CHAPTER 7 ROCKS

Objectives

After studying this chapter, students should be able to:

(i) identify the major types of rocks.

(ii) describe the structure and components of the rock type.

(iii) describe the characteristics of the rock types.

(iv) describe the processes involved in the formation of rock type.

(v) describe the use and importance of rocks to man.

7.1 Definition and Classification of Rocks

The word 'rock' may be defined as the aggregates, combination or coming together of mineral particles. Such minerals could be sand, clay, slate, granite, *etc.* It may be hard like granite or gneiss and may be soft as clay or mud. All the rocks differ significantly from one another on the basis of appearance, texture, structure, origin, mode of formation, colour, degree of resistance to erosion, *etc.*

Generally, rocks can be classified into three types on the basis of their origin (how they are formed), appearance, mineral content and age, namely:

(i) Igneous Rocks

(ii) Sedimentary Rocks

(iii) Metamorphic Rocks

7.2 Types of Rock

(i) *Igneous Rocks*

These are rocks that are formed out of the cooling and solidification of molten magma. It is found either below the surface or on the surface of the Earth. Igneous rock comes from the Latin word 'ignis' meaning that they are formed by the action of fire. Its mode of formation or origin is due to greater temperatures within the Earth's crust.

These rocks are formed as a result of the cooling down and solidification of molten magma which is found within the core and mantle of the Earth. The mantle is made up of the SIMA and the SIAL. The SIAL directly lies on the top of the SIMA. By this arrangement, the SIMA has very high temperature which makes it to be in a solid state coupled with the tremendous pressure exerted by the rocks lying on its top.

This change in temperature and pressure causes the mineral and rock material within the core to become molten. This pool of molten mineral and rock material deep within the core and mantle is collectively known as magma. Creation of cracks within the overlying rocks will force the molten magma to force its way towards the Earth's surface and where it reaches the surface, will cool down rapidly and become solid to become various types of extrusive igneous rocks. Where it does not reach the Earth's surface, it will cool down slowly and become solid inside the rocks within the Earth's crust and form various types of intrusive igneous rocks.

Types of Igneous Rocks

IGNEOUS ROCKS can be sub-divided on the basis of mineral composition and the way they are formed. There are basically two types, namely:

(a) Extrusive igneous rocks or volcanic rocks.

(b) Intrusive igneous rocks or plutonic or hypabbysal rocks.

Extrusive Igneous Rocks

These rocks are otherwise known as volcanic rocks. These are rocks formed as a result of the pouring out of molten magma into the Earth's surface through volcanoes as lavas. They tend to solidify rapidly on the Earth's surface and contain small crystals. A typical example is the basalt which forms lava flow, lava sheets and lava plateau *e.g.* Antrim in Northern Ireland, the Deccan Plateau of India, the Biu Plateau in Borno State, Nigeria. Other examples include Longuda Plateau found north of the Benue River.

Intrusive Igneous Rocks

These rocks are also called plutonic or hypabbysal rocks. They are formed at greater depth under the Earth's crust. They have cooled down slowly and solidified at a slow pace such that several crystals are formed. Since they exist under great depth, they are later exposed to the surface by agents of denudation (weathering and erosion). Examples of plutonic rocks include granite, dolerite and gabbro. Intrusive igneous rocks can be further sub-divided into two groups:

(a) Acid rocks: These are rocks that contains a great number of crystals. Generally, they have been known to contain a high percentage of silica over 52% and at the same time with little or no iron or magnesium. They are lighter in colour and also light in weight. Examples include granite.

(b) Basic rocks: These rocks have opposite attributes of acid rocks. Unlike acid rocks, they contain less proportion of silica, and are dark in colour and heavy in weight. They also contain a high percentage of iron. An example is the basalt.

Characteristics of Igneous Rocks

1. They are formed from the cooling down and solidification of molten magma.
2. Its nature and character depend largely on the chemical composition of the magma, that is, whether there is large presence of silica or nit, and the mode of cooling.
3. Where it contains silica, it is light in colour and not heavy in weight.
4. Where it is basic, that is little or no presence of silica, the rock is dark in colour and heavy in weight.
5. They contain a lot of crystals.
6. Its grains or components are arranged in a random or irregular way without a particular pattern.
7. They often contain semi-cracks called joints or fine cracks called fissures.
8. They do not contain fossils or remains of dead plant and animal organisms.
9. They are usually hard and impervious.
10. They are highly resistant to erosion and other weather elements due to their hard texture.

(ii) Sedimentary Rocks

SEDIMENTARY ROCKS are rocks formed from sedimentary and tiny pieces of pre-existing rocks deposited by agents such as water, ice glacier and wind which have accumulated over a long period of time. They are distinguished from the other rock types by some unique attributes such as layer formation and presence of fossils (remains of dead animals and plant organisms). The eroded materials have been consistently piled over several years.

Mode of Formation

Sedimentary rocks are formed first when eroded materials are moved mechanically from other rocks or through solution of materials which dissolve in water. The eroded materials are then carried away from their original

source and deposited in layers known as **STRATA** and are demarcated by lines known as **BEDDING PLANES.**

Types of Sedimentary Rocks

Sedimentary rocks may be classified under three major categories on the basis of their origin and composition. Namely:

(a) **Mechanically-formed Sedimentary Rocks:** These are formed from the accumulation of materials derived from other pre-existing rocks (igneous rocks) that have become cemented together over a long period of time. Examples include sandstone, breccia, shale, clay and conglomerate. These rocks may be sub-divided into three sub-categories on the basis of the sizes of their grains. These sub-categories include argillaceous or clayey sediments, arenaceous or sandy sediments and rudaceous or very coarse sediments.

(i) Argillaceous or clayey sediments: These consist of grains with diameters less than 0.002mm. Examples include mud, clay, mudstone and shale.

(ii) Rudaceous sediments: These consist of fine grains with diameter greater than 2mm. They are usually rounded and when they are not are called BRECCIA. Other examples include scree, gravel and shingles.

(iii) Arenaceous or sandy sediments: These consist of coarse sediments with diameter ranging between 0.002 to 2.0mm and include sand, sandstone, conglomerate, grit, *etc.*

(b) **Organically or biologically formed sedimentary rocks:** These are rocks which have been formed from the remains of dead animal organisms such as corals or shellfish, whose fleshy parts have been decomposed into hard shells known as calcareous sediments. Examples include limestone, chalk, *etc.* Similarly, the remains of plant organisms include coal which is formed when plants growing mostly in swampy forests are buried beneath accumulating sediments. Often times, the weight of the sediments squeezes out the water from the plant remains. As the remains are pressed together, they form rocks such as peat, lignite and coal. These rocks are collectively known as carbonaceous rocks.

Characteristics of Sedimentary Rocks

1. They are formed from sediments laid down in layers known as STRATA by agents such as water, wind, waves and glaciers. They are also called stratified rocks.
2. They are derived from pre-existing rocks, hence, they are otherwise known as derived rocks.
3. They may be mechanically formed, organically formed or chemically formed.
4. They contain fossils which are remains of dead plant and animal organisms.
5. They are soft in texture and less resistant to erosion.
6. The strata of the rocks vary in thickness from a few, centimeters to many meters and each stratum is separated from another by a line known as the BEDDING PLANE.
7. They do not contain crystals and are not crystalline in structure.

(iii) *Metamorphic Rocks*

METAMORPHIC ROCKS are rocks that are formed from pre-existing rocks when they are changed by great heat or pressure or a combination of both. They are formed from the process of metamorphism. The changes which the original rocks pass through are usually physical and chemical in nature. These changes therefore affect the texture and the entire composition of the rocks. Indeed, the character and make up of metamorphic rocks is largely controlled by content of the parent rock and changes it has undergone in the process of formation.

Metamorphism are of three types:

(i) **dynamic metamorphism** which is caused by the effect of pressure force on surrounding and overlying rocks.

(ii) **thermal metamorphism** which is a process involving the effect of temperature or heat changes on rocks beneath the earth's surface.

(iii) **thermo-dynamic metamorphism** which is the combined effect of heat and pressure forces on rocks.

The process of change may result in changes in the mineral composition and structure of a rock such that new minerals may be formed. The minerals are formed into a parallel or near parallel arrangement known as BANDING.

Mode of Formation

Metamorphic rocks are formed out of pre-existing rocks, that is, igneous and sedimentary rocks. In the process of formation, the pre-existing rock is subjected to great heat, pressure or a combination of both. The effect of heat and pressure changes the texture, composition or structure of the rocks. These changes may be physical or mechanical. Hence, it is possible, for example, for clay to be changed to slate, limestone into marble, granite into gneiss, shale into schists and coal into graphite.

Characteristics of Metamorphic Rocks

Metamorphic rocks have the following attributes or characteristics, namely:

1. They are harder and more compact than the original rocks, that is, igneous and sedimentary rocks.
2. They are products of the effect of heat, pressure or the combination of the two on original rocks.
3. Most precious stones or gems such as diamond, onyx, emerald, sapphire, marble, etc are all metamorphic rocks.
4. They are highly resistant to the forces of denudation such as erosion weathering, mass wasting, *etc.*

Economic Importance and Uses of Rocks

Rocks are of immense benefits and uses to man which include:

1. They are used for building and construction purposes through the introduction of hard and durable rocks such as granite that is used for building.
2. They are sources of mineral such as gold, diamond, limestone, petroleum etc which are raw materials used in the production of important products needed by man.
3. They are important sources of fuel and power, especially through sedimentary rocks such as coal and petroleum that are used for generating power for use in industries and domestic home.
4. They serves as important tourist attractions such as huge rock outcrops, mountains, hills *e.g.* Zuma rock in Abuja, Olumo rock in Abeokuta and special rock arrangements in Plateau State, all Nigeria.
5. Rocks serves as parent material from which soils are formed when they are acted on by forces such as weathering, mass washing, *etc.*
6. Some rocks serve as ornaments used on building *e.g.* marble castings used for wall and floor decorations.
7. Rocks are used for domestic purposes such as cooking *e.g.* potash used in cooking, salt for seasoning food, grinding stone for grinding pepper, *etc.*
8. Rocks influence the availability, supply and amount of ground water in a particular place.
9. Rocks are raw materials needed in the production of industrial products *e.g.* limestone used for making cement.
10. They are used in making medicinal products *e.g.* kaolin used in making syrups used in curing indigestion, *etc.*
11. Rocks especially hills influence the climate of a place and also assist in the formation of rain *e.g.* relief rainfall.

12. Rocks especially landform features such as hills serves as natural sites for human settlements especially for security purposes.
13. Rocks are used for ornaments (worn by man) such as gold, diamond, *etc.*

Summary

- Rocks are aggregates of several mineral particles and are largely found within the earth's crust.
- Rocks are classified on the basis of age, origin, appearance and mode of formation.
- Rocks can be classified into three types: igneous, sedimentary and metamorphic rocks.
- Each rock types are composed of chemical and physical elements *e.g.* oxygen, silicon, aluminium, calcium, iron, *etc.*
- There are two main types of igneous rocks: intrusive and extrusive igneous rocks. Sedimentary rocks are of three types: mechanically-formed, organically-formed and chemically-formed sedimentary rocks.
- Metamorphic rocks are formed as a result of the effect of heat and pressure on original rocks and are of three types: dynamic, thermal and thermo-dynamic metamorphic rocks.
- Rocks are of various uses to man such as raw materials in industries, sites for human settlements, parent material for soil formation and storage for underground water.

Revision Questions

Objective Questions

1. Which of the following most accurately describe the layers of rock close to the Earth's surface?
    A. Rock layer
    B. hydrosphere
    C. Earth's crust
    D. Atmosphere
2. Rocks on or near the surface are classified into 3 groups according to
    A. their age alone.
    B. their colour.
    C. their mode of origin.
    D. their hardness.
3. Which one of the following rocks is igneous?
    A. clay
    B. gneiss
    C. loess
    D. basalt
4. One of the most common metamorphic rock is
    A. lava.
    B. slate.
    C. sandstone.
    D. chalk.
5. Which two of these rocks is classified as sedimentary?

    I. Granite II. Sandstone III. Limestone IV. Marble V. Basalt
    A. I and IV
    B. II and V

C. IV and III

D. II and III

6. Graphite is a metamorphic rock which has been produced form

A. limestone.

B. coral.

C. coal.

D. sand.

7. Plutonic rocks are igneous rocks that have hardened

A. beneath the Earth's crust.

B. on the Earth's surface.

C. inside volcanoes.

D. in the Earth's crust.

8. Metamorphic rocks are formed by

A. the decay of plants

B. the accumulation of skeletons

C. wave action

D. pressure or heat

9. Which of the following pairs do not go together?

A. volcanic – obsidian

B. metamorphic – marble

C. plutonic – granite

D. sedimentary – gneiss

10. If metamorphic rocks are the result of heat or pressure which of the following statements is unlikely to be true?

A. They often form the axes of great mountain chains

B. They are associated with the deparition of muds and silts in tropical areas

C. They frequently occur on the periphery of volcanic areas

D. They are generally crystalline but the crystals are arranged in layers.

Answers

1. C 2. C 3. D 4. B 5. D 6. C 7. A 8. D 9. D 10. B

Essay Questions

1a. Describe the major types of rocks.

b. Identify four characteristics of igneous rocks.

2a. Give two reasons why sedimentary rocks are called derived rocks.

b. Describe two differences between sedimentary rocks and metamorphic rocks.

3a. Suggest three reasons why metamorphic rocks are regarded as changed rocks.

b. Describe the characteristics of each of the following rock types:

(i) Graphite (ii) Coal (iii) Granite

4a. Give two examples each of igneous rocks and metamorphic rocks.

b. Describe with examples, the process of formation of the three classes of sedimentary rocks.

5. Describe the characteristics and mode of formation of metamorphic rocks.

b. Give five importance of rocks to man.