# Sedimentary Rocks

Sedimentary rocks form at the Earth's surface through interactions of the hydrologic system and the crust. Fortunately, many of these processes are in operation today, and geologists actively study rivers, deltas and oceans of all parts of the Earth. This research indicates that the diagenesis (or the formation) of sedimentary rocks involves four major processes:

Formation involves:
1) Weathering of preexisting rock: Weathering is the interaction between the elements in the atmosphere and the rocks exposed at the Earth's surface. This process can take place chemically or physically.

2) Transportation to a new site: Transportation is done mostly by running water. However, glaciers and wind can also transport sediment, although their activity is somewhat restricted to special climate zones. Sorting that occurs during transportation is an important factor in the genesis of sedimentary rocks. This sorting is according to both size and composition, and the entire sorting process is referred to as sedimentary differentiation. Well sorted and rounded sediments are referred to as mature.

3) Deposition of the eroded material: Deposition occurs in a specific sedimentary environment. This environment reflects the physical, chemical and biological conditions that exist at the place of deposition. Distinctive types of texture, composition, internal structure, and fossil assemblages are developed in each environment. The environments include continental, marine and shoreline.

4) Lithification: Compaction and Cementation transforms the loose, unconsolidated sediment into solid rock (lithification). The weight of continually accumulating material helps compress and compact the buried sediment into rock. Cementation occurs as mineral matter, carried by water seeping through the pore spaces of tight grains, is precipitated. Cements are commonly made of quartz, calcite or limonite.

Sedimentary rocks typically occur in layers or **strata**. Groups of strata are often called formations, which typically have distinct characteristics, and are mapable over a geographic area.

The boundary between two formations (or any distinct layers) is called a **contact.**

Sedimentary rocks cover 75% of continents.

Sedimentary rocks preserve a record of:

1) ancient landscapes
2) climate
3) mountain ranges
4) erosional history of an area
5) fossils

Sedimentary rocks are sediments that have been compacted and cemented to form solid rock bodies (lithified). The original sediments can be composed of:

1) Fragments of other rocks and minerals, such as gravel from a river, sand from a beach (or desert), mud from a deep ocean.
2) Chemical precipitates, such as salt in a salt lake or ocean.
3) Organic materials, such as coral in a reef or vegetation in a swamp.

**Sedimentary Rock Classification**

1) **Clastic** - Made out of chunks of stuff cemented together by some sort of of cement material, usually silica or sometimes calcite.

| Size | Character | Minerals | Name | Environment |
|---|---|---|---|---|
| Clay | fissile | Clay minerals | Shale | Lake, Deep Marine |
| Clay and silt | not fissile | Clay minerals | Mudstone | Lake, Deep Marine |
| Silt | fissile | Micas, Quartz | Siltstone | Lake, River |
| Sand | mature | Quartz | Quartz SS | Beach, Eolian |
| | immature | Quartz, Feldspar | Arkose | Desert Wash |
| | immature | Quartz, mafic rock frags | Graywacke | River, Tectonic area |
| Gravel | mature | Quartz and rocks | Conglomerate | Fluvial (River) |
| | Immature | Quartz and rock frags | Breccia | Alluvial |

Non-Clastic

1. **Chemical-these rocks are typically denser because they crystallize from fluids.**

a) Crystalline Subgroup, Limestone Family (mineral-Calcite {Reacts with acid})

| Mineral | Characteristics | Name | Environment |
|---|---|---|---|
| Calcite | Dense, layered | Travertine | Cave |
| Calcite | Contains Ooids | Oolitic Limestone | Deep Marine |
| Calcite | Dense, solid, unlayered | Crystalline Limestone | Deep Marine |
| Calcite, Dolomite | Dense, grayish, unlayered | Dolostone | Deep Marine |
| | Acid reaction only when powdered | | |

b) Crystalline Subgroup, Evaporites

| Mineral | Characteristics | Name | Environment |
|---|---|---|---|
| Gypsum | Soft, cleavage | Rock Gypsum | Eolian, Playa |
| Halite | S-M, salty, cleavage | Rock Salt | Eolian, Playa |
| Chert | Hard, conchoidal | Chert | Deep Marine |

2. Biogenetic: **Biochemical and/or Organic**

a) Biochemical

| Mineral | Characteristics | Name | Environment |
|---|---|---|---|
| Calcite | Powdery, Reacts | Chalk | Marine |
| Quartz | Powdery, Low SG, no rxn | Diatomite | Marine |
| Calcite | Fossils, Reacts to HCl | Fossiliferous LS | Continental Shelf |
| Calcite | Fossil granola bar | Coquina | Continental Shelf |
| Calcite | Dense fine grained mud | Micritic Limestone | Deep Marine |

b) Organic

| Mineral | Characteristics | Name | Environment |
|---|---|---|---|
| Carbon | Black, Low SG | Coal | Lagoon |

**Sedimentary Structures**

Sedimentary rocks commonly show layering and other structures that result from the movement, sorting, and deposition by currents or wind as part of the hydrologic cycle.

Examples: 1. Stratification (or bedding)
-occur in distinct layers
-Groups of strata-Formation
-occur in organized sequences

2. Cross Bedding
-Layers are inclined at an angle in the stratification
-Sand grains are moved by currents that form sand waves

3. Graded Bedding
-Characterized by a progressive decrease in size upward through the bed. Produced by turbidity currents and storms.

4. Ripple Marks: occur due to movement in water

5. Bed Surface Marks
   a) Mud cracks: occur when the water evaporates and the mud begins to lose its moisture.
   b) Scour Marks
   c) Fossils

Transgression-Regression Sequences

An important aspect of stratification is that the rock layers do not occur randomly, but overlie one another in definite sequences and patterns. One of the simpler and more common patterns in a vertical sequence is the cycle of sandstone, shale and limestone. This pattern is produced by the advance and retreat of shallow seas over the continental platform. The following cross section is a representation of a transgressive-regressive sequence.

Sandstone

Shale

Limestone

Shale

Sandstone

Sedimentary Environments

A sedimentary environment is the place where sediment is deposited and encompasses the physical, chemical and biological conditions that exist there. The primary source areas are the continents, shoreline, and marine environments. The major sedimentary environments are as follows:

1) Continental Environments

a) **Alluvial Fans** are fan-shaped deposits of gravel, sand, and mud that accumulate in dry basins at the bases of mountain ranges.

b) **Eolian** (wind) environments include sand seas of deserts, where sand dunes are built and transported by wind, areas where windblown dust accumulates.

c) **Fluvial** (river) environments are river channels, river bars and adjacent floodplains.

d) **Lakes** (Lacustrine) are bodies of nonmarine water, including freshwater lakes on continental lowlands and saline lakes in isolated basins.

e) **Glacial** environments are the areas where sediment is deposited by glaciers. Most obvious are the margins of ice, where sediment carried by the glacier is dropped as the ice melts. Other subenvironments of a glacier are lakes and meltwater streams.

2) Shoreline Environments

a) **Deltas** are deposits of mud, silt, and sand that form at the mouths of rivers, where they empty into the sea or lake.

b) **Beaches** are shoreline accumulations of sand.

c) **Barrier islands** are linear bodies of sand built offshore by the action ocean waves.

d) **Lagoons** are elongated bodies of seawater located between the mainland and barrier islands of reefs. Low wave energy permits the deposition of mud.

e) **Tidal flats** are shoreline areas that are covered with water at high tide and uncovered at low tide. Mud is the major type of sediment deposited.

3) Marine Environments

a) **Shallow-marine** environments extend from the shore to the edges of the continental shelves. Lime and mud are the principal types of sediment deposited.

b) **Organic reefs** are solid structures built from corals, algae, and the shells of other marine organisms. Reefs grow in warm, shallow water near islands and continents.

c) **Deep-marine** environments characterize the deep oceans beyond the continental slopes and include deep-sea fans and abyssal plains. Turbidites are the major types of sediment deposited.

Sedimentary Basins

1) Rift Basins: form in continental rift areas, like the Red Sea.
2) Passive Margin Basins: form along the edges of continents that are not near tectonic boundaries, like the US east coast.
3) Intracontinental Basins: develop in the interior of continents, initially because of subsidence near a rift.
4) Foreland Basins: form on the continent side of a mountain belt.

## SIGNIFICANCE OF SEDIMENTARY ROCKS: WHY DO WE STUDY THIS?

Sedimentary rocks are of great economic importance; so great that they have been a controlling factor in the development of our industry.

Neolithic Age: First use of flint and chert for arrowheads, axes, and tools

Modern Age: Coal, petroleum and natural gas originate and are contained in sedimentary rocks.

Gravel, sand and Limestone are the major building materials of our culture. Examples:

Clay: ceramics, bricks
Sands: Glass
Limestone: Buildings, cement, statues
Evaporites: Salt

## PALEOCURRENTS AND PALEOGEOGRAPHY

Paleocurrent structures, such as cross-bedding, show patterns of sediment dispersal from which it is possible to deduce ancient geographic and geologic conditions at the time sediment was deposited, such as locations of highlands, ancient shorelines, and the direction of the regional slope down which the sediment was deposited.