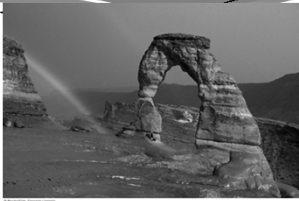


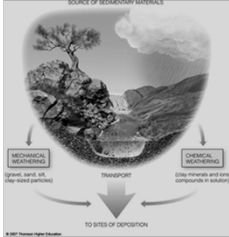
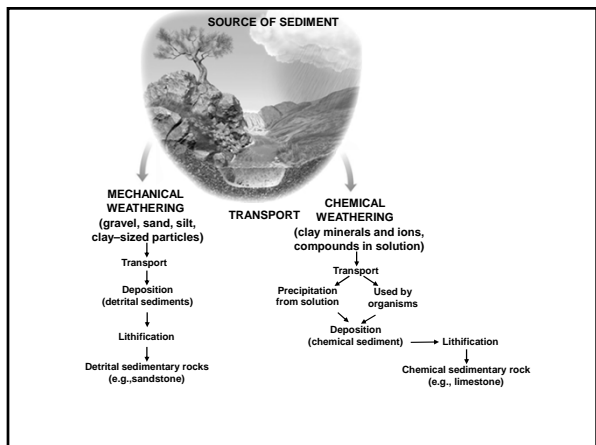
# Chapter 7



Sediment and Sedimentary Rocks

## Sediment and Sedimentary Rock

- Sedimentary rocks are made of sediment.
- The two primary types of sediment are detrital and chemical.
  - Detrital** sediment consists of solid particles, products of mechanical weathering.
  - Chemical** sediments consist of minerals precipitated from solution by inorganic processes and by the activities of organisms through chemical weathering.

## Sediment Sources, Transport and Deposition

- Sediment Transport and Deposition**
  - Sedimentary material weathers, undergoes erosion and transport to a new location.
  - Transportation of sediment results in rounding and sorting.
- Why are rounding and sorting important in sediments and sedimentary rocks?**
  - Both are important in determining how fluids move through sediments and sedimentary rocks
  - The amount of rounding and sorting depends on **particle size, distance of transportation, and depositional processes.**

## Sediment Sources, Transport and Deposition

❖ Classification of particle sizes in sediments

Size	Sediment Name
>2 mm	Gravel
1/16-2 mm	Sand
1/256-1/16 mm	Silt } Mud*
<1/256 mm	Clay }

\*Mud is a mixture of silt and clay-sized particles

❖ Gravel includes pebbles, cobbles and boulders

## Sediment and Sedimentary Rocks

- Sediment Transport and Deposition**
  - Eventually the sediment comes to rest in a depositional environment.
  - Depositional environments are areas of sediment deposition that can be defined by their physical characteristics (topography, climate, wave and current strength, salinity, etc.).

### Sediment and Sedimentary Rocks

- Sediment Transport and Deposition
  - Major depositional settings are continental, transitional, and marine.
  - Each of these depositional settings includes several specific subenvironments.

### Sediment and Sedimentary Rocks

How Does Sediment Become Sedimentary Rock?

- Thru the process of **lithification** of sediment is converted into sedimentary rock.
- **Step 1: Compaction** - The volume of a deposit of sediment decreases as the weight of overlying sediment causes a reduction in pore space (open space) as particles pack more closely together.
- *Compaction alone is sufficient for lithification of mud into shale.*

### Sediment and Sedimentary Rocks

How Does Sediment Become Sedimentary Rock?

- Thru the process of **lithification** of sediment is converted into sedimentary rock.
- **Step 2: Cementation** is a process that glues the sediments together.
- The most common cements are calcite and silica, but iron oxide and iron hydroxide are important in some rocks.
- *Compaction alone will not form rocks from sand and gravel.* Cementation is necessary to glue the particles together into rocks.

### Detrital Sedimentary Rocks

Sediment	Process	Rock
Gravel > 2 mm	Compaction/cementation	Conglomerate (Rounded clasts) Sedimentary breccia (Angular clasts)
Sand 2 mm - 1/2 mm	Compaction/cementation	Sandstone (Quartz sandstone (mostly quartz), Arkose (> 25% feldspars))
Silt 1/2 mm - 1/16 mm	Compaction/cementation	Siltstone (Mostly silt)
Clay < 1/16 mm	Compaction	Mudstone (Silt and clay), Claystone (Mostly clay)

\*Foliate refers to rocks capable of splitting along closely spaced planes.  
© Brooks/Cole, Cengage Learning

### Types of Sedimentary Rock

- Detrital Sedimentary Rocks are made of solid particles of pre-existing rocks.
- Detrital sedimentary particles are classified according to grain (particle) sizes, in decreasing diameter:
  - Gravel (including boulders, cobbles and pebbles)
  - Sand
  - Silt
  - Clay (or mud).

### Types of Sedimentary Rock

- Detrital sedimentary rocks are classified on the basis of particle size.
- Examples include conglomerate, breccia, sandstone, siltstone, mudstone, and shale.
- **How do conglomerate and sedimentary breccia differ?**
  - Both begin as detrital gravel. Conglomerate consists of rounded gravel, breccia consists of gravel with sharp edges.

### Types of Sedimentary Rock

- Chemical and Biochemical Sedimentary Rocks
  - Chemical and biochemical sedimentary rocks are substances derived from solution by inorganic or biochemical processes.
  - Some have a crystalline texture, meaning they are composed of a mosaic of interlocking crystals.
  - Others have a clastic texture, meaning that they are made of fragments, like shells that are glued together.



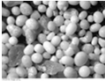
### Types of Sedimentary Rock

Chemical and Biochemical Sedimentary Rocks are classified on the basis of composition.

TABLE 7.2 Classification of Chemical and Biochemical Sedimentary Rocks			
Chemical Sedimentary Rocks			
Texture	Composition	Rock Name	
Varies	Calcite (CaCO <sub>3</sub> )	Limestone	Carbonate rocks
Varies	Dolomite [CaMg(CO <sub>3</sub> ) <sub>2</sub> ]	Dolostone	
Crystalline	Gypsum (CaSO <sub>4</sub> · 2H <sub>2</sub> O)	Rock gypsum	Evaporites
Crystalline	Halite (NaCl)	Rock salt	
Biochemical Sedimentary Rocks			
Clastic	Calcite (CaCO <sub>3</sub> ) shells	Limestone (various types, such as chalk and coquina)	
Usually crystalline	Altered microscopic shells of SiO <sub>2</sub>	Chert (various color varieties)	
	Carbon from altered land plants	Coal (lignite, bituminous, anthracite)	

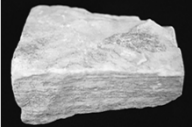

### Types of Sedimentary Rock

- Chemical Sedimentary Rocks
  - **Carbonate rocks** consist primarily of minerals containing the carbonate ion, such as limestone and dolostone.
  - **Dolostone** forms when magnesium replaces calcium in limestone.


### Types of Sedimentary Rock

- Chemical Sedimentary Rocks
  - **Evaporites** form by precipitation of minerals during the evaporation of water.
  - Examples are bedded rock salt (halite) and rock gypsum.


### Types of Sedimentary Rock

- Chemical / Biochemical Sedimentary Rocks
  - Chert forms from direct precipitation in pore spaces or the accumulation of microscopic silica-shelled organisms deep in the ocean.



### Types of Sedimentary Rock

- Biochemical Sedimentary Rocks
  - **Coal** is a biochemical sedimentary rock composed largely of altered land plant remains.



### Sedimentary Facies

- Geologists realize that if they trace a sedimentary layer far enough, it will undergo changes in composition and/or texture.
- Sedimentary facies are bodies of sediment or sedimentary rocks which are recognizably different from adjacent sediment or sedimentary rocks.
- These facies are deposited in different depositional (sub) environments.

### Sedimentary Facies

- Marine Transgression and Regression
- A **marine transgression** occurs when sea level rises with respect to the land, resulting in offshore facies overlying nearshore facies.
- A **marine regression**, caused when the land rises relative to sea level, results in nearshore facies overlying offshore facies.

### Reading the Story in Sedimentary Rocks

- Sedimentary Structures
  - Some sedimentary structures, such as ripple marks, bedding, cross-bedding, and mud cracks form shortly after deposition.
- Sediments are most commonly deposited horizontally in water. One of the most common is strata or bedding
- Sedimentary structures are useful in determining the types of environments in which the sediments were deposited

### Reading the Story in Sedimentary Rocks

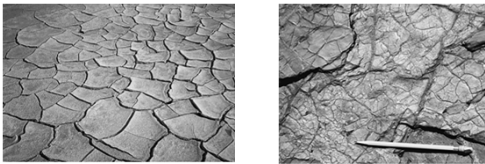
- Cross-bedding** preserves layers deposited at an angle.
- They are common in depositional environments like sand dunes, shallow marine deposits and stream-channel deposits
- How is cross-bedding used to determine ancient current directions?**
- Understanding how physical features like cross-beds form today can reveal important ancient climate information such as current directions.

### Reading the Story in Sedimentary Rocks

- Ripple Marks**
- Depositional environment: streams or shallow marine?
  - Streams have a current and leave behind asymmetric dunes.
  - Shallow marine crossbeds exhibit a symmetrical shape from the rocking motion of the waves.

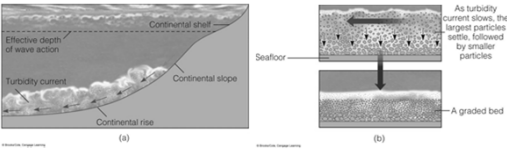
**Reading the Story in Sedimentary Rocks**

- **Mud cracks**
- **Depositional environment: Lagoons and mudflats**



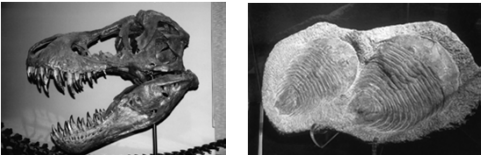
**Reading the Story in Sedimentary Rocks**

- **Graded Beds**
- **Depositional environment: Submarine fans - tell us the location of the ancient shelf margin**



**Reading the Story in Sedimentary Rocks**


- **Fossils are the remains and traces of ancient life**
- **They provide the only record of prehistoric life, and are used by geologists to correlate strata, and to interpret depositional environments.**



**Reading the Story in Sedimentary Rocks**

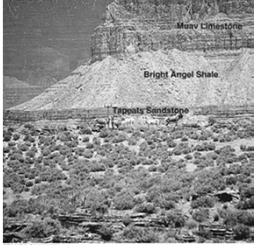
**Determining the Environment of Deposition**

- **How do we know that the Navajo Sandstone formed as a desert dune deposit?**




**Reading the Story in Sedimentary Rocks**

- **Determining the Environment of Deposition**



These are rocks in the Grand Canyon in Arizona. **Under what sedimentary conditions were these rocks deposited?**



**Important Resources in Sedimentary Rocks**

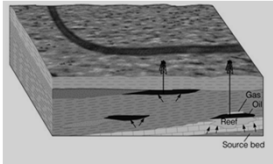
- **Many important natural resources are sedimentary rock deposits. These include:**
  - Sand and gravel
  - Coal
  - Clay
  - Evaporites (like salt)
  - Oil and gas
  - Uranium
  - Banded-iron formations

### Important Resources in Sedimentary Rocks

#### Petroleum and Natural Gas

Most oil and gas reserves are found within sedimentary rocks.

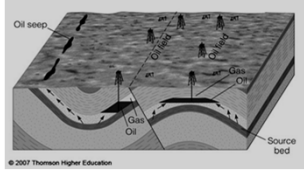
- What are stratigraphic and structural traps? Both are areas where petroleum, natural gas, or both accumulate in economic quantities.
- Stratigraphic traps form because of facies changes in the rock layers (strata).



### Important Resources in Sedimentary Rocks

#### Petroleum and Natural Gas


- Structural traps form as the result of folding or fracturing (faulting) of rocks.



### Important Resources in Sedimentary Rocks

#### Petroleum and Natural Gas

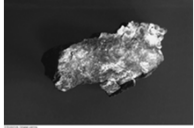
- **Oil shale** is a fine-grained sedimentary rock that contains **kerogen** from which liquid oil and combustible gases can be derived.
- None is mined at present in the United States.



### Important Resources in Sedimentary Rocks

#### Uranium

- Most uranium is used in nuclear reactors. The uranium comes from the minerals carnotite and uraninite.
- The richest ores are found in Wyoming, Utah, Arizona and New Mexico in ancient stream deposits.
- Large reserves of low grade ore is found in the Chattanooga Shale, which covers portions of several states.



### Important Resources in Sedimentary Rocks

#### Banded Iron Formation

- A banded iron formation consists of alternating thin layers of chert and iron minerals, mostly iron oxides. Nearly **all** of Earth's iron ore is mined from ancient banded iron formations.

