



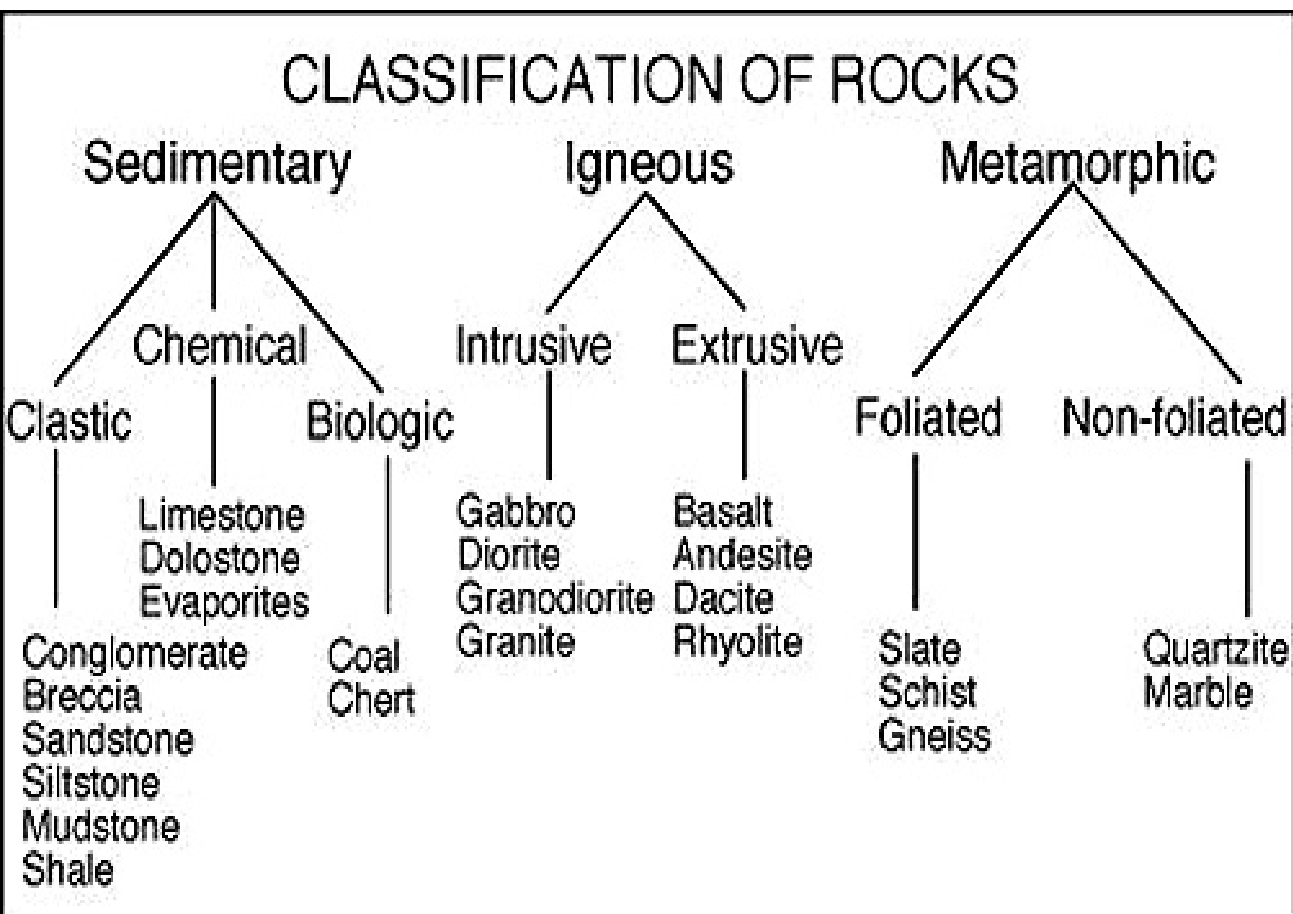
Minerals and Rocks

Minerals

- ▶ A mineral is defined as a naturally occurring organic and inorganic substance, having an orderly arrangement of atoms and a definite composition and physical properties.
- ▶ About 98% of the total crust of the earth is composed of eight elements namely **oxygen, sodium, calcium, iron, magnesium, silicon, aluminium and potassium** and the rest is constituted by titanium, hydrogen, phosphorus, manganese, carbon, sulfur, nickel and other elements. **These elements combine with other elements to form substances called minerals.**
- ▶ Broadly the minerals can be classified into metallic and non-metallic minerals.
- ▶ **Metallic Minerals:**
 - ▶ These minerals are composed of metals and can be divided into three subtypes -
 - ▶ **Precious metals** - Platinum, gold, silver, etc.
 - ▶ **Ferrous metals** - Iron mixed with other metals.
 - ▶ **Non-ferrous metals** - Metals other than iron like copper, aluminium, lead, zinc, tin, etc.
- ▶ Metallic minerals are generally obtained from igneous rocks, and are malleable and ductile.
- ▶ **Non-Metallic Minerals:**
 - ▶ These minerals are composed of non-metals like sulphur, silicon, phosphorus. For example, cement is a mixture of non-metallic minerals. Non-metallic minerals are generally obtained from sedimentary rocks, lacking malleability and ductility.

Rocks

- ▶ Rock is the solid mineral material forming the surface of the earth, a rock is composed of one or more minerals.
- ▶ **Petrology** is the science of rocks which includes the studying of mineral composition, structure, texture, origin, occurrence, alteration and relationship with other rocks.
- ▶ The age of a rock is determined based on **carbon-14 dating**.
- ▶ Classification of Rocks:



— Types —

Intrusive
(Slow cooling of magma)




Granite
Diorite



Gabbro

Extrusive
(Rapid cooling of lava)




Pumice
Obsidian



Basalt

— Types —

Clastic
(Compaction of broken rocks)




Sandstone
Conglomerate

Chemical
(Compaction of dissolved minerals)




Iron ore
Rock salt

Organic
(Compaction of organic materials)




Coal
Limestone

— Types —

Foliated
(Distinguished by layers)




Slate
Gneiss



Phyllite

Non-foliated
(No distinguishable layers)




Marble
Quartzite



Hornfels

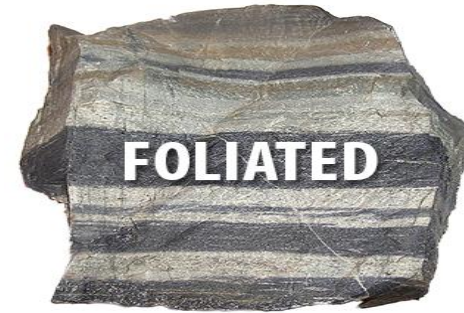
Types of Rocks

▶ Igneous Rocks:

- ▶ “Ignis” in Latin means ‘fire’.
- ▶ Igneous rocks are formed out of magma and lava from the interior of the earth. When magma in its upward movement cools and turns into solid form, it is called igneous rock.
- ▶ These are called as the “**Primary Rocks**”.
- ▶ There are two types of igneous rocks:
 - Intrusive Rocks:
 - Intrusive rocks are formed when magma rises and cools within the crust which gives rise to various forms like batholiths, laccoliths, dyke etc. eg: Granite.
 - Extrusive Rocks:
 - Extrusive rocks are formed when cooling and solidification takes place on the surface of the earth. eg: Basalt Deccan Traps.
- ▶ Igneous rocks are also classified based on the texture, size and arrangement of grains or other physical conditions of the materials. If the magma cools slowly at great depths, mineral grains increase in their size. Sudden cooling at the surface results in small and smooth grains.
- ▶ **The igneous rocks are the oldest of all the rocks.** Pegmatite, gabbro, granite, basalt, tuff are some of the examples of igneous rocks.

▶ Sedimentary Rocks:

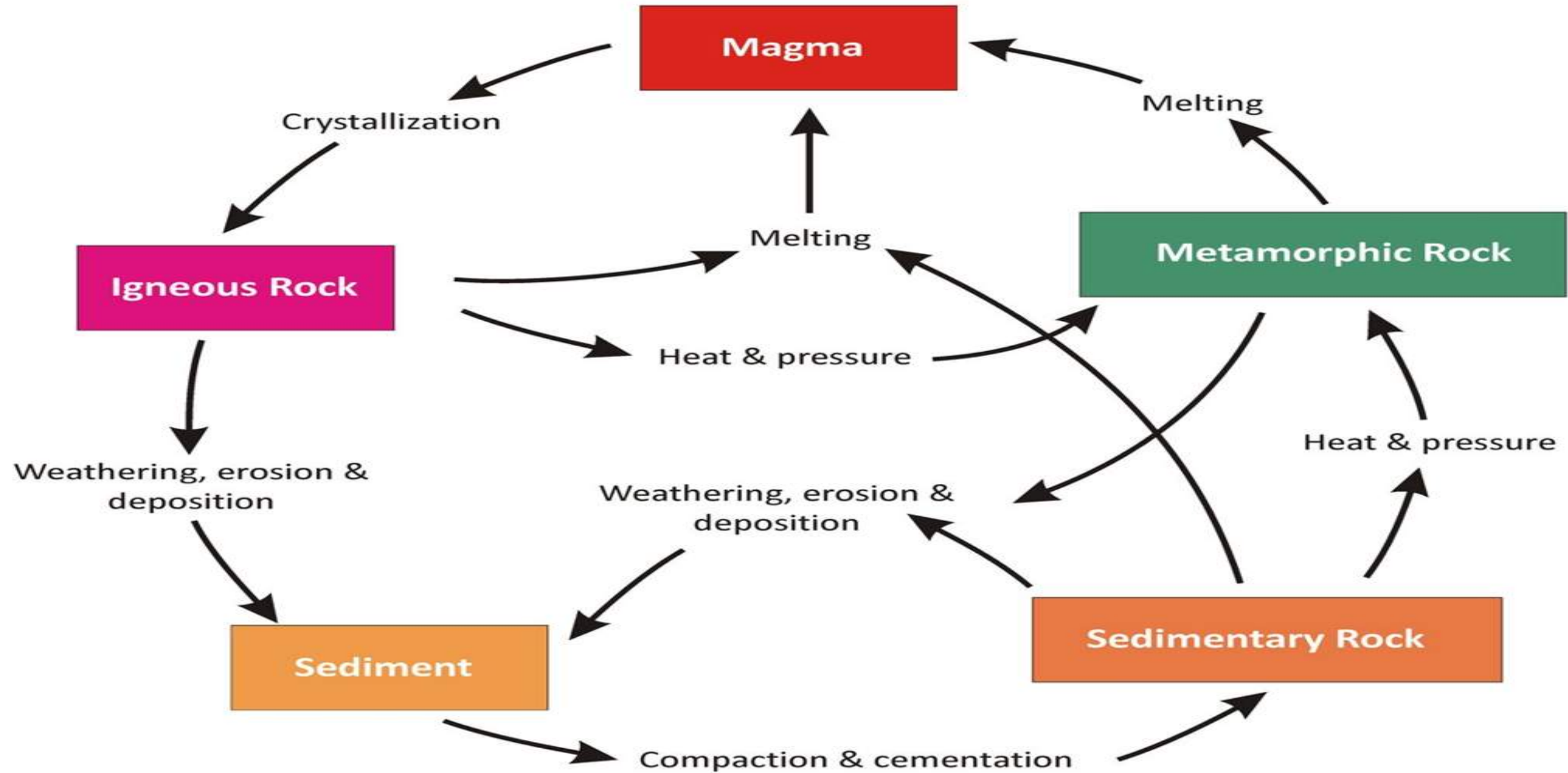
- ▶ The word 'sedimentary' is derived from the Latin word sedimentum, which means settling.
- ▶ Rocks of the earth's surface undergo denudation and are broken into various fragments and are transported by different exogenous forces and deposited.
- ▶ These deposits through compaction turn into sedimentary rocks. The process is called "lithification".
- ▶ Sedimentary rocks occupy only 5% of the earth. They are layered or stratified of varying thickness.
- ▶ Sedimentary rocks are of three types depending upon the mode of formation -
 - ▶ **Mechanically** formed sedimentary rocks - For example, conglomerate, loess, limestone, sandstone, etc.
 - ▶ **Chemically** formed - For example, potash, halite, etc.
 - ▶ **Organically** formed - For example, chalk, coal, limestone, geysers, etc.



▶ Metamorphic Rocks:

- ▶ The word metamorphic means 'change of form'.
- ▶ The metamorphic rocks form under the action of pressure, volume and temperature (PVT change).
- ▶ Metamorphism occurs when rocks are forced down to lower levels by tectonic activities or when molten magma rising through the crust come into contact with the crustal rocks or the underlying rocks are subjected to great amounts pressure by overlying rocks.
- ▶ Metamorphism is a process by which the already consolidated rocks undergo recrystallisation and reorganization of materials within original rocks.
- ▶ **The igneous and metamorphic rocks together account for 95% of the earth.**
- ▶ They are again divided into two 1) **Foliated Rocks** (patterns of lines) 2) **Non-Foliated Rocks** (No patterns of Lines)

Rock Cycle



Geomorphic Process

- ▶ The formation and deformation of landforms on the surface of the earth are a continuous process which is due to the continuous influence of external and internal forces. The internal and external forces causing stresses and chemical action on earth materials and bringing about changes in the configuration of the surface of the earth are known as geomorphic processes.
- ▶ The Geomorphic process is by two types:
 - 1) Endogenic Process
 - 2) Exogenic Process

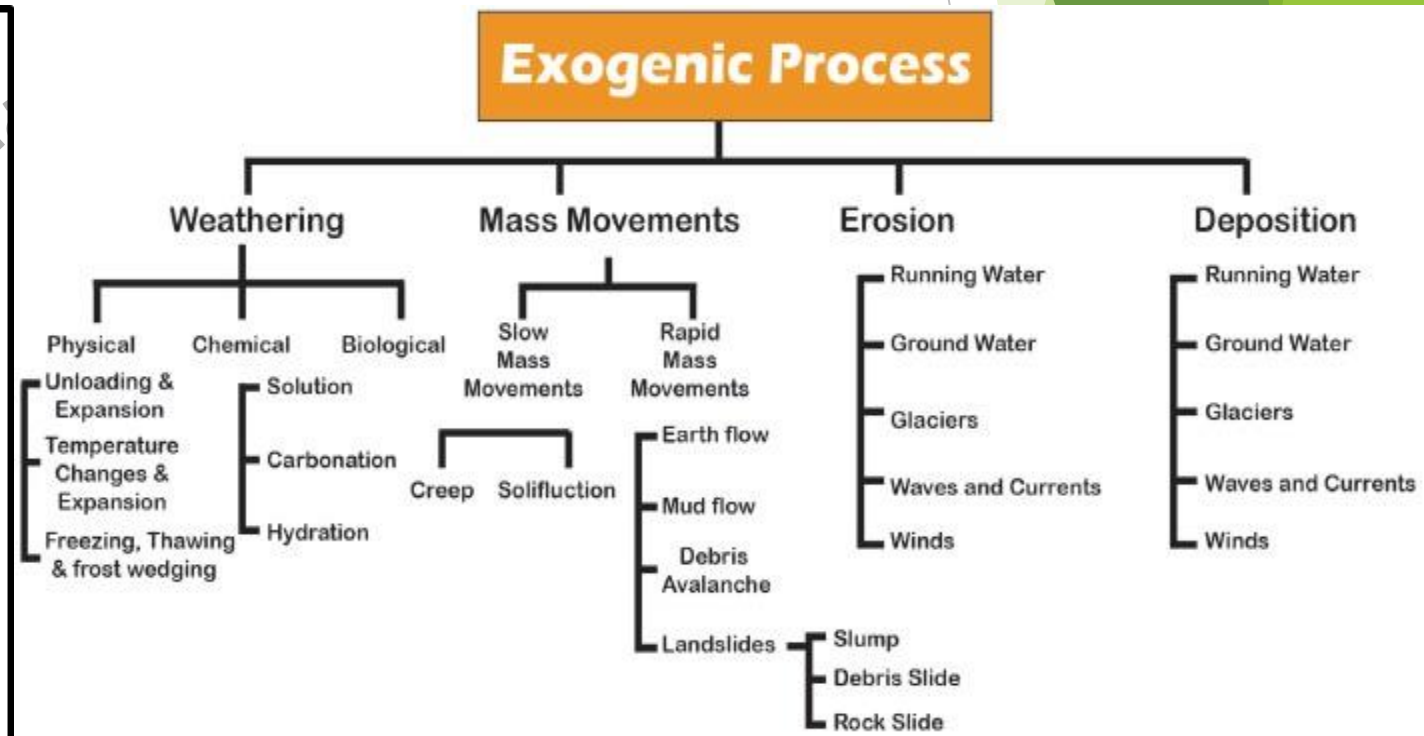
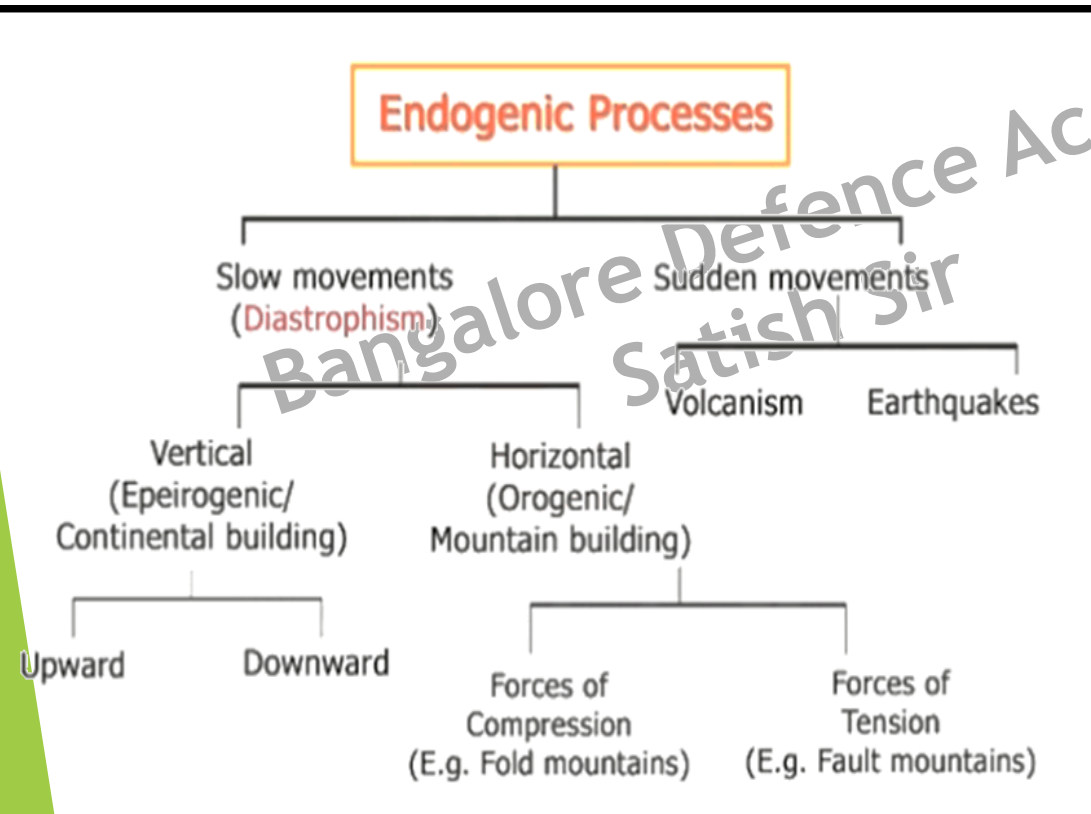


Figure 4.1 Exogenic processes

Weathering

- ▶ Weathering is defined as mechanical disintegration and Chemical decomposition of Rocks through the actions of various elements of **Weather and Climate**.
- ▶ The process results from forces of weather like rain action, variations in temperature and frost action.
- ▶ Weathering is the initial stage in the formation of soil.
- ▶ This process is accountable for the fragmentation of the rocks into smaller fragments and making the way for the creation of not only soils and regolith, but also mass movements and erosion.



Physical

Chemical

Biochemical

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Physical Weathering

► It leads to disintegration and break down of rocks due to temperature change, Frost action, wind action and removal of super incumbent load.



Block Disintegration

► Most of the Physical weathering processes are caused by thermal expansion and pressure release.



Granular Disintegration



Exfoliation

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Block Disintegration

Frost Action

- High Latitude Phenomenon
- Effective in Sedimentary Rocks

Temperature Change

- Phenomenon in Deserts where temperature contrasts is high
- Effective in Igneous Rocks.



Granular Disintegration

Granular disintegration occurs in rocks made up of many coarse-grained minerals. Minerals with a darker shade absorb more heat than those with a light color.

This phenomenon can be observed in Hot deserts where the Temperature Contrast is more



Exfoliation

Due to removal of
super incumbent
load.

Combined action
of wind and heat
in hot and
monsoon climate.



Chemical Weathering

- ▶ Disintegration and decomposition of Rocks Due to Chemical reaction is called as chemical weathering.
- ▶ Chemical weathering involves the interaction of rock with mineral solutions (chemicals) to change the composition of rocks. In this process, water interacts with minerals to create various chemical reactions and transform the rocks.
- ▶ Chemical weathering is enhanced by such geological agents as the presence of water and oxygen, as well as biological agents as the acids produced by microbial and plant root metabolism.

**Solution (or)
Carbonation**

Oxidation

Hydration

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Solution (or) Carbonation

- On coming in contact with water many solids Disintegrate and mix up as suspension in water

- Minerals like calcium carbonate and calcium magnesium bicarbonate present in limestone are soluble in water containing carbonic acid and are carried away in water as solution.



Oxidation

- Oxidation occurs where there is ready access to the atmosphere and oxygenated waters

- In the process of oxidation rock Breakdown occurs due to the disturbance caused by addition of oxygen



Hydration

- Hydration is the chemical addition of water in which minerals take up water and expand

- Repetition of this process causes fatigue in the Rocks and may lead to their disintegration.
- Eg: Clay Rocks



Biotic Weathering

- ▶ In these type of weathering Plants, animals and Humans largely control the rate of weathering.
- ▶ The Process of removal of minerals and iron from the rock is known as biological weathering.
- ▶ This process brings physical changes in the rock due to growth or movement of organisms.

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Floral

Faunal

Anthropogenic

Floral Weathering

The roots of the Plants weakens the Rocks by breaking them into blocks

Decaying plants help in the production of acids which enhance decay and solubility of some elements



Faunal Weathering

Burrowing animals like Rabbit , fox , earthworms, termites rodents etc. help in physical breakdown of rock

Decaying animals help in the production of acids which enhance decay and solubility of Rocks.



Anthropogenic Weathering

Man accelerate and decelerate the rate of weathering because of his economic activities like

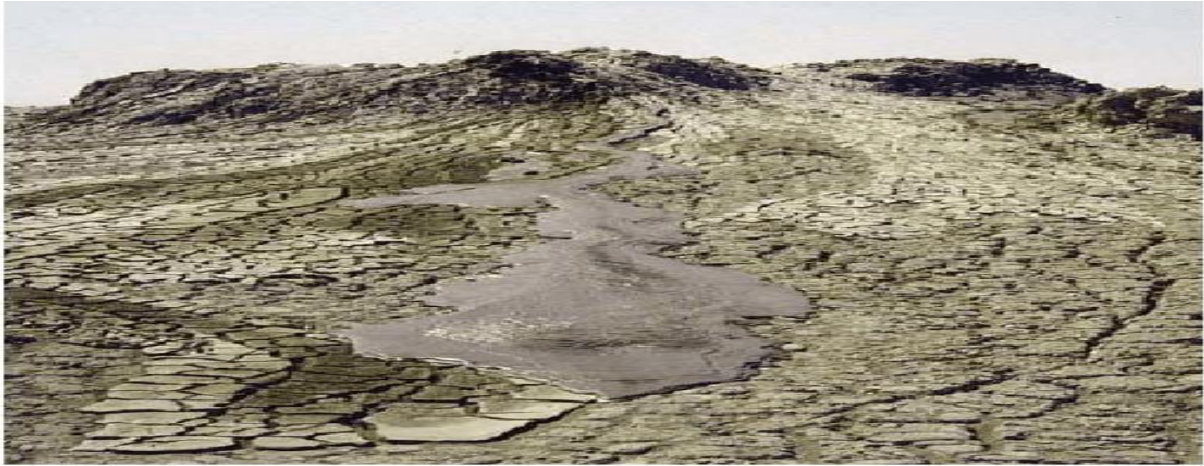
Deforestation,
Agriculture,
Building
Infrastructure like
Roads, Railways,
Dams, Mining,
Terrace farming
etc.



Mass Movements



Soil Creep



Mud Flow



Landslide

Soils

- ▶ Soil is very important and valuable resource for every human being.
- ▶ Soil is the mixture of Rock debris and Organic material which develop on the earth's surface.
- ▶ The major factors that determine Soils characteristics are Parental Material, Climate, Topography, Organism, Time etc.
- ▶ Major constituents of soil are mineral particles, humus, water and air.
- ▶ A soil horizon are generally layers parallel to the Soils crust, whose physical characteristics differ from the layers above and beneath.



Parental Material

Climate

Topography

Organism

Time