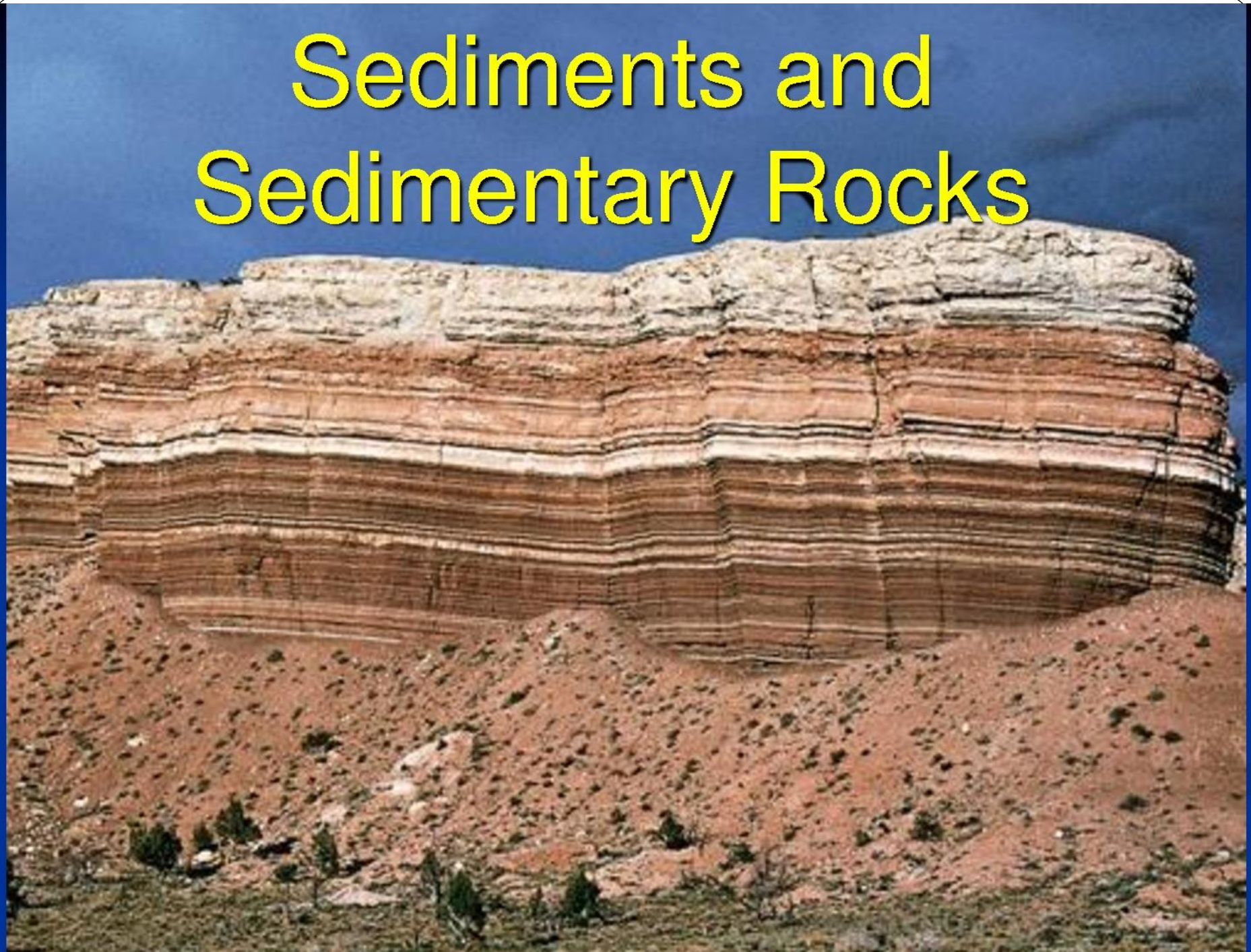
Sediments and Sedimentary Rocks



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- How they are formed?
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Introduction

- What are Sedimentary Rocks

  Sedimentary Rocks are a product of the surface processes of the earth (weathering, erosion, rain, stream flow, wind, wave action, ocean circulation). The starting material for sedimentary rocks are the rocks outcropping on the continents. Processes of physical and chemical weathering break down these source materials into the following components:
- **small fragments** of the source rock (gravel, sand, or silt size) that may be identifiable rock fragments or individual minerals
- **new minerals** produced by weathering processes (mainly clays)
- **dissolved** portions of the source rock (dissolved salts in river and ocean water)

- Agents of Sedimentation:

  Sedimentary rocks are formed from the solid debris and the dissolved minerals matter produced by the mechanical and chemical breakdown of pre-existing rocks, or in some cases from the skeletal material of dead plants and animals.

Formation of Sedimentary Rocks

- Weathering

  The first process, ***weathering***, is anything that breaks the rocks into smaller pieces or sediments. This can happen by the forces of like wind, rain, and freezing water.

- Transport

Transport, moves these materials to their final destination. Rivers are the main transporting agent of material to the oceans. During transport the sediment particles will be sorted according to size and density and will be rounded by abrasion. Material that has been dissolved during weathering will be carried away in solution. Winds may also play a role .

- Deposition

  The third process, ***Deposition.The*** sediments that form from these actions are often carried to other places by the wind, running water, and gravity. As these forces lose energy the sediments settle out of the air or water. As the settling takes place the rock fragments are graded by size. The larger heavier pieces settle out first. The smallest fragments travel farther and settle out last. This process of settling out is called deposition.

- Lithification

  Finally, after the sediment has come to rest, ***Compaction*** and ***Cementation*** of the sediment occur and a sedimentary rock is formed. Compaction is effected by the burden of younger sediment that gets piled on top of older sediments (rearrangement of particles, packing, dewatering). Minerals precipitated from the pore waters in these sediments cement together adjacent sediment grains. Thus, a coherent solid rock is formed.

Significance of Sedimentary Rocks

- Oil and gas

  Not only oil and gas, but also a large variety of other resources are extracted from sediments and sedimentary rocks. Coal (mined extensively in southeastern Indiana) and lignite are special kinds of sedimentary rocks (carbonaceous sediments), and they constitute a very large resource that should last for several hundred additional years.

- Iron ore

  Most of the iron ore in the world is mined from Precambrian sedimentary rocks, the largest lead-zinc-silver and copper deposits occur in sedimentary rocks (mostly Precambrian, especially Proterozoic), and the largest gold and uranium deposits also are located in sedimentary rocks as well (Archean to Proterozoic in age).

- Bauxite, the main ore for Aluminum production is basically a fossil soil (also a sediment) that formed in tropical climates. If we then also add the many building stones that are quarried from sedimentary rocks, and add in the raw materials for ceramics (clay minerals from mudstones and shales), it is quite obvious that sedimentary rocks are indeed of considerable importance, and that it pays to understand them well.

Classification of Sedimentary Rocks

- Detrital sedimentary rocks
- Organic sedimentary rocks
- Chemical sedimentary rocks

Detrital Sedimentary Rocks

- Called Clastic and terrigenous
- Detrital sedimentary rocks are classified according to the sizes of their grains.
- Wentworth Table

- Particulate sediments can be of many sizes, from huge boulders to tiny clays. However, we generally recognize only three or four major categories of sizes, separating them more or less arbitrarily. Anything larger than 2mm is called ***GRAVEL***. Particles between 2 mm and 1/16th of a mm (about the diameter of a sewing thread) are called ***SAND***. Particles smaller than this are too small to see, and are often lumped as ***MUD***, with the coarser of these tiny sizes sometimes called ***SILT*** and the finer ***CLAY***.

WENTWORTH SCALE OF ROCK PARTICLE SIZES

Classification	Particle size (diameter)
Boulder	Above 256 mm
Cobble	64–256 mm
Pebble	4–64 mm
Gravel (or Granule)	2–4 mm
Very coarse sand	1–2 mm
Coarse sand	0.5–1 mm
Medium sand	0.25–0.5 mm
Fine sand	0.125–0.25 mm
Very fine sand	0.062–0.125 mm
Silt	0.004–0.062 mm
Clay	Less than 0.004 mm

Organic sedimentary rocks

- Two groups of organic sedimentary rocks are separated:

1. Organic limestone

   Organic limestone consist of sea shells(calcium carbonate) cemented together. There are three common varieties of organic limestones.

- Fossiliferous limestones
- Coquina
- Chalk

2 Coals

Coals consists of carbon residue of plants that were buried with sediments and later compacted and distilled by heat and pressure of deep burial.

Chemical sedimentary rocks

- Primary chemical sedimentary rocks
- Secondary chemical sedimentary rocks

Primary chemical sedimentary rocks

- These are precipitated within open space at or near earths surface. Examples are rocks deposited within streams, lakes and oceans as a result of evaporation of water and those within caves owing to the loss of carbon dioxide from water.

These rocks include

- Rock salt

  It is typically **formed** by the evaporation of salty water (such as sea water) which contains dissolved Na+ and Cl- ions

- Rock gypsum

  As a rock, gypsum is a **sedimentary** rock, typically found in thick beds or layers. It forms in lagoons where **ocean waters** high in **calcium** and sulfate content can slowly evaporate and be regularly replenished with new sources of water. The result is the **accumulation** of large beds of **sedimentary** gypsum.

- Chemical limestone

  Limestone is a sedimentary rock composed largely of the minerals calcite and aragonite, which are different crystal forms of calcium carbonate($CaCO_3$). Most limestone is composed of skeletal fragments of marine organisms such as coral, foramsand molluscs.

  Limestone makes up about 10% of the total volume of all sedimentary rocks.

Secondary chemical sedimentary rocks

- They develop through the chemical change of earlier rocks by elements transported by water.

They include

- Dolostone

  is a rock that consists of dolomite produced by the replacement of limestone by the activity of magnesium in water.

- Chert

  chert is a rock that consists of fine crystalline quartz.

Textures of sedimentary Rocks

- Size of grains

  The size of grains is an important textural feature of a terrigenous rocks(from erosion of rock on land), as an indication of distance between its source and depositional areas, as well as an easily observes property which may be used to distinguish and classify the rock. The coarsest particles are deposited near the source are, and most of the finest particles are carried in suspension to greater distances before they settle.

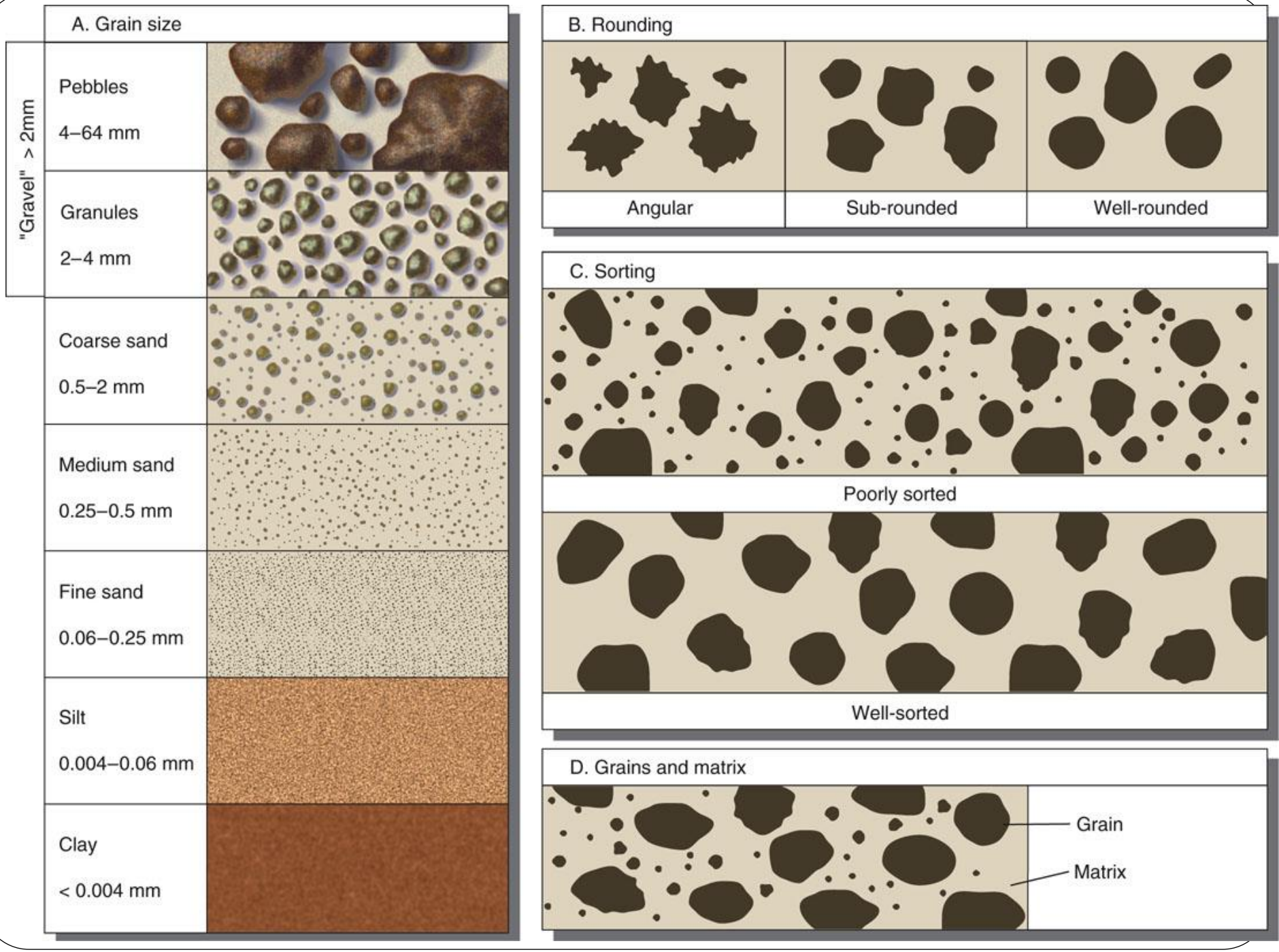
- Degree of roundness

The degree of roundness of grains is related to the amounts of abrasion suffered during transport, and hence to distance travelled from their source before deposition. Roundness is related to the sharpness or curvature of edges and corners of grains. It is also dependent on the size and hardness of the grains and the violence of impact of one against another.

A property associated with roundness of grains is **sphericity**, which defines the degree the particle or grain approaches the shape of a sphere. Equidimensional particles have a greater prospect of becoming spherical during transportation than other shapes of particle.

- Degree of sorting

  The relative homogeneity of a rock is expressed as its degree of sorting, a well sorted rock consisting of similarly sized particles. In contrast, a poorly sorted rock has a wide range of particle sizes.


A. Grain size
"Gravel" > 2mm
Pebbles
4–64 mm
Granules
2–4 mm
Coarse sand
0.5–2 mm
Medium sand
0.25–0.5 mm
Fine sand
0.06–0.25 mm
Silt
0.004–0.06 mm
Clay
< 0.004 mm
B. Rounding
Angular
Sub-rounded
Well-rounded
C. Sorting
Poorly sorted
Well-sorted
D. Grains and matrix
Grain
Matrix

Description of sedimentary rocks

- **Conglomerate**

  The pebbles and gravels on consolidation and cementation produce a rock known as conglomerate. The pores of a conglomerate are filled up with a matrix which is composed of fine sands, rock particles and some cementing material.

- **Breccia**

  A breccia is a rock resembling conglomerate but having angular fragments instead of rounded pebbles.

- **Sandstone**

  A sandstone is mainly composed of sand size grains of quartz which are cemented together. The cementing material may be silica, calcite, iron-oxide or clay.

- **Shale**

  It is a laminated fine grained sedimentary rock which is mainly composed of clay minerals and some silt-size grains of quartz.

- **Limestone**

  Limestones consist chiefly of calcite and dolomite with varying amounts of impurities such as chalcedony or clay.

- **Marl**

  Impure limestone which contain mixture of clay and calcarious matter, are known as marls.

- **Dolomite**

  Dolomite is a magnesium limestone which is composed of double carbonate of calcium and magnesium. It is distinguished from ordinary limestone by its greater hardness, greater specific gravity, and inferior solubility in hydrochloric acid.

Description of Sedimentary Rocks

Conglomerate

Breccia

Description of Sedimentary Rocks

Sandstone

Shale

Description of Sedimentary Rocks

Limestone

Marl

Dolomite