

Chapter - 5

Minerals and Rocks

- **Petrology:** It is science of rocks. A petrologist studies rocks in all their aspects viz., mineral composition, texture, structure, origin, occurrence, alteration and relationship with other rocks.
- **Igneous Rocks:** Igneous rocks form out of magma and lava from the interior of the earth, they are known as primary rocks. The igneous rocks (**Ignis - in Latin means 'Fire'**) are formed when magma cools and solidifies.
- **Sedimentary Rocks:** The word 'sedimentary' is derived from the Latin word sedimentum, which means settling.
- **Metamorphic Rocks:** The word metamorphic means 'change of form'. These rocks form under the action of pressure, volume and temperature (PVT) changes. Metamorphism occurs when rocks are forced down to lower levels by tectonic processes or when molten magma rising through the crust comes in contact with the crustal rocks or the underlying rocks are subjected to great amounts of pressure by overlying rocks.
- **Lithification:** Rocks (igneous, sedimentary and metamorphic) of the earth's surface are exposed to denudational agents, and are broken up into various sizes of fragments. Such fragments are transported by different exogenous agencies and deposited. These deposits

through compaction turn into rocks. This process is called lithification.

- **Metamorphism:** It is a process by which already consolidated rocks undergo recrystallisation and reorganization of materials within original rocks.
- **Dynamic Metamorphism:** Mechanical disruption and reorganization of the original minerals within rocks due to breaking and crushing without any appreciable chemical changes is called dynamic metamorphism.
- **Rock Cycle:** Rock cycle is a continuous process through which old rocks are transformed into new ones.
- **Lineation:** In the process of metamorphism in some rocks grains or minerals get arranged in layers or lines. Such an arrangement of minerals or grains in metamorphic rocks is called foliation or lineation.
- **Banding:** Sometimes minerals or materials of different groups are arranged into alternating thin to thick layers appearing in light and dark shades. Such a structure in metamorphic rocks is called banding.
- **Banding Rocks:** Rocks displaying banding are called banded rocks

INTRODUCTION

- This unit deals with Minerals, elements, characteristics of minerals such as crystal form cleavage, fracture, lustre, colour, streak, transparency, structure, hardness specific gravity, important minerals such as feldspar, quartz, pyroxene, amphibole, mica, olivine and their characteristics classification of minerals, rocks, igneous, sedimentary, metamorphic rocks rock cycle Minerals found in the crust are in solid form where as in interior they are in liquid form 98% of the crust consist of eight elements

1. oxygen

2. Silicon

3. Aluminium

4. Iron.

5. Calcium

6. Sodium

7. Potassium

8. Manganese

the rest is
constituted by

titanium, hydrogen,

phosphorous, manganese, sulphur carbon, nickel & other elements

Table 5.1: The major Elements of the Earth's Crust

Sl. No.	Elements	By Weight(%)
1.	Oxygen	46.60
2.	Silicon	27.72
3.	Aluminium	8.13
4.	Iron	5.00
5.	Calcium	3.36
6.	Sodium	2.83
7.	Potassium	2.59
8.	Magnesium	2.09
9.	Others	1.41

Mineral

Mineral naturally occurring inorganic substance having an orderly atomic structure and a definite chemical composition and physical properties. It is composed of two or three minerals /single element ex. S, Cu, Ag, Au, Graphite. There are at least 2000 minerals in the crust. There are at least six mineral groups which form rocks in the crust. The basic source of all minerals is the hot magma in the interior of the earth. Coal, petroleum and natural gas are organic minerals



Physical Characteristics

(i) **External crystal form** — determined by internal arrangement of the molecules — cubes, octahedrons, hexagonal prisms, etc.

(ii) **Cleavage** — tendency to break in given directions producing relatively plane surfaces — result of internal arrangement of the molecules — may cleave in one or more directions and at any angle to each other.

(iii) **Fracture** — internal molecular arrangement so complex there are no planes of molecules; the crystal will break in an irregular manner, not along planes of cleavage.

(iv) **Lustre** — appearance of a material without regard to colour; each mineral has a distinctive lustre like metallic, silky, glossy etc.

(v) **Colour** — some minerals have characteristic colour determined by their molecular structure—malachite, azurite, chalcopyrite etc., and

some minerals are coloured by impurities. For example, because of impurities quartz may be white, green, red, yellow etc.

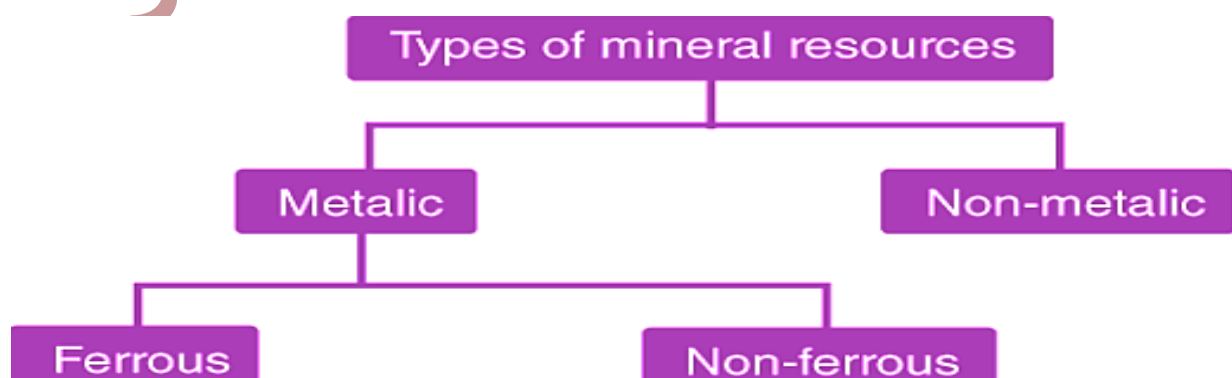
(vi) Streak — colour of the ground powder of any mineral. It may be of the same colour as the mineral or may differ— malachite is green and gives green streak, fluorite is purple or green but gives a white streak.

(vii) Transparency — transparent: light rays pass through so that objects can be seen plainly; translucent — light rays pass through but will get diffused so that objects cannot be seen; opaque — light will not pass at all.

(viii) Structure — particular arrangement of the individual crystals; fine, medium or coarse grained; fibrous — separable, divergent, radiating.

(ix) Hardness — relative resistance being scratched; ten minerals are selected to measure the degree of hardness from 1-10. They are: 1. talc; 2. gypsum; 3. calcite; 4. fluorite; 5. apatite; 6. feldspar; 7. quartz; 8. topaz; 9. corundum; 10. diamond. Compared to this for example, a fingernail is 2.5 and glass or knife blade is 5.5.

(x) Specific gravity — the ratio between the weight of a given object and the weight of an equal volume of water; object weighed in air and then weighed in water and divide weight in air by the difference of the two weights.



Metallic Minerals

These minerals contain metal content and can be sub-divided into three types:

- (i) **Precious metals** : gold, silver, platinum etc.
- (ii) **Ferrous metals** : iron and other metals often mixed with iron to form various kinds of steel.
- (iii) **Non-ferrous metals** : include metals like copper, lead, zinc, tin, aluminium etc.

Non-Metallic Minerals

These minerals do not contain metal content. Sulphur, phosphates and nitrates are examples of non-metallic minerals. Cement is a mixture of non-metallic minerals

Rocks

- The earth's crust is composed of rocks.
- A rock is an aggregate of one or more minerals.
- Rock may be hard or soft and in varied colours.
- For example, granite is hard, soapstone is soft. Gabbro is black and quartzite can be milky white. Rocks do not have definite composition of mineral constituents.
- Feldspar and quartz are the most common minerals found in rocks.



Types of Rocks

- **Igneous Rocks** — solidified from magma and lava.
- **Sedimentary Rocks** — the result of deposition of fragments of rocks.
- **Metamorphic Rocks** — formed out of existing rocks undergoing recrystallisation.

1) Igneous Rocks or Primary Rocks

- The solidification of magma formed the first rocks on earth.
- Rocks formed out of solidification of magma (molten rock below the surface) and lava (molten rock above the surface) and are known as igneous or primary rocks.
- Having their origin under conditions of high temperatures the igneous rocks are unfossiliferous.
- Granite, gabbro, basalt, are some of the examples of igneous rocks.
 - There are three types of igneous rocks based on place and time taken in cooling of the molten matter, plutonic rocks, volcanic rocks and intermediate rocks.
- There are two types of rocks based on the presence of acid-forming radical, silicon, acidic rocks and basic rocks.



2) Sedimentary Rocks or Detrital Rocks

- Sedimentary rocks are formed by lithification — consolidation and compaction of sediments.
- Hence, they are layered or stratified of varying thickness.
Example: sandstone, shale etc.
- Sediments are a result of denudation (weathering and erosion) of all types of rocks
- These types of rocks cover 75 per cent of the earth's crust but volumetrically occupy only 5 per cent (because they are available only in the upper part of the crust).
- Ice deposited sedimentary rocks are called till or tillite.
Winddeposited sediments are called loess.
- Depending upon the mode of formation, sedimentary rocks are classified into:

1. **mechanically formed** — sandstone, conglomerate, limestone, shale, loess.

2. **organically formed** — geyserite, chalk, limestone, coal.

3. **chemically formed** — limestone, halite, potash. Water containing minerals evaporate at the mouth of springs or salt lakes and give rise to Stalactites and stalagmites (deposits of lime left over by the lime-mixed water as it evaporates in the underground caves).

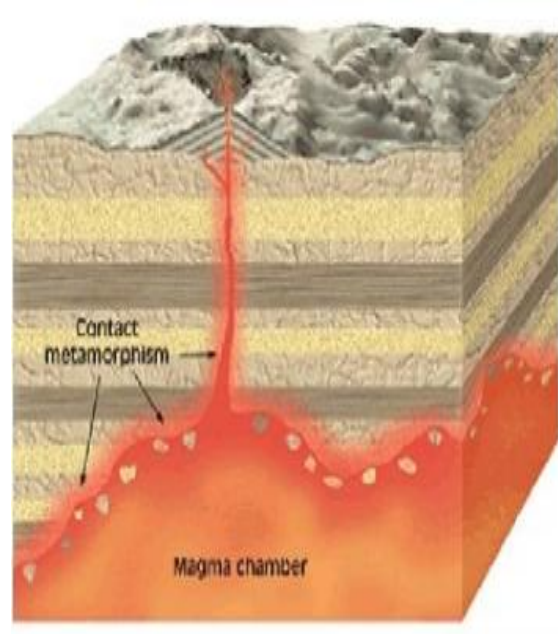
Stalactites and stalagmites

Water containing minerals evaporate at the mouth of springs or salt lakes and give rise to Stalactites and stalagmites (deposits of lime left over by the lime-mixed water as it evaporates in the underground caves)



3) Metamorphic Rocks

- The word metamorphic means 'change of form'.
- Metamorphism is a process by which recrystallisation and reorganisation of minerals occur within a rock. This occurs due to pressure, volume and temperature changes.
- When rocks are forced down to lower levels by tectonic processes or when molten magma rising through the crust comes in contact with the crustal rocks, metamorphosis occurs.
- In the process of metamorphism in some rocks grains or minerals get arranged in layers or lines. Such an arrangement is called foliation or lineation
- Sometimes minerals or materials of different groups are arranged into alternating thin to thick layers. Such a structure is called banding.
- **Gneissoid, slate, schist, marble, quartzite** etc. are some examples of metamorphic rocks.



Causes of Metamorphism

- **Orogenic (Mountain Building) Movements:** Such movements often take place with an interplay of folding, warping and high temperatures. These processes give existing rocks a new appearance.

- **Lava Inflow:** The molten magmatic material inside the earth's crust brings the surrounding rocks under the influence of intense temperature pressure and causes changes in them
- **Geodynamic Forces:** The omnipresent geodynamic forces such as plate tectonics also play an important role in metamorphism

Some Examples of Metamorphism

Granite $\xrightarrow{\text{Pressure}}$ Gneiss
Clay, Shale $\xrightarrow{\text{Pressure}}$ Schist
Sandstone $\xrightarrow{\text{Heat}}$ Quartzite
Clay, Shale $\xrightarrow{\text{Heat}}$ Slate $\xrightarrow{\text{Heat}}$ Phyllite
Coal $\xrightarrow{\text{Heat}}$ Anthracite, Graphite
Limestone $\xrightarrow{\text{Heat}}$ Marble

Metamorphic Rocks in India

- The gneisses and schists are commonly found in the Himalayas, Assam, West Bengal, Bihar, Orissa, Madhya Pradesh and Rajasthan.
- Quartzite is a hard rock found over Rajasthan, Bihar, Madhya Pradesh, Tamil Nadu and areas surrounding Delhi.
- Marble occurs near Alwar, Ajmer, Jaipur, Jodhpur in Rajasthan and parts of Narmada Valley in Madhya Pradesh.
- Slate, which is used as a roofing material and for writing in schools, is found over Rewari (Haryana), Kangra (Himachal Pradesh) and parts of Bihar.
- Graphite is found in Orissa and Andhra Pradesh.

Rock cycle

- Rock cycle is a continuous process through which old rocks are transformed into new ones.
- Igneous rocks are primary rocks, and other rocks form from these rocks.
- Igneous rocks can be changed into sedimentary or metamorphic rocks.
- The fragments derived out of igneous and metamorphic rocks form into sedimentary rocks.
- Sedimentary and igneous rocks themselves can turn into metamorphic rocks.
- The crustal rocks (igneous, metamorphic and sedimentary) may be carried down into the mantle (interior of the earth) through subduction process and the same meltdown and turn into molten magma, the source for igneous rocks

