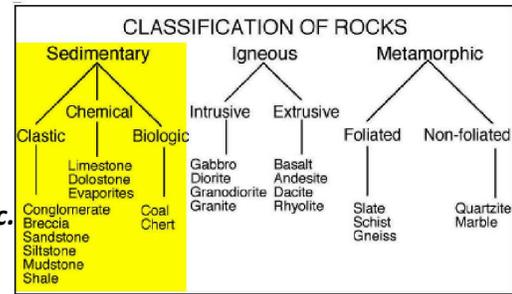
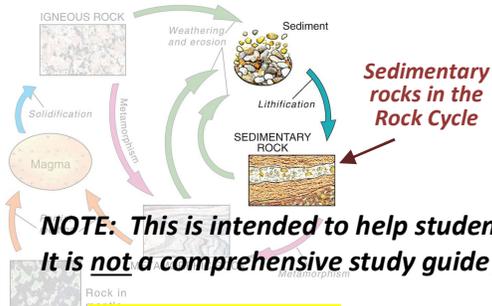


Chapter Outlines



Sedimentary Rocks

Sedimentary rocks cover about three-fourths of the surface of the continents. There are three kinds of sedimentary rocks: clastic, chemical, and organic. **Clastic (detrital) sedimentary rocks** form from consolidation of material such as gravel, sand, or clay (*sediment*) derived from the weathering and breakdown of rocks. **Chemical sedimentary rocks** result from biological or chemical processes, generally under water, that crystallize minerals which accumulate on the sea floor and from chemical precipitation. **Organic sedimentary rocks**, such as coal, have as their major component accumulations of organic remains from plants or animals that make the rock distinctive.

Sediment

- Sediment** - loose, solid particles originating from:
 - weathering and erosion of pre-existing rocks
 - chemical precipitation from solution
 - accumulation of the skeletal remains of small organisms

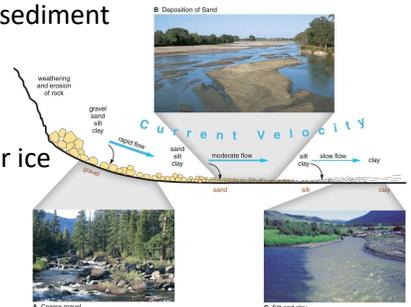
From Sediment to Sedimentary Rock

Source → slope → settle

- Source (weathering)**, for most sediments is the weathering of a 'parent' rock
- Slope (transportation)**, contributes to the erosion and transportation of sediment
- Settling (deposition)**, of the sediments takes place when they reach a low spot, transportation ceases and deposition occurs.

Erosion & Transportation

- movement of sediment away from its source, typically by water, wind, or ice
- rounding** of particles occurs due to abrasion during transport
- sorting** occurs as sediment is separated according to grain size by transport agents, especially running water
- sediment size decreases with increased transport distance



Erosion & transportation change to deposition as current slows

Deposition

- settling and coming to rest of transported material
- accumulation of chemical or organic sediments, typically in water

Preservation – sediment must be preserved, as by burial with additional sediments, in order to become a sedimentary rock

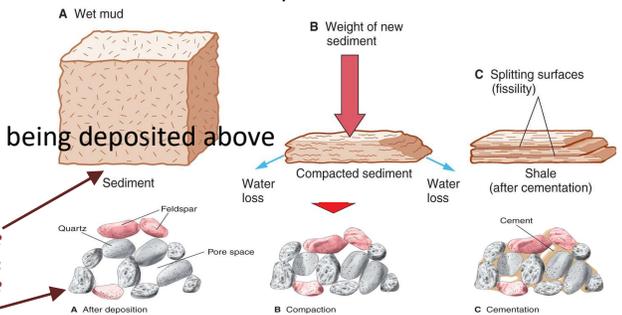
Lithification of sediments (turning into rock)

- Consolidation** - Settling into layers of sediment
- Compaction** – by weight of more and more sediments being deposited above
- Cementation** – by chemicals in the groundwater

Clastic Sedimentary Rocks

- Size classification is:
 - Gravel** – grain size larger than 2mm
 - Sand** – grains size is 1/16 to 2mm
 - Silt** – grain size 1/256 to 1/16mm (feels gritty)
 - Clay** – grain size less than 1/256mm (feels smooth)
- Cements (*by minerals in solution*)
 - Calcite – CaCO_3
 - Silica – SiO_2
 - Iron oxide – Fe_2O_3 (*less common*)
- Conglomerate and Breccia**
 - coarse-grained clastic** sedimentary rocks

Lithification of shale & of sandstone



Conglomerate – more rounded



Breccia – more angular

- conglomerate composed of **rounded gravel**
- breccia composed of coarse, **angular rock fragments**
- Sandstone - **medium**-grained *clastic* sedimentary rock. Types determined by composition:
 - **quartz sandstone** - >90% quartz grains
 - **arkose** - mostly feldspar, with quartz grains
 - **graywacke** - sand grains surrounded by dark, fine-grained matrix, often clay-rich
- Siltstone – slightly coarser-grained than shales; non-fissile
- Shale – fine-grained clastic sedimentary rock; **fissile** (*splits into thin layers*)
 - silt- and clay-sized grains
 - sediment deposited in lake bottoms, river deltas, floodplains, and on deep ocean floor
- Mudstone – silt and clay-sized grains; massive/blocky (*“if you can’t tell, just call it ‘mudstone’!”*)
- Claystone – predominantly clay-sized grains; non-fissile

Chemical Sedimentary Rocks

- Carbonates - calcites predominate. Examples:
 - Limestone - calcite, $CaCO_3$ precipitated directly from seawater or accumulated organisms
 - Dolomite (or Dolostone) - $CaCO_3$ with some Mg
 - Chalk - $CaCO_3$
- Siliceous - hard, compact, fine-grained, formed almost entirely of silica. Examples:
 - Diatomite - silica, SiO_2 ; from microscopic skeletons
 - Chert - silica, SiO_2 ; mainly from animals, then re-crystallized
- Evaporites – form from evaporating saline waters (*lakes, oceans*). Examples are:
 - Rock salt – halite, $NaCl$; precipitated
 - Rock gypsum - $CaSO_4 \cdot 2H_2O$; precipitated
 - Travertine - $CaCO_3$; precipitated in caves or as tufas



A 'limestone' made up of shell fragments, also called *Coquina*



Evaporites on a desert playa



The Dead Sea is an active evaporite environment

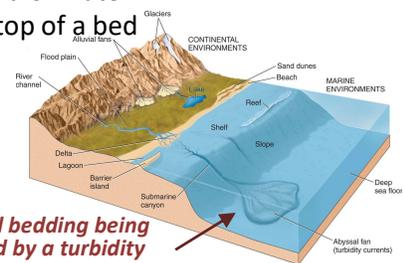
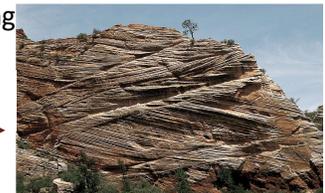
Organics in Sedimentary Rocks

- Coal – sedimentary rock forming from compaction of partially decayed plant material
 - Peat (carbon) → Lignite (carbon) → Bituminous coal (carbon) → Anthracite coal (metamorphic) (carbon)
- Oil and natural gas
 - originate from organic matter in marine sediment
 - subsurface 'cooking' can change organic solids to oil and natural gas
 - can accumulate in porous overlying rocks as it ascends through the overlying sedimentary beds

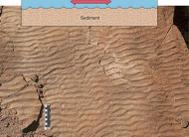
Sedimentary Structures - features within sedimentary rocks produced during or just after settling

- Bedding - the most common sedimentary structure
 - series of visible layers within a rock
- Cross-bedding – common in sandstone
 - series of thin, inclined layers within a horizontal bed of rock
 - indicative of deposition in ripples, bars, dunes, deltas
- Ripple marks - small ridges formed on surface of sediment layer by moving wind or water
- Graded bedding – progressive change (*decrease*) in grain size from bottom to top of a bed
- Mud cracks - polygonal cracks formed in drying mud
- Fossils
 - traces of plants or animals preserved in rock
 - hard parts (*shells, bones*) more easily preserved as fossils

Cross-bedding in sandstone



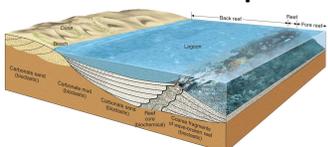
Graded bedding being formed by a turbidity current



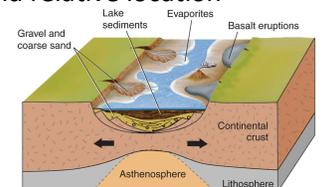
Ripple marks

Sedimentary Rock Interpretation - Sedimentary rocks give important clues to the geologic history of an area

- Source area - locality that eroded and provided sediment
 - sediment composition, shape, size and sorting are indicators of source rock type and relative location
- Depositional environment - location where sediment came to rest. Examples:
 - Terrestrial - rivers, alluvial fans, Lakes, swamps, deserts, glacial, River channels and flood plains, dunes
 - Marine - continental shelf, continental slope & rise, abyssal plain, reefs
 - Transitional – beaches, barrier islands, delta, lagoons, estuaries



'Lagoon' depositional environment



Inland sea (being created at a rift zone). A likely evaporite depositional environment