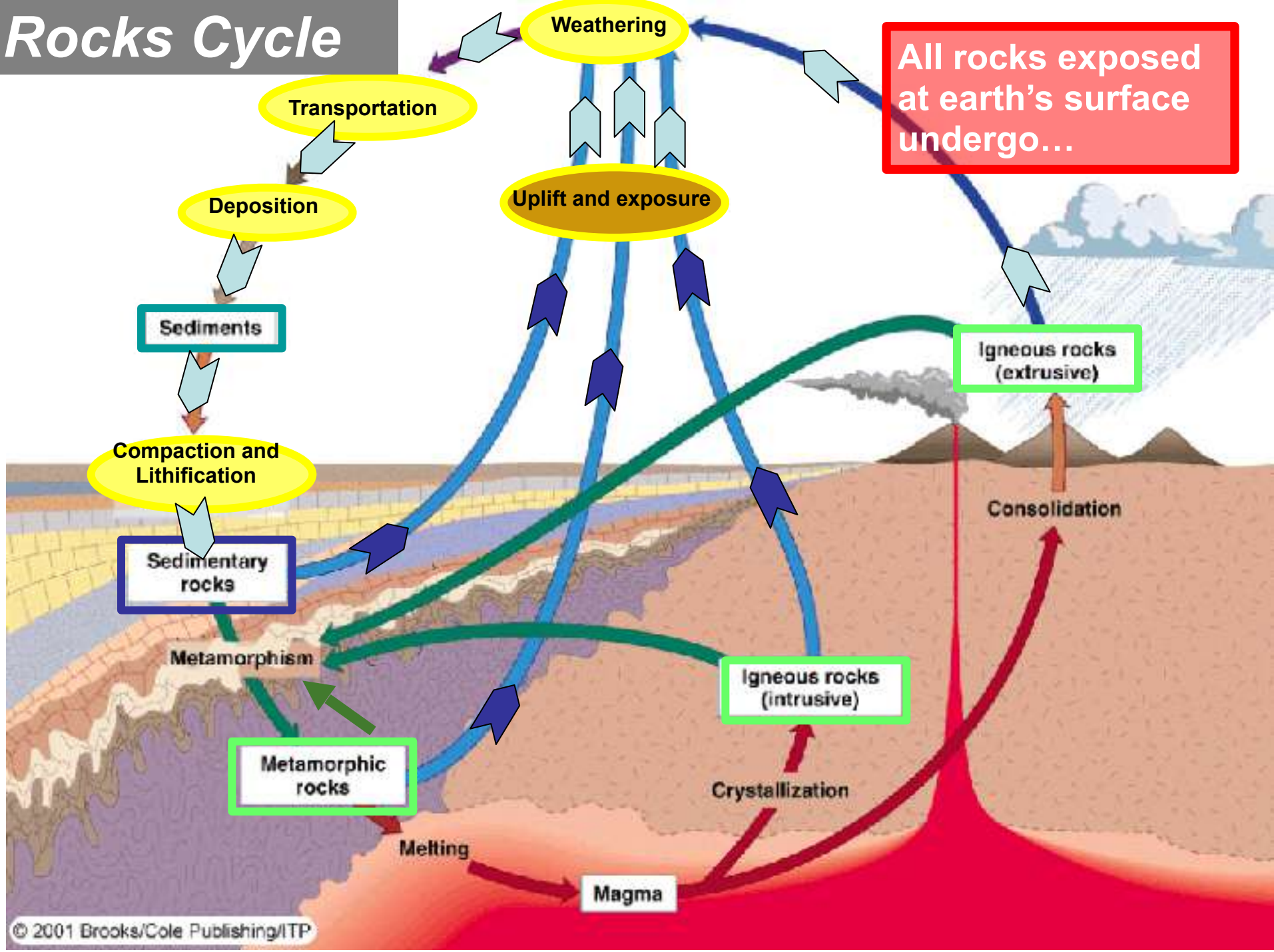
- **Rocks formed from material derived from preexisting rocks by surfacial processes followed by diagenesis**
- **There are two main classes of sedimentary rocks**
  - ***Clastic (detrital) sedimentary rocks*** **are formed from bits and pieces of previously existing rocks, called clasts or detritus**
  - ***Chemical sedimentary rocks*** **are formed in several ways**
    - **By precipitation from aqueous solution**
    - **From plant material**
    - **From animal material**

Clastic Sedimentary Rocks

Processes Leading to Formation of Clastic Sedimentary Rocks

- ***Weathering:*** **the processes that change rocks' size and composition at or near Earth's surface**
- ***Erosion and Transportation:*** **removal of rock particles (clasts) from their source by water, wind, or glacial ice**
- ***Deposition:*** **the settling of clasts on Earth's surface as sediments, leads to formation of a sedimentary bed**
- ***Compaction:*** **pressing together of clasts, squeezing out pore water, by pressure exerted by overlying beds**
- ***Lithification:*** **cementation of clasts together to form a sedimentary rock**
- ***Diagenesis:*** **a process of conversion of unconsolidated sediments to coherent sedimentary rocks**

Rocks Cycle


Weathering
Transportation
Deposition
Sediments
Compaction and Lithification
Sedimentary rocks
Metamorphism
Metamorphic rocks
Melting
Magma
Crystallization
Igneous rocks (intrusive)
Uplift and exposure
Consolidation
Igneous rocks (extrusive)
All rocks exposed at earth's surface undergo…
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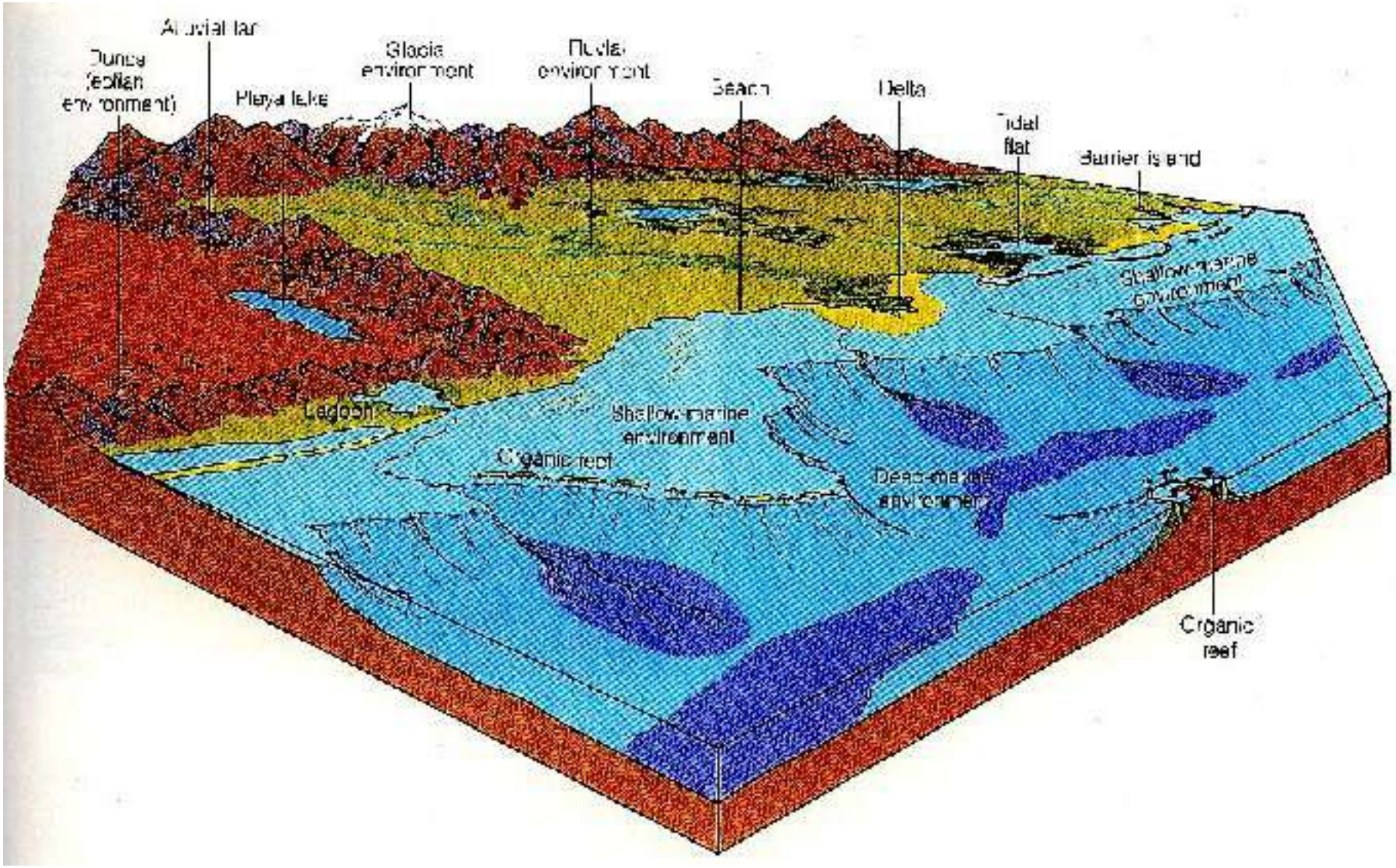
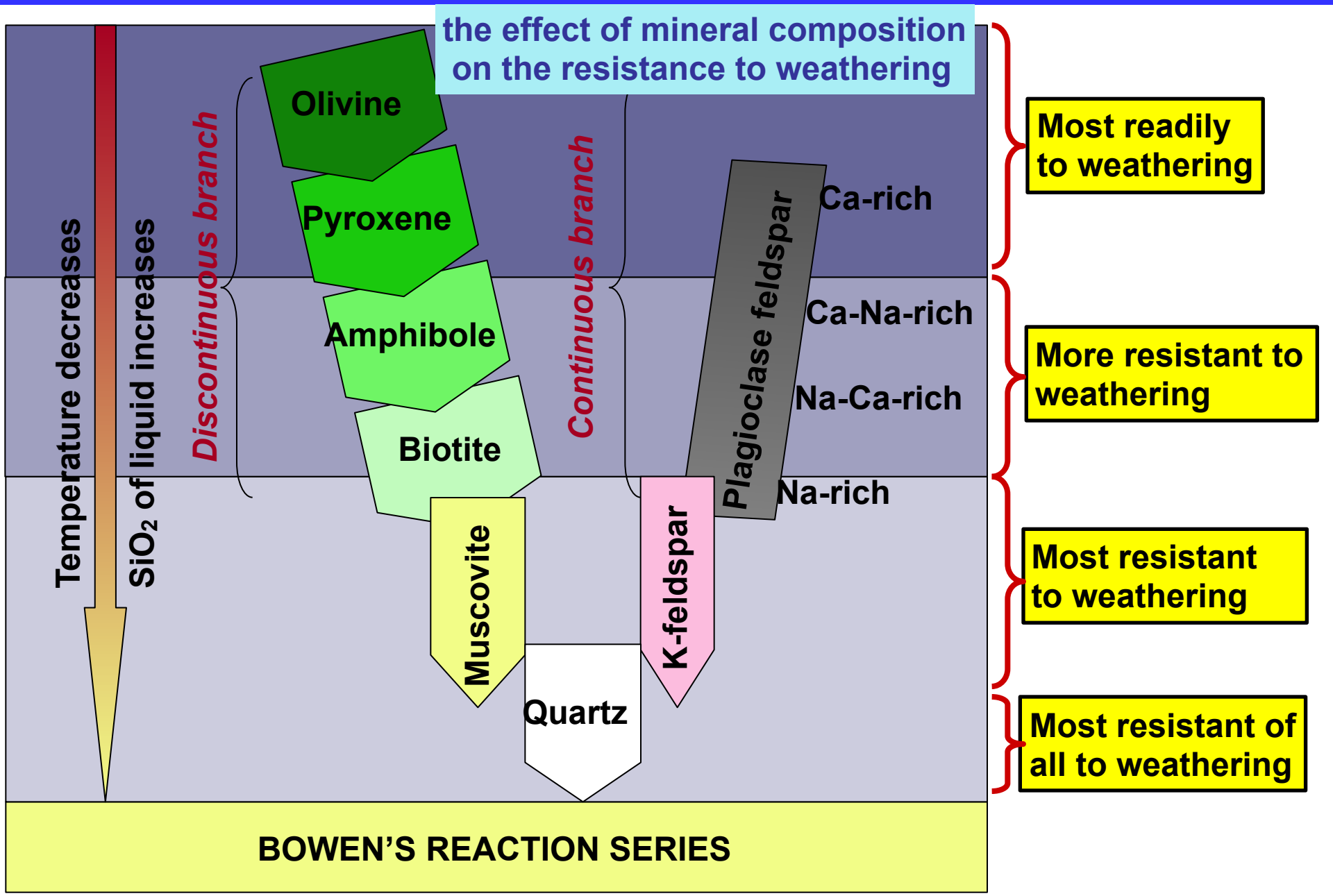
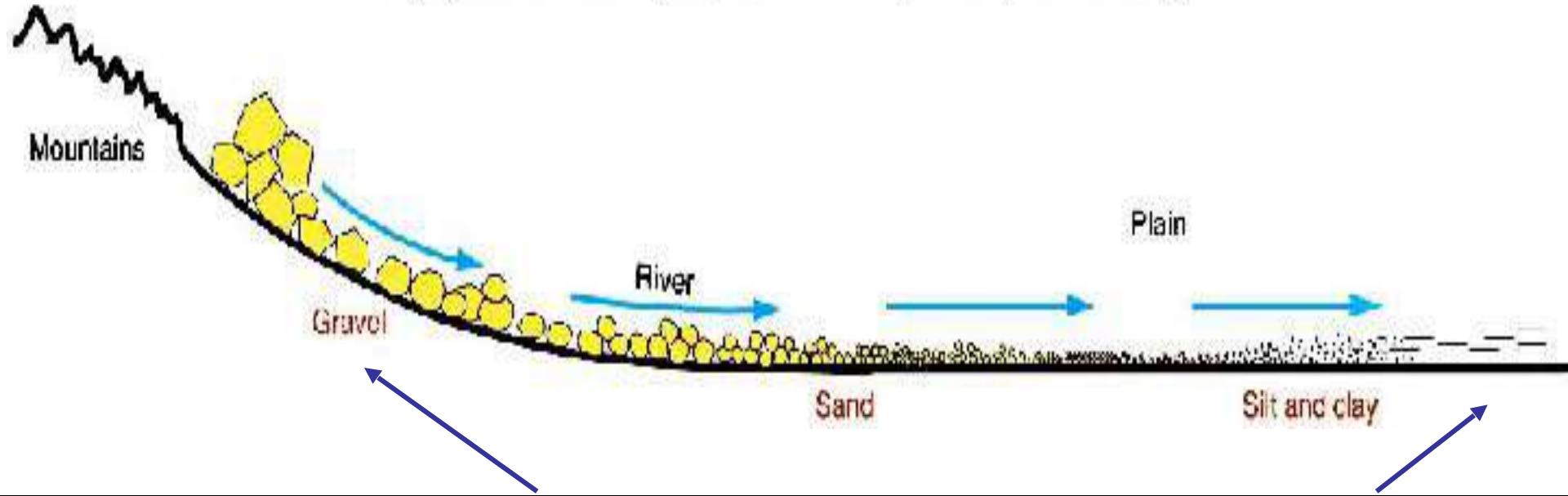
Where do the sediments form?



Resistance of Minerals to Weathering

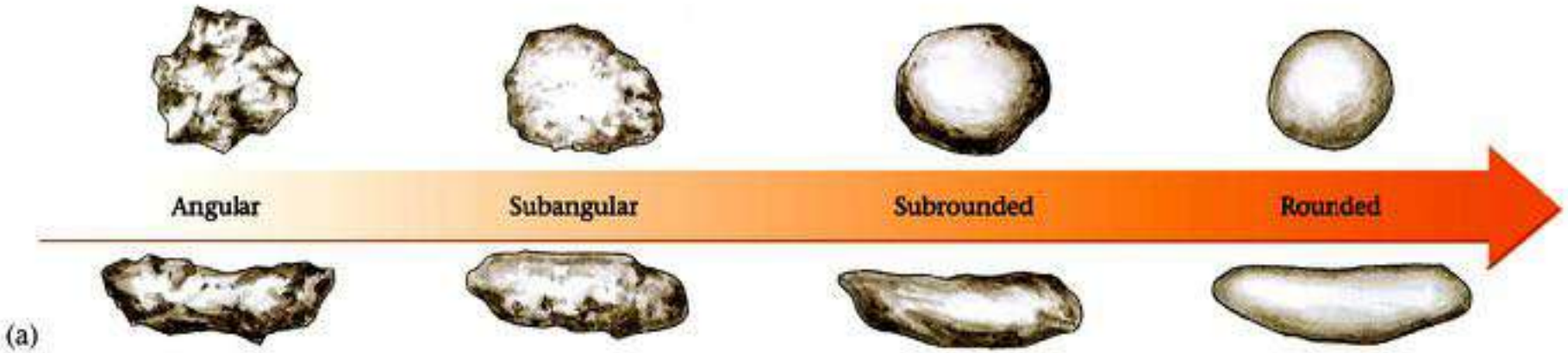


Effect of Weathering, Gradient, Distance from Source-Rock on Clast Size, Shape, Sorting, and Composition



	Close to source		*Far from source*
clast size	large clasts		small clasts
clast shape	angular clasts		rounded clasts
sorting	poorly sorted sediments		well sorted sediments
composition	rich in mafic minerals and feldspar		quartz sands and clays

Effect of Weathering, Gradient, Distance from Source-Rock on Clast Size, Shape, Sorting, and Composition



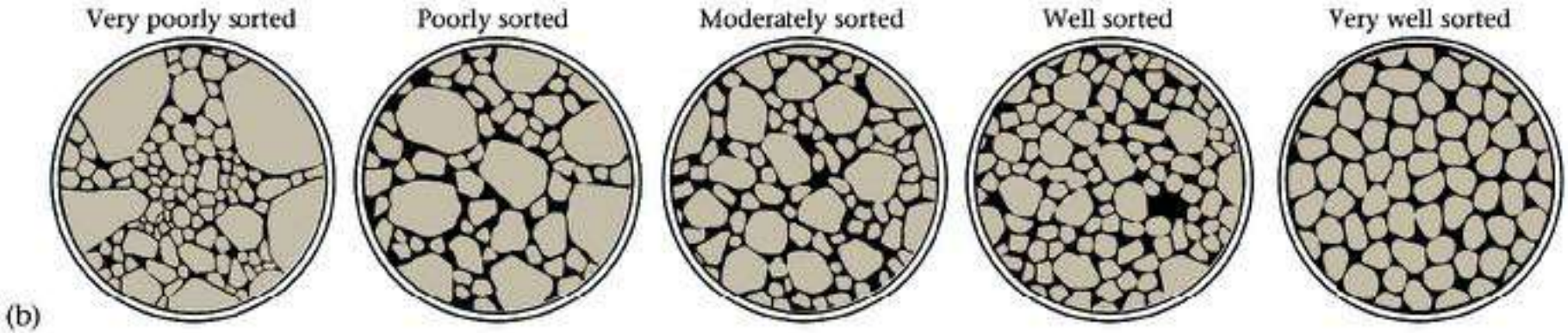
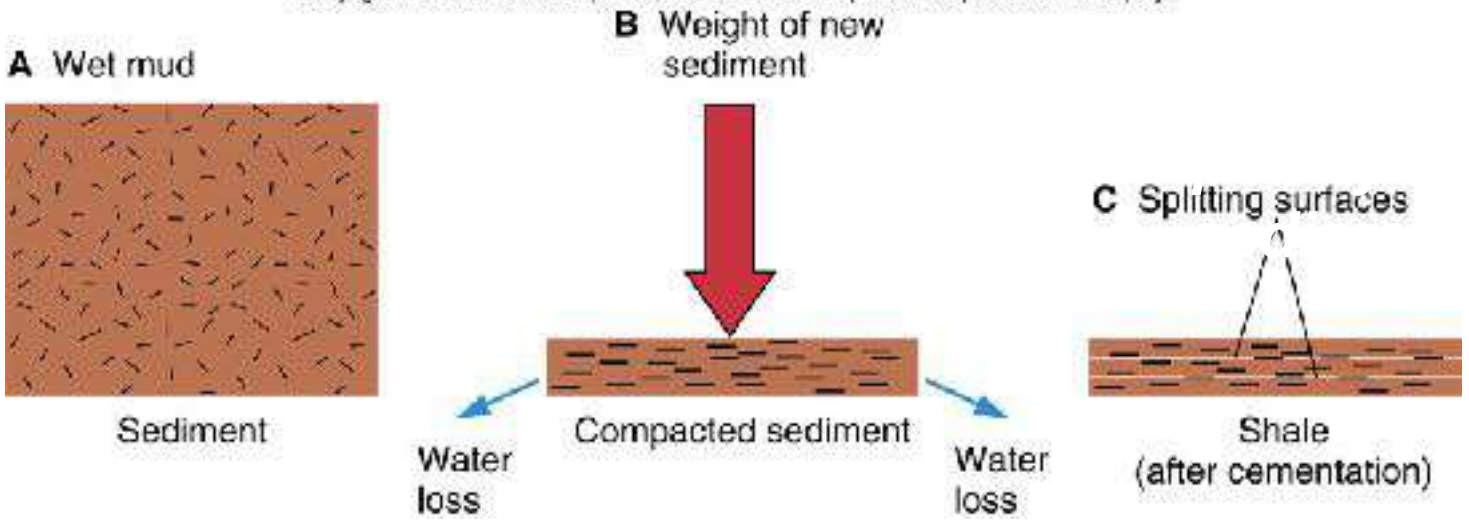
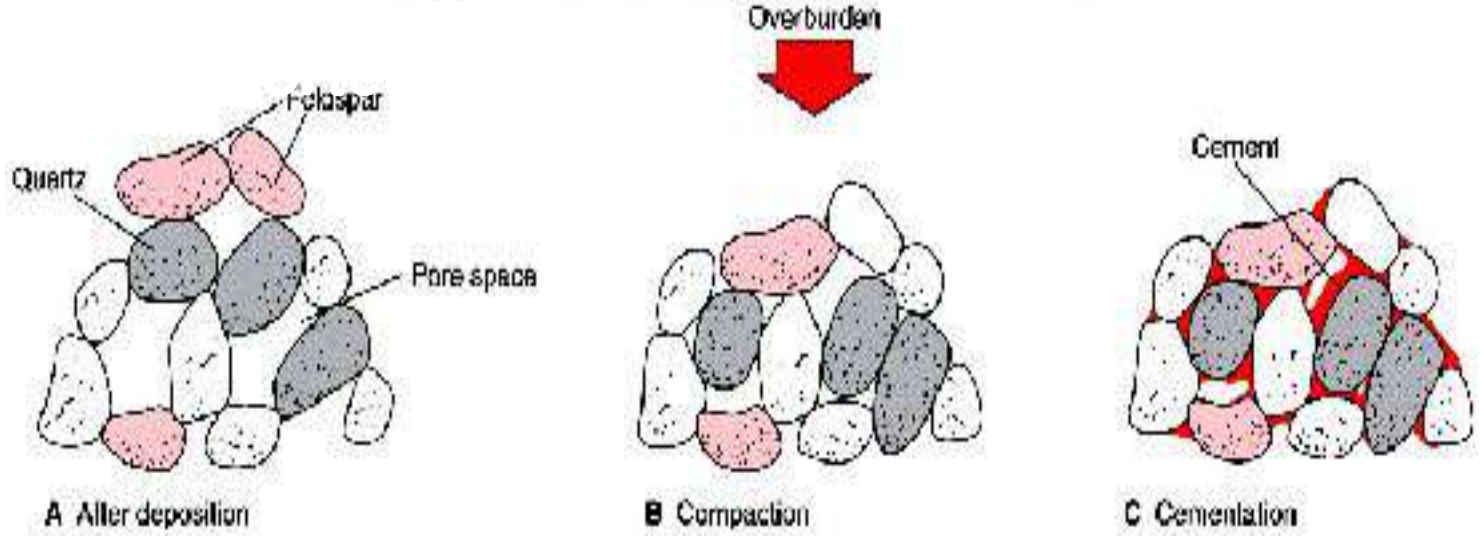


FIGURE 7.18

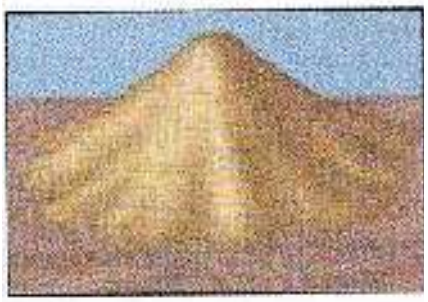
Effects of Compaction, Cementation on Sediments



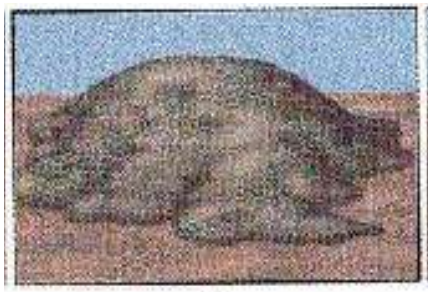


From sediments to sedimentary rocks

gravel



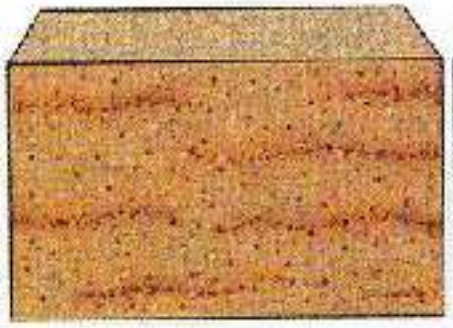
sand



silt

clay

conglomerate



sandstone

siltstone

claystone

Clastic Sedimentary Rock's Texture

Texture:

the relationship between the grains of minerals forming a rock

a. grain size
b. roundness
c. sorting
d. fabric
e. fragment, matrix, & cement

Clastic Sedimentary Rock's Texture

a. Grain size:

- Grain (particle, clast, fragment) size is primary distinguishing factor for clastic sedimentary rocks
- Size means diameter of rock's grains

Clastic Sedimentary Rock's Texture

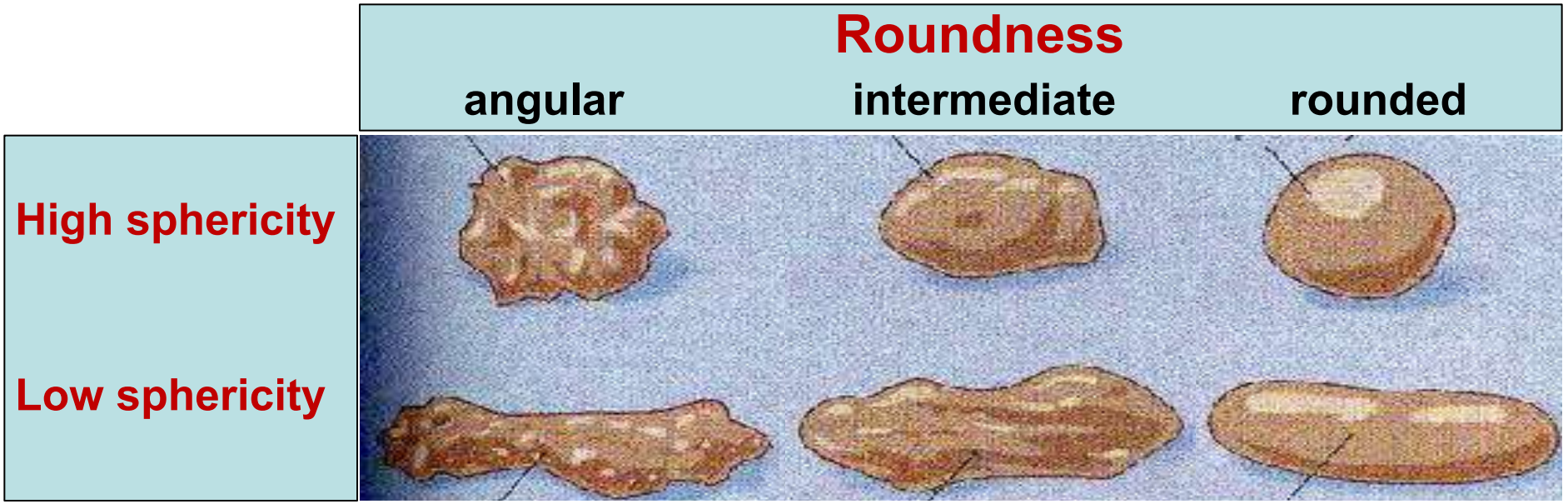
Size (mm)	Sedimentary clasts		Sedimentary rocks
>256	–	Boulder	Conglomerate (predominantly rounded clasts) or Breccia (predominantly Angular clasts)
128 – 256	Coarse-	Cobble	
64 – 128	Fine-	Cobble	
32 – 64	Very coarse-	Pebble	
16 – 32	Coarse-	Pebble	
8 – 16	Fine-	Pebble	
4 – 8	Very fine-	Pebble	
2 – 4	–	Granule	
1 – 2	Very coarse-	Sand	Sandstone
1/2 – 1	Coarse	Sand	
1/4 – 1/2	Medium-	Sand	
1/8 – 1/4	Fine_	Sand	
1/16 – 1/8	Very fine	Sand	
1/32 – 1/16	Very coarse-	Silt	Siltstone Mudstone Claystone or Shale
1/64 – 1/32	Coarse	Silt	
1/128 – 1/64	Fine-	Silt	
1/256 – 1/128	Very fine	Silt	
<1/256	–	Clay	

Wentworth' Scale

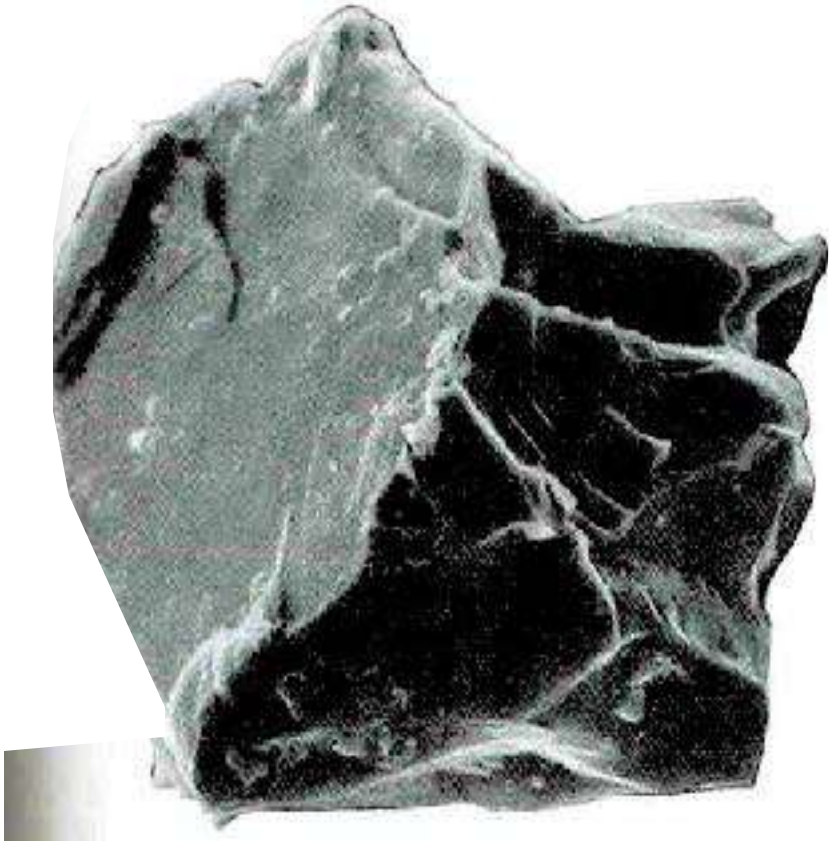
Clastic Sedimentary Rock's Texture

b. Sphericity vs roundness

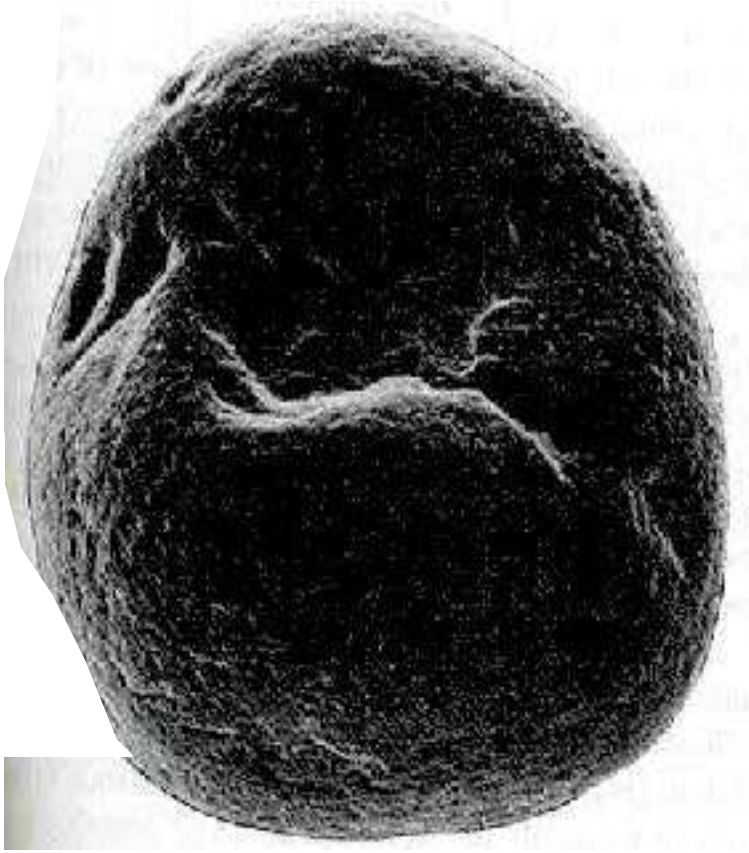
- **Sphericity is a degree of similarity to a ball shape**
- **Roundness is a degree of roundedness of the edges of a fragment**



Shapes of sand grains



Angular

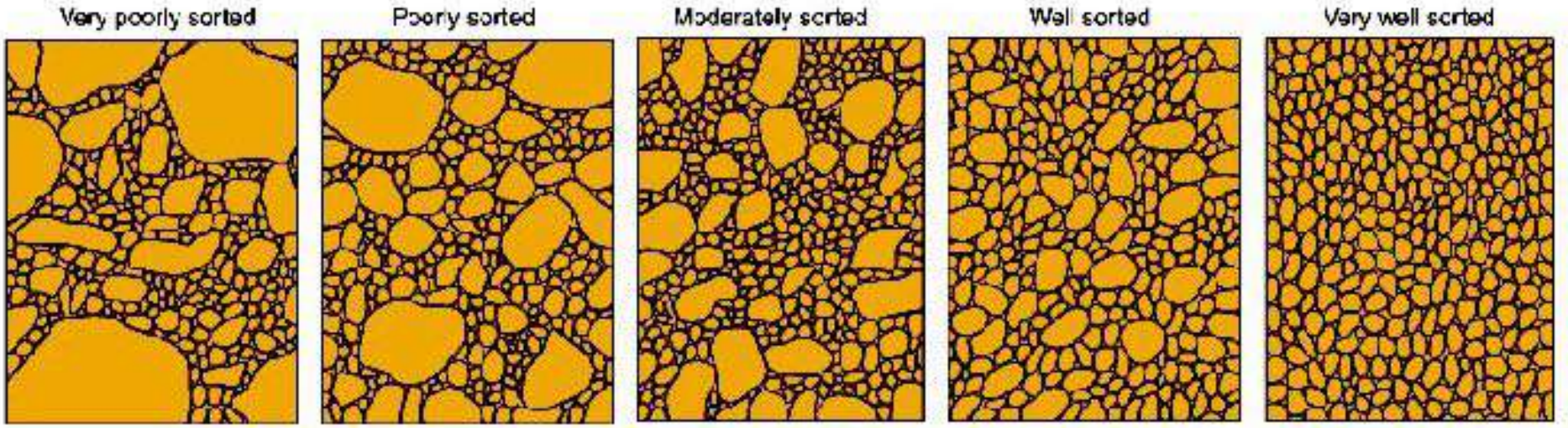


rounded

Clastic Sedimentary Rock's Texture

c. Sorting

- **Degree of similarity in particle size**



Clastic Sedimentary Rock's Texture

This quartz grains are:

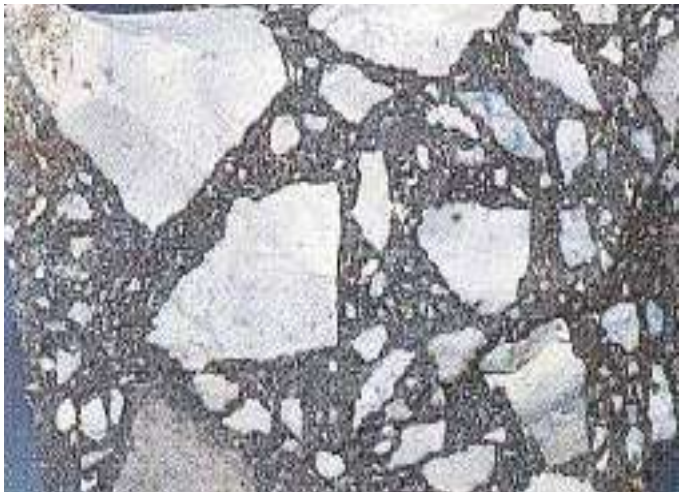
-well-sorted

-well-rounded

Clastic Sedimentary Rock's Texture

d. Fabric

- Opened fabric
- Closed fabric



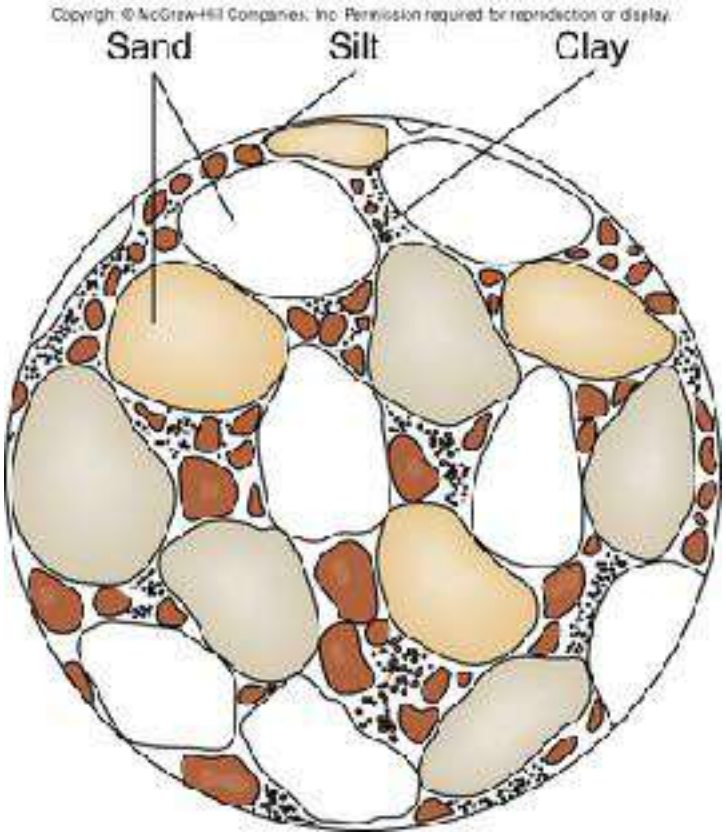
Opened fabric

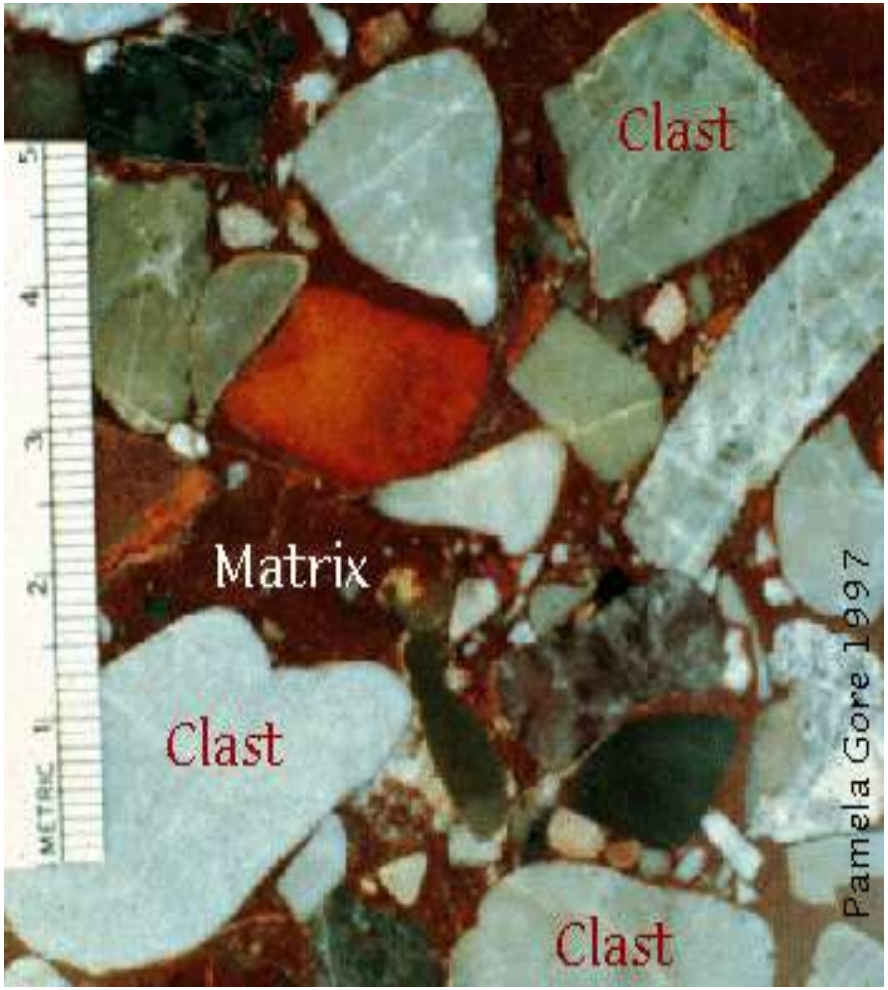
Closed fabric

Clastic Sedimentary Rock's Texture

e. Fragments, matrix, cement

- **Fragments (clasts)**
- **Matrix**
- **Cement**





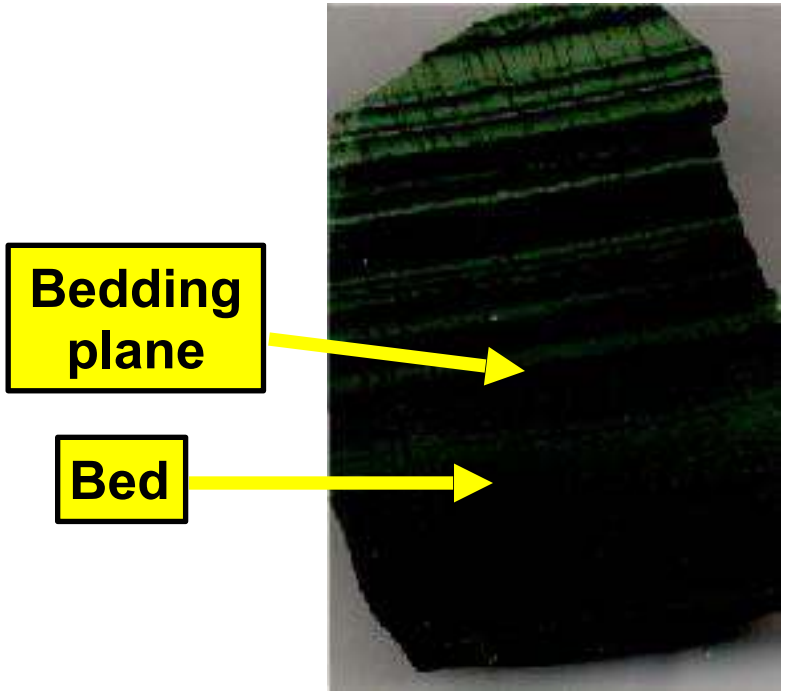
Clastic Sedimentary Rock's Texture

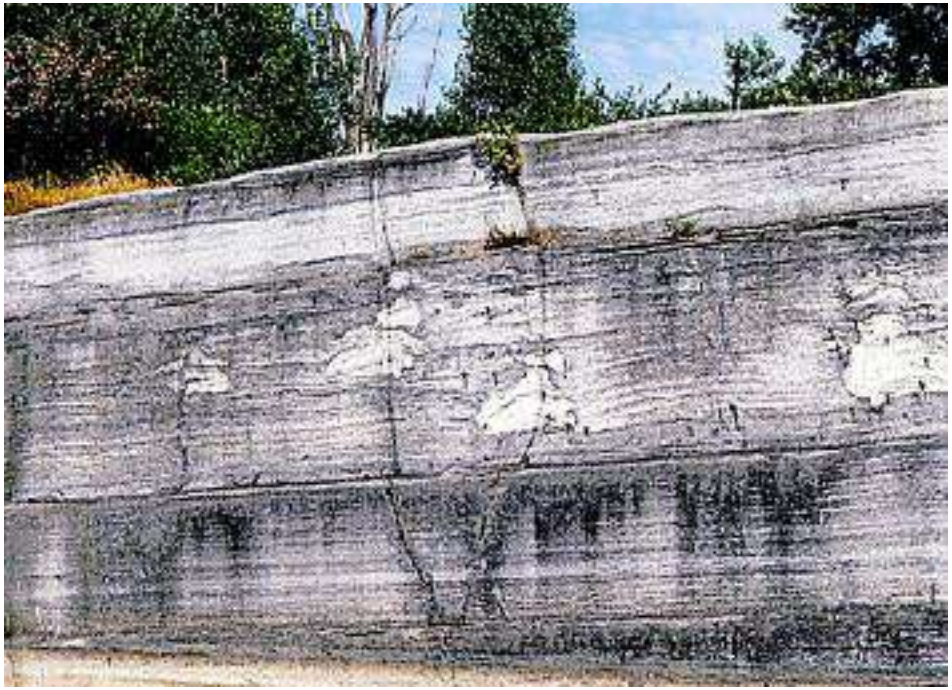
The Most Common Sedimentary Cements

- **Calcite**
  - The most common cement present in marine sedimentary rocks
  - Also common in sedimentary rocks formed from sediments deposited in evaporite basins
  - Calcite cemented sedimentary rocks give a positive acid test (will fizz when an acidic solution is dropped on them)
- **Hematite**
  - The cement present in red colored terrigenous (land-derived) sedimentary rocks, very common
  - Hematite cemented rocks will not fizz when an acidic solution is dropped on them
- **Silica**
  - The cement present in terrigenous (land-derived) sedimentary rocks that are not red, very common
  - Silica cemented rocks will not fizz when an acidic solution is dropped on them

Clastic Sedimentary Rock's Structure

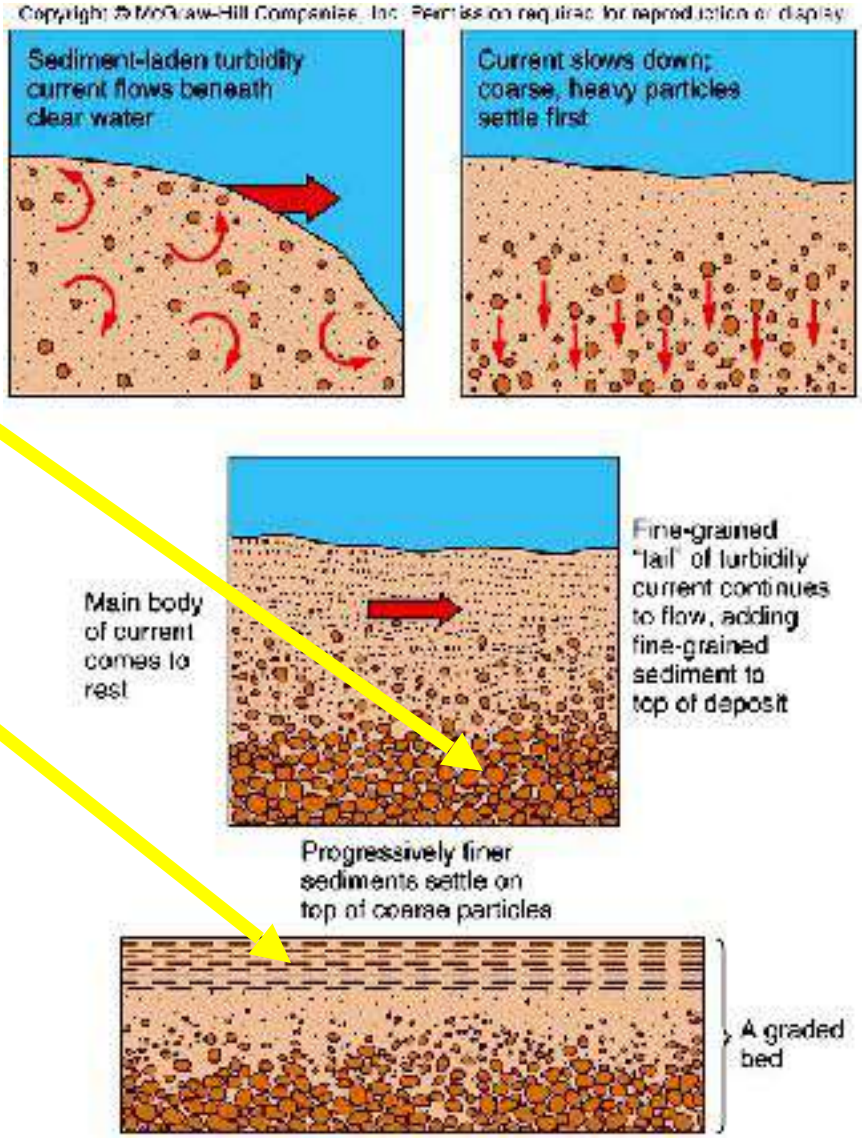
- ***Sedimentary Beds and Bedding Planes***
  - ➢**Beds represent distinct sedimentary event, times when deposition occurred**
  - ➢**Bedding planes represent pauses between sedimentary events, times when deposition ceased**





Clastic Sedimentary Rock's Structure

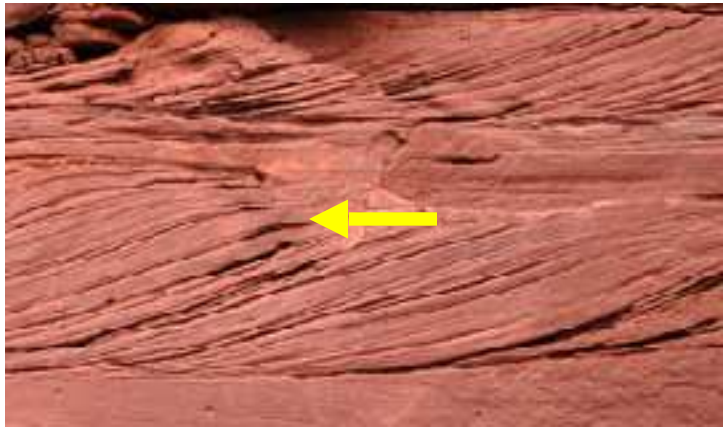
- ***Graded Sedimentary Beds***
  - ➢**Form in response to decrease in energy during deposition**
  - ➢***Larger, heavier clasts*, first pebbles then sand, settle out first, in the bottom of the bed**
  - ➢***Smaller, lighter clasts*, silt and finally clay, settle out last in the top of the bed**



Clastic Sedimentary Rock's Structure

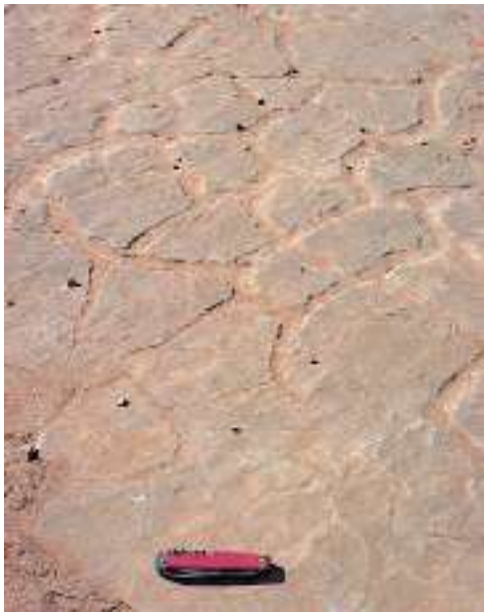
- ***Cross Beds***
  - **Cross beds are deposited in response to movement of a current**
  - **Cross beds are unidirectional if the *current was constant in direction***
  - **Cross beds are bi-directional if the *current was not constant in direction***
  - **Note: these beds are tilted**

Current direction



Clastic Sedimentary Rock's Structure

- ***Mud Cracks***
  - ➢ **Mud cracks form when mud dries up**
  - ➢ **Their shape and size may vary considerably**

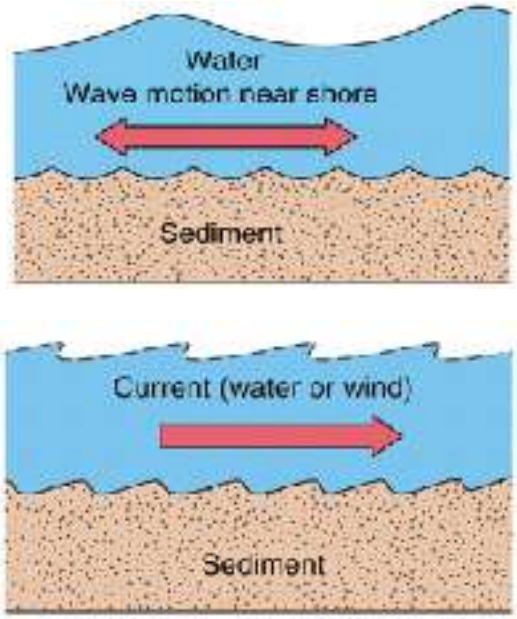


Mudcracks in a sedimentary rock

Mudcracks in fresh sediment

Clastic Sedimentary Rock's Structure

- ***Ripple Marks***
  - Are formed in response to movement of a current
  - ***Symmetrical ripple marks*** form if current is back-and-forth, bi-directional
  - ***Asymmetrical ripple marks*** form if current is constant in direction



Clastic Sedimentary Rock's Structure

- ***Raindrop Imprints and casts***
  - ➢**Form when big rain drops fall on mud**
  - ➢***Raindrop imprints*** **are depressions formed on the bed upon which the raindrops fell**
  - ➢***Raindrop casts*** **are knobs formed on the bottom of the bed deposited on top of the bed upon which the raindrops fell**

Raindrop imprints and mudcracks

Clastic Sedimentary Rock's Structure

- ***Fossils***
  - ➢Are any evidence of life preserved in ancient rocks
  - ➢Include bones, teeth, shells, molds and casts, petrified wood, impressions, footprints, etc.

Chemical Sedimentary Rocks

Chemical Sedimentary Rocks

- derived from material carried *in solution* to lakes/ seas
- *precipitation* from solution to form "chemical sediments"
  - by precipitation from aqueous solution
  - from plant material
  - from animal material

Chemical Sedimentary Rocks

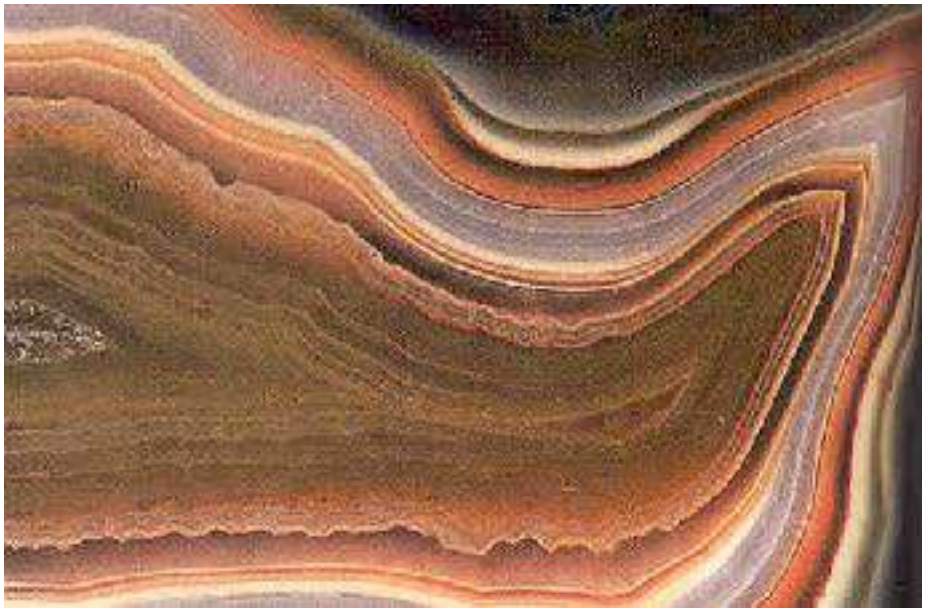
Salt flats, Utah

Death Valley, California

Evaporites

- water evaporates and dissolved stuff is deposited
- mostly marine rocks, but some lakes/ playas
- Salt, gypsum, potash

Chemical Sedimentary Rocks

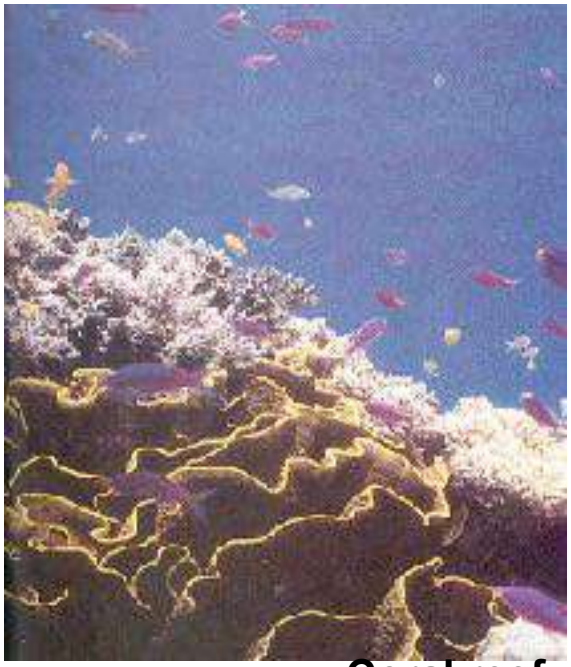


T&L Fig 6.12 Agate

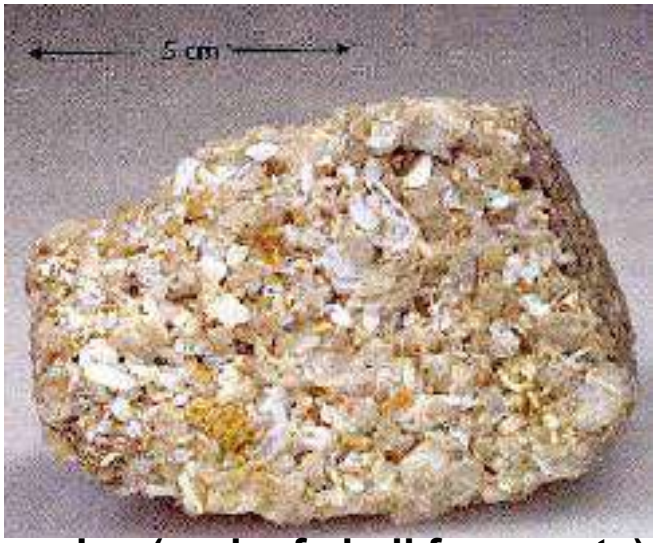
Chert

- very fine grained silica
- also called flint, jasper, agate
- most formed in ocean
- occurs as layers (beds) & as irregular blobs in limestone
- marine creatures remove silica from sea water, make shells

Chemical Sedimentary Rocks



Coral reef

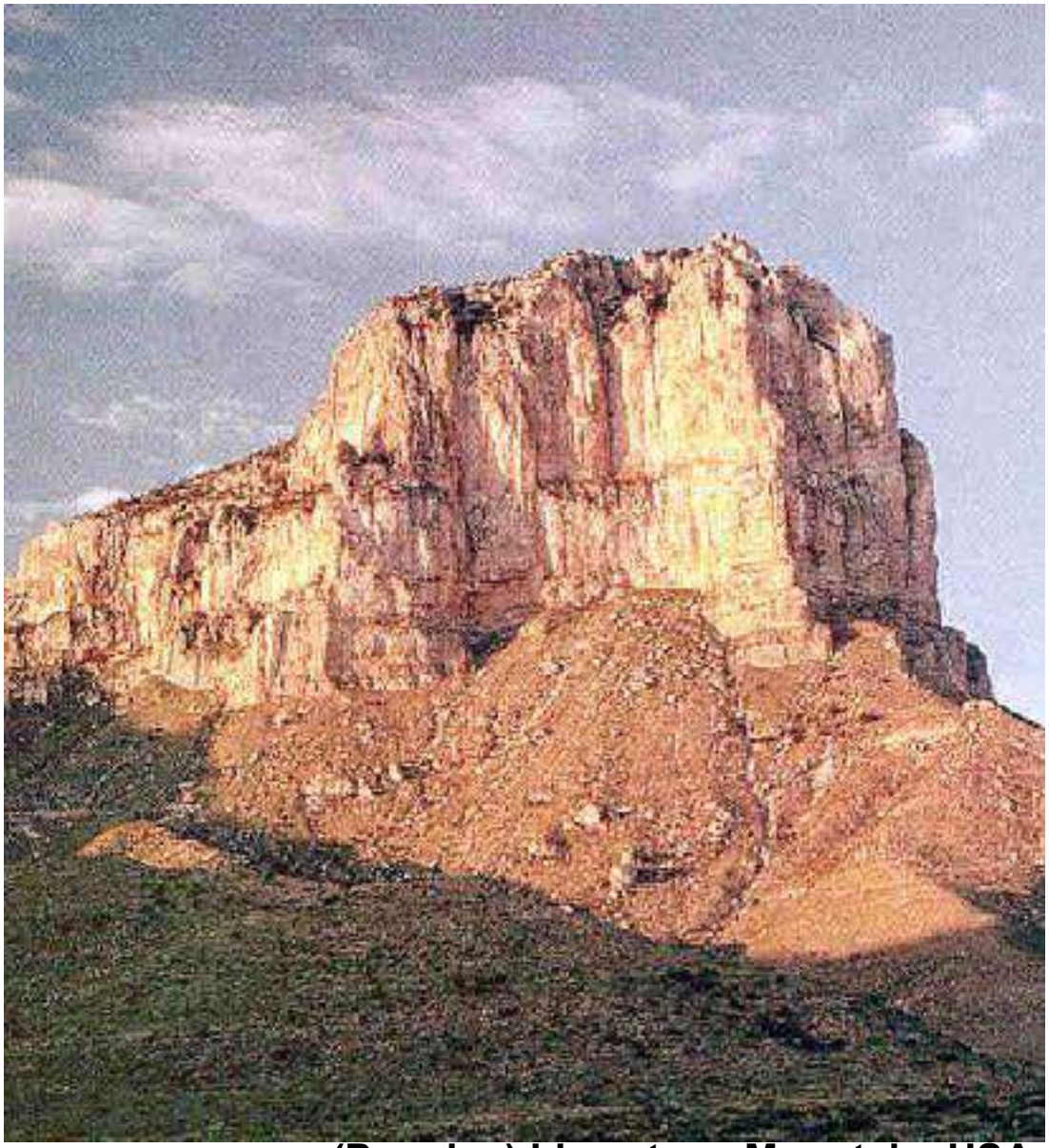


Coquina (rock of shell fragments)

Limestone

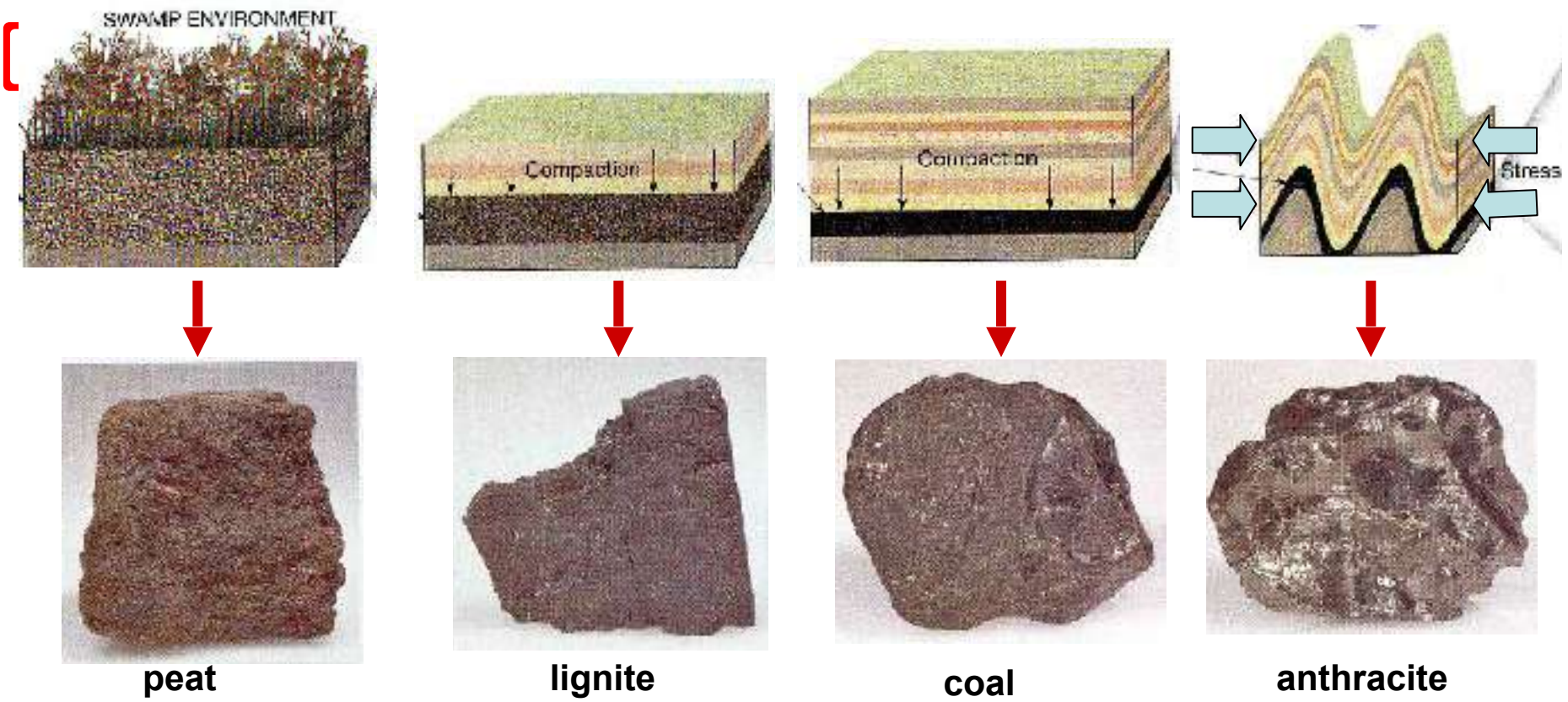
- formed by marine organisms (corals, clams, algae)
- composed primarily of calcite (calcium carbonate $CaCO_3$)
- most abundant chemical sedimentary rock
- 10% of all sedimentary rocks (by volume)
- some deposited directly out of ocean or other waters

Chemical Sedimentary Rocks



(Permian) Limestone Mountain, USA

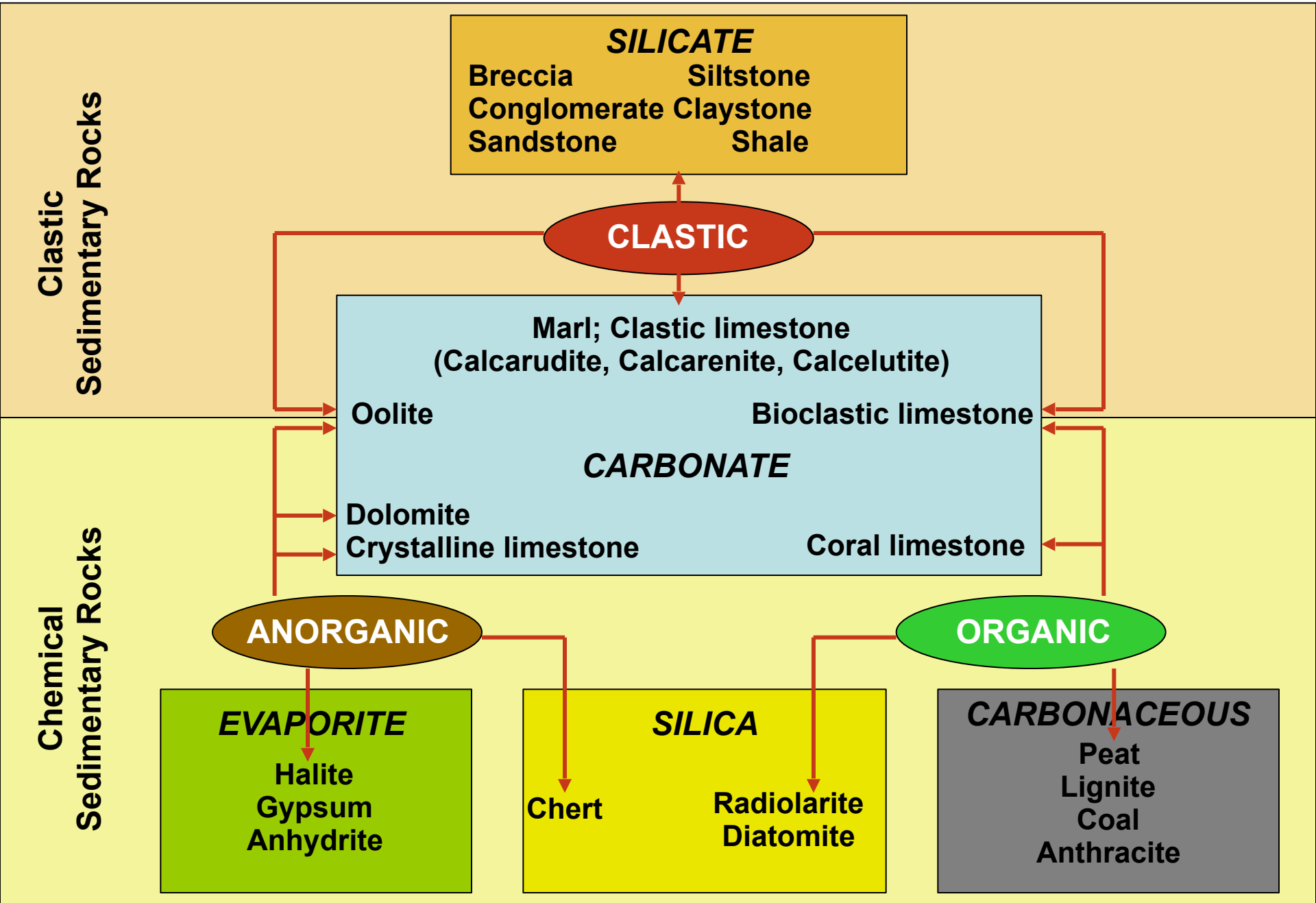
Chemical Sedimentary Rocks



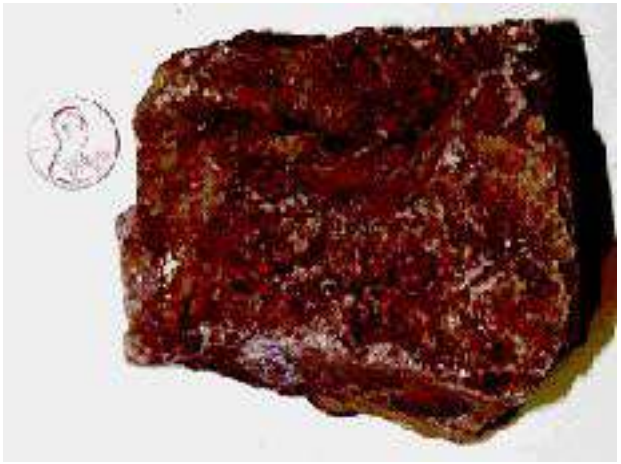
Coal

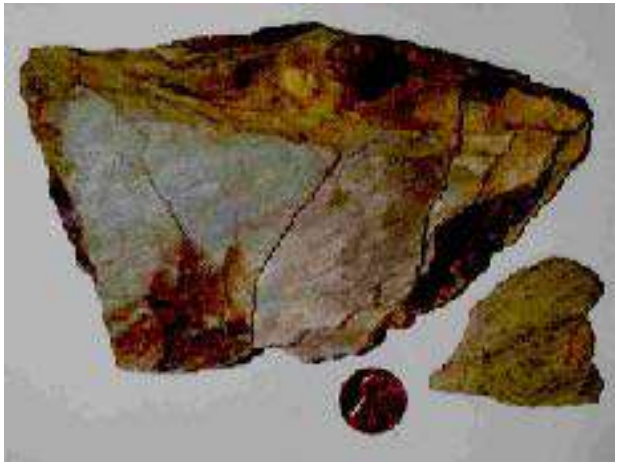
- ❑ buried and compacted plant material
- ❑ different kinds of coal, depending on formation process

Classification of Sedimentary Rocks

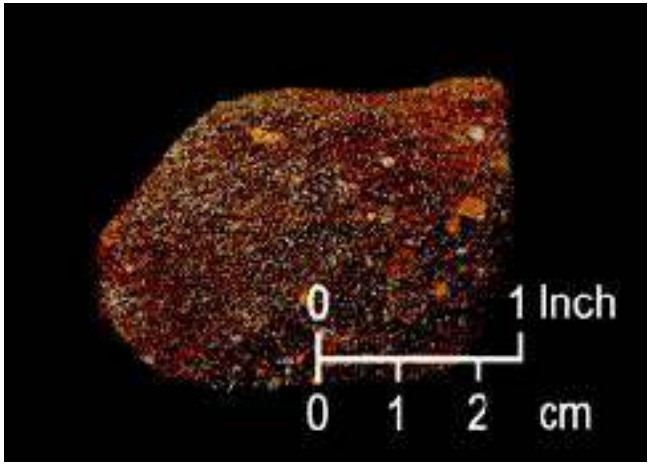


Clastic Sedimentary Rocks:
Mudstones

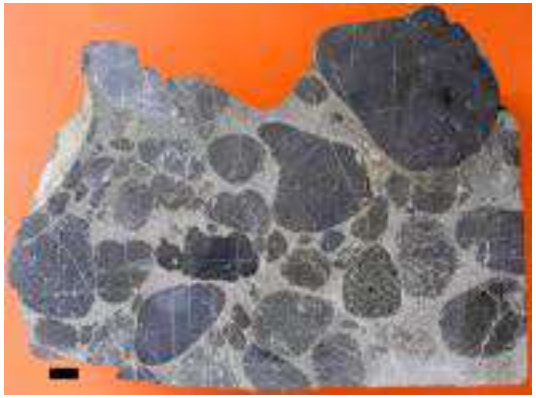




Clastic Sedimentary Rocks:
Sandstones



Clastic Sedimentary Rocks:
Conglomerates



Clastic Sedimentary Rocks:
Breccias

Chemical Sedimentary Rocks:
Formed by Precipitation from Aqueous Solution

1. The Evaporites

a. Halite (NaCl)

b. Calcite ($CaCO_3$)

c. Gypsum ($CaSO_4 . H_2O$)

2. Precipitated Silica

Chert

Chemical Sedimentary Rocks:
Formed from Plants Material: The Coal

Peat **Lignite** **Bituminous coal (soft coal)**

Coal seams in Mesa Verde National Park

Bituminous coal

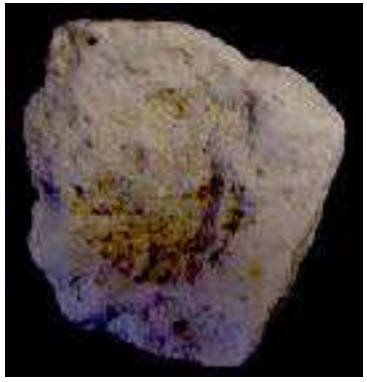
Chemical Sedimentary Rocks:
Formed from Animal Material: The Limestones

All contain $CaCO_3$ ***All will fizz in contact with acid***

1. Limestone (a limey mudstone)

2. Fossiliferous limestone

3. Coquina



4. Chalk

Thank You