Sedimentary Rocks and Structures Reading

Sedimentary Rocks

Sedimentary rocks are layered or stratified rocks formed at or near the earth's surface in response to the processes of weathering, transportation, deposition and compaction or cementation.

Processes:

Weathering - Sediments are produced by physical and chemical weathering that breaks rock into smaller pieces or dissolved ions. Both types of weathering work together as physical weathering produces a greater surface area for chemical weathering. Chemical weathering weakens rocks so that they are more vulnerable to physical forces.

Transportation - Transporting medium is usually water but may be wind or glacial ice.

Deposition - Occurs when energy necessary to transport particles is no longer available. Deposition can also be the result of chemical precipitation due to changing conditions.

Lithification - Involves several steps. All taken together are termed *diagenesis*.

Compaction - Water and air are squeezed out and pore spaces are reduced.

Cementation - Particles are bound by minerals such as silica, calcite and iron oxides, usually from water passing through the sediments. This fills the pore spaces.

Recrystallisation - Mineral grains recrystallise and grow together. The sediments become hardened into rock. This is particularly important in limestone formation.

A weathered sandstone outcrop at Tamarama Beach (Sydney) demonstrates layering within the sandstone

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Origin of Sedimentary Material

- Derived directly from pre-existing rocks. Ex. quartz.
- Derived from weathered products of these rocks. Ex. clay.
- Produced by chemical precipitation. Ex. calcite.
- The first two processes result in detrital or clastic rocks. Third produces nondetrital or chemical sedimentary rocks.

Minerals of Sedimentary Rocks

- Clay - Important constituent of mudstones and shales but occurs in minor amounts in all sedimentary rocks.
- Quartz - Most abundant constituent of sandstone. In addition to detrital quartz, free silica can be chemically precipitated as opal, chalcedony and chert.
- Calcite - Chief constituent of limestone. Precipitates from seawater which is saturated in both Ca^{+2} and CO_3^{-2}. Small changes in both temperature and pressure are enough to cause precipitation. Differs from most compounds in that solubility decreases with increasing temperature.
- Dolomite $CaMg(CO_3)_2$ - Most important constituent of dolostone.
- Feldspars - Occur in sedimentary rocks formed by very quick deposition and burial allowing no time for feldspars to alter to clay.
- Iron oxides and sulfides - Chemical precipitates dictated by the environment at the site of deposition.
- Salts and gypsum - Chemical precipitates occurring in restricted sedimentary basins under arid climatic conditions. Modern analog is the Middle East (Red Sea).
- Volcanic Debris - Glass and other pyroclastic material incorporated into sediments.
- Organic Material - Forms coal and gives color to black shales.

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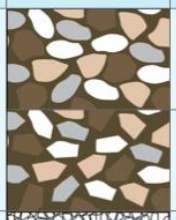
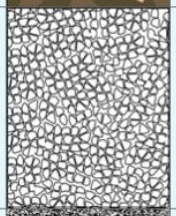
Clastic Sedimentary Rocks

Clastic rocks are formed from broken or fragmented grains.

Clastic texture (particle size)		Sediment name	Rock name
Coarse (over 2mm)		Gravel (rounded particles)	Conglomerate
		Gravel (angular particles)	Breccia
Medium (1/16 to 2 mm)		Sand	Sandstone (If abundant feldspar is present, the rock is called Arkose)
Fine (1/16 to 1/256 mm)		Mud	Siltstone
Very fine (less than 1/256 mm)		Mud	Shale

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Nonclastic Sedimentary Rocks (chemical or biological)

In chemical and biological sedimentary rock, the grains are interlocked through crystallisation. This results in an igneous appearing texture with very little open space.

Composition	Texture	Rock name	
Calcite, $CaCO_3$	Nonclastic: Fine to coarse crystalline	Crystalline Limestone	
		Travertine	
	Clastic: visible shells and shell fragments loosely cemented	Coquina	Biochemical Limestone
	Clastic: various size shells and shell fragments cemented with calcite cement	Fossiliferous Limestone	
	Clastic: Microscopic shells and clay	Chalk	
Quartz SiO_2	Nonclastic: very fine crystalline	Chert (light coloured) Flint (Dark coloured)	
Gypsum $CaSO_4.2H_2O$	Nonclastic: fine to coarse crystalline	Rock gypsum	
Halite, NaCl	Nonclastic: fine to coarse crystalline	Rock salt	
Altered plant fragments	Nonclastic: fine grained organic matter	Bituminous coal	

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Sedimentary Rocks and Structures Reading

Features of sedimentary rock

Structures formed during deposition

Bedding - Layering of sedimentary rocks. Each bed represents a homogeneous set of conditions of sedimentation. New beds indicate new conditions.

Graded beds - These occur when a mass of sediment is deposited rapidly. The bedding has the coarsest sediment at the bottom and finest at the top. Often found forming in submarine canyons. A collection of graded beds is termed a turbidite deposit.

Ripple Marks - Waves of sand often seen on a beach at low tide and in stream beds.
a) Current - asymmetrical - Rivers
b) Oscillation - symmetrical – Beaches

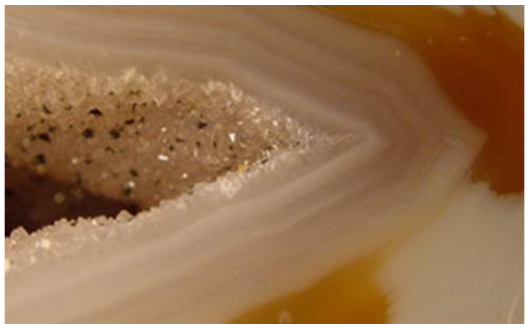
Mud Cracks - Polygonal-shaped cracks which develop in fine grained sediments as they dry out. Common in arid environments, such as a desert.

Structures formed after deposition

Nodule - Irregular, ovoid concentration of mineral matter that differs in composition from the surrounding sedimentary rock. Long axis of the nodule usually parallels the bedding plane and seems to prefer certain layers.

Concretion - Local concentration of cementing material. Generally round. Usually consist of calcite, iron oxide or silica. Can exceed 1 meter in diameter.

Geode - Roughly spherical structures up to 30 cm in diameter. Outer layer consists of chalcedony and the inside is lined with crystals. Calcite and quartz are the most common.



Layers are clearly visible in outer portion of this polished geode.

Other features

Fossils - Any direct evidence of past life. Examples are dinosaur bones, shells of marine organisms, plant impressions, etc.

References:

- Salsbury R (2004). Geode rings (image). Wikimedia Commons.
- Sandstone formation at Tamarama Beach, Sydney (image). (2010). Wikimedia Commons.
- Tompkins DE, Watkins JM (2016). *Exploring Earth and Environmental Science: Year 11*, 2nd Edition. Earth Science Western Australia.