

Outline 4: Sedimentary Rocks

Basic Aspects of their Study

Main Points

- Environments of Deposition
- Color of Sedimentary Rocks
- Grain Size
- Grain Sorting
- Sedimentary Structures

Main Points, cont'd

- Clastic Sedimentary Rocks
- Chemical Sedimentary Rocks
- Rock Units
- Time Units
- Facies
- Correlation

Environments of Deposition

- 3 Major Environments
- Marine
- Continental or Terrestrial
- Transitional

Marine Environments

- Continental Shelf
- Shelf Edge
- Slope
- Ocean Floor

Continental or Terrestrial Environments

- Glacial - both Alpine and Continental
- Alluvial Fans - at the base of mountains
- Lakes
- Rivers and Floodplains = Fluvial
- Swamps
- Deserts

Transitional Environments

- Beaches
- Barrier Islands
- Tidal Flats
- Lagoons and Bays
- Estuaries
- River Deltas

Color of Sedimentary Rocks

- Color can be useful in the interpretation of depositional environments.
- Black color - indicates deposition in the absence of oxygen in either the ocean, lakes, or swamps.
- Red color - indicates deposition in the presence of abundant oxygen in a warm, humid terrestrial environment.

Grain Size

- Grain size can be an indicator of the energy of the environment.
- Generally speaking, higher energy water or wind currents are required to move larger grain sizes.

Grain Size, cont'd

- Size ranges: small to large
- clay, $<1/256$ mm
- silt, $>1/256$ mm
- sand, 1/8-2 mm
- granules, 2-4 mm

- pebbles, >4mm
- cobbles, >64mm (>3 in.)
- boulders, >256 mm (>1 ft.)

Grain Sorting

- Grain sorting can also be an indicator of the energy of the environment.
- Well-sorted sediments are deposited in high energy environments. Currents sort the grains by size.
- Poorly-sorted sediments may indicate weak currents, or transport by glaciers.

Sedimentary Structures

- Provide clues to depositional environments. Some examples:
- Cross bedding - rivers, dunes, tidal channels
- Graded bedding - storms and turbidites
- Ripple marks - lower energy
- Mud cracks - subaerial exposure

Clastic Sedimentary Rocks

- Produced by weathering of rocks.
- Breccia - large, angular grains
- Conglomerate - large, rounded grains
- Sandstone
- Siltstone
- Shale or Mudstone

Chemical Sedimentary Rocks

- Produced by chemical precipitation.
- Evaporites - formed by evaporation of seawater
- Salt, NaCl
- Gypsum, CaSO₄
- Carbonates
- Limestone, CaCO₃
- Dolostone, CaMg(CO₃)₂

Carbonates

- Typically, carbonates form in warm, clear water free of clastic sediment.
- Carbonate grainstone - composed of sand-sized grains from invertebrate skeletons or oolites.
- Carbonate mudstone - clay and silt-sized grains from pellets and calcareous algae.

Rock Units

- Sedimentary rocks are divided into formations.
- Formations can be divided into members.
- Formations can be combined into groups.

Rock Units, cont'd

- Formation name consists of two parts:
 - Geographic name
 - Lithology or simply Formation
- Examples:
 - Burlington Limestone
 - Morgantown Sandstone
 - Juniata Formation (no dominant lithology)

Rock Units, cont'd

- Example of rock unit divisions:
 - Borden Group: 3 formations
 - Edwardsville Formation
 - Carwood Sandstone
 - New Providence Shale
 - Kenwood Siltstone Member (within the New Providence)

Time Units

- Time can be separated into "pure" time and "rock" time. Rock time is divided into time stratigraphic units.
- Time stratigraphic units sometimes parallel formation boundaries, but often they cross formation boundaries.

Time Units

- Time Units
- Era
- Period
 - Epoch
 - Age
- Devonian Period
- Time Stratigraphic
- (Erathem)
- System
 - Series
 - Stage
- Devonian System

Sedimentary Facies

- Facies - general appearance or aspect of sedimentary rocks. Often correspond to rock units.
- A reflection of the depositional environment.
- Lithofacies - defined by lithologic features
- Biofacies - defined by organic features

Sedimentary Facies

- Facies occur laterally adjacent to one another just as do their depositional environments.
- Two different facies can have similar lithofacies but different biofacies, or vice-versa.

Sedimentary Facies

- Facies migrate laterally with changes in sea level.
- Rising sea level = transgression. Marine facies overlie nonmarine facies.
- Falling sea level = regression. Nonmarine facies overlie marine facies.

Causes of Changes in Sea Level

- Changing ice volumes at the poles – geologically rapid.
- Thermal expansion or contraction of the oceanic crust – geologically slow.
- Continental tectonics or subsidence – geologically slow.
- Shoreline progradation from river and deltaic sedimentation – geologically local.

Correlation

- Determination of the equivalence of bodies of rock at different locations. There are two kinds of correlation:
- Lithostratigraphic - matching up continuous formations.
- Chronostratigraphic - matching up rocks of the same age. Usually done with fossils, i.e. Biostratigraphy

Correlation

- Over short distances lithostratigraphic correlation is the same as chronostratigraphic correlation.
- Over medium distances they are not the same.
- Over long distances only chronostratigraphic correlation can be used.