Exogenic Processes And Sedimentary Rocks

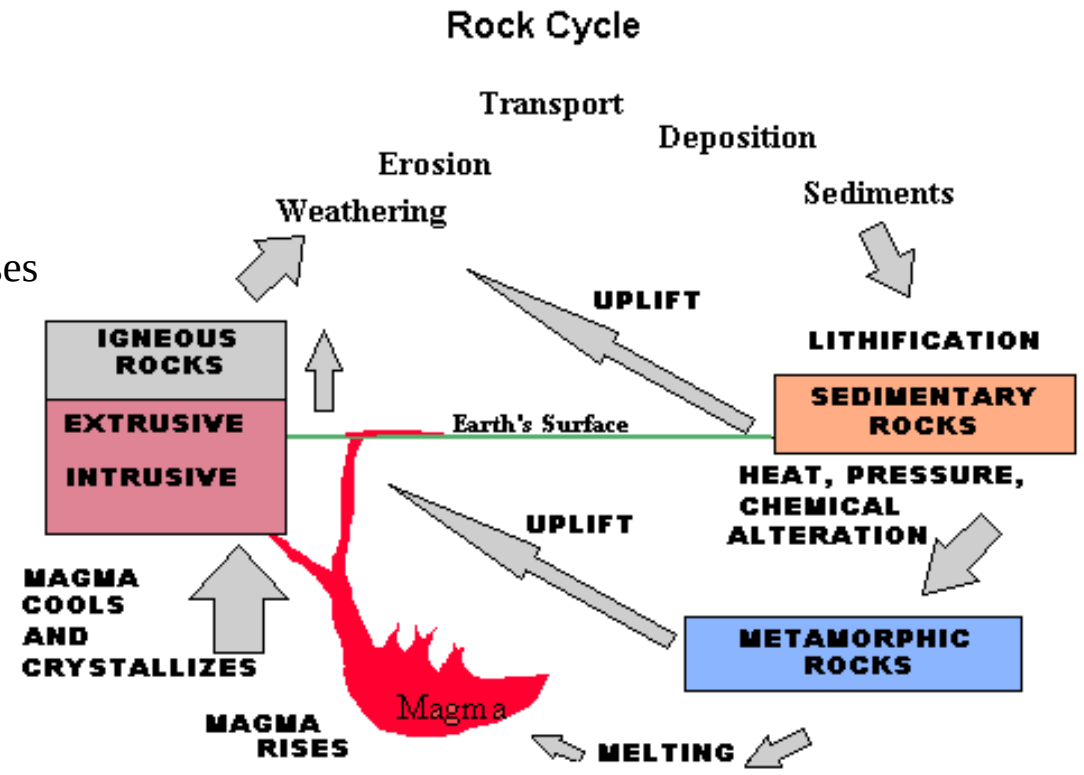
Exogenic Processes And Sedimentary Rocks

Geomorphic Processes: Physical processes which create and modify Landforms on the surface of the earth

Endogenous (Endogenic)

vs

Exogenous (Exogenic) Processes



Exogenic Processes And Sedimentary Rocks

I. Endogenous Processes

Endogenous Processes are large-scale landform building and transforming processes, they create relief.

- **Igneous Processes**
  - **Volcanism:** Volcanic eruptions → ***Volcanoes***
  - **Plutonism:** Igneous intrusions

- **Tectonic Processes** **(**Also called **Diastrophism)**
  - **Folding:** anticlines, synclines, mountains
  - **Faulting:** rift valleys, graben, escarpments
  - **Lateral Faulting:** strike-slip faults

Earthquakes → *evidence of present-day tectonic activity*

Exogenic Processes And Sedimentary Rocks

2. Exogenous Processes

Also called Gradational Processes, they comprise degradation and aggradation, they modify relief

Continuum of processes Weathering → Mass Wasting → Erosion → Transportation → Deposition

These processes are carried through by **Geomorphic Agents**: gravity, flowing water (rivers), moving ice (glaciers), waves and tides (oceans and lakes), wind

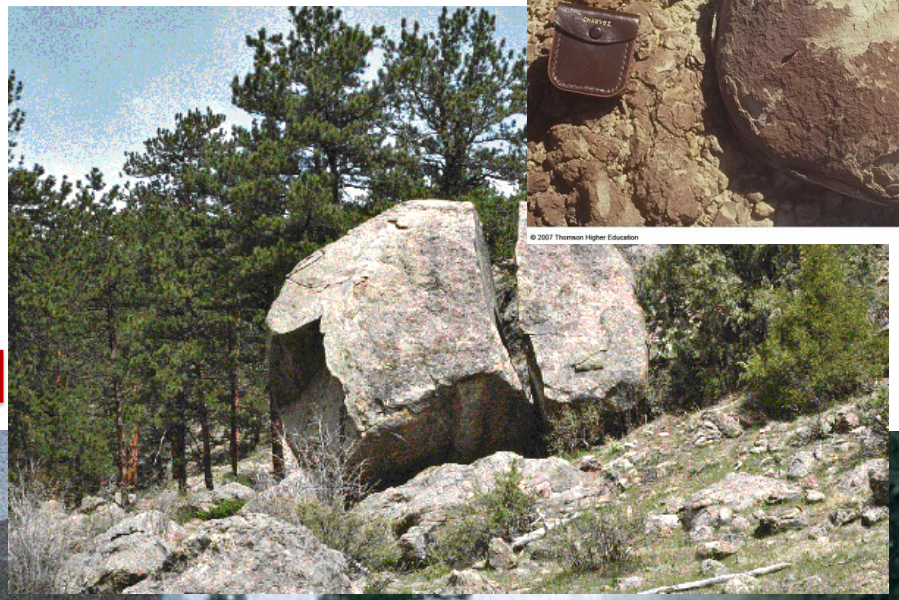
- **Degradation Processes** (Also called Denudation Processes)

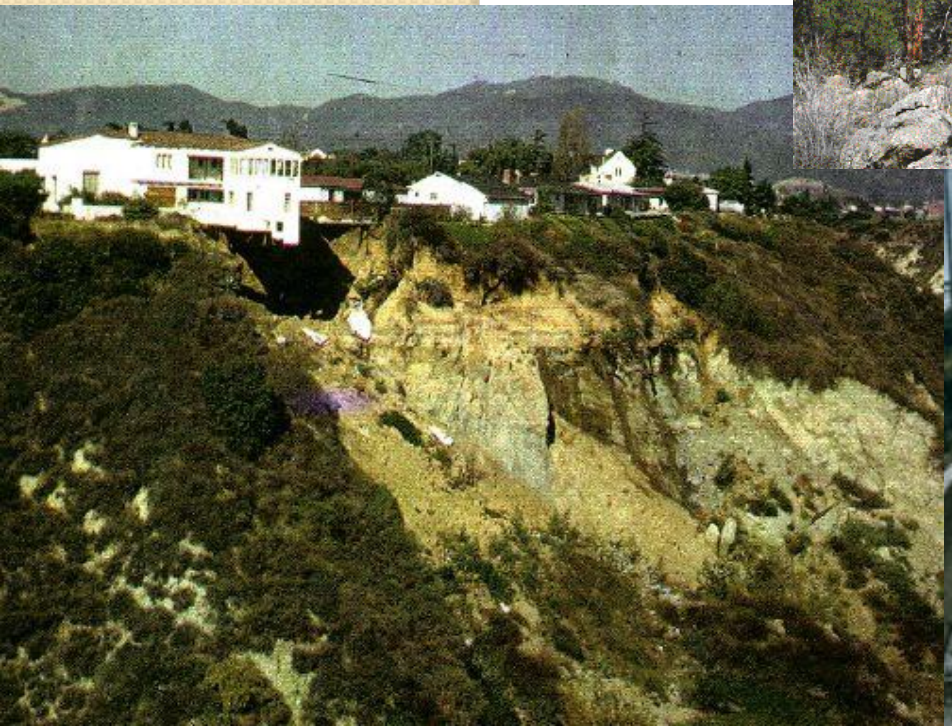
a. Weathering , b. Mass Wasting and c. Erosion and Transportation

- **Aggradation Processes**
    a. Deposition – fluvial, eolian, glacial, coastal

DEGRADATION PROCESSE

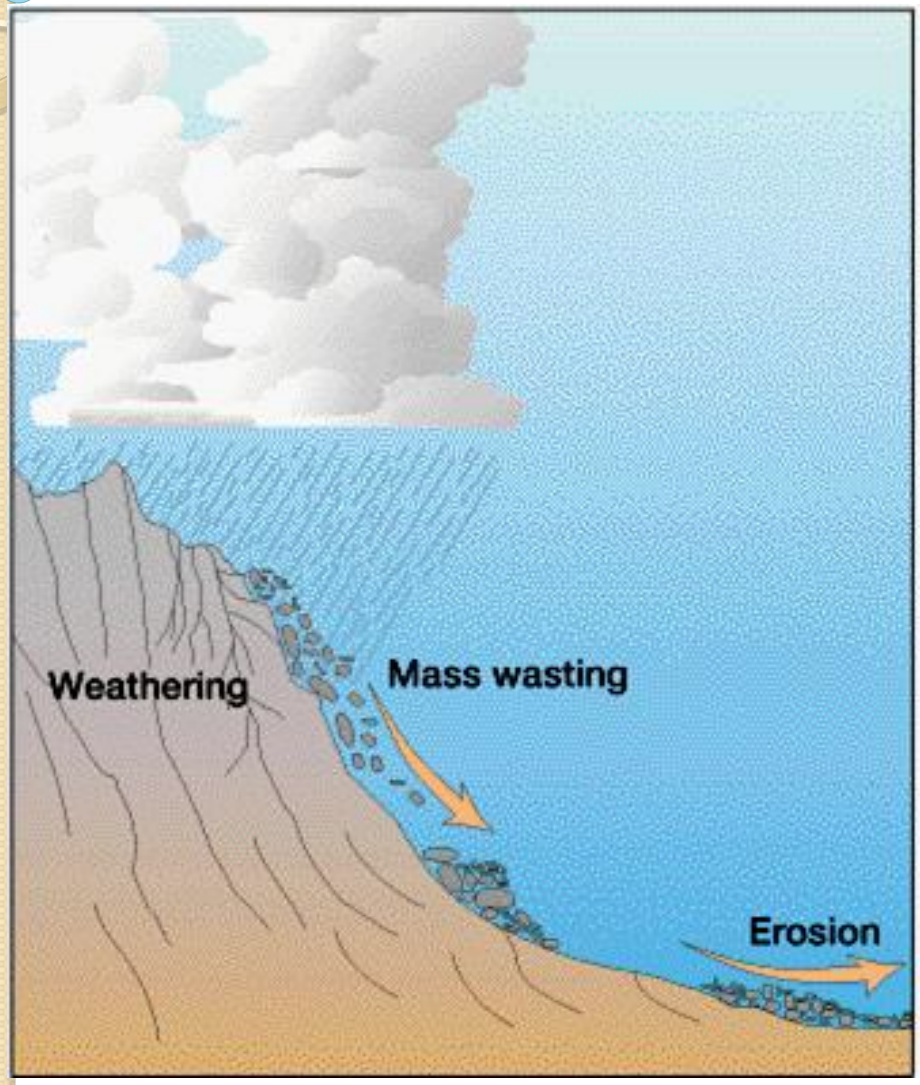
WEATHERING, MASS WASTING, EROSION AND TRANSPORTATION





Exogenic Processes And Sedimentary Rocks

2. Exogenous Processes



Relationship:

Weathering, Mass Wasting, Erosion and Transportation

Together, these processes are responsible for ***Denudation*** of Earth's surface

Exogenic Processes And Sedimentary Rocks

Exogenous Processes

Weathering

Weathering is disintegration and decomposition of rocks, no transportation involved.

More precisely, it involves the mechanical or physical disintegration and/or chemical decomposition that fragments rock masses into smaller components, before being moved by gravity or transported by other agents

The processes begin in microscopic spaces, cracks, joints, faults, fractures, lava vesicles and other rock cavities

Types of Weathering:

1) Physical or Mechanical Weathering,
2) Chemical Weathering, and
3) Biological Weathering

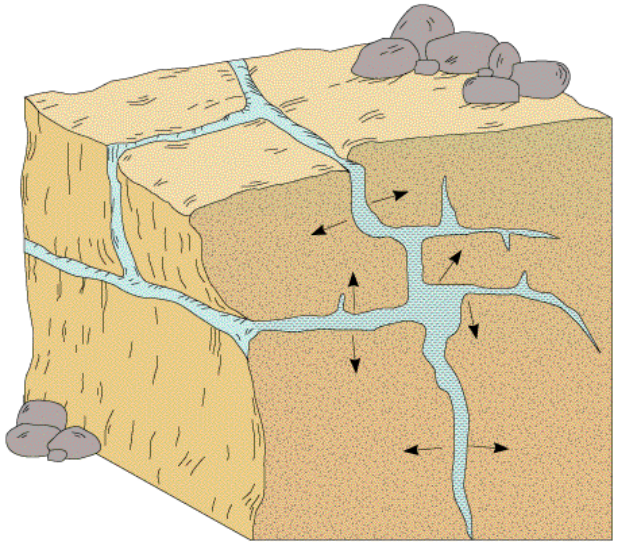
Exogenic Processes And Sedimentary Rocks

Exogenous Processes

Physical or Mechanical Weathering

Disintegration and decay of rocks via weather elements: high temperatures, extreme cold and freeze-thaw cycles.
No change in chemical composition of rocks

Exfoliation; due to thermal expansion/contraction and/or release of pressure when buried rocks are uplifted and exposed.



Exogenic Processes And Sedimentary Rocks

Exogenous Processes

Physical or Mechanical Weathering

Abrasion:

Many rocks along a stream or beach are rounded and smooth. They have been shaped by collisions with other rocks as they tumbled downstream and with silt and sand carried by moving water. As particles collide, their sharp edges and corners wear away.

The mechanical wearing and grinding of rock surfaces by friction and impact is called ***abrasion***. Note that pure water itself is not abrasive; the collisions among rock, sand, and silt cause the weathering..

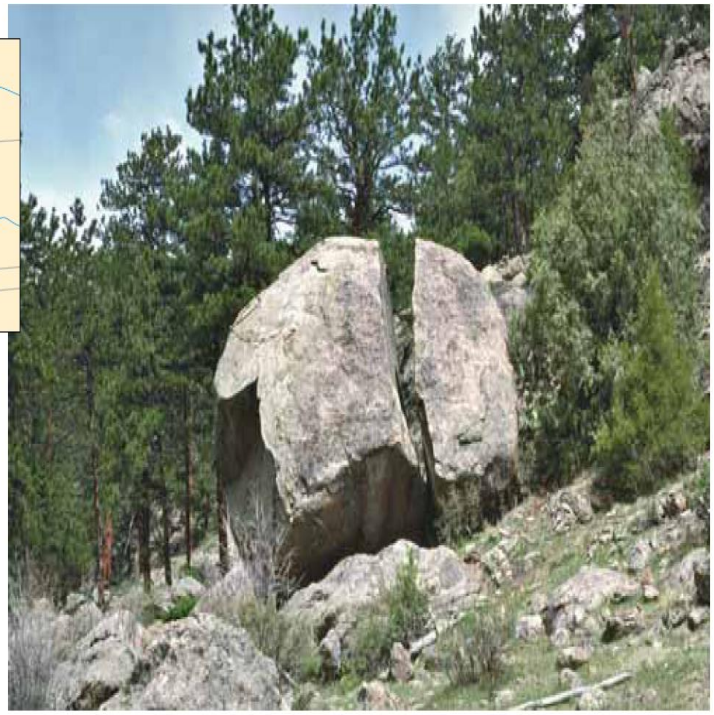
Exogenic Processes And Sedimentary Rocks

Exogenous Processes

Physical or Mechanical Weathering

Frost Wedging: The most important type of mechanical weathering; freeze-thaw repetition.

Water expands when it freezes. If water accumulates in a crack and then freezes, its expansion pushes the rock apart in a process called frost wedging. In a temperate climate, water may freeze at night and thaw during the day. Ice cements the rock together temporarily, but when it melts, the rock fragments may tumble from a steep cliff.



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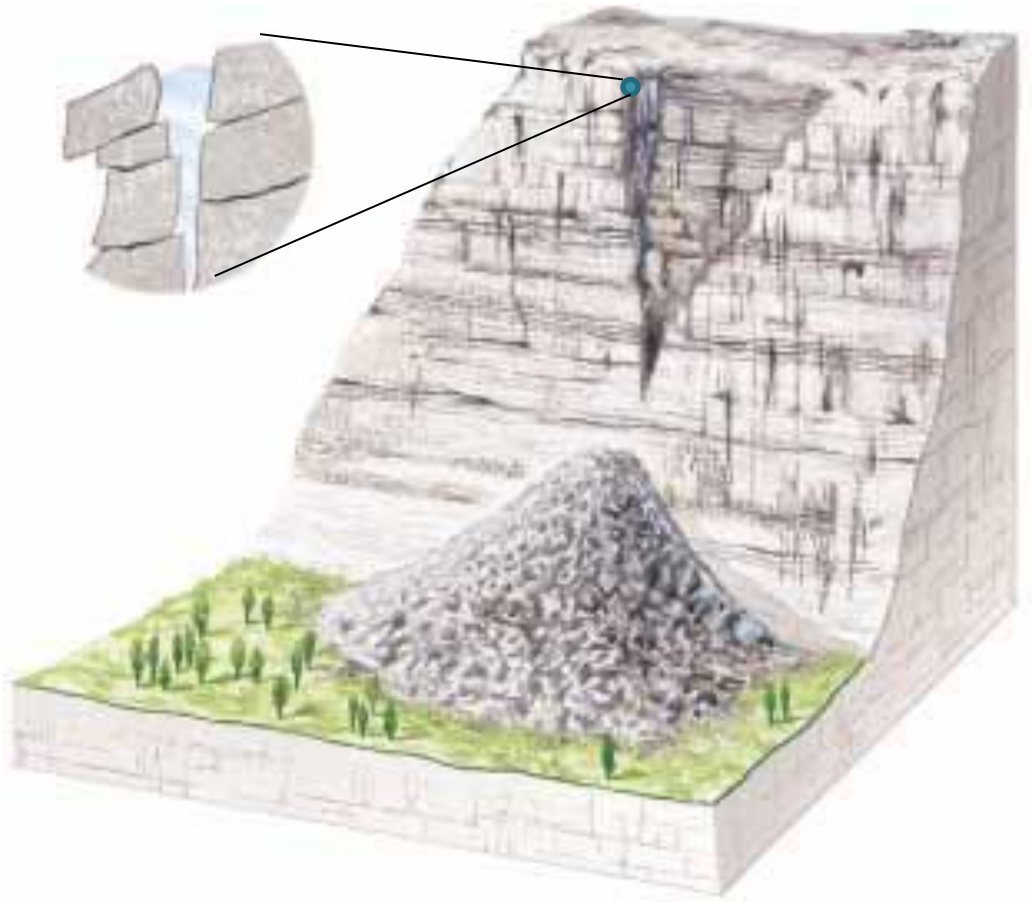
Exogenous Processes

Physical or Mechanical Weathering



Exogenic Processes And Sedimentary Rocks

Exogenous Processes

Chemical Weathering

Decomposes rocks through a chemical change in its minerals

Oxidation – important in iron-rich rocks – reddish coloration like rust

Hydrolysis – igneous rocks have much silica which readily combines with water and form new minerals or rocks, For example, feldspar, the most abundant mineral in the Earth's crust, weathers by hydrolysis to form clay.

Carbonation and Solution – Carbon dioxide dissolved in water reacts with carbonate rocks to create a soluble product (calcium bicarbonate)

Exogenic Processes And Sedimentary Rocks

Exogenous Processes

Biological Weathering

Plants and animals contribute to weathering.

Roots physically break or wedge rock
Lichens (algae and fungi living as single unit), remove minerals and weaken rock by releasing acids
Burrowing animals can increase weathering.

Exogenic Processes And Sedimentary Rocks

Exogenous Processes

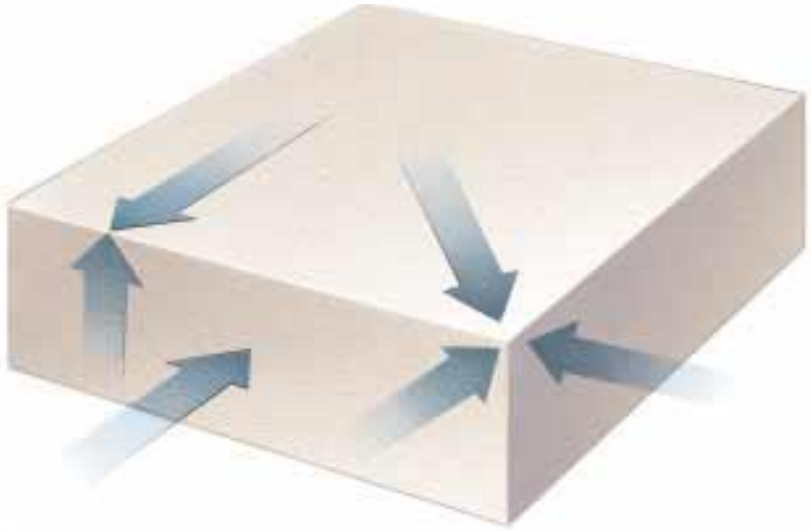
CHEMICAL AND MECHANICAL WEATHERING OPERATING TOGETHER

Chemical and mechanical weathering work together, often on the same rock at the same time. Chemical processes generally act only on the surface of a solid object, so the reaction speeds up if the surface area increases. Mechanical processes crack rocks, thereby exposing more surface area for chemical agents to work on . After mechanical processes fracture a rock, water and air seep into the fractures and initiate chemical weathering. (Explain Fig) . As a result of the multidirectional attack, the corners and edges weather most rapidly; the faces, attacked from only one direction, weather more slowly. Over time, the corners and edges become rounded in a process called spheroidal weathering..

Exogenic Processes And Sedimentary Rocks

Exogenous Processes

CHEMICAL AND MECHANICAL WEATHERING OPERATING TOGETHER



Exogenic Processes And Sedimentary Rocks

Exogenous Processes

SOIL:

Mechanical weathering produces both large rock fragments and small particles such as sand and silt. Chemical weathering forms clay and dissolved ions. Some of these weathering products accumulate on the Earth over bedrock. This material is called ***regolith***.

Soil scientists define soil as upper layers of regolith that support plant growth. Soil commonly consists of sand, silt, clay, and organic material

Exogenic Processes And Sedimentary Rocks

Sedimentary Rocks

Weathering decomposes bedrock. Flowing water, wind, gravity, and glaciers then erode the decomposed rock, transport it downslope, and finally deposit it on the sea coast or in lakes and river valleys. Finally, the loose sediment is cemented to form hard sedimentary rock. Sedimentary rocks make up only about 5 percent of the Earth's crust. However, because they form on the Earth's surface, they are widely spread in a thin veneer over underlying igneous and metamorphic rocks. As a result, sedimentary rocks cover about 75 percent of continents. Many sedimentary rocks have high economic value. Oil and gas form in certain sedimentary rocks. Coal, a major energy resource, is a sedimentary rock. Limestone is an important building material, both as stone and as the primary ingredient in cement. Gypsum is the raw material for plaster. Ores of copper, lead, zinc, iron, gold, and silver concentrate in certain types of sedimentary rocks.

Exogenic Processes And Sedimentary Rocks

Sedimentary Rocks

TYPES OF SEDIMENTARY ROCKS:

Sedimentary rocks are broadly divided into four categories:

1. Clastic sedimentary rocks are composed of fragments of weathered rocks, called clasts, that have been transported, deposited, and cemented together. Clastic rocks make up more than 85 percent of all sedimentary rocks. This category includes sandstone, siltstone, and shale.

2. Organic sedimentary rocks consist of the remains of plants or animals. Coal is an organic sedimentary rock made up of decomposed and compacted plant remains.

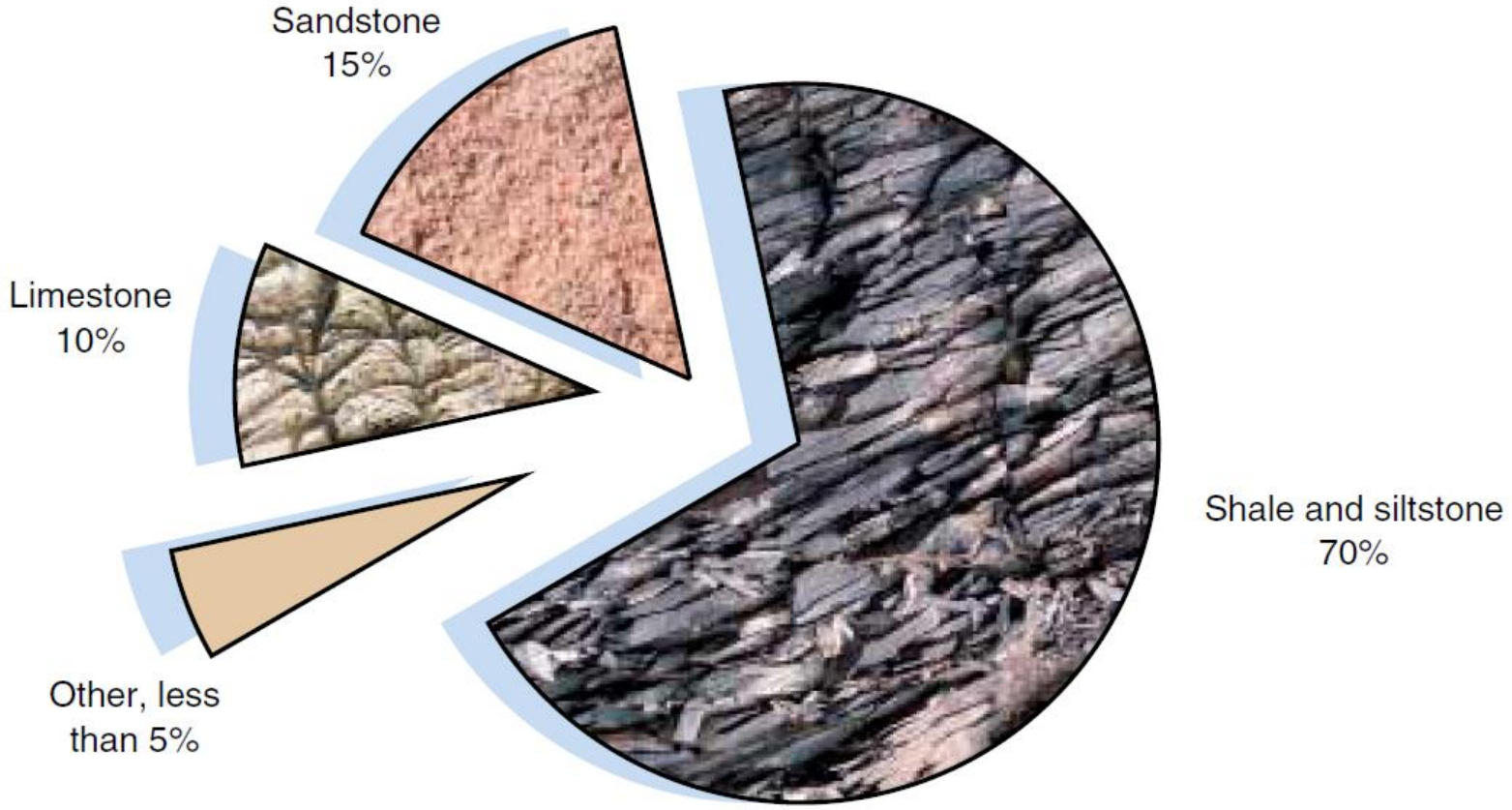
3. Chemical sedimentary rocks form by direct precipitation of minerals from solution. Rock salt, for example, forms when salt precipitates from evaporating seawater or saline lake water.

4. Bioclastic sedimentary rocks Most limestone is composed of broken shell fragments. The fragments are clastic, but they form from organic material. As a result, limestone formed in this way is called a bioclastic rock.

Exogenic Processes And Sedimentary Rocks

Sedimentary Rocks

TYPES OF SEDIMENTARY ROCKS:



Exogenic Processes And Sedimentary Rocks

Sedimentary Rocks

TYPES OF SEDIMENTARY ROCKS:

1. CLASTIC SEDIMENTARY ROCKS

Clastic sediment consists of grains and particles that were eroded from weathered rocks and then were transported and deposited in loose, unconsolidated layers at the Earth's surface. The sand on a beach, boulders in a river bed, and mud in a puddle are all clastic sediments. Clastic sediment is named according to particle size.

DIAMETER (mm)	SEDIMENT		CLASTIC SEDIMENTARY ROCK
256– 64–	Boulders Cobbles Pebbles	Gravel (rubble)	Conglomerate (rounded particles) or breccia (angular particles)
2–	Sand		Sandstone
1/16–	Silt	Mud	Siltstone } Mudstone
1/256–	Clay		Claystone or shale } Mudstone

Exogenic Processes And Sedimentary Rocks

Sedimentary Rocks

TYPES OF SEDIMENTARY ROCKS:

1. CLASTIC SEDIMENTARY ROCKS

- *TYPES OF CLASTIC ROCKS*
  - *Conglomerate and Breccia:* Conglomerate and breccia are coarse-grained clastic rocks. In a conglomerate the particles are rounded, and in a sedimentary breccia they are angular. Because large particles become rounded rapidly over short distances of transport, sedimentary breccias are usually found close to the weathering site where the angular rock fragments formed.

Exogenic Processes And Sedimentary Rocks

Sedimentary Rocks

TYPES OF SEDIMENTARY ROCKS:

1. CLASTIC SEDIMENTARY ROCKS

- *TYPES OF CLASTIC ROCKS*
  - *Sandstone:* Sandstone consists of lithified sand grains. When granitic bedrock weathers, feldspar commonly converts to clay, but quartz crystals resist weathering. As streams carry the clay and quartz grains toward the sea, the quartz grains become rounded. The flowing water deposits the sand in one environment and the clay in another. Consequently, most sandstones consist predominantly of rounded quartz grains

The word sandstone refers to any clastic sedimentary rock comprising primarily sand-sized grains. Most sandstones are quartz sandstone and contain more than90 percent quartz.

Exogenic Processes And Sedimentary Rocks

Sedimentary Rocks

TYPES OF SEDIMENTARY ROCKS:

2. ORGANIC SEDIMENTARY ROCKS

Organic sedimentary rocks, such as chert and coal, form by lithification of the remains of plants and animals.

- *Types of Organic Sedimentary Rocks:*
  - *CHERT:* Chert is a rock composed of pure silica. It occurs as sedimentary beds interlayered with other sedimentary rocks and as irregularly shaped lumps called nodules in other sedimentary rocks. Microscopic examination of bedded chert often shows that it is made up of the remains of tiny marine organisms that make their skeletons of silica rather than calcium carbonate.
  - *COAL:* When plants die, their remains usually decompose by reaction with oxygen. However, in warm swamps and in other environments where plant growth is rapid, dead plants accumulate so rapidly that the oxygen is used up long before the decay process is complete. The undecayed or partially decayed plant remains form peat. As peat is buried and compacted by overlying sediments it converts to coal, a hard, black, combustible rock

Exogenic Processes And Sedimentary Rocks

Sedimentary Rocks

TYPES OF SEDIMENTARY ROCKS:

2. ORGANIC SEDIMENTARY ROCKS

Exogenic Processes And Sedimentary Rocks

Sedimentary Rocks

TYPES OF SEDIMENTARY ROCKS:

3. CHEMICAL SEDIMENTARY ROCKS

Some common elements in rocks and minerals, such as calcium, sodium, potassium, and magnesium, dissolve during chemical weathering and are carried by ground water and streams to the oceans or to lakes. Most lakes are drained by streams that carry the salts to the ocean. Streams flow into the lake. As a result, water escapes only by evaporation.

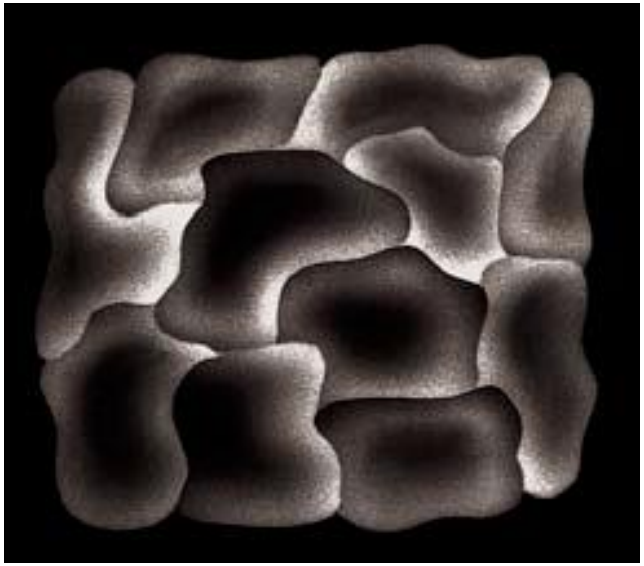
Evaporites form when evaporation concentrates dissolved ions to the point at which they precipitate from solution. As the individual crystals precipitate, they interlock with each other to produce grain boundaries like those of an igneous rock. The interlocking texture forms a solid rock, even though the rock may never have been compacted or cemented.

Exogenic Processes And Sedimentary Rocks

Sedimentary Rocks

TYPES OF SEDIMENTARY ROCKS:

3. CHEMICAL SEDIMENTARY ROCKS



Exogenic Processes And Sedimentary Rocks

Sedimentary Rocks

TYPES OF SEDIMENTARY ROCKS:

4. BIOCLASTIC ROCKS

Carbonate rocks are made up primarily of carbonate minerals, which contain the carbonate ion $(CO_3)^{2-}$. The most common carbonate minerals are calcite (calcium carbonate, $CaCO_3$) and dolomite (calcium magnesium carbonate, $CaMg(CO_3)^2$). Calcite-rich carbonate rocks are called limestone, whereas rocks rich in the mineral dolomite are also called dolostone. Many geologists use the term dolostone for the rock name to distinguish it from the mineral dolomite. Clams, oysters, corals, some types of algae, and a variety of other marine organisms convert dissolved calcium carbonate to shells and other hard body parts. When these organisms die, waves and ocean currents break the shells into small fragments, called bioclastic sediment. A rock formed by lithification of such sediment is called bioclastic limestone, indicating that it forms by both biological and clastic processes.

Exogenic Processes And Sedimentary Rocks

Sedimentary Rocks

TYPES OF SEDIMENTARY ROCKS:

4. BIOCLASTIC ROCKS

Chalk: is a very fine-grained, soft, white bioclastic limestone made of the shells and skeletons of Micro-organisms that float near the surface of the oceans.

Niobrara chalk of western Kansas consists of the remains of tiny marine organisms.

Exogenic Processes And Sedimentary Rocks

Sedimentary Rocks

SEDIMENTARY STRUCTURES

Nearly all sedimentary rocks contain sedimentary structures, features that developed during or shortly after deposition of the sediment. These structures help us understand how the sediment was transported and deposited. The most obvious and common sedimentary structure is bedding, or stratification—layering that develops as sediment is deposited.

Bedding forms because sediment accumulates layer by layer. Nearly all sedimentary beds were originally horizontal because most sediment accumulates on nearly level surfaces.

Exogenic Processes And Sedimentary Rocks

Sedimentary Rocks

SEDIMENTARY STRUCTURES

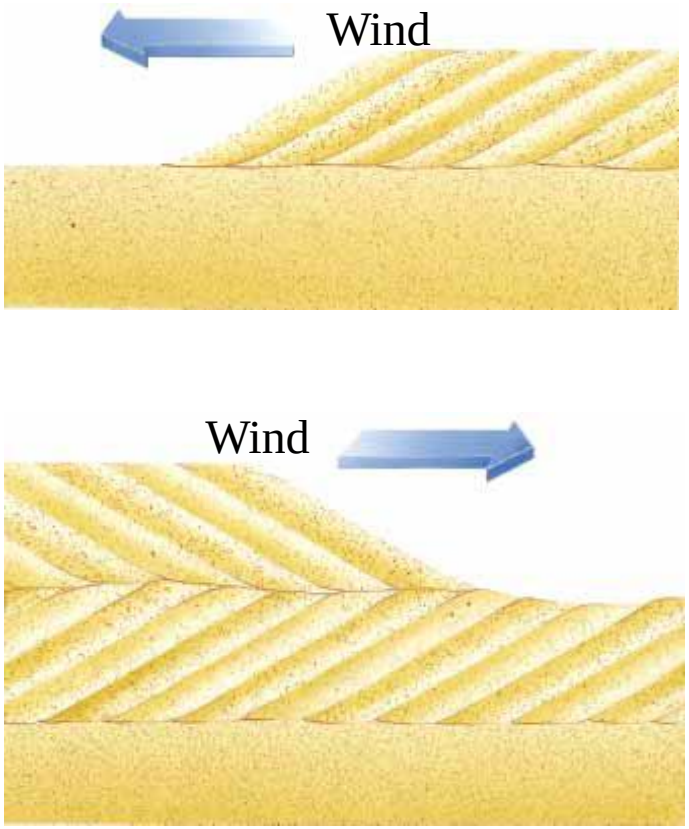
Cross-bedding consists of small beds lying at an angle to the main sedimentary layering. Cross-bedding forms in many environments where wind or water transports and deposits sediment. For example, wind heaps sand into parallel ridges called dunes, and flowing water forms similar features called sand waves, cross-beds are the layers formed by sand grains tumbling down the steep downstream face of a dune or sand wave. Cross-bedding is common in sands deposited by wind, streams, ocean currents, and waves on beaches.

Exogenic Processes And Sedimentary Rocks

Sedimentary Rocks

SEDIMENTARY STRUCTURES

Cross-bedding

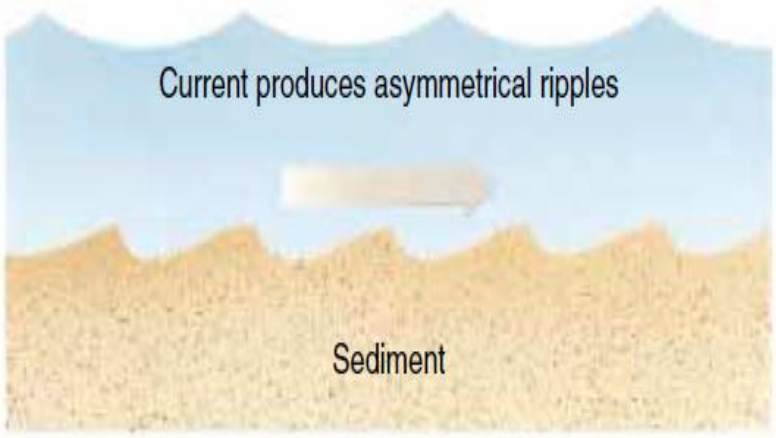


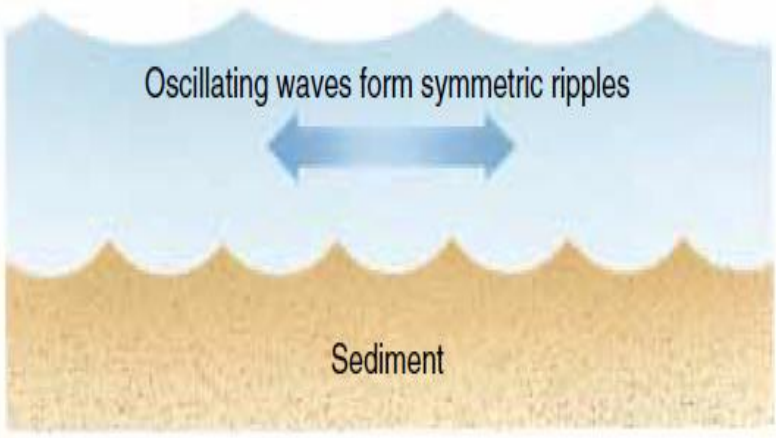
Exogenic Processes And Sedimentary Rocks

Sedimentary Rocks

SEDIMENTARY STRUCTURES

Ripple marks are small, nearly parallel sand ridges and troughs that are also formed by moving water or wind. They are like dunes and sand waves, but smaller. If the water or wind flows in a single direction, the ripple marks become asymmetrical. In other cases, waves move back and forth in shallow water, forming symmetrical ripple marks in bottom sand. Ripple marks are often preserved in sandy sedimentary rocks.





Exogenic Processes And Sedimentary Rocks

Sedimentary Rocks

SEDIMENTARY STRUCTURES

Graded bedding the largest grains collect at the bottom of a layer and the grain size decreases toward the top. Graded beds commonly form when some violent activity, such as a major flood or submarine land-slide, mixes a range of grain sizes together in water. The larger grains settle rapidly and concentrate at the base of the bed. Finer particles settle more slowly and accumulate in the upper parts of the bed.

Exogenic Processes And Sedimentary Rocks

Sedimentary Rocks

SEDIMENTARY STRUCTURES

Mud cracks are polygonal cracks that form when mud shrinks as it dries. They indicate that the mud accumulated in shallow water that periodically dried up. For example, mud cracks are common on intertidal mud flats where sediment is flooded by water at high tide and exposed at low tide. The cracks often fill with sediment carried in by the next high tide and are commonly well preserved in rocks.

Mud cracks form when wet mud dries and shrinks.

Exogenic Processes And Sedimentary Rocks

Sedimentary Rocks

INTERPRETING SEDIMENTARY ROCKS: DEPOSITIONAL ENVIRONMENTS

Geologists study sedimentary rocks to help us understand the past. When geologists study sedimentary rocks, they ask questions such as: Where did the sediment originate? Was the sediment transported by a stream, wind, or a glacier? In what environment did the sediment accumulate? If it was deposited in the sea, was it on a beach or in deep water? If it was deposited on land, was it in a lake, a stream bed, or a flood plain? Geologists answer these questions by analyzing the minerals, textures, and structures of sedimentary rocks. Additionally, the size and shape of a sedimentary rock layer contain clues to its depositional environment. Accurate interpretations of depositional environments are often rewarding because valuable concentrations of oil and gas, coal, evaporites, and metals form in certain types of environments. Depositional environments vary greatly in scale, from an entire ocean basin to a 3-meter-long sand bar in a stream. Many small-scale environments may be active within a single large-scale depositional system.

Exogenic Processes And Sedimentary Rocks

Sedimentary Rocks

Texture Of Sedimentary Rocks

1	2
	
CLASTIC TEXTURE Visible grains, coarser than sand; grains are angular (grain size > 2 mm) Breccia	CLASTIC TEXTURE Visible grains, coarser than sand; grains are rounded (grain size > 2 mm) Conglomerate

Exogenic Processes And Sedimentary Rocks

Sedimentary Rocks

Texture Of Sedimentary Rocks

3

CLASTIC TEXTURE
Visible grains, coarse sand-size
(grain size between 1/16 and 2 mm)

Arkose Sandstone

4

CLASTIC TEXTURE
Visible grains, sand-size;
the rock feels gritty to the touch
(grain size between 1/16 and 2 mm)

Quartz Sandstone

Exogenic Processes And Sedimentary Rocks

Sedimentary Rocks

Texture Of Sedimentary Rocks

5

CLASTIC TEXTURE
The grains barely visible;
the rock feels mostly smooth to the touch
(grain size between 1/256 and 1/16 mm)

Siltstone

6

CLASTIC TEXTURE
The grains are not visible;
the rock feels smooth to the touch
(grain size smaller than 1/256 mm)

Mudstone (clay and silt)

Exogenic Processes And Sedimentary Rocks

Sedimentary Rocks

Texture Of Sedimentary Rocks

7

CLASTIC TEXTURE
The grains are not visible,
but Foliation is very evident

Shale

Exogenic Processes And Sedimentary Rocks

Common Sedimentary Rocks

Breccia

Breccia is a term most often used for clastic sedimentary rocks that are composed of large angular fragments (over two millimeters in diameter). The spaces between the large angular fragments can be filled with a matrix of smaller particles or a mineral cement that binds the rock together.

Exogenic Processes And Sedimentary Rocks

Common Sedimentary Rocks

Coal

Coal is an organic sedimentary rock that forms from the accumulation and preservation of plant materials, usually in a swamp environment. Coal is a combustible rock and, along with oil and natural gas, it is one of the three most important fossil fuels. Coal has a wide range of uses; the most important use is for the generation of electricity.

Exogenic Processes And Sedimentary Rocks

Common Sedimentary Rocks

Chert:

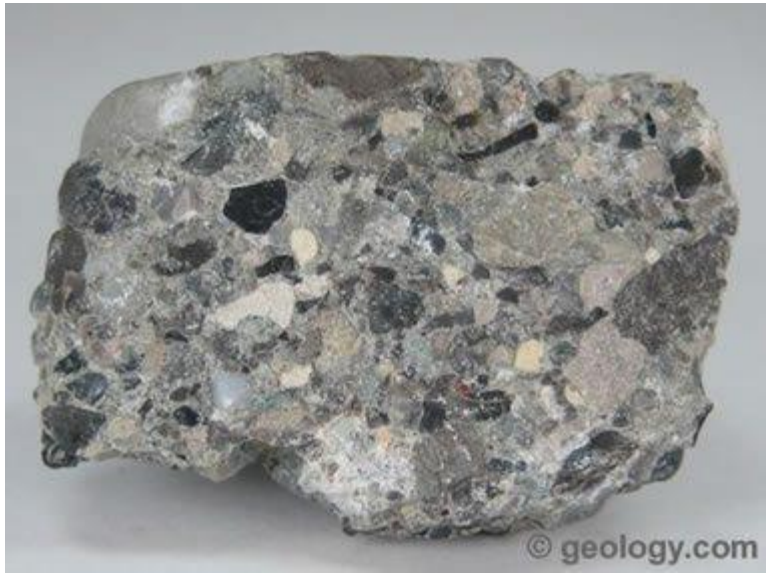
Chert is a microcrystalline sedimentary rock material composed of silicon dioxide (SiO2). It occurs as nodules, concretionary masses, and as layered deposits. Chert breaks with a conchoidal fracture, often producing very sharp edges. Early people took advantage of how chert breaks and used it to fashion cutting tools and weapons. The name "flint" is also used for this material.

Exogenic Processes And Sedimentary Rocks

Common Sedimentary Rocks

Conglomerate

Conglomerate is a clastic sedimentary rock that contains large (greater than two millimeters in diameter) rounded clasts. The space between the clasts is generally filled with smaller particles and/or a chemical cement that binds the rock together.



Exogenic Processes And Sedimentary Rocks

Common Sedimentary Rocks

Dolomite

also known as "dolostone" and "dolomite rock," is a sedimentary rock composed primarily of the mineral dolomite, $CaMg(CO_3)^2$. Dolomite is found in sedimentary basins worldwide. It is thought to form by the post depositional alteration of lime mud and limestone by magnesium-rich groundwater.

Exogenic Processes And Sedimentary Rocks

Common Sedimentary Rocks

Iron Ore

Earth's most important iron ore deposits are found in sedimentary rocks. They formed from chemical reactions that combined iron and oxygen in marine and fresh waters. The two most important minerals in these deposits are iron oxides: hematite (Fe_2O_3) and magnetite (Fe_3O_4). These iron ores have been mined to produce almost every iron and steel object that we use today - from paper clips to automobiles and steel beams.

Exogenic Processes And Sedimentary Rocks

Common Sedimentary Rocks

Limestone

Limestone is a sedimentary rock composed primarily of calcium carbonate ($CaCO_3$) in the form of the mineral calcite. It most commonly forms in clear, warm, shallow marine waters. It is usually an organic sedimentary rock that forms from the accumulation of shell, coral, algal, and fecal debris. It can also be a chemical sedimentary rock formed by the precipitation of calcium carbonate from lake or ocean water.

Exogenic Processes And Sedimentary Rocks

Common Sedimentary Rocks

Oil shale

Oil shale is commonly defined as a fine-grained sedimentary rock containing organic matter that yields substantial amounts of oil and combustible gas upon destructive distillation.

Exogenic Processes And Sedimentary Rocks

Common Sedimentary Rocks

Sandstone

Sandstone is a sedimentary rock composed of sand-size grains of mineral, rock, or organic material. It also contains a cementing material that binds the sand grains together and may contain a matrix of silt- or clay-size particles that occupy the spaces between the sand grains.

Exogenic Processes And Sedimentary Rocks

Common Sedimentary Rocks

Siltstone

Siltstone is a sedimentary rock composed mainly of silt-sized particles. It forms where water, wind, or ice deposit silt, and the silt is then compacted and cemented into a rock.

Exogenic Processes And Sedimentary Rocks

Questions:

1. What are the Endogenous processes? Explain these process briefly?
2. Describe physical/ mechenical weathering?
3. Briefly describe the types of sedimentary rocks?
4. By which agents the cross bedding form?
5. What is graded bedding and in which environment they form?
6. Describe some common sedimentary rocks?

Exogenic Processes And Sedimentary Rocks