Chapter 7

Sediment and Sedimentary Rocks

Sediment and Sedimentary Rock

- The two primary types of sediment are detrital and chemical. Sedimentary rock is simply rock made up of consolidated sediments.
- **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 thru chemical weathering.

Fig. 7.1, p. 159

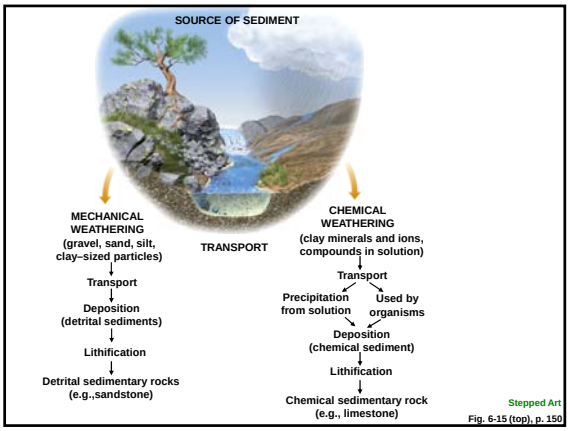


Fig. 6-15 (top), p. 150

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

TABLE 7.1 Size Classification of Sedimentary Particles

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

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

- Gravel includes pebbles, cobbles and boulders

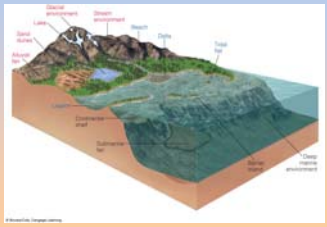
Table 7.1, p. 158

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.).
  - They provide geologist with clues as to how the rock formed and what the geologic past was like.

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.

Fig. 7.3, p. 160

Sediment and Sedimentary Rocks

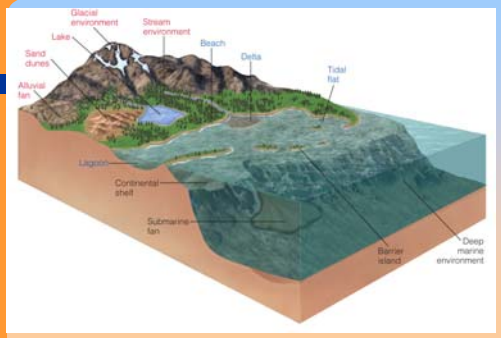


Fig. 7.3, p. 160

Sediment and Sedimentary Rock

How Does Sediment Become Sedimentary Rock?

- Thru the process of ***lithification*** of sediment is converted into sedimentary rock.

- Lithification involves two processes
- **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.

Fig. 6.19c, p. 153

Sediment and Sedimentary Rock

How Does Sediment Become Sedimentary Rock?

- Lithification involves two processes
- **2. Cementation** is a process that glues the sediments together.
- The most common cements are calcium carbonate 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.

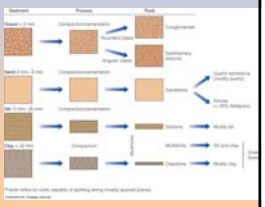


Fig. 6.18, p. 152

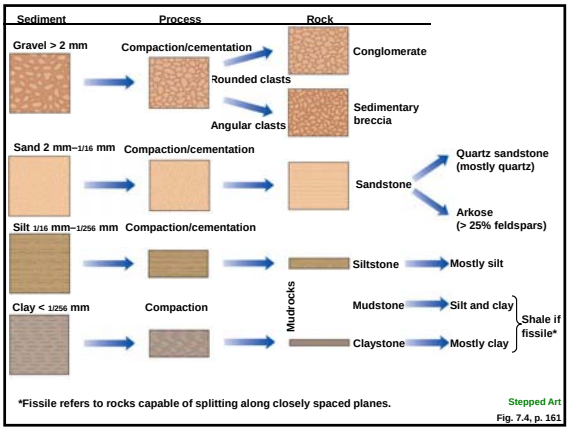


Fig. 7.4, p. 161

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 Rocks

- 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.


Fig. 7.5, p. 162

Types of Sedimentary Rocks

- 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 Rocks

- Chemical and Biochemical Sedimentary Rocks

TABLE 7.2 Classification of Chemical and Biochemical Sedimentary Rocks

Texture	Composition	Rock Name	
Chemical Sedimentary Rocks			
Varies	Calcite ($CaCO_3$)	Limestone	Carbonate rocks
Varies	Dolomite [$CaMg(CO_3)_2$]	Dolostone	
Crystalline	Gypsum ($CaSO_4 \cdot 2H_2O$)	Rock gypsum	Evaporites
Crystalline	Halite (NaCl)	Rock salt	
Biochemical Sedimentary Rocks			
Clastic	Calcite ($CaCO_3$) shells	Limestone (various types, such as chalk and coquina)	
Usually crystalline	Altered microscopic shells of SiO_2	Chert (various color varieties)	
	Carbon from altered land plants	Coal (lignite, bituminous, anthracite)	

Table 7.2, p. 162

Types of Sedimentary Rocks

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



Fig. 7.6, p. 163

Types of Sedimentary Rocks

- Chemical Sedimentary Rocks
  - ***Evaporites***
  - Bedded rock salt (halite) and rock gypsum are chemical evaporite sediments formed by precipitation of minerals during the evaporation of water.


Fig. 7.7, p. 164

Types of Sedimentary Rocks

- Chemical Sedimentary Rocks
  - ***Bedded Chert***
    Marin County, California

    The origin of chert is highly debated.

Fig. 7.8, p. 164

Types of Sedimentary Rocks

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

Fig. 7.9, p.165

Sedimentary Facies

- *Geologists realize that if they trace a sedimentary layer far enough, it will undergo changes in composition and/or texture.*
  - Bodies of sediment or sedimentary rocks which are recognizably different from adjacent sediment or sedimentary rocks and are deposited in a different depositional (sub) environment are known as sedimentary facies.
  - Today we recognize modern facies changes when we go from an inland area with rivers to the beach.

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
    - Note the difference in the vertical rock sequence that occurs in a transgression versus a regression.

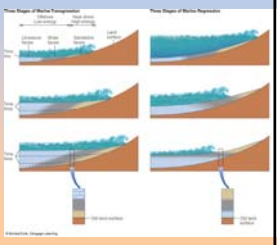


Fig. 7.10, p. 166

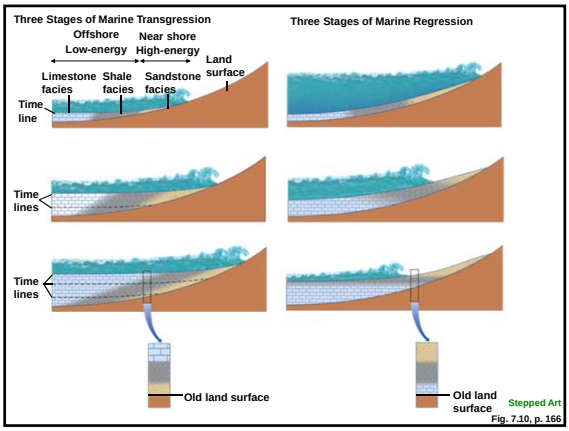


Fig. 7.10, p. 166

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.
- Sedimentary structures are useful in determining the types of environments in which the sediments were deposited.
- Sediments are most commonly deposited flat in water. One of the most common is ***strata or bedding.***

Reading the Story in Sedimentary Rocks

- Sedimentary Structures
  - Depositional environments are also inferred by comparison of these structures with present-day depositional environments.
- ***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.

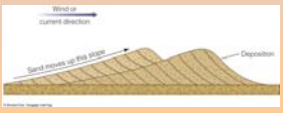


Fig. 7.12, p. 167

Reading the Story in Sedimentary Rocks

❖Sedimentary Structures

❖ ***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.

Fig. 7.14, p. 168

Reading the Story in Sedimentary Rocks

❖Sedimentary Structures

❖ ***Mud cracks***

❖ *Depositional environment: Lagoons and mudflats*

Fig. 7.15, p. 169

Reading the Story in Sedimentary Rocks

❖Sedimentary Structures

❖ ***Graded Beds***

❖ *Depositional environment: Submarine fans – tell us the location of the ancient shelf margin*

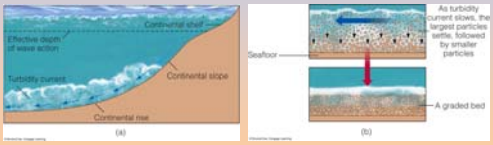


Fig. 7.13, p. 168

Reading the Story in Sedimentary Rocks

❖Fossils-Remains and Traces of Ancient Life

- ❖ Fossils are the remains of past life and are usually found only in sediments and sedimentary rocks.
- ❖ They provide the only record of prehistoric life, and are used by geologists to correlate strata, and to interpret depositional environments.

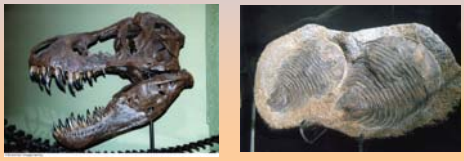


Fig. 7.16, p. 169

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?**

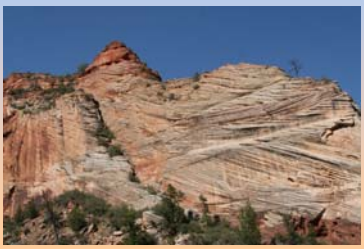
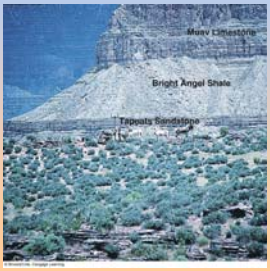


Fig. 7.17, p. 172

Reading the Story in Sedimentary Rocks

Determining the Environment of Deposition

❖Sedimentary Rocks in the Grand Canyon



Under what sedimentary conditions were these rocks deposited?

Fig. 7.11, p. 166

Important Resources in Sedimentary Rocks

❖ ***Many important natural resources are sedimentary rock deposits. These include:***

- ❖Sand and gravel
- ❖Coal
- ❖Clay
- ❖Evaporites (like salt)
- ❖Banded-iron formations.
- ❖Oil and gas

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).

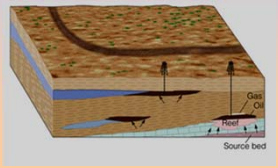


Fig. 7.18, p. 173

Important Resources in Sedimentary Rocks

❖Petroleum and Natural Gas

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

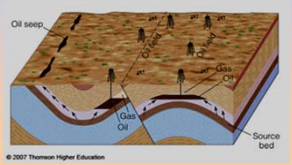


Fig. 7.18, p. 173

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 because oil and gas from conventional sources are cheaper. Oil shale and tar sands are increasingly important petroleum reserves.

Fig. 7.18, p. 173

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.

Fig. 7.19, p. 176

Important Resources in Sedimentary Rocks

❖Banded Iron Formation

❖Why is banded iron formation such an important sedimentary rock?

❖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.

Fig. 7.19, p. 176