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# **GEOLOGY & ECOLOGY**

## **General Secondary Certificate**

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غير مصرح بتداول هذا الكتاب خارج وزارة التربية والتعليم والتعليم الفني

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## بِسْمِ اللَّهِ الرَّحْمَنِ الرَّحِيمِ

### مقدمة:

في إطار تطوير التعليم لمواكبة المتغيرات العالمية والمحلية واستكمالاً للجهود الحثيثة التي تقوم بها وزارة التربية والتعليم للارتقاء بمستوى محتويات المناهج الدراسية وربطها بالمجتمع والبيئة فقد كلف الأستاذ الدكتور وزير التربية والتعليم نخبة من أساتذة الجامعات المتخصصين بالتعاون والتنسيق مع المسؤولين من الوزارة لإعادة تقييم ومراجعة المحتوى العلمي لمادة الجيولوجيا وعلوم البيئة في المرحلة الثانوية في ضوء المعايير القومية التي أعدتها الوزارة . ولقد قامت اللجنة المكلفة بإجراء التعديلات والإضافات اللازمة التي أدت إلى :

- (١) التخلص من التكرار والحشو غير المبرر واستبعاد الأجزاء التي سبق للطالب دراستها في مراحل سابقة والتركيز على المفاهيم الرئيسية الهامة .
- (٢) إعادة صياغة بعض أجزاء الكتاب بطريقة منطقية متسلسلة ومنظمة.
- (٣) إضافة بعض المفاهيم والتطبيقات لمواكبة الاتجاهات العلمية الحديثة.
- (٤) ربط موضوعات الدراسة بالحياة اليومية وتأثيراتها البيئية وتطبيقاتها الصناعية.
- (٥) إدخال بعض الموضوعات التي تتيح للطالب معرفة الظواهر المختلفة المؤثرة على شكل سطح الأرض مثل الزلازل والبراكين.
- (٦) إعداد بعض الأشكال التوضيحية وتوظيفها لخدمة المفاهيم العلمية.
- (٧) تحديد الأهداف المرجوة من دراسة كل فصل من فصول الكتاب وضعت في مقدمته لتعطي مؤشراً للطالب والمعلم على مدى ما حققه.
- (٨) تنوع التقييم ليتضمن قياس للمستويات المختلفة من التعليم والقدرات المتنوعة من الفهم والتحليل والتركيب .

والكتاب في صورته الحالية ينقسم إلى جزئين الأول في الجيولوجيا ويحتوي على خمسة أبواب تتيح للطالب معرفة مفهوم علم الجيولوجيا وفروعها ودراسة في علوم المعادن والصخور وحركة القارات والعمليات المختلفة التي تحدث في الغلافين المائي والهوائي. والجزء الثاني في العلوم البيئية ويحتوي علي باين يتناول الأول المفاهيم البيئية والثاني استنزاف الموارد البيئية وقد قام المركز الاستكشافي للعلوم بعمل التصميمات والإخراج الفني لهذا الكتاب طبقاً لأحدث المواصفات العالمية للكتب الدراسية المطورة، مع مراعاة أن يكون عدد أسطر الصفحة الواحدة مناسباً لإراحة العين، مع الإكثار من الصور المعبرة عن المادة العلمية، واستخدام كود ألوان لتحديد المفاهيم الهامة والتطبيقات المختلفة والأمثلة المحلولة، والاهتمام بتصميم الغلاف كعامل جاذب للطالب.

نتمنى أن يكون هذا الكتاب في صورته الجديدة مصدراً مفيداً للعلم والمعرفة في مجال الجيولوجيا وعلوم البيئة على مستوى الثانوية العامة وأن يحقق الغاية المرجوة وأن يكون خير معين لطلابنا الذين نتمنى لهم النجاح والتوفيق .

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**PART 1**

**CHAPTER 1**

**Geology and  
Material of  
the Earth**

## Objectives

**After studying chapter one the student should be able to:**

1. Write a definite definition of (earth science) geology.
2. Mention the branches of geology.
3. Mention the relation between geology and other science branches.
4. Compare between the different components of the earth planet.
5. Illustrate the main components of the atmosphere.
6. Compare between the tectonic and the primary geologic structures.
7. Identify the different types of folds and the faults.
8. Illustrate the different types of folds and unconformity surfaces mention the scientific terms that used in describing them.v
9. Compare between different kinds of faults.
10. Identify some geologic structure in the field or in the school environment.
11. Compare between faults and joints and mention the importance of them.
12. Identify the unconformity.
13. Compare between different types of unconformity.

## GEOLOGY AND THE MATERIAL OF THE EARTH

If we contemplate now in our life we can say what is in our world is not geology? Before answer this question firstly we must know what is geology? What are the natural phenomenon which are explained by it? What are its main branches? Finally, what is the relation between it and other different sciences?

**Geology:** word is composed of two parts which are “Geo” which means the “Earth” and “logus” which means “science” that’s means the science of Earth which is the science which deal with everything has relationship with Earth, its components, its movements, its history, its phenomenon and its wealth.

The natural phenomena which are explained by Geology: Earth’s surface is consists of continents, oceans and seas, the continents differs from one place to another in some regions and we find also that mountain chains are extended in a certain direction while in others we find valley and plains of different shapes. Also the seas, some are relatively shallow while others are as deep as 11,000 m. Also, we notice that volcanoes happen in certain regions some of them become inactive then suddenly start its activity, magma released from it or earthquake causing damage for villages and cities completely. The extraction of minerals and ores as well as petroleum and underground water near the Earth’s surface or in depth is known phenomenon used for long time.

### Different Branches of Geology:

**Physical Geology:** is the branch which is mainly concerned with the external and internal processes affecting the rock of the Earth’s crust.

**Mineralogy and crystallography:** is the branch which is mainly concerned with the study of minerals, their physical and chemical properties and the forms of their crystal systems.

**Hydrogeology:** is the branch which is related to whatever concerns groundwater aquifers, supply and withdrawal and use of water in agriculture and land reclamation.

**Structural Geology:** is the branch which deals with the different structures, which exist on rocks resulting from the effect of both external and internal forces that continually work with variable degrees of forces on Earth’s crust.

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**Stratigraphy:** is a branch which deals with the rules and conditions that govern the formation of the layers and the sites of deposition of the sediments after weathering and transportation by different natural factors.

**Paleontology:** deals specifically with studies of fossils and the remains of living organisms, vertebrates, invertebrates or plants that characterize the sediments, by which we can determine the geologic age and environmental conditions for its formation.

**Geochemistry:** is the branch which deals with the study the chemical structure for minerals and rocks, distribution of elements in the Earth's crust and determine the type and ratio of mineral ore in the Earth crust.

**Engineering Geology:** is the branch which deals with the study of mechanical and geometrical properties of rocks in order to establish the different engineering structures such as dams, tunnels, giant bridges and skyscrapers and towers.

**Petroleum Geology:** deals with all processes concerning the formation of oil or gas, their migration and accumulation in reservoirs rocks.

**Geophysics:** is the branch which deals with the exploration of oil traps, ore deposits and ground water using physical sensitive sets.

## **The importance of Geology in our life:**

The economic and industrial evolution depends on geology as the wealth which extracted from the Earth and using it.

## **The most important benefits of Geology:**

1. Prospection for mineral ores as gold, iron, silver and others.
2. Discovering the different energy resources as coal, oil, natural gas and radioactive minerals.
3. Searching about building materials as limestone, shale, marble, gypsum and others.
4. Help in planning for habitation projects as building new cities, dams, tunnels and establishment of safe districts from the dangers and disasters.
5. Search of raw materials used in many chemical industries as sodium, sulphur, chlorine that necessary for manufactures of fertilizers, insecticides and drugs.
6. Exploration of sources of groundwater for the new reclaimed areas .
7. Geology plays an important role in the success of military operations.

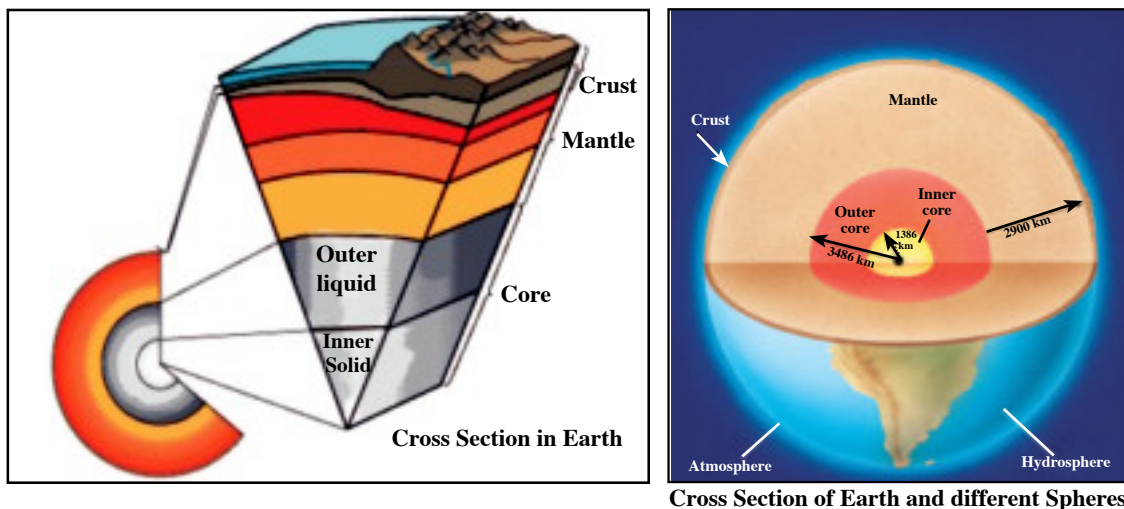


## Components of Earth planet

The planet Earth has six main components which are:

### 1. The Crust:

The crust is the outermost thin shell (layer) of the earth. It varies in thickness, being thin under open seas and oceans (8 to 12 km) consists of basaltic rocks which is called Sima (silica and magnesium) and about 60 km under continents consists of granitic rocks which is called Sial (silica and aluminium). The crust's rocks are igneous, sedimentary and metamorphic. Although the difference in density between Sial and Sima, crust is always in what is known as isostatic equilibrium.



### 2. The Mantle:

The mantle forms more than 80% of the volume of Earth's rocks and extends from the base of the crust to a depth of about 2900 km. It is composed of iron, magnesium and silicon oxides in the form of solid rocks except the upper part of the mantle (Asthenosphere) with a thickness reaches about 350 km which is partially molten and elastic rocks which behave as fluids under certain conditions resulting from pressure and temperature that allow for the spread of convection currents which permits the drifting of the continents above.

### 3. The Core:

The core is the innermost zone of Earth with a radius of about 3486 km. It forms about one sixth (1/6) of the Earth by volume, but being composed of materials with very high

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density, it makes about one third (1/3) of the Earth by weight. The pressure there is very high reaches about millions of the atmospheric pressure and the temperature is more than 5000°C.

The studies that obtained by scientist when they analyzed the seismic waves that spread through the Earth's zones during the occurrence of earthquakes helped greatly in determining that the earth's core could be divided into two parts:

## \* Outer Core

with a thickness about 2100 km and consisting mainly of molten iron and nickel and stands under a pressure of 3 millions atmospheric pressure and with a density reaches about 10 gm/cm<sup>3</sup>.

## \* Inner Core

consisting of rocks of very high density about 14 gm/cm<sup>3</sup> and with a radius of 1386 km.

Thus, scientists were able to explain the origin of the magnetic field of Earth may be generated from the presence of outer core that composed of molten material revolves around the rocky solid inner core.

## 4. The Atmosphere:

Scientists think that during the formation of Earth planet, several elements and chemical compounds, which were in contact with the molten materials to remain in their gaseous state forming later in time our atmosphere which gets as high as 1000 km above the earth's surface. The air density and also the atmospheric pressure decreased as we go higher from the earth's surface to be low as one half of its value for every 5.5 km high till it vanished at higher altitude.

The main constituents of the atmosphere in volume are the Nitrogen (78%) and Oxygen (21%) and other gases with percentage doesn't exceed 1%, the most important of them is Hydrogen, Helium, Argon, krypton and Xenon with variable amounts of water vapour, carbon dioxide and Ozone. It can be also noticed that the ratio of Oxygen decreases and becomes less and less at higher altitude which gives human being a state of suffocation at high altitude.

## 5. The Hydrosphere:

During and after the formation of the solid earth and atmosphere, a tremendous amount of water vapour that already present due to eruptions of old volcanoes had been extremely condensed resulting heavy rains which fell on land to fill the gaps and large basins had formed on the surface during solidification of Earth's surface forming the hydrosphere.

The Hydrosphere includes all the waters of the seas and oceanic basins, rivers and lakes that cover about 72% of the total surface area of the Earth, including the underground water which fills the pore spaces in rocks and soil in the ground.

The hydrosphere surrounded the Earth from all sides forming what is known as sea level which is internationally recognized and all heights of different topographical features are attributed to such as mountains, plains, plateaus, valleys and others features that forming the rocks of earth's crust.

## 6. Biosphere:

We will study it in detail in the second part.

## Geological Structures

It has to be mentioned here that all types of rocks constituting the crustal material of the earth, particularly the sedimentary rocks never stay as they have been deposited but subjected from time to time to internal and external forces that make the rocks take new forms and situations. These forms what are known as geological structures.

### ➤ Types of Geological Structures:

#### 1. Primary Geological Structures:

These type of structures, remains in rocks of the crust under the influence of climatic and environmental conditions such as drought, heat and the effect of wind and water currents ... etc. and without any interference of tectonic forces or earth movements.

As examples of such primary structures are cross bedding, ripple marks, graded bedding and mud cracks..etc. These are considered the most important primary geological structures and the wide spread specially in sedimentary rocks.



Mud Cracks



Cross Bedding



Ripple Marks

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## 2. Secondary Geological Structures:

These form what are known as tectonic geological structures due to being formed by forces emitted from the interior Earth. They are huge fissures and cracks and violent torsions which often we see deform the crust during our geological trips in mountainous and desert areas. Those internal forces that our planet Earth is subjected to. These forces causing earthquakes, ramage seas and oceans, regression and transgression of their water on the land, and drifting the continents and their movements around each other. As well as make the rocks take forms other than those taken before such as folds, faults and fractures or joints which deforms the crust.

We will study in detail the tectonic structures due to its economic importance.

### Examples of Tectonic Structures

#### First: Folds

The Folds are considered one of the most important tectonic structures and they exist quite clearly in sedimentary rocks, which appear on the form of layers vary in their thickness and extension in nature from one place to another.

Fold is known as bending or wrinkling happens to the rocks of the earth's crust.

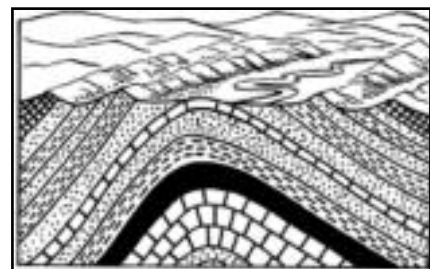
It may be simple as single fold or often composed of several connected folds. It is often arising as a result of exposing the surface of the earth's crust to pressure forces.

#### The geologic and economic importance of folds:

1. Represent traps and reservoirs for crude petroleum oil, ground water and mineral ores deposit on it.
2. Determine geological chronology of rocks (in terms of older or younger)
3. Evidenced from folds on geological events.



Folds in nature



Anticlinal Fold

**Although folds take different shapes but the most familiar of all are those which are known as anticlines and synclines and all share in some geological characteristics:**

- a) They occupy different areas of the earth's crust, ranging from a few meters to tens of square kilometers in the same region.
- b) Fold is rarely found individually in nature, but often several folds are found connected together.
- c) Folds are rarely found in nature in definite shapes and systems, because folds are subjected to repeat folding, we find that the majority of them may complicate the shape by fractures and cracks.

➤ **Structural elements of the folds :** Most of the folds could be described (defined) by several structural elements some of them are:

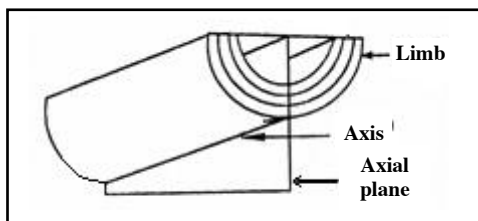
**1. Axial plane:** it is defined as the imaginary plane which divides the fold into two equal and identical parts in all aspects.

**2. Limbs:** they are represented as rock blocks which found on both sides of axial plane.

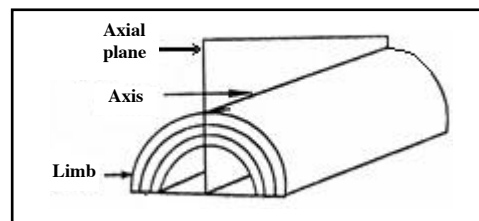
**3. Axis:** which is defined as the imaginary line of intersection of the axial plane with any surface of all different layers. Since any fold always consists of a succession of different layers and each one of these layers has its own axis, then it is expected that the axial plane should contain all these axes.

➤ **Folds are generally classified according to the following:**

- a) The appearance which folds are exposed in the field.
- b) The positions of which structural elements of the fold might take in nature.
- c) The type and nature of tectonic forces that affecting the rocks during the mechanical folding process.



Elements of Synclinal Fold



Elements of Anticlinal Fold

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**The most common types of folds are:**

\* **Anticlines Folds** which are characterized by :

The layers are concaved upward and its oldest layers are found in the center.

\* **Synclines Folds** which are characterized by :

The layers are concaved downward and its youngest layers are found in the center.

## **Second: Faults**

Faults are considered to be one of the most important tectonic structures. The faults are defined as fractures or cracks cutting rock masses and accompanied by relative movement (displacement) of rock masses along both sides of fault plane.

### **Faults Structural Elements:**

Faults, as in the case of folds, have also their structural elements with the most important of all are:

1. **The fault plane:** it is the plane on both sides, the fractured rock masses move with relative movement to each other resulting in displacement.
2. **Hanging wall:** the rock mass which found above the fault plane.
3. **Foot wall:** the rock mass which found under the fault plane.



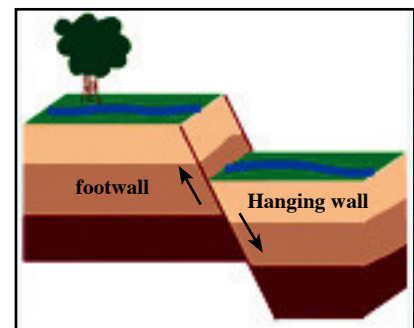
**Faults in Nature**

### **Determination the type of fault:**

To find out the type of the fault whether it is normal or reverse fault, we must first know the direction of rock mass movement on one side of the fault plane according to the direction of the same rock mass movement on the other side of the fault plane.

**On this basis, faults can be classified as the following:**

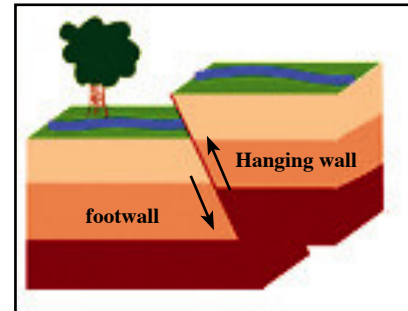
a) **Normal fault:** fracture is resulting by tension where the hanging wall is moving downward along the fault plane with respect to those that occupying the footwall.



**Normal Faults**

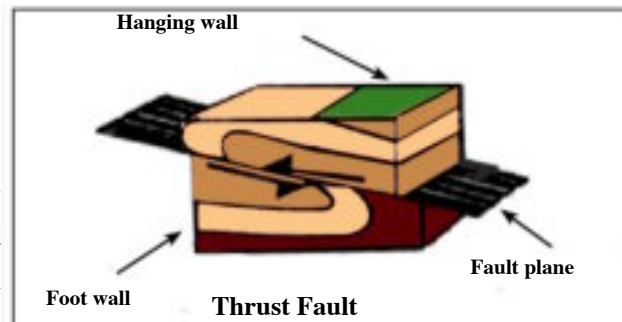


b) **Reverse fault:** fracture is resulting by compression where the hanging wall is moving upward along the fault plane with respect to those that occupying the footwall.



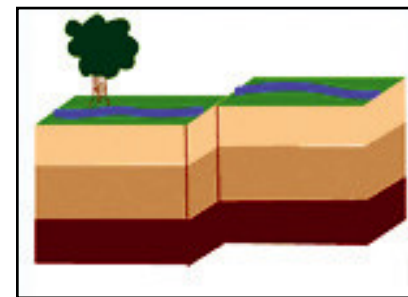
Reverse Fault

c) **Thrust fault:** It is a type of reverse faults and distinct from the reverse fault that its fault plane is almost horizontal (with low angle of dip). So it is called “creeping fault” because its broken rocks almost creep horizontally for certain distance on the fault plane.



Thrust Fault

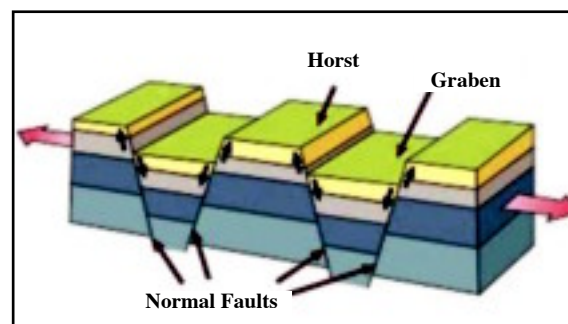
d) **Strike - slip fault:** where the rock mass moves horizontally in the same plane without vertical displacement.



Strike - slip Fault

e) **Horsts:** occur when the rocks are affected by two normal faults combine in footwall.

f) **Grabens:** occur when the rocks are affected by two normal faults combine in hanging wall.



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## The importance of faults:

1. Considered as traps for petroleum oil.
2. Hot water and springs are rising along fault plane. Helwan sulphurised water in Helwan area and Ein El Sokhna on the western side of the Suez Gulf and Hammam Faraoun on the eastern side of the Suez Gulf which are used for tourism and treatment.
3. Deposition of calcite minerals, manganese, copper and economic tin ores due to rising of mineral water through the cracks along the fault plane.

## Structural features associated with faults by which it is possible to determine the fault's locations:

1. The fault plane is polished, sometimes with lines parallel to the rocks movement.
2. The presence of a fault breccia which are crushed rocks have sharp edges. Beside the hot springs and mineral deposition along faults planes. This is in addition to other features such as the rise of water springs and deposition of minerals along the fault plane.

**Notes:** The structures of folds and faults also appear in igneous and metamorphic rocks, but are less clear than their appearance in sedimentary rocks because bedding features of the sedimentary rocks which appear on the form of different layers vary from each other in their thickness, extension, color, mineral and chemical composition, cementing material, texture and fossils content.

## Third: Joints

Joints are geological structures of tectonic origin. These are fractures present in different types of rocks; igneous, sedimentary and metamorphic without any evidence of movement. The distance between joints varies from a few centimeters to tens of meters; depending on:

- \* The type of rock.
- \* The thickness of the rock.
- \* The method of response of rock to the forces affecting it.

It is worth mentioning that the Ancient Egyptians had benefited from the presence of joints in the rocks in their constructing temples and tombs, as well as in making obelisks.

## Introduction of Historical Geology

The main aim of geology is determining of the earth history which can be determined by geologist through studying the rocks generally and sedimentary rocks and the fossil which it contains specially.

In spite of the great achievements which geology had reached in many aspects of life but the most important for humanity knowledge is achieving



Geological time line for earth which is called as ( Geological time scale) where the geological events are put in its correct order and this geological time scale is not complete in one place due to periods of time which sedemes stops as some layers disappear as result of denudation or non-deposition of some time which is called (unconformity surface) which we will study in the next pages. Many methods had been used to determine the age of Earth such as the decay of Radioactive substances which have determined the age of Earth by 4-6 billion years (4600 billion years old) and also developing of life which depends on fossils that is widely spread geographical and have limited time range which is called index fossil.

Through whole of this we devide history of earth into two large eons:

**1/ CRYPTOZIC** (unknown life eon) which starts with the begings of earth history till 542 million years ago - and this eon devided into three eras (Hadean - Archean - Proterozoic)

**2/ PHANEROZOIC** (Known life eon) which starts from 542 million years till now.

And this eon is devided into three eras which are (paleozoic - Mesozoic - Cenozoic) and every era can be devided into periods and each period can be devided into rimes (Epochs)

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Eon	Era	Periods	Epoch	Plants and animal develop	
Phanerozoic	Cenozoic (Mammals periods)	Quaternary	Holocene	Human appearance, developing of Mammals and prevalence of birds, appearing of grasses and Nematodes, flowering plants abundant, dinosaurs and many living organisms are extinct	
			Pleistocene		
		Tertiary	Pliocene		
			Miocene		
			Oligocene		
			Eocene		
	Mesozoic Reptile Epoch	Cretaceous	Paleocene	Flowering plants abundant, modern bony fishes appear, dinosaurs disappear at the end of the period, birds is developed and Eutheria mammeles appear	
				Jurassic	Giant reptiles (dinosaurs) abundant and small mammals spread and birds, first appearance
				Triassic	Flying, aquatic and terrestrial reptiles and ammonite spreading and mammals, first appearance
	Paleozoic Invertebrate Epoch	Permian	Carboniferous	Angiospermae (Flowering) Plant abundant, beginning of reptiles and flourishing of marine life	
				Devonian	Appearing of scally trees and ferns which were formed coal and amphibians spread
				Silurian	Beginning of conifers, trees and insects and fish abundant
				Ordovician	First vascular plant and fish (First vertebrates)
Cambrian				First green land plants and fungi and invertebrates differentiate	
				trilobites dominant beginning of skeletal organisms	
Cryptozoic	Proterozoic	Known as (pre-cambrian) and it represents 87% of Earth age	Green algae - beginning of multicellular living organisms		
	Archeozoic		Beginning of unicellular living organisms such as: Anaerobic bacteria / The oldest rocks		
	Hadean		Formation of Earth and its lithosphere, atmosphere and hydrosphere		

By Studying of the geological record, it has been proved that ( regression ) seas on land and ( transgression ) seas away of land which caused periods of deposition and non-deposition or denudation and that cause formation of geological structures which called ( unconformity structures )

**Unconformity Structures:**

Unconformity surface is denudation or non-deposition surface. It is clear and distinctive. It separates between two groups of rock masses and indicates the absence of deposition for periods of time up to tens of millions of years and is inferred by several evidences.

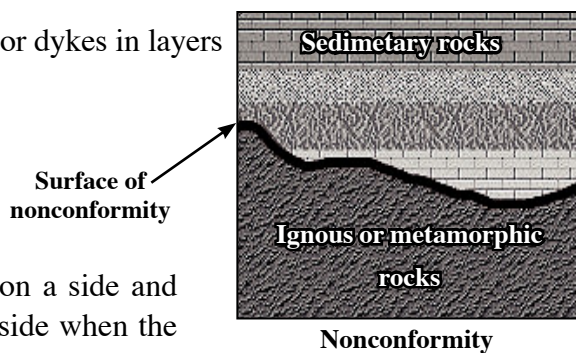
**Evidences indicating Unconformities:**

1. Presence of rounded conglomerate lie directly above the surface of unconformity.
2. Sudden change in the sequence of fossil contents between the layers.
3. Difference in the inclination (angle of dip) of strata on both sides of the surface of unconformity.
4. The presence of geological structures or dykes in layers overlying layers.

**Types of unconformities**

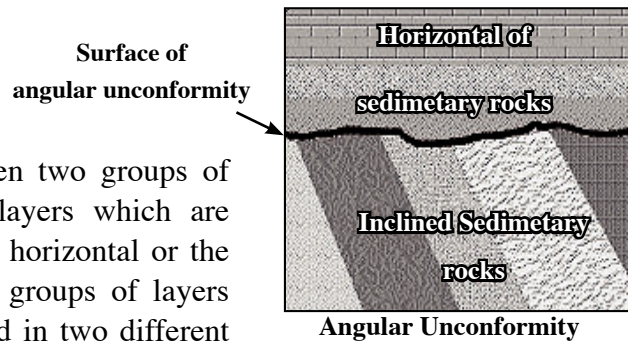
**Nonconformity:**

This type consists of sedimentary rocks on a side and metamorphic or igneous rocks on the other side when the sedimentary rocks are younger and lie above.



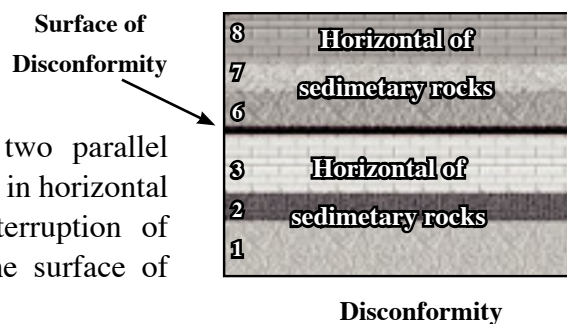
**Angular unconformity:**

The angular unconformity is between two groups of sedimentary rocks. The older group layers which are tilted and the younger group layers are horizontal or the Angular unconformity is between two groups of layers of sedimentary rocks which are inclined in two different directions.



**Disconformity:**

The disconformity surface is between two parallel groups of layers of sedimentary rocks, almost in horizontal position and occur due to erosion or interruption of sedimentation. Geologist can distinguish the surface of disconformity through fossils contents



## Exercises

1. What is meant by geology?
2. What is the difference between structural geology and physical geology?
3. What are the most important components of our planet Earth?
4. What is meant by fold? What are their types?
5. Write briefly about the properties of normal and reverse faults?
6. Write briefly about horsts, grabens, strike-slip fault.
7. Give Reasons:
  - a) Scientists found the answer of the origin of the magnetic field of Earth.
  - b) The primary structures are different from the secondary structures.
  - c) Thrust fault is called creeping fault?
  - d) There is no complete Geological time scale in one place
8. Compare between :
  - a) Nonconformity and Disconformity
  - b) Fossils of jurassic and silurian periods.
  - c) Fossils of triassic and carboniferous periods.
9. Mention the evidences indicating each of the following:
  - a) Faults.
  - b) Unconformities.
10. Define the following
  - a) The Index fossil
  - b) The Geology
  - c) The joint

**PART 1**

**CHAPTER 2**

**Minerals**

## Objectives

**After studying chapter two the student should be able to:**

1. Illustrate the concept of a mineral for geologist specialized in mineralogy.
2. Explain the natural conditions needed for the formation of minerals.
3. Explain the reasons of different shapes of crystals.
4. Compare between the external shapes of different crystals.
5. Mention the optical properties of the minerals.
6. Mention the cohesive properties of the minerals.
7. Attain the skills of differentiation between the different hardness of minerals
8. Compare between colour and streak.
9. Compare between natural gem stones and artificial gem stone.
10. Compare between cleavage and fracture.

## Minerals

Man lives on the outer surface of the Earth's crust, indirect contact with its materials, utilizing them for his daily life and benefits. He cultivates crops in the Earth's soils, lives in houses built from materials which extract from its rocks and minerals and if we look to the way we live, we will find that our life with all we need is so much related, mostly by indirectly way, to what is on or near the earth surface. We will learn much by studying the composition of the crust to benefit from its constituents and to protect ourselves from natural disasters such as earthquakes and volcanic eruptions.

That's happen by studying the components of Earth crust as rocks and minerals which form them which we contact with it and life will be hard without it, in peace and war.

Man has known and utilized minerals since a very long time, Paleolithic man used chert to make knives and spears to kill animals to feed on them and to defend himself. He also used colorful minerals, e.g. yellow and red ochre such as heamatite and lemonite to colour the walls of the caves he lived in, and after knowing fire he widely used clay to manufacturing hard ceramic (pots)

Ancient Egyptians have also used coloured minerals and stone for ornamentation, such as those of amethyst, Malachite, emeralds and turquoise. Now minerals are used in a lot of industries as calcite used in cement industry, quartz in glass industries, magnetite and hematite in steel industries which used in building, car industries and railways and feldspar used in making ceramic They also extracted metals such as copper and gold from their ores and shaped them into different objects.

The crust is composed of three types of rocks, igneous, sedimentary and metamorphic.

By definition, a rock is an aggregate of one or more minerals. Some rocks are made of one mineral "single mineral", an example is limestone composed of the mineral calcite ( $\text{CaCO}_3$ ). In general, a rock consists of a group of minerals that have some common properties.

For example, the minerals of an igneous rock have crystallized from the magma at a relatively small range of temperature and pressure. Granite composed of quartz, feldspar and mica and they are all have common properties Also, minerals of a detritus sedimentary rock, transported and deposited by a river are within a limited range of grain size and its specific gravity. The best example is the cultivated land of the Nile Valley, formed of silt and clay representing the flood plain deposits of the Nile.

## CHAPTER 2

### Mineral definition:

The above shows that a mineral is the basic natural unit from which a rock is formed. The mineral for geologist specializing in mineralogy is solid, inorganic, naturally occurring substance having definite chemical composition (can be expressed) and a distinct crystalline form. So that the coal and oil are not minerals because coal is organic origin and has not special crystal form and increases oil in addition to the previous, it is liquid and has no definite chemical structure but oil adding to the previous it is liquid and has not definite chemical structure.

### The Mineral formation:

The element	Weight percentage
Oxygen	46.6 %
Silicon	27.7 %
Aluminum	8.1 %
Iron	5.0 %
Calcium	3.6 %
Sodium	2.8 %
Potassium	2.6 %
Magnesium	2.1 %
The rest of elements	1.5 %


( The common elements of Earth crust )

Minerals, as all other natural constituents of Earth, are formed of the elements which are known to us. Some minerals are formed of one element for example, gold, sulphur, graphite, copper and also diamond are formed of. However, the majority of minerals are formed of two or more elements which unite to form a stable compound according to chemical bonds, laws. Quartz as example consists of silicon dioxide and calcite consists of calcium carbonate.

Although man identified elements exceed one hundred, we find a limited number of them, only eight elements, form more than 98.5% by weight of the rocks of the crust. These eight elements are arranged in descending order oxygen, silicon, aluminum, iron, calcium, sodium, potassium and magnesium make rocks of the crust. These are given in the table. This means that all other elements, including most forming minerals of economic value, e.g. copper, gold, carbon, lead, tin and platinum share in the formation of only 1.5% of the rocks of Earth's crust.



Mineralogists could define more than two thousands minerals, most of them found in little amount in nature. If we count common minerals and that which have economic value we will found they do not exceed two hundreds minerals. While the minerals which form the rocks of Earth's crust, do not exceed tens and divided to few mineral groups, the most famous groups are silicates then carbonates after that the economic minerals as oxides, sulphides, sulphate, and native elements minerals...etc.

	Mineral groups	Examples of minerals
<p>The most</p>  <p>The less</p>	Silicates	Quartz – orthoclase – plagioclase – mica –amphibole – pyroxene – olivine
	Carbonates	Calcite - dolomite
	Oxides	Hematite – magnetite
	Sulphides	Pyrite - Galina – sphalerite
	Sulphates	Gypsum – anhydrite – barite
	Native elements minerals	Gold – copper – graphitr – sulpher – diamond.

( Chemical groups which forming minerals)

One of the cornerstones in the definition of minerals is having a definite chemical compositions and fixed atomic structure.

According to the mineral chemical structure, few minerals have a fixed and definite chemical compositions, e.g. quartz made of  $\text{SiO}_2$ . While the majority of minerals have a composition that changes due to the replacement of one element by another, but is usually in small limits this that does not change the atomic structure of the mineral. Accordingly, we find that the main item in mineral definition is its crystallized substance, such that the crystal form controls the shape of mineral and their physical properties as colour, hardness, cleavage and fracture but also in its chemical properties.

## Crystal Structure of Mineral

Accordingly, it would be interested to learn about how the mineral internal structure formed?

The mineral forms from arrangement of atoms within a mineral in orderly arrangement, creating what is known as crystal form.

The crystal is solid geometrical body has outer plane surfaces known as crystal faces.

# CHAPTER 2

## The structural building of halite

The crystal form of halite(sodium chloride) known as rock salt which consists of combination between positive sodium ions with negative chlorine ions in a repeated sequence produces characterized crystal for halite in form of cubic shape “equant”

### From the main elements when studying minerals:

1) The crystal axis: it is the line passing by crystal center and the crystal rotates around it then faces, edges or angles of the crystal may be repeated two or three times. They are symbolized by ( a, b, c ) in case of difference in length or (a1 , a2 , a3 ) in case of equal lengths from examples are vertical symmetrical axis.

2) Angles between axes: are symbolized by (  $\alpha$  ,  $\beta$  ,  $\gamma$  ) the crystal symmetrical degree depends on the length of axis and the angles between them

3) The crystal symmetrical plane:

which divides the crystal into two identical halves.

according to the previous the mineral crystals may be divided into seven crystal system.

### Crystal Systems:

Mineral crystals can be classified into several different crystal systems. The classification crystal systems depends on the lengths of the crystal axes and angles between these axes as follows:

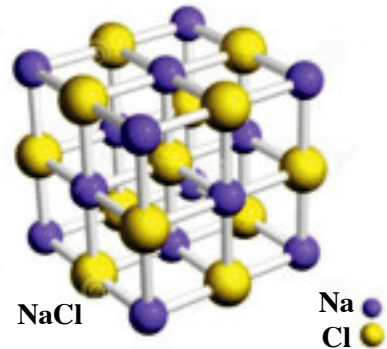
Where ( a , b , c ) indicate the lengths of axes , while (  $\alpha$  ,  $\beta$  ,  $\gamma$  ) indicate the angles between axes

1. **Cubic System:** The crystal has three axes which are equal in lengths and has perpendicular angles. This system is characterized by the greatest number of crystalline symmetric systems.

$$(a_1 = a_2 = a_3) \text{ and } (\alpha = \beta = \gamma)$$

2. **Tetragonal System :** The crystal has three perpendicular axes, two of them are equal in length and the third is different

$$(a_1 = a_2 \neq c) \text{ and } (\alpha = \beta = \gamma).$$



Crystalline system of Halite mineral



Cubic



Tetragonal



Orthorhombic

**3. Orthorhombic System :** The crystal has three axes which are unequal in lengths and perpendicular angles  
( $a \neq b \neq c$ ) and ( $\alpha = \beta = \gamma$ )

**4. Monoclinic System:** The crystal has three axes which are unequal in lengths, two axes are perpendicular and the third is inclined. ( most of minerals are related to this class.)

( $a \neq b \neq c$ ) and ( $\alpha = \beta \neq \gamma$ )

**5. Triclinic System :** The crystal has three axes, all are different in lengths and are not perpendicular. ( $a \neq b \neq c$ ) and ( $\alpha \neq \beta \neq \gamma$ )

**6. Hexagonal System:** The crystal has three horizontal axes which are equal in lengths, intersects each other by equal angles. They are perpendicular to the forth axis which differs in length. The forth vertical axis is hexametrical with the presence of horizontal symmetrical plane.  
( $a_1 = a_2 = a_3 \neq c$ )

**7. Trigonal System :** The crystal has three horizontal axes which are equal in lengths, intersects each other by equal angles. They are perpendicular to the forth axis which differs in length. **The forth vertical axis is trimetric with no horizontal symmetrical plane.** ( $a_1 = a_2 = a_3 \neq c$ )

All systems have three axes except the hexagonal and trigonal have four axes.



Monoclinic



Triclinic



Hexagonal



Trigonal

## Physical properties of minerals:

One of the most important duties of geologist is to identify the minerals in the places of their existence in the field. He firstly uses the apparent properties and that make it easier to be observed in hand specimen to initially identify the mineral and then confirmed by laboratory to identify ways that require devices and complex analyzes. Here's a quick discussion of the most important and distinctive physical properties, which can be classified into optical, cohesive and magnetic properties ... etc.

### First: Optical Properties of Minerals:

These properties depend on the interaction between the incident light on the mineral and that reflected from its surface. The most important optical properties are:

#### 1. Luster:

Luster Is the ability of mineral to reflect light that falling on its surface.



Metallic Luster

## CHAPTER 2

a) **Metallic luster:** Some minerals show a metallic luster and resemble metals that reflect light so much that the mineral is bright or brilliant such as ( pyrite – galena – gold )

b) **Non-metallic luster :** Minerals which have a non-metallic luster, are described as familiar examples to us from such as:

1/ Vitreous (glassy) as in ( quartz and calcite)

2/ Pearly as in (feldspar)

3/ Adamantine luster as in (diamond).

4/ Dull or earthy luster: The least intensity luster and its surface is matte (dull) as in (kaolinite)



Non-metallic luster

### 2. Colour:

The colour of a mineral depends of the length of light waves reflected from its surface. Although colour is the most obvious property of minerals, it may not be very useful for their identification because most of minerals change the colour by changing its chemical composition or contain small portion of impurities may change the colour of the same mineral. For examples are:

a) Quartz which found in different colours as rose quartz due to the presence of manganese impurities, purple to violet quartz (amethyst) the colour is due to impurities of iron oxides, milky quartz is white like milk due to minute gas bubbles, smoky quartz, its grey to black colour due to breaking some bonds when they are exposed to high energy radiations as from a radioactive source while the pure quartz is transparent or colourless and known as “rock crystal”.



Amethyst

b) Sphalerite (zinc Sulphide) is yellowish transparent, which turns brownish colour when small amounts of iron replace zinc in its atomic structure.

On the other hand, certain minerals have a permanent and unchanging colour “known as real or native colour”. For example the yellow colour of sulphur and the green colour of malachite (hydrrous copper carbonate).

### 3. Streak:

Streak is the colour of the powdered mineral that we get it by scratching mineral on a piece of unpolished porcelain. Streak has a constant colour for minerals whose colour changes due to changing type or quantity of the impurities, and so it is one of the properties that can be relied upon to identify the minerals is. Such as “hematite” mineral has two colours dark grey and red while its streak is red, pyrite which is characterized by golden colour, its streak is black and quartz which has different colors, its streak is white only.



Streak

#### 4. Play of colour:

Certain minerals change their colour when moved in front of human eyes in the different directions (or in front of a source of light). This property, known as play of colour, characterizes some precious and semiprecious gemstones that used as ornamental.

- Diamond for example, disperses falling light on it into red and violet then gives strong luster in all directions.
- Precious opal mineral is characterized by spangling or what known as “Cat’s eyes” is also where mineral luster which has fibrous tissues, is rippling depending on the direction of view.



Translucent minerals

#### 5. Transparency:

The transparency of a mineral is the transparency degree of minerals or the ability degree to which light can pass through minerals.

- Transparent mineral:** The mineral is transparent if we can see a clear picture through it.
- Translucent mineral:** The mineral is translucent (semitransparent) if the picture seen through it is not clear.
- Opaque mineral:** The mineral is opaque if the mineral does not transmit light at all.











### Second: Cohesive Properties of Minerals:

#### 1. Hardness:

The hardness of a mineral is its ability to resist scratching. It is determined relatively where a harder mineral will scratch a softer mineral of lower hardness. Hardness is determined numerically according to the “Mohs” scale in which minerals are arranged from 1 to 10 in degree of hardness. The softest mineral, number 1 on the scale, is talc, while diamond, which can scratch all other minerals, has a hardness of 10.

# CHAPTER 2

## Mohs scale of Hardness

Mineral	Talc	Gypsum	Calcite	Fluorite	Apatite	Orthoclase	Quartz	Topaz	corundum	Diamond
hardness	1	2	3	4	5	6	7	8	9	10
Shape										

### Determination the Hardness in the field or lab.:

It is easy to determine hardness in the geological fields or laboratory by using set of hardness pens that made of alloys which have the same degrees of hardness identified in Mohs scale. In the case of unavailability these pens of Mohs scale, we use objects with common usage in our daily life with known hardness, for example, the hardness of human fingernail is about 2.5 i.e. it scratches talc and gypsum but it does not scratch calcite. A copper coin has a hardness of about 3.5 A piece of window glass has a hardness of about 5.5; the streak plate of ceramic has a hardness of about 6.5

Fortunately, most minerals have hardness less than 6.5 which makes the determination of hardness relatively easy. As used hardness property to distinguish between natural and precious gemstone that are expensive and those industrially imitation ornamental stones of glass material or aluminum oxide. The most important gemstones and precious minerals, in addition to their attractive colors, they do not been scratched easily, therefore, most of them exceeding hardness of 7.5, while imitation ornamental stones are characterized by attractive colors but their hardness are often less than 6.

### 2. Cleavage:

Cleavage is the ability of the mineral to split along planer surfaces representing the weaker planes produce smooth surfaces when minerals are broken or pressed.

### Types of cleavage:

- Cleavage in one direction: The best example of cleavage what is seen in mica mineral which is characterized by good cleavage in one direction which is known as “flaky cleavage”. It is splitting easily along one basal plane forming thin plates or sheets. Graphite also has good basal cleavage where the cleavage is in a direction Paralled to the base of the crystals



plate or sheet cleavage in Mica

- b) Cleavage in more than one direction: Many minerals have cleavage in more than one direction (two or three directions). Halite and galena have perfect cubic cleavage. Calcite, on the other hand, has rhombohedra cleavage. Many minerals, e.g. quartz have no cleavage.

### 3. Fracture:

Fracture is the shape of surface resulting from the breaking the mineral, and the resulting shape of the fracture does not follow any described plane of cleavage and compared to known forms such as conchoidal fracture that characterizing quartz and flint or rough fracture with uneven surface, or jagged fracture with sharp elevations that characterizes the majority of minerals in nature.



Cubic cleavage in Galena

### 4. Malleability and ductility:

A feature reflects the extent of ease or possibility of malleable and ductile a mineral to form a thinner sheet or wires such as gold, silver or copper. On the other hand, the minerals are considered as brittle or breakable if they are fragmented by hammering .



Conchoidal fracture in Quartz

### Third :Other Properties:

**Minerals are also identified by the use of other properties as:**

1. Specific gravity: is the ratio between mineral mass and the mass of the same volume of water. Specific gravity of minerals are ranging between light, medium and heavy. Such as specific gravity of galena is 7.5 and specific gravity of gold is 19.3
2. Magnetic properties: in terms of their attraction to magnet as magnetite and hematite or not attraction with magnet as gold and diamond.
3. Thermal properties: such as the ability of mineral fusion to melt and its melting point (high or low).
4. Other properties: in addition to properties help identifying the minerals. The taste of mineral such as (salty in halite or bitter or etc ... ) and the touch and smell.



### Exercises

1. Human life is highly related to the mineral constituents of the Earth. Discuss.
2. “ man knew minerals from long periods ago” discuss this sentences.
3. What are the constituents of rocks? Give examples of common rocks are there monomineralic rocks? Give example.
4. Comment of the statement “minerals of a rock may have common properties”.
5. What is the most common mineral groups forming rocks of the crust? Give one example for each group.
6. Define a mineral. Give examples for natural components are not regarded as minerals?
7. How does the shape of crystal become definite according to differentiation of the length axis and the angels between them?
8. Mention the eight elements which form the majority of minerals and rocks of the crust.
9. Discuss the optical properties of minerals and show how you can use them in identifying a mineral.
- 10 Define luster and give the terms used to describe the degree of reflection of light from the surface of a mineral
11. Is the colour from the main differentiated properties between minerals? Discuss the importance of colour in the process of identifying a mineral.
12. Why are gemstones characterized by precious stones? What are the differences between natural and artificial ornamental stones?
13. Mention some cohesive properties of minerals, discuss two of them.
14. Define the term hardness. Give examples of minerals of high degree of hardness.
15. Mention the Mohs scale of hardness
16. Define cleavage and show how you can describe it?



**PART 1**

**CHAPTER 3**

**Rocks**

## Objectives

**After studying chapter three the student should be able to:**

1. Recognize the rock cycle.
2. Draw a diagrammatic figure for rock cycle.
3. Recognize the principal divisions of rocks.
4. Explain the reasons of changing one type of rocks to another.
5. Expect the changes, which happen to any type of rocks when it is exposed to new conditions.
6. Mention the concept of lithified, metamorphism and crystallization.
7. Explain the relation between cooling and crystallization.
8. Explain the conditions of igneous rocks formation.
9. Recognize the place where the igneous rock had been formed from its texture.
10. Analyze the diagrammatic figures for the mineralogical structure of igneous rocks.
11. Compare between the plutonic, volcanic and intrusive igneous rocks.
12. Recognize the different shapes of intruded igneous bodies under earth's surface.
13. Clarify the formation steps of sedimentary rocks.
14. Explain how the lithification process happens.
15. Mention the types of sedimentary rocks.
16. Classify the sedimentary rocks according to the size of its grains.
17. Mention examples for different types of sedimentary rocks.
18. Recognize the metamorphic rocks.
19. State reasons of metamorphism and their location.
20. Differentiate practically between the different types of rocks.
21. Recognize volcanoes.
22. Recognize the parts of the volcano.
23. Recognize the shapes of volcanic igneous rocks.
24. Recognize the difference between volcanic breccia and volcanic bombs.

## Rocks

We have Previously studied that the earth's crust is the solid outer layer of the earth and it consists of igneous, sedimentary or metamorphic rocks and also we have studied that the mineral is the building unit of the rock. So what is the rock?

**The rock** is a natural solid body consist of number of minerals combined together at different ratios and sometimes consists of one mineral only.

Each rock is characterized by definite chemical structure so it has its own physical properties that distinguish it from others.

### Types of rocks

Rocks can be classified into three types according to their origin, these are: -

#### 1. Igneous Rocks:

It is the first type of rocks which formed on the earth crust and from which all other rocks are formed due to different geological processes so it is called "the mother of rocks" or "primary rocks".

It is formed due to cooling and crystallization of molten material (magma) when its temperature decreases, whether inside the earth's layers or on the surface.

The most famous igneous rocks are: granite, andesite and basalt.

#### 2. Sedimentary Rocks:

It is the rocks that formed due to fragmentation of ancient igneous, sedimentary or metamorphic rocks due to weathering processes then transfer the fragments by natural transportation factors then deposition and consolidation of fragments.

For examples are sandstone, mudstone and limestone.

#### 3. Metamorphic Rocks:

It is the rocks that formed when igneous or sedimentary rocks are affected by intense heat or pressure or both together so it is metamorphosed into new rock of new properties that doesn't belong to the other two original rocks.

For examples of metamorphic rocks, marble and mica schist.

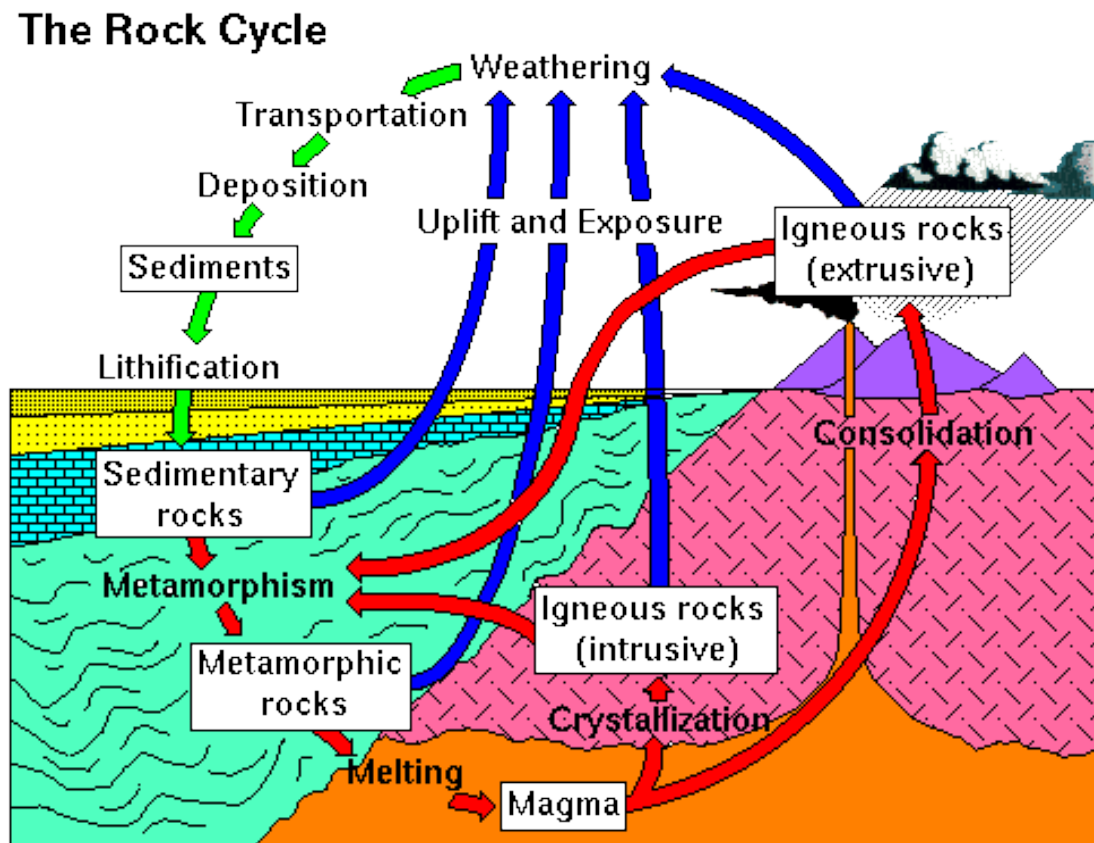
## CHAPTER 3

### The most important differences between the three types of rocks:

1. Igneous rocks are massive, crystalline, nonporous rocks that don't contain fossils.
2. Sedimentary rocks are stratified (found in layers), rarely crystalline, often porous and often contain fossils.
3. Metamorphic rocks are foliated (in the form of sheets) or massive, crystalline and nonporous rocks and may contain distorted fossils.

### The rock cycle:

James Hutton, Scotch scientist in 1785, was the first who related between the three known types of rocks on the earth and the effect of atmosphere and hydrosphere and their geological processes that leads to changes in rocks from one type to another in one cycle called the **rock cycle**, that passes through several steps or stages as follow:



### Stages of Rock Cycle:

#### ● Weathering Process

It is the impact of weather factors as rains and winds where the fragmentation and decomposition of igneous rocks into small pieces of rock detritus are happened. This process occur due to the weather factors so it is called weathering process. There are two types of this process: a mechanical weathering and chemical weathering.

#### ● Transportation Process

Detritus are transported fragments to depositional basins in lowland areas by natural transporting factors of rivers or glaciers which are sliding on the mountains surfaces with the help of gravity or by wind currents in deserts or by water currents in the seas so new surface is eroded to activate weathering process.

#### ● Sedimentation Process

When the ability of the transporting agent weakens as a result of lowering in slope or decreasing in the velocities, the transported detritus deposits and accumulates in the bottom of the sea or ocean taking the shape of horizontal beds, which increase in thickness by the continuous of deposition.

#### ● Lithification Process

The lower beds are affected by the weight of highly upper layers making its grains closer to each other, adhesive and cohere by cementing materials to consolidate and then the loose sediments are changed into hard lithified and consolidated sedimentary rocks.

#### ● Metamorphism Process

The sedimentary rocks or other rocks go slowly down to great depths in areas where the relative instability of the surface layer of the Earth is significantly thus exposing to increasing of temperature and pressure changing those rocks into new rocks called metamorphic rocks and the change usually includes minerals types and texture of the rock so that the appropriate balance of unstable rock occur with the new conditions of temperature and pressure.

#### ● Melting Process

When the metamorphic rocks or any other type subjected to significant increase in temperature and pressure in great depth their mineral constitutes melt when reaching melting point.

#### ● Cooling and Crystallization Process

When magma goes out from magma chamber and exposed to low temperature, it solidifies forming igneous rocks. They may be intruded underground to give plutonic igneous rocks such as granite, or erupted to the surface as lava in the volcanic eruption regions to give

# CHAPTER 3

volcanic igneous rocks such as basalt and andesites.

The cycle starts again from the beginning by the effect of weathering on surface rocks which change the earth surface.

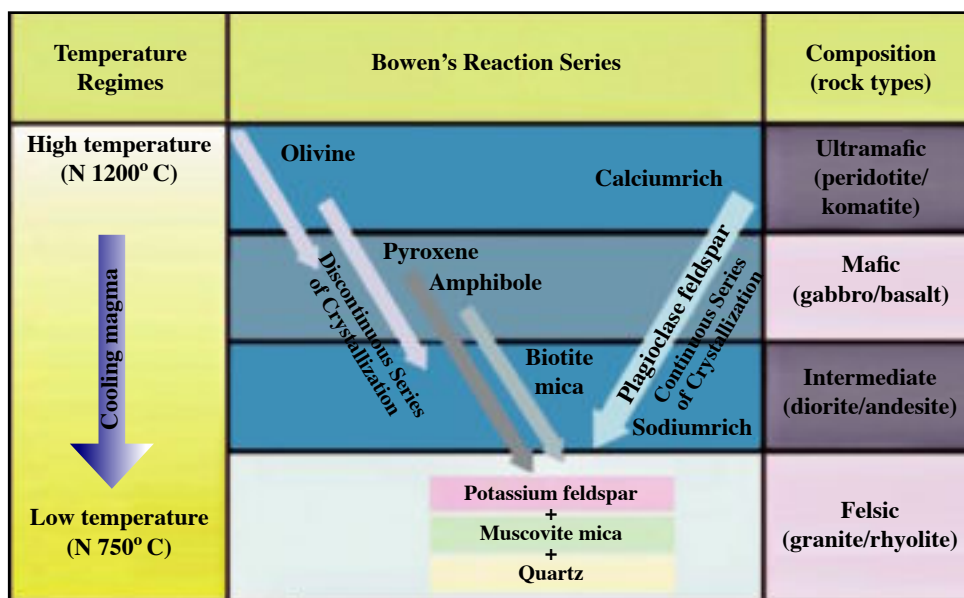
Now let's identify the three types of rocks igneous, sedimentary and metamorphic according to (formation, types and properties)

## Igneous rocks

As it had been mentioned previously, igneous rocks are formed by the crystallization and solidification of molten rock materials by cooling. This molten rock is viscous liquid and known as magma or lava and contains the eight elements of silicate minerals in form of ions, in addition to some gases ( the most important of them is water vapour).these elements remains trapped within this viscous liquid under high pressure in the upper part of mantle which characterized by partially molten (elastic)rocks.

### Formation of Igneous rocks

The scientist Bowen experiments on magma reactions explained that when the temperature of magma decreases crystallization process start, the first crystallized minerals are those minerals rich in Iron, Magnesium and Calcium. Thus as 50% of magma is crystallized the molten part loses these three elements completely and so it becomes rich is Sodium and Potassium and also increasingly its content which increases hence these elements crystallize in later stages of crystallization. These reactions are explained by Bowen in the following schematic diagram which is known as **Bowen's Reaction Series**.



From this diagram shows two sides, the right side shows the continuous reactions related to calcic feldspar (calcium rich feldspar) then gradually sodium replaces calcium forming (calcium sodium rich feldspar) then sodium rich feldspar while the left side begins with Olivine which is the first mineral crystallizes followed by Pyroxene then Amphibole finally Biotite (black mica) at the end.

During the last stage of crystallization and after the most of magma solidified, crystallization of magma happens in the form of potassium feldspar minerals then white mica and finally quartz mineral is the last crystallized of magma minerals.

We can observe that crystallization of magma includes six groups (mineral systems) arranged according to speed of cooling:

1. Olivine (the first crystallized mineral groups)
2. Pyroxene
3. Amphibole
4. Feldspar (Plagioclase & Orthoclase)
5. Mica (Biotite and Muscovite)
6. Quartz (the last crystallized mineral)

### Principles of Igneous rocks classification:

**Igneous rocks can be classified according to:**

1. Place of crystallization of rocks which effects on the rate of cooling and texture.
2. Mineral composition of rocks which depends on the chemical structure.

### First: Classification according to place of crystallization and texture:

#### a) Plutonic Igneous Rocks

The slow cooling which occurs at great depth in earth away from its surface allows large number of ions to accumulate at the crystallization center consists of coarse texture, and small number of large-sized crystals seen with the naked eye which characterize these types of rocks such as Granite, Diorite and Gabbro, Peridotite.

#### b) Intruded Igneous Rocks

When the magma flows to the surface but the surrounding conditions doesn't allow it to flow to the surface, it intruded between the surrounding rocks then cooled down and take different shapes and its texture has large crystals due to slow cooling in deep places and smaller crystals crystallized at the new places near to earth's surface where the cooling is faster forming intruded igneous rocks which its texture is known as **porphyritic texture** where large crystals are surrounded by small undergrounded crystals which have almost the

## CHAPTER 3

same mineral composition (as Dolerite, Microdiorite and Microgranite)

### c) Volcanic Igneous Rocks (Extruded)

When volcanic lava extruded during volcanic eruptions into earth's crust or near to it the lava cools very fast so it doesn't take enough chance for crystallization so it forms a glassy texture (non-crystalline) like Obsidian fine texture (micro crystals) of large numbers that can not be seen by naked eye like rhyolite or frothy texture due to the presence of gaseous bubbles during crystallization such as Pumice.

But Basalt, Andesite and Komatite have glassy of fine texture.

### Second: Classification according to Mineralogy (mineral composition):

#### a) Acidic igneous rocks (Felsic)

It is the rocks that contain more than 66% silica and sodium and potassium feldspar, mica and quartz with ratio 25% and amphibole it has light pink color, crystallizes at low temperature less than 800°C .

The most famous examples **granite** which has coarse texture which is commonly used in the construction due to natural beauty specially after polishing, also **microgranite** which has porphyry texture (intruded rock) and Rhyolite which has fine texture volcanic rock, Obsidian which has glassy texture also Pumice which has air bubbles so it is light weight.

#### b) Intermediate igneous rocks

These rocks are intermediate in mineral and chemical composition which has 55% to 66% silica, plagioclase feldspar which is rich in calcium and sodium also contains Amphibole, Mica and Quartz and a percent of potash feldspar.

They crystallize at moderate temperature; their colors are moderatet between light and dark.

Their examples are **Diorite** which has coarse texture, **Microdiorite** of porphyry texture and the most famous of it is volcanic **Andesite** related to Andes mountains.



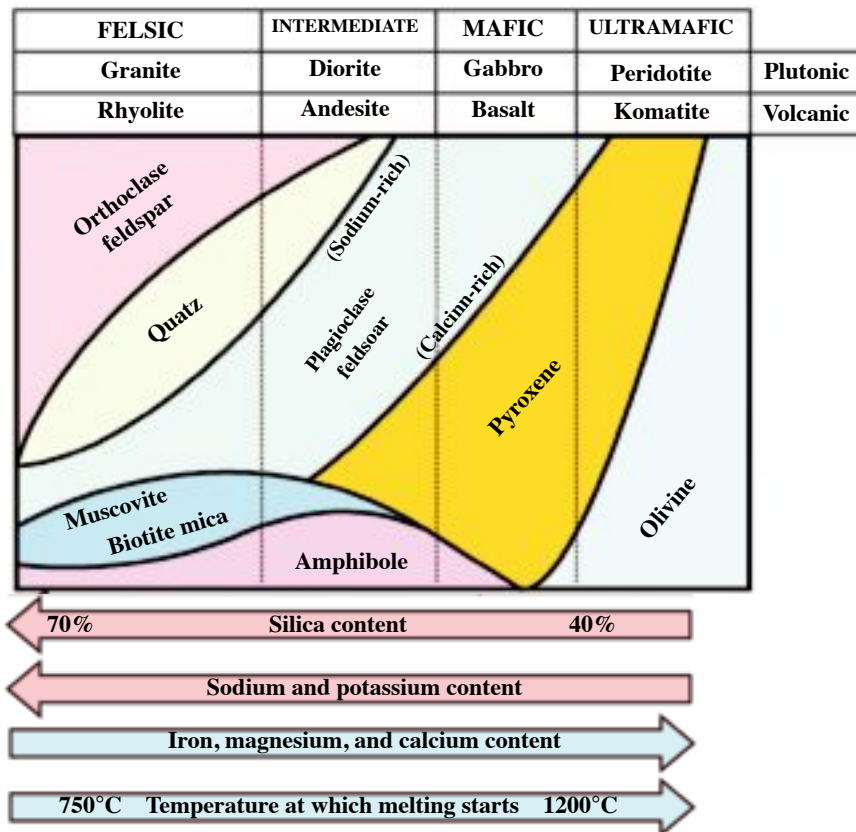


Figure represents the mineralogy of common igneous rocks

Shows the silica percent, elements and temperature of crystallization

### c) Basic igneous rocks (Mafic)

These rocks are poor in silica content which ranges from 45% to 55%. They crystallize at temperature more than 1100°C at the early stages of magma crystallization.

They are rich in iron, magnesium and calcium minerals so it has black colors such as Olivine, Pyroxene, plagioclase calcic feldspar and some Amphibole.

Their examples are Plutonic Gabbro, Dolerite of porphyry texture and Basalt which is the most famous and used for roads pavement.

### d) Ultrabasic igneous rocks (Ultramafic)

Rocks that are poor in silica less than 45%, they are the first crystallized rocks on cooling the magma, they have dark black colors which are rich in Olivine, pyroxene .

Their examples are plutonic **Peridotite** and volcanic Komatite.

### Equivalent Igneous Rocks

They are an igneous rocks which have the same chemical and mineral structure but they differ in place of formation, texture and grains size example Granite (plutonic), Microgranite (intruded ) and rhyolite (volcanic)

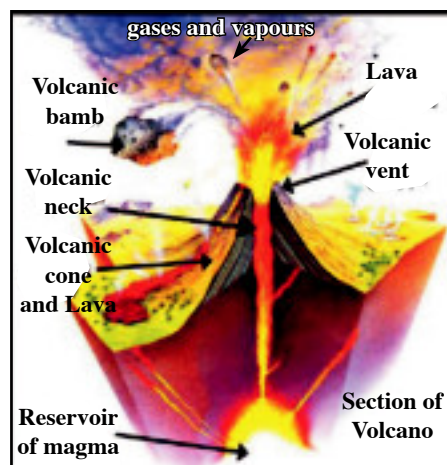
### Volcanoes

The volcano is a hole or fracture in the earth's crust which permits the molten rocks and the trapped gases to leave outside the Earth's surface. The molten rocks are coming from temporary chambers or cavities of magma (magma reservoir) present at great depths under the earth's surface.

#### Reasons of volcanoes and their eruptions

The Energy of trapped gases in the molten materials are considered main force of volcanic eruptions, which is evident in the areas of subduction plate tectonics where they cause fractures in Earth Surface through which these volcanoes erupted.

The magma is erupted through the cracks and in the earth's crust rocks to reach the surface and the rising magma is working on melting what encounter of rocks. When magma reaches the surface of the Earth it is called lava. When lava is exposed to air and normal atmospheric pressure, it cools rapidly and solidifies to form volcanic rocks, which usually in the form of a cone.



#### ❖ Volcanoes components:

The opposite figure represents the parts of a volcano, which consists of:

- **Volcanic Vent (Crater)**
- **Volcanic neck:** The volcanic substances are erupted through it into the crater.
- **The volcanic cone:** It represents the shape of the volcano and contains the volcanic vent.
- Reservoir of magma (magma chamber)

#### ❖ Types of volcanoes:

The volcanic eruptions are considered the most the horrific and catastrophic phenomena in nature and the volcanoes are divided into: -

- Most volcanoes become completely extinct volcanoes (inactive volcanoes) after their eruptions where magma chambers are completely empty of molten material.
- Others continue in their eruptions as “Stromboli” volcano in Italy

- Others erupt at discontinuous periods as “Vesuvius” volcano in Italy and “Etna” volcano in Sicily Island.

### ❖ Volcanoes products:

During volcanic eruptions, molten minerals substances “lava” come out the craters, with estimated temperature about 1200°C. Lava are accompanied by large quantities of gases and vapours such as ammonia, hydrogen sulfide, carbon dioxide, water vapour and others, that associated together with some erupted minute mineral materials called volcanic ash which all these spread in air. Also volcanic bombs and volcanic breccia are got out from the volcanic vents.

### The effects and benefits of volcanoes:

**It has clear effect of the earth’s surface where it:**

1. They add annually millions of tons of volcanic rocks to the earth’s surface, which may appear as thin sheets with great extension and appear as volcanic plateaus or mountains.
2. Appearance a new volcanic island if volcanic eruptions happened under the surface of the water in the seas and oceans.
3. The volcanoes lead to the formation of very fertile soil of volcanic ash.
4. The formation of volcanic rounded lakes if rain water gathered in the craters extinct volcanoes
- 5- The formation of metamorphic rocks as a result of touching magma to surrounding rocks.

So volcanoes are considered of the construction factors of the earth’s crust.

## Geological Structure of Igneous Rocks in Nature

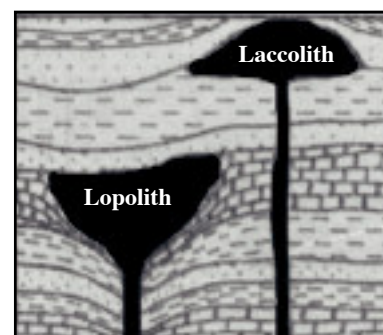
### First: shapes of intruded plutonic igneous bodies

#### 1. Batholith

The largest intruded igneous bodies and it extends hundreds of kilometers and its thickness is several kilometers.

#### 2. Domes:

Produced when magma rises in narrow slot and then accumulates, rather than spreading horizontally, it may be normal dome and called “**Laccoliths**” in case of high viscosity magma which press on the above layers rocks to bend layers up causing Anticline fold.



Laccoliths and Lopoliths

## CHAPTER 3

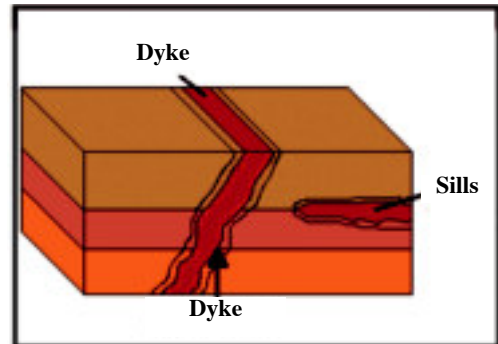
Or it may be inverted dome and called “**lopoliths**” when the opposite is happening and magma is of low viscosity which bends layers down causing Syncline fold.

### 3. Dykes:

These result when magma is intruded in the surrounding rock so that they are cutting them.

### 4. Sills:

They result when the magma is intruded concordant (parallel) with the bedding planes and they are not intersecting them.



Dyke and Sills

## Second: Shapes of Extruded Volcanic Rocks

### 1. Lava Flows:

When lava of volcanic eruptions is consolidated on earth's surface. It takes the shapes of ropes or pillows.

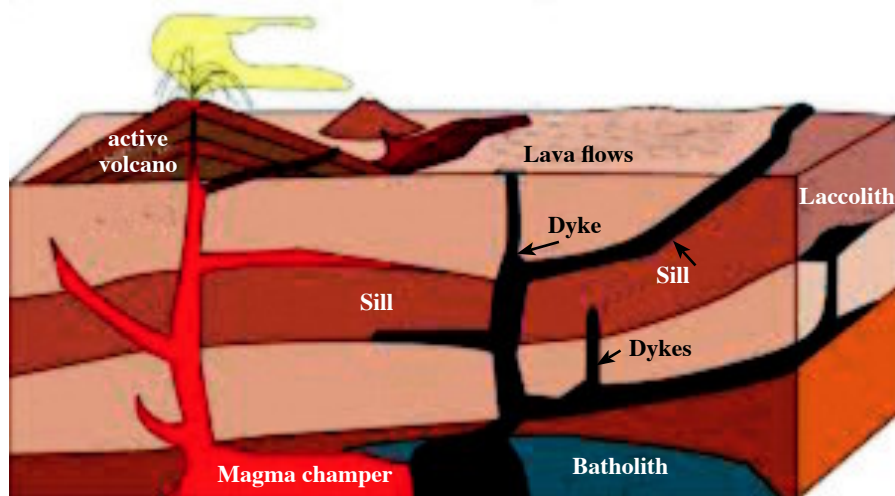
### 2. Volcanic Pyroclastics:

They are produced by breaking down the volcanic necks and including:

- a) **Volcanic breccia:** rocks have sharp edged fragments which spread around the volcano.
- b) **Volcanic ash:** very fine grained carried by wind for long distances and may cross the seas to deposit on another continent.

### 3. Volcanic Bombs:

They are oval-shaped massive rocks, composed of lava materials that freeze (solidified) near the earth's surface.



Shapes of igneous rocks in nature

## Sedimentary Rocks

### Formation:

Sedimentary rocks are formed due to deposition of products (detritus) of weathering processes, whether they are solid or soluble and are carried by transportation natural agents to depositional basins so they are deposited in parallel layers one over the other.

### Characteristics of Sedimentary Rocks:

1. It covers  $\frac{3}{4}$  of earth's crust in relatively thin layers. It represents 5% only of rocks of earth's crust in volume.
2. Most of them have economic value as limestone, phosphates, coal and iron deposits and also sandstone.
3. Includes muddy rocks in which oil, natural gas & kerogen are formed and also Porous Rocks like sandstone, limestone and sand in which oil, natural gas & underground water are stored.
4. The types of sedimentary rocks are few relatively to those of igneous and metamorphic rocks so it can be classified into a very limited number, three of them are abundant and these are mudstone, sandstone and limestone which form about 90% of sedimentary rocks.

### Classification of Sedimentary Rocks

The most common classification according to mode of formation: -

#### First: Clastic (Detritus) Sedimentary Rocks:

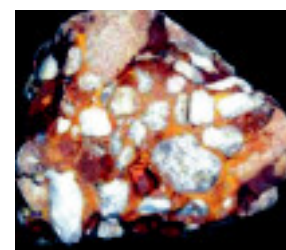
They are classified according to the dominant size of their solid fragments in their components into the following classes:

##### 1. Gravels Deposits:

Gravels consist of rounded fragments in size of pebbles and boulders which are more than two millimeters in diameter. When gravels are lithified and consolidated by cementing material, the rock is known as **conglomerate**. But if the grains have sharp edges, they are called **breccias** which is a rock commonly used in the work of decoration (ornamentation) of walls.



Breccias



Conglomerate

##### 2. Sands Deposits:

Sands are composed of grains ranging from 2 mm to 62 microns in diameter most of these grains are quartz and the lithified rock are known as sandstone. From these sand deposits are the sand dunes in deserts. (Micron = 1/1000mm)

## CHAPTER 3

### 3. Mud Deposits:

They are composed of a mixture grains of silt (size is 62 to 4 microns) and clay size (size is less than 4 microns). Both are usually mixed to form mud deposits such as most components of Egypt agricultural soil.

When mud deposits becomes lithified forming the mud stone but they usually show the fissility or lamination as a result of compressing their components and so it is called shale or laminated mud



Sandstone



Shale

### Second: Chemical Sedimentary Rocks:

Chemical sedimentary rocks are formed as result of precipitation of the dissolved salts in water which is due to evaporation of water and the increase of salts concentration or due to chemical reactions.

#### Chemical sedimentary rocks are divided into:

1. Calcareous rocks: as limestone which is found in stalactite and stalagmite and Dolomite.
2. Silica rocks as Flint rock (light and dark).
3. Evaporates rocks as gypsum (hydrous calcium sulphate), anhydrite (calcium sulphate) and table salt rock which is halite mineral (sodium chloride).
  - These salts are deposited as a result of the evaporation of water from semi-closed or closed lakes (inland lakes) or in the coastal sabkhas. Man has used this phenomenon in the extraction of table salt from sea water by industrial evaporation in the salt works (rock salt).
4. There are other types of chemical deposits such as some iron ores sediments, and the most famous example in Egypt is oolitic iron ores at Aswan, which is composed of red iron oxide (Hematite).

### Third: Biogenic and Biochemical Sedimentary Rocks:

- Fossiliferous Limestone: We all know that marine organisms build their inner skeleton or outer hard parts (shells) of calcium carbonate which they extract from sea water. When they die the hard parts accumulate on the bottom of the sea to form fossiliferous limestone of biogenic origin which are the solid remains of living marine organisms that may belong to vertebrates (such as fish,.. etc) or invertebrates (such as molluscs, coral reefs and minutes living organisms as foraminifera or plants as calcareous algae) of organic origin.



- Phosphate rocks also contain fossilized remains of marine animals vertebrate containing phosphate in addition to phosphates minerals components which increase the concentration of phosphate ratio in the biochemical rocks.
- Coal is another type of economical biogenic rocks. It is formed when plants are buried in the bottom of the earth away from oxygen for long time, so the plant tissues lost their volatile constituents and carbon gets concentrated forming coal. This is usually done in the swamp land behind river deltas where the conditions are suitable for landfilling (rapid burial) of plant remains in the absence of air this (reducing environment).

### Energy Resources in Organic Sedimentary Rocks:

#### 1. Oil and Gas:

Oil and gas, although they are not considered as deposits, but they have been formed and are stored within sedimentary rocks.

Oil and gas are hydrocarbons, i.e. composed of hydrogen and carbon which have been formed by the decay of animal and plant remains of marine micro organisms, which are deposited to be buried with fine grained muddy sediments away from atmospheric air. These rocks are known as source rocks. Where organisms are matured at a depth of 2-4 km in the ground and the temperature ranges between 70 to 100°C, and then changed into liquid and gaseous states of hydrocarbons. After that the hydrocarbons move or migrate and accumulate to the porous reservoir rocks which are made of the sands, sandstone and sometimes limestone.

#### 2. Oil shale (Kerogen)

It is a muddy rock rich in hydrocarbons, are mostly of plant origin and it is a waxy solid state known as kerogen, which decomposes (turns) to oil substances when it is heated the rock to about 480°C. It is an important source of energy, although it is not currently exploited but kept as reserves until natural oil have been consumed of Earth or when the price of its production is a competitor to production price of natural oil.

## Metamorphic rocks

### Formation

Metamorphism of the rock is the change of rocks to new other state if it is subjected to conditions of increasing temperature and pressure so that it requires re-equilibrium and re-crystallization to be adapted the new conditions. And so any rock whether it was igneous, sedimentary or even metamorphic may be metamorphosed when it is subjected to increase in temperature and pressure in earth's interior.

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**Features of Metamorphism :( Manifestations of metamorphism) (Appearances).**

## **Metamorphism appears in the rock as:**

- The change of its minerals to new minerals , sometimes.
- The change of its rock texture so that it becomes more crystallized.
- The arrangement of its minerals in perpendicular directions to the direction of the effect of the applied pressure during its growth.

## **Types of Metamorphic Rocks**

### **1. Massive Metamorphic Rocks**

They are the rocks originated from changing rocks under the effect of high temperature when they are in contact or adjacent to mass of magma, and the effect of metamorphism decreases gradually as the rocks becomes far from the area of contact magma. This results an increase in the size of the crystals forming massive granular texture as in **quartzite** which is resulting from metamorphosis quartz of sandstones when it is exposed to very high temperature.



**Marble**

As well as marble rock resulting from exposure of limestone to intense temperature under the ground, where crystals of calcite are cemented and compacted together so marble becomes more solid and cohesive. Many types of marble with attractive colors and because of impurities which makes using marble as one of the ornamental stones is desirable.

### **2. Foliation Metamorphic Rocks**

- These rocks originated due to the effect of both temperature and pressure where the crystals grow under effect of temperature in definite directions in form of sheets of flakes perpendicular to direction of pressure forming foliation texture such as **slate** rock that produced from metamorphism of shale under effect of high pressure and low heat relatively (less than 200°C) and it is used in the construction purposes.
- Schist rocks are different types and the most important type is **mica schist** a shows foliation property due to the parallel arrangement of mica crystals in one direction in the mud rock and due to the effect of high temperature,



**Mica schist**



**Gneiss**



the crystal growth will be in the perpendicular direction to the direction of pressure to reduce its impact. Mica schist consists of thin sheets which are similar in mineral composition, connected and not intermittent.

- While **gneiss** is a metamorphic rock from granite which exposed to temperature and pressure, and their mineral crystals are arranged in parallel rows and not connected and intermitted.

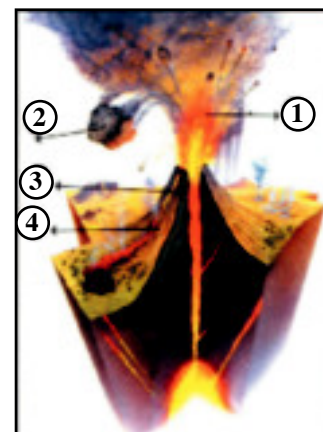
### Reasons and Places of Metamorphism

Metamorphism usually takes place during mountain building movements (Orogenic Movement) or when the rocks are in direct contact or adjacent to the magma of high temperature or in lesser extent during movement of two blocks of rocks along faults planes causing friction that causes increase in temperature.

## CHAPTER 3

### Exercises

1. Mention the types of rocks in nature and mention the main differences between them.
2. Discuss the rock cycle and describe its different stages.
3. Discuss the relation between the three types of rocks and show how one changes into the other in the rock cycle.
4. Mention one difference between each of the following: -
  - a) Granite and Basalt
  - b) Granite and Gabbro
  - c) Rhyolite and Diorite
5. Show the difference between
  - a) Laccoliths and lopoliths.
  - b) Volcanic breccia and volcanic bombs.
  - c) Breccia and conglomerates.
6. Describe the mode of formation of chemical sediments and give examples of rocks of chemical origin.
7. What are the most important biogenic deposits related to plants. Explain how they had been formed?
8. What are the source oil rocks? How and where oil has been formed?
9. Mention what you know about kerogen.
10. Discuss the levels of crystallization during the formation of igneous rocks. Clarify the difference in texture of plutonic, volcanic and intrusive rocks.
11. Mention the mineralogical composition and texture of the most common volcanic rocks. Clarify the relation between the texture and the conditions of formation.
12. Why rock are changed by metamorphism and clarify where it happens?
13. Mention examples for the rocks which have been metamorphosed by pressure and heat.
14. Discuss the characterized texture for the metamorphic rocks.
15. Look at the figure and answer the questions
  - a) Write what each number indicates.
  - b) Put a suitable address for this figure.
  - c) Write the scientific term which indicates this figure.
  - d) Explain the factors, which led to this phenomenon and what are their effects.
16. Write down the scientific terms which indicate each of the following:
  - a) An opening permits the passage of molten rocks and gases outside the earth surface.
  - b) Magma when it had been at the surface of the earth.



**PART 1**

**CHAPTER 4**

**Earth Movements  
and  
Continental drift**

## Objectives

### After studying chapter four the student should be able to:

1. Explain the reasons of the variation in the ecological conditions during the geological time.
2. Mention the relation between the ecological variables and genetic variations.
3. Explain the reasons of formation of carbon layers in Egypt during carboniferous period.
4. Illustrate the formation of phosphate in Safaga and Qseer.
5. Compare between rainy era and drought era during last Glacial period.
6. Give an applicable example for isostatic balance.
7. Mention some evidences of earth's movements.
8. Illustrate the presence of marine sedimentary rocks in Everest Mountain.
9. Compare between the epeirogenic and orogenic movements.
10. Mention the continental drift theory.
11. Compare between sima and sial.
12. Illustrate the reasons of continental drift.
13. Mention the evidences of the continental drift theory.
14. Identify why some minerals take a different directions.
15. Prove the occurrence of continental drift and give evidences.
16. Illustrate the presence of fossils of some primitive plants in different continents.
17. Illustrate the similarities of mountains of western southern Africa with that of Argentina on base of continental drift.
18. Mention the objection theory of continental drift.
19. Critique the objections of continental drift theory.
20. Mention the points of tectonic plates theory.
21. Explain the reasons of tectonic plates movement.
22. Explain the continental drift and earthquakes and volcanoes origin on bases of tectonic plates theory.
23. Explain the formation of Atlantic and Indian oceans.
24. Explain the formation of Red sea.
25. Use scientific methods of thinking to explain another geological phenomena.
26. Define Earthquakes and its reasons.
27. Mention the different kinds of earthquakes.
28. Mention the different kinds of earthquakes' waves.
29. Determine the location of epicenter of earthquake.
30. Compare between earthquake intensity and ability.
31. Estimate the role of scientists and their efforts.

## Earth Movements and Continental Drifts

### First: Environment and balance of geologic activities

Through the geological time, the ecologic conditions varied greatly due to variation between water-covered areas and land and changing topographic terrains as well as transition of climatic zones as a result of shifting Earth's poles which affect the living organisms, whether animals or plants.

The consequent are migrations or accumulation in certain regions of the Earth's surface and scarcity in other regions. The environmental changing is usually accompanied by genetic changes promote, after a long period of time, the appearance of other species more adapted to this new environmental conditions.

### Examples of the Ecological Adaptation of Organisms

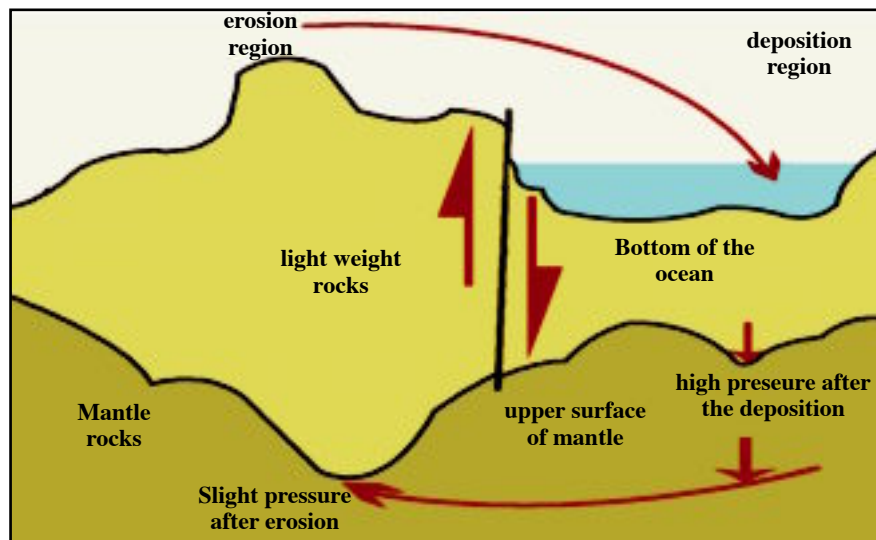
- The flourishing of the vegetative cover during Carboniferous period (300 million years ago) as a result of warm and moist climatic conditions and plains of organic rich soil needed to plant. These conditions result the accumulation of vegetation organic matter in large quantities buried deep enough and had provided the chance to transform plant residues to coal seams which their quality varies depending on the degree of transformation. An example, occurrence of coal seams in Bedaa and Thora area south west Sinai.
- other example, the rock salts layers (NaCl and others) had accumulated during the Permian period (250 million years ago) occurred in central Europe representing different environmental conditions from previous example. These was marked by the spread of depositional basins with great extension and small depth, sometimes intermittently connected with ocean water then separated of it several times, which provided an opportunity to concentration and deposition of salts in the form of layers as a result of evaporation processes for high temperatures under arid climatic conditions.
- A third example of the accumulation of organisms in certain environmental conditions is the accumulation of phosphate deposits, which consists of marine vertebrate animals remains during the upper Cretaceous period (90 million years ago) was reported in North Africa. These deposits reflected that ordinary temperature and normal salinity prevailed in shallow marine conditions. The result is the spread of these deposits of economic value. Examples in Egypt are the phosphate rocks existing near Safaga and Quseir (Red Sea Coast) and in Seba'eya (Nile valley, Upper Egypt) and in Abo Tartur (New valley, Western desert).

## CHAPTER 4

- Among the familiar examples are those variations in ecologic conditions recorded during the Glacial period (since about one million years ago) and the consequent progress of this the ice sheet to south in the northern hemisphere made up glacial periods and was accompanied by periods of heavy rains (rainy periods) in southern areas of the northern hemisphere. By retreat of these ice sheets northward during the periods between glacial periods, the southern areas of the northern hemisphere were described as dry areas (interglacial periods) in the same periods mentioned before had given rise to environmental conditions as a result of decline and rising sea, affecting the flourishing and intensity of the vegetative cover during rainy periods and consequently the proliferation of animal groups that feed it. During dry periods, the vegetative cover had been deteriorated, causing decline of animal groups accordingly. These cyclic regime had been continued since the beginning of the Glacial period and ended more than twenty thousand years ago, where soils and crops improved considerably in the northern areas of the African Great Sahara and resulted in prolific farms for the profits, welfare and civilization of the human being.

### The isostatic balance and it's relation to some catastrophes:

The geophysical studies done by professor **Airy** proved that the mountain chains that spread all over the earth's crust which formed of **Sial rocks** those of light rocks of low average density  $2.8 \text{ gm/cm}^3$  to be in state of equilibrium with the surrounding depressions and plains due to presence of root for these mountains that sink in the mantle of high density rocks for distances reaches four times its height. This state of equilibrium agree completely with many of the geological phenomena we have observed due to weathering processes and occurrence of some destructive earthquakes in areas between huge mountains and surrounding depressions.



The Balance of Earth's Crust

Due to continuous erosion on top of mountains and plateaus, the exposed rocks are disintegrated and transported away causing lowering in the weight of these mountains and decreasing the affecting pressure on underneath rock layers. Whereas the pressure increases in areas where fragments are transported due to depositions processes.

Consequently, gradual flow of the light molten rock (magma) which is rich in feldspar and quartz forming the granite in upper mantle layers under the deposition areas to the disintegration areas so the mountains rise up and earth crust regain its balance.

### **Balance of the earth's crust**

A classic example for this balance is the River Nile basin prior to 1964 (last annual flood in Egypt).it is calculated that the Nile carried annually more than 100 million tons of load in the form of sand, silt and clay during the flood season (August and September) and built up its delta within millions of year ago through the old seven branches (now reduced to only two branches Damietta and Rosita). As a result of these tremendous amounts of sediments and their excessive weight and increasing pressure in the delta and its cone which extends northwards for more than 10 kilometers in the Mediterranean sea, and the present sedimentation south of the High Dam in Aswan, elastic rocks (magma) flow gradually southwards to compensate what transported of sediments from Abyssinian plateaus and equatorial Africa, thus maintaining the crust in an equilibrium and stable state.

### **Earth Movements and Their Effects on the Rocks:**

During the long history of the Earth (4600 million years), the Earth had been subjected to numerous movements which changed the landmasses, areas of seas and oceans and consequently the mode of life that existed during the different ages.

### **The evidences that reflect occurrences of earth movements:**

1. The occurrence of sedimentary strata, which were originally of marine deposits and accumulated on ocean floor, building up the summits of mountains and plateaus, ex. summit of Everest (Himalaya Mountains) at an elevation 8840 meters above sea level and there is rocks like it in the base of the Dead Sea at 762 meters below sea level.
2. The occurrence of coal seams at great depths below sea level, which were originally thick vegetative remains, flourished and developed on the earth's surface above sea level.
3. The occurring of phosphate beds above sea level in some countries (regions). These phosphate beds were originally represent remains of marine vertebrates which dwelled in shallow marine environments.
4. The presence fossiles of coral reefs in the high places above sea level and it was marine living organisms. in the form of colonies on the continental shelf of the coastal region in any warm

## CHAPTER 4

marine environment of high energy, clear water and has high salinity conditions affected by high amount of lighting and rich in organic matter.

5. A recent example of earth subsidence, the presence of remains of submerged Roman Temples in Alexandria waters, as well as many villages and coastal surveillance centers in northern delta has been flooded by seawater.

### Earth movements are classified into two main categories:

#### 1. Epeirogenic Movements:

This name is derived from the Latin origin “Epeiros = continent” which means that it is a slow movement which acts for a successive geologic time and affects extensive regions of the continent or ocean floor causing gradual uplift or subsidence of the sedimentary sequence without deformation neither by folding nor faulting. The emerged strata appear almost horizontal or in the form of plain folds at high altitude above sea level.

This kind of movement plays an important role in distribution and relationship between continents and oceans throughout different geological times.

As an example for this movement is the grand canyon of Colorado River in North America. Here, the Marine sediments remain horizontal on both sides of the canyon attaining an elevation of 1580 m. above sea level same as its original state of deposition.

Which signifies that areas of land were uplifted without exposing to deformation during uplifting processes that continued slowly and consecutively for long times.

#### 2. Orogenic Movements:

The name is also derived from the Latin origin (Ores = Mountain) and it is relatively rapid movement compared to the Epeirogenic movement. In the meantime, it changes the shape of the strata causing tight folding and intensive faulting through low inclined faults with great side displacements. The effect of this movements usually appears on limited distinction extent for long distances on earth’s crust rocks where the deposits accumulates over each other’s to occupy small areas after it was flattened on large areas and resulted in chains of mountains in local regions.

From the examples are the Atlas mountain chains of north Africa (which extend in Tunisia, Algeria and Morocco), the Alps mountain chains of central Europe (which extend in France, Switzerland, Italy, Austria and Hungary) and the Himalayas mountain chains (north of India) and north Egypt, such mountain chains are reported extending from Maghara massif mountain in north Sinai to Bahariya oasis in the Western Desert through the areas of Shabarawet Southrn Ismalia and Abu Roash west Cairo.

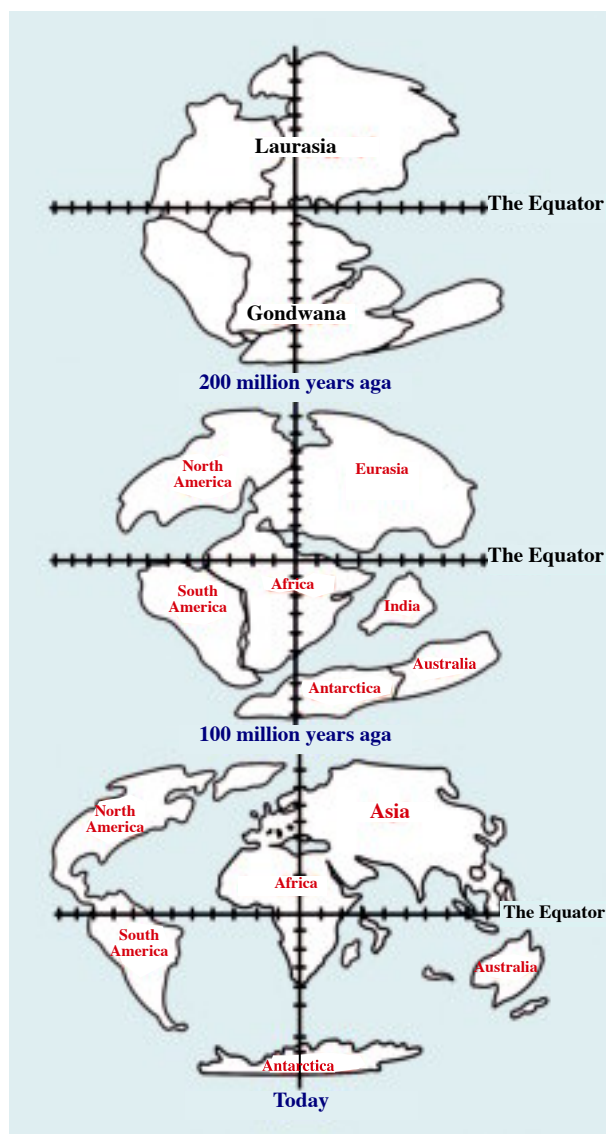


It is noticed that the magma is extruded through deep seated faults and reaches near the surface where it cools down giving rise to fine crystalline igneous rocks either inter stratified or cutting across the deep and surface rocks. In some instances, the magma ascended violently reaching the surface forming local volcanoes with lava flows, pluralistic material, volcanic dust and gases. The lava flows along the slopes of the volcanic cone carrying rock boulders and transporting them to low areas where they cool down.

## Second: Continental Drift and Theory of Plate Tectonics

### Continental Drift

The great similarity between meanders of the eastern coast lines of both North and South America and meanders of the western coast lines of Europe and Africa gives the idea as if they were one land piece and drifting away from one another. Similarly, the co-relatable criteria of the rocks of these continents and close features of ancient life and distribution of climatic belts on the two opposite sides of the Atlantic Ocean inspired **Alfred Wegener** a German Meteorologist, to introduce his theory in (1922) which claims that the continents of the Earth were a huge vast landmass (called **Pangaea**) formed of the Sial (the sial rocks which is dominant in continental bodies) whose rocks are rich in silica about 70% and aluminum, (hence the name Sial) which is prevailing in the continental bodies, over Sima (sima which form the ocean beds & extend under the continents), whose rocks are less rich in silica about 45% but is the dominant and followed by Magnesium, (hence the name Sima). The rocks of the Sima build up ocean floors and extend under the continents at great depths during Paleozoic era. This single vast landmass (Pangaea) started by the Mesozoic era (since 220 million years



Continental Drift Theory

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ago) to split into pieces far apart from each other and they achieved their present positions as our modern continents by during the Pleistocene time.

Wagener attributed this slow drift to convection currents of heat in Sima which have enormous capability of folding and faulting the crust causing pronounced difference in the topography particularly on the edges of large continents as North and South America,

Africa and Australia where great mountain chains are formed due to continental drift.

### Evidences supporting theory of continental drift:

Since the theory of continental drift was introduced by Wegener, it has been argued for more than 50 years. However, the evidences for the theory and justifications were convincing and the following proofs were introduced:

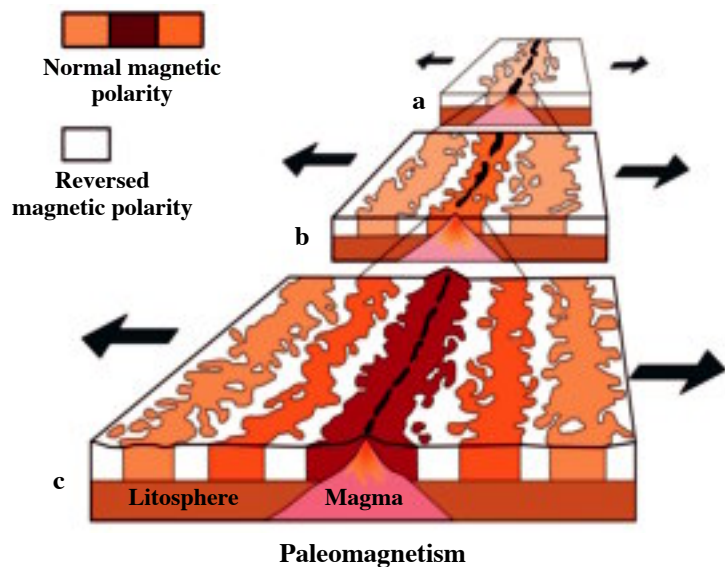
#### (1) Paleomagnetism:

It is the magnetism of rocks that containing magnetized minerals such as iron oxides which affected by Earth's magnetic field during formation of those rocks, where some magnetic minerals in rocks show similarity in the direction and intensity of the magnetic field at their formation, which gives evidence of the old magnetic field of Earth and their behavior in different geological eras.

During study of igneous & sedimentary rocks scientist found that the deviation angle of magnetic needle of compass is  $90^\circ$  at pole &  $0^\circ$  at equator.

If a sample of rocks is found with deviation angle of  $20^\circ$  near the people we conclude that its original position was near to equator and that is an evidence of continental drift different ages as well as for rocks of the same age in different parts of the world.

As well as at the study of mid-ocean ridge shows the similarities of magnetic polarity changes on both sides of the mid-ocean ridge as shown in the figure which indicating the occurrence of continental drift.



## (2) Paleoclimate:

The climatic belts are arranged nowadays in a parallel manner extending from East to West. They grade from the equatorial, tropical (desert), and temperate (Pasture and herbs areas) then securities deciduous forests, conifer forests end with the freezing polar climate.

And from the study of geological record we can support the continental drift through:

- a) **Ancient Evaporites Deposits** : Evaporites are salt deposits which accumulated as layers as a result of the evaporation of solutions containing these salts in an arid dry climatic regions. Through the study of the ancient evaporites, where currently exists in extremely cold areas of northern hemisphere in northern Europe and Canada.
- b) **Old coral reefs and coal**: From the study of rocks containing coral reefs and coal which exist only in tropical and equatorial environment respectively. The presence of these rocks closer to polar regions today that differ than the environment of formation indicates the continental drift theory.

## (3) Late Paleozoic Glaciations:

In the southern hemisphere, Cretaceous outcrops show many striking similarities among the rocks of the various continents from late Paleozoic up to Cretaceous. These are recorded in South America, the Falkland islands, South Africa, India, Australia and Antarctica.

This phenomenon reflects the existence of a great southern continent called Gondwanaland. The distribution of ancient glacial deposits on the various southern lands is one of the convincing lines of evidence for continental drift particularly the identical features of the glacial cover in both South America and Africa that indicates that they were one continent that drifted away from each other.

## (4) Animals and plant fossils:

Presence of an assemblage of some reptiles fossils that can't cross the oceans and trapped in the rocks of southern continents only, also the presence of leaves, seeds and fossils of primitive terrestrial plants in southern continents and India, prove that there was a connection between these continents.

## (5) Geological structure of the continents:

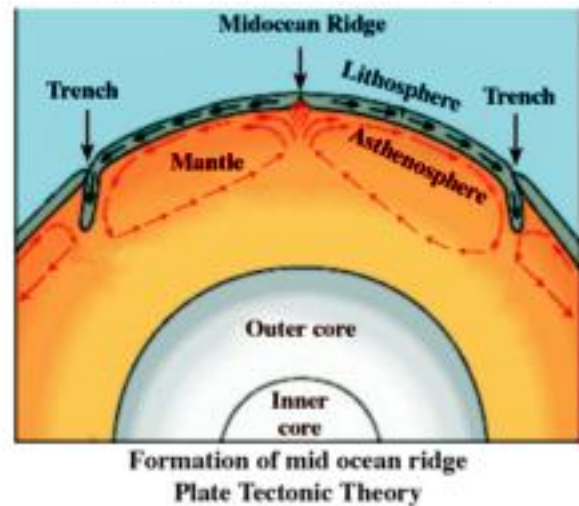
Furthermore, some anciently formed mountain chains now terminate abruptly at the continental margins. If these continents are joined together, their geologic structures will match up between the landmasses. As an example, is the close similarity between the mountains of south Africa and their counterparts in Argentina to the west Africa and the

## CHAPTER 4

mountain of Australia to the east Africa and also western African coast with the eastern south america coast.

### Plate Tectonics Theory

This theory was proposed by scientists Isaacs , Oliver and Sykes in 1968 followed by a series of studies based on the assumption that the earth surface is made up of a number of large lithospheric plates either oceanic or continental each attaining up to 100 km in thickness. The boundaries of these plates are located at tremendous growing fractures extending for long distances on deep ocean floors or on high mountain chains. These plates are in continuous motion in very slow speed due to the presence of rotational convection current resulting in all massive structural phenomena on earth's crust.



### Reasons of Plate Tectonic Motion

The motion of plate tectonics resulted due to the variation in temperature distribution in mantle which forms rotational convergent currents in magma which exists in the upper layers of mantle.

These currents are two kinds, one is moving downward forming the deep trenches and the other is moving upward forming the mid oceanic ridge.

Seas and oceans beds are formed of heavy specific gravity basaltic rocks (high density) called

Sima whereas continents formed of light specific gravity granitic rocks of (low density) called Sial, so these oceanic plates slides under the continental one and then melt in mantle when are driven by convection current. There are three types of motions are divergent , convergent and sliding and we are studying them in detail:

### There are three kinds of boundaries movements which are :

1. Divergent boundary motion
2. Convergent boundary motion
3. Transform plate boundary (sliding) motion

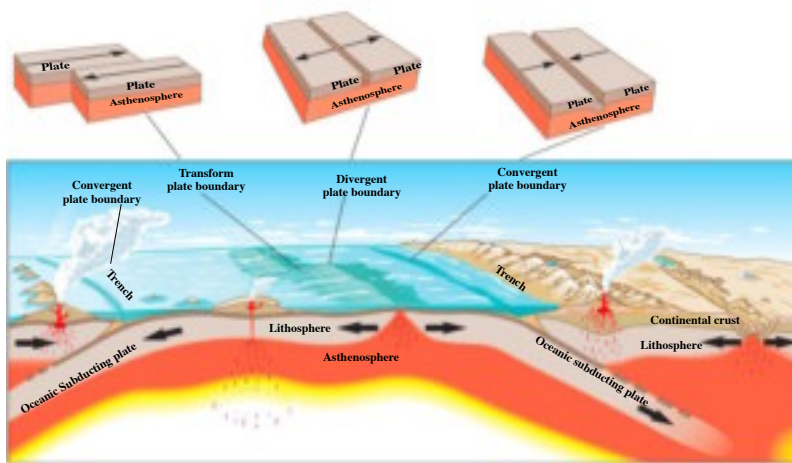
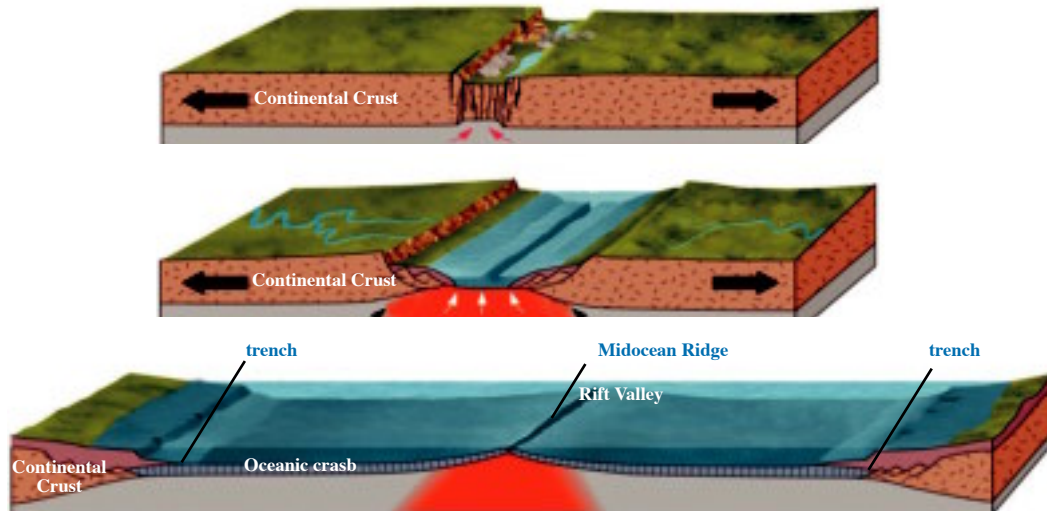


Plate Tectonic Motion

### 1. Divergent Plate Motion :

Also known as constructive motion, which arise from tension force where two plates move away from each other's as in mid continental drift and red sea where the Arabian plate move apart from the African plate so a new oceanic plate is formed between two continents or between number of continents as in Indian and Atlantic oceans.



Formation of Rift Valley and Mid Ocean Ridge

### 2. Sliding (Transform) Plate Motion :

Produced as a result of sliding of edge of a plate with edge of other plate forming transforming vertical faults causing fractures or deformations also some volcanoes and earthquakes may be resulted as San Andreas fault and also appears in Aqaba gulf.



## CHAPTER 4

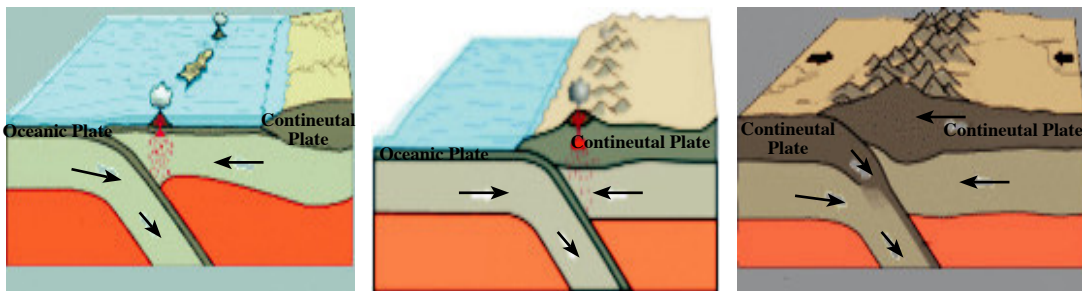
### 3. Convergent Plate Motion :

Also known as destructive motion, it produced as a result of moving of two plates towards each other where they meet and colloid together . This movement may be between

A) two continental plates where collision leads to the formation of mountains chains as Himalaya

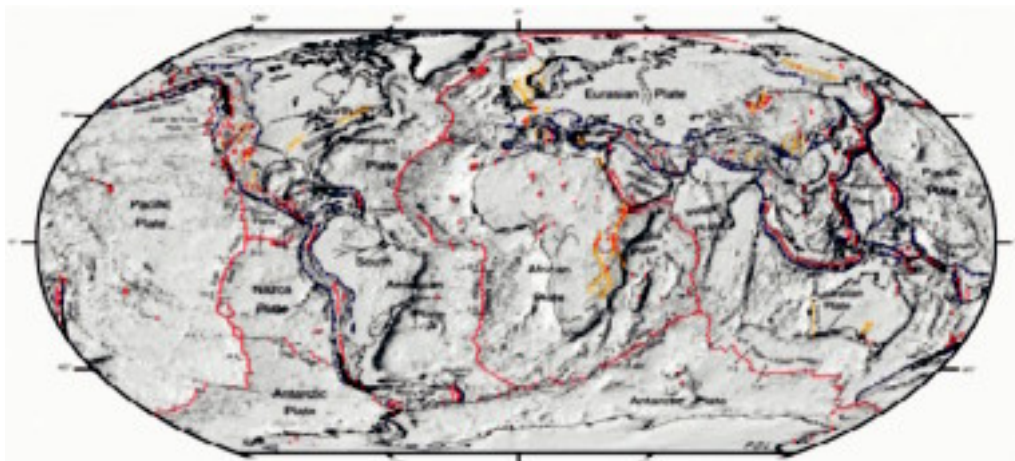
B) two oceanic plates where one of them slides under the other producing deep oceanic trenches and volcanic island arcs.

C) one oceanic plate and other continental plates where the density of the two plates are differ, the oceanic plate sinks below the continental plate in mantle layer and melts completely forming chain of mountains as Andes mountain in southern America also in Mediterranean sea.



Types of plate Tectonic Motion

Through continuous study and plotting the sites of earthquake foci on the world map, seven large tectonic plates are traced. These are, the African, Eurasian, North American, South American, Pacific, Australian, Antarctic plates, plus a number of smaller ones, and as mentioned before, all are moving slowly.



Large Tectonic Plates

The continent would split away and oceanic basin is gradually and very slowly formed. As what happened in Africa continent, where the Red Sea originated and is widening and its sides continue moving apart by a rate of about 2.5 cm per year. The same applies true for Gondwana continent and gave rise to origination of Atlantic and Indian oceans.

From the previous, it is clear that the use of the term of continental drift and spread of the sea floor are not enough to contain all the terminology related to modern plate tectonic.

## Earthquakes

**Earthquakes** is a trapped energy inside the earth's layers which escaped in form of consecutive quick fast shocks (seismic waves) one after the other, occurred on the earth's crust and may cause massive destruction or as weak as to be felt by human.

### Examples of Recent Earthquakes which have Obvious Effect:

- The earthquake that struck Egypt in October 12th, 1992 and destroyed thousands of buildings and killed about 600 persons.
- Recently Tsunami (Marine seismic) that surprised many Asian countries bordering on Indian Ocean in December 26th, 2004 which killed tens thousands of people and destroyed villages and coastal cities in Indonesia, the Philippines, India and other countries.
- Finally the earthquake that struck Japan in 2011 and caused great disaster.

### Types of Earthquakes:

#### 1. Volcanic Earthquakes :

Their occurrences are associated with volcanic activity which indeed are local earthquakes, their impact do not extend in large areas (spread for limited areas).

#### 2. Tectonic Earthquakes:

They occur in areas where the rocks subjected to faulting as a result of the motion of tectonic plates often. They are the most common earthquakes occurrence.

#### 3. Plutonic Earthquakes:

Their foci are found at great depths reaches more than 500 km under the Earth's surface.

## CHAPTER 4

### The most important reasons of earthquakes :

It is due to breaking of rock masses sudden fractures as result of exposure to intense pressure or tension process which the rocks is not strong enough to bear these forces then broken and liberated the enormous potential energy and turns into kinetic energy.

The kinetic energy moves from the earthquake epicenter in the form of seismic waves spread to the vast distances and vibrate the rocks that pass out until reach Earth's surface doing vibration to constructions which leading to their cracking or destruction.

Disturbance will be as stronger as possible in the region can be located directly above the earthquake epicenter and this area is known as the epicenter point, and the intensity of the mechanical turbulence decreases quickly away from this point.

The device used to record earthquake is Seismograph.

### Seismic Waves

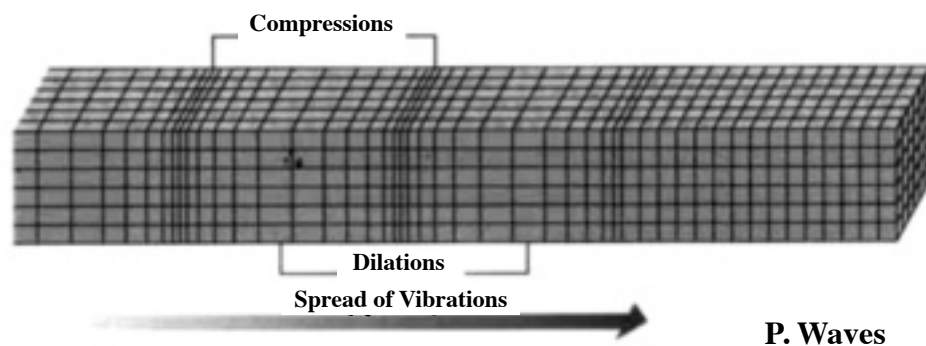
**There are two types of earthquakes' (seismic) waves :**

1. Body (Primary and Secondary) Waves.
2. Surface Waves.

#### First : Body Waves

##### 1. Primary Waves (P-Waves)

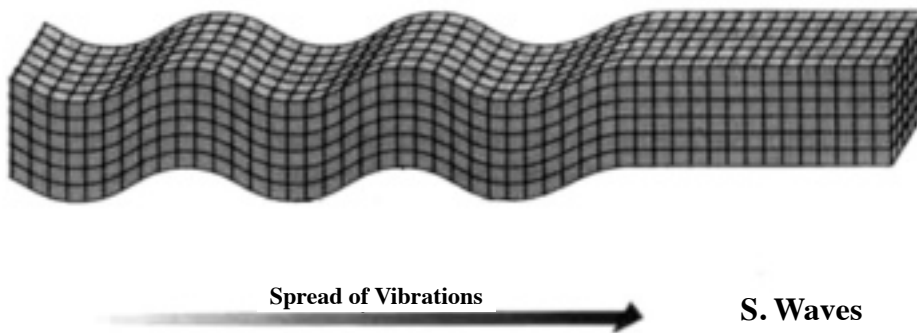
They are longitudinal (primary) waves spread very fast and they are the first to reach the seismic monitoring machines (seismogram). They spreads all over solids, liquids and gaseous bodies.





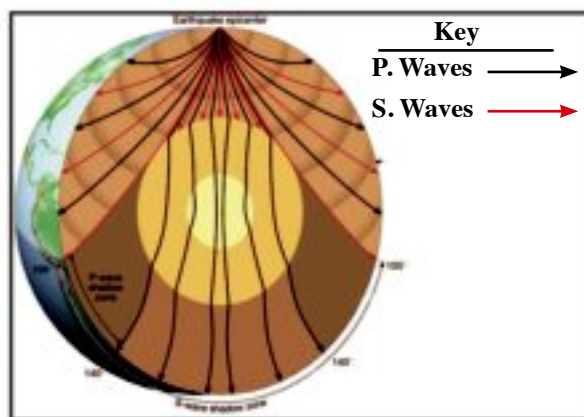
## 2. Secondary Waves (S-Waves)

They are transverse (oscillatory) waves of slower primary waves. They can't spread in liquids or gases that means they spread only in solid bodies.



### The Importance of Studing Body Waves:

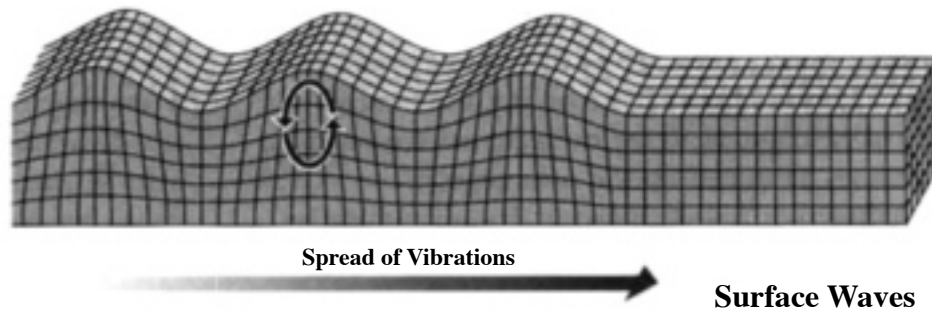
- Through the study of these waves, the scientists discover Earth's interior structure core and can determine the earthquake foci.



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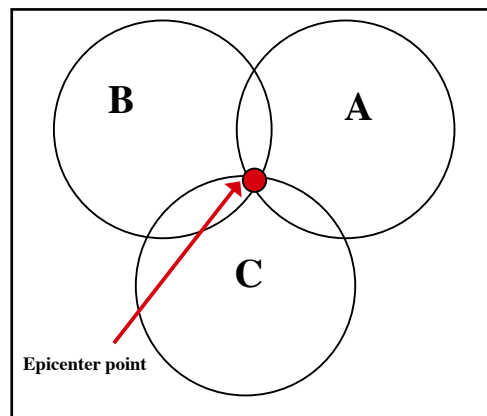
### Second: Surface Waves

They are called the long waves and they are complex waves of high frequency that spread near earth's crust. They resulted from the high energy of primary and secondary waves. They are the last waves reaches the seismograms and they are also the cause of mass destruction.



### Determination of the Location of Epicenter:

By cooperation between three seismographic stations (A,B and C) each one determine the relative time of the arrival of the three types of waves. By knowing their speed and times of their arrival, so we can determine the distance between station and the surface foci earthquake. Then we draw three circles on a maps, each station represents the center of a circle the point of intersection of these circles is the epicenter point.



Determination of Epicenter Point

## Earthquakes Measurements

### Measuring the Intensity of Earthquakes:

The intensity is a specific measurement of the damage results by the earthquake beside the reaction of people by it.

The most common intensity scale used in US and world is the modified Mercalli scale in 1931. This scale is divided into twelve scales between very weak one (which are not felt by human) to very strong (which causes mass destruction).

### Magnitude Scale of Earthquakes:

When comparing quantitatively the earthquake, we must use a more accurate measuring scale than Mercalli depends on the amount of energy released, Charles Richter in 1935 had developed this scale.

Richter scale measures the magnitude of the earthquake (i.e. the total amount of energy released from the earthquake's source).

The magnitude of strongest earthquake till now was 9.5 on Richter scale in Chile 1960.

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### Exercises

1. What is meant by isostatic equilibrium and its effect on the crust surface?
2. Mention three example for each of the Epeirogenic and Orogenic movements? And the effect of each of them on rocks?
3. What are the ecologic conditions favouring flourishing of the vegetative cover and the economic deposits relative to it?
4. Discuss briefly the origin of continental drift theory and the criteria supporting it.
5. What is meant by (tectonic plate) how it is formed and its effect on the shape and stability of the crust?
6. Define the earthquake and explain its types?
7. Write briefly on plutonic earthquake, earthquake foci, Richter scale?
8. How can you determine the location of earthquake epicenter?
9. Write the scientific terms for each of the following statements?
  - 1) Kind of earthquakes its foci at great depth of the earth
  - 2) Sudden earth shocks one after the other which cause great mass destruction (catastrophic).
  - 3) Longitudinal primary waves spread very fast and it is the first to reach the seismic monitoring machines
10. Give reason for each of the following statements?
  - a) Presence of salt (saline) rocks in mid-Europe in Permian Era.
  - b) Presence of phosphate layers on land.
  - c) Growth of coral reefs in red sea and its absence in Mediterranean.
  - d) Formation of great rift of Colorado river and Alpine chain.
11. What do you know about the origin and history of the Red Sea in the light of plate tectonics theory?
12. Compare between?
  - 1) Sima and Sial.
  - 2) Epeirogenesis and Orogenic movements.
  - 3) Primary and secondary waves of earthquakes.

**PART 1**

**CHAPTER 5**

**Equilibrium between  
atmosphere, hydrosphere  
and lithosphere**

## Objectives

**After studying chapter five the student should be able to:**

1. Explain the apparent instability of earth's topography.
2. Compare between the internal and external forces affecting on the earth.
3. Explain the meaning of erosion.
4. Explain the steps included by erosion.
5. Explain the meaning of weathering.
6. Explain the factors effect on mechanical weathering.
7. Compare between mechanical and chemical weathering.
8. Explain the effect of chemical weathering in granite.
9. Compare between the winds as an agent of degradation and as an agent of deposition.
10. Identify the differential erosion and formation of terraces.
11. Show the degradation effect of rains.
12. Explain the meaning of torrent, and compare between degradation and deposition factors of it.
13. Define the meaning of river and its different stages.
14. Compare between the river as an agent of degradation and as agent of deposition.
15. Compare between wind load and river load.
16. Explain how the delta is formed.
17. Define the underground water.
18. Compare between the groundwater as an agent of degradation and as agent of deposition.
19. Explain the degradation factor of seas.
20. Identify the sea zones and their type of sedemints.
21. Mention the meaning of lakes and ways of its formation.
22. Compare between fresh and saline lakes.
23. Explain how the soil is formed.
24. Compare between the residual soil and the transported soil.

## Equilibrium between atmosphere, hydrosphere and lithosphere

You think that the surface of earth including the topography is constant and it's not change by time, because the influence of the various factors usually slow and cannot be easily observed at a specific time, but over the years and times we can noticed this change to become clear, for example the effect of the wind that carry sand from one place to another to cover landmarks, such as buildings and trees and other assets in the desert environment. We also note that the accumulation of sand in the form of sand dunes, so the shape of the earth's surface is changing by the wind factor and also earthquakes and volcanoes that contribute among the factors that are changing the Earth's surface where cause a decline in the earth's crust in some places and stand heights in other places, as well as add amounts of the underground to the earth's surface, As the lava spills from, we believe that stability in the form of the earth's surface is in fact virtual stability only, but in fact the form of the earth is constantly changing due to different natural factors, which can be divided into two main sections:

### First: external factors:

The external factors include the effect of the atmosphere and hydrosphere in the earth's crust, From the examples of these factors the change in temperature, rain and wind and the resulting of torrential, rivers, lakes, seas, oceans and glaciers, as well as plants and animals.

### Second: Internal processes:

These factors resulted from the latent heat of earth's interior, and different internal pressures which cause earthquakes, volcanoes and earth's movements retraction.

Both internal and external factors effect on the earth's shape which resulted in shapes and geological structures the so called topography, we will talk in details on external factors only.

### External or surface factors

The external factors that cause change the surface of the Earth's crust, it derives its energy from the sun, these factors are working hard in the earth's surface to become flat free from any topography so it has degradation effect, but the external factors regain its equilibrium through uplifting of great parts from earth's surface due to earth's movement and volcanic activities but if not of these factors the earth's surface becomes flat and free of any topography from long times this surface is called **base level of erosion** and which is the lowest level that constructive factors can be reach in Earth's surface for which the external factors are done to reach it to be equal to sea level, this means that the external factors have destruction factor which is called denudation and another constructive which is called deposition. So

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**the external processes** have two factors, one is destructive (denudation) and the other is constructive (deposition).

### (1) Denudation

It means the effect of the external processes on rocks, fragment it then transport these fragments from its place to expose a new surface of rocks to this process again. This process is called erosion. The transporting agents as (water, wind, torrents and rivers) are transported these fragments to deposit to form layers of sedimentary rocks.

**It is divided into three stages:**

- a) Weathering.
- b) Erosion and transportation by water, winds, or both.
- c) Transportation of sediments by gravity.

In the following these processes will be discussed in some detail.

### (a) Weathering:

All materials or rocks are exposed on the surface of the earth to the effects of weather factors, although this effect is changeable from rock to another according to many factors, look at the surface of a piece of marble



or any other ornamental stones or look at the front of a new building, you find its surface is smooth and shiny. You can compare the surface of rock of an old building you find the surface may become very rough and lost its luster and shine.

Another example, the body of the Sphinx, which was smooth surface during its construction, but now it was fractured and rough under the affect atmospheric factors for more than three thousand years. The end result of weathering of rocks is the fragmentation of rocks into smaller pieces due to mechanical weathering or decomposition of the rocks minerals into new ones by chemical weathering.

### Mechanical Weathering

Mechanical weathering is the breakdown of rock masses into smaller fragments of the same mineral composition as the original rock or decomposition of the rock into its constituting minerals under the effect of physical weathering conditions without change in its chemical or mineral structure. For example, a block of granite, composed of the three essential minerals: potash feldspare, mica and quartz. If this block is broken down to pieces



in the size of gravel each grain contains the three minerals of granite rock. But if we break it into smaller pieces, each in the size of a sand grain. Each grain will consist only of one mineral only of the three constituent minerals.

### **Factor of Mechanical weathering:**

Mechanical weathering occurs in nature under the effect of physical (natural) factors as freezing of water, the continuous change in temperature and the change in overloads on rocks also the life activity of both plants and animals which has clear results on rock desintegration.

#### **1. Repeated Freezing and melting of water in rocks fractures**

Repeated Freezing and melting of water in rocks' fractures and joints is considered as one of the most important processes of mechanical weathering in cold polar areas or high mountains. Where water freezes to ice and its volume increases causing pressure on sides of rock fractures and joints near the surface even it is horizontal or vertical and its wide increase and would be separated the block from the mother rock. Blocks and fragments usually fall and accumulate at the foot of the mountain or cliff and form a talus slope.

#### **2. Variation in temperature:**

The heat expansion resulted from surface expansion of rock and its mineral structure and its repeated contraction due to changes in daily temperature especially in arid desert areas represents one of the most weathering factors which decrease the coherence forces between the mineralogical components of the rocks due to the great difference in temperature between day and night this cause its desintegration and as the time passes this process is repeated, the fragmentation of gravels in desert is related to the repeated changes in temperature.

#### **3. The release of pressure due to erosion:**

Another factor has great effect in mechanical weathering is the expansion of rocks due to releasing of load due to erosion, When a thick sequence of strata is eroded which were represent a load or weight for underneath rocks or appearance of igneous plutonic rocks on the surface that were under high pressure the rock are expanded due to the releasing of the uploads.

This is seen in granites when they become exposed on the surface. The rock surface separates into successive spheroid shells (like the skin of an onion) following the direction of joints. This feature, known as spheroidal weathering or exfoliation, is aided by the change of feldspar to clay by chemical weathering.

### 4. The impact of life factors of plants and animals:

We are aware of the impact of life factors in the break up and the dismantling of the outer surface of the land components:

- (a) The roots of the plant strike in the soil or rock joints at its search for water, making them loose or break down.
- (b) the animals and insects that live below the surface helping to dig the soil and contribute to make it break down and subject to movement with transportation factors.

### Chemical weathering

**Chemical weathering:** is the decomposition of mineralogical components of the rocks to form new minerals as a result of adding new element or more to the chemical composition or by missing some elements that lead to change in the chemical composition. This occurs under the influence of weather conditions near the surface especially in the presence of water, which influential factor in chemical weathering is considered even those minerals become in equilibrium with the new conditions.

The ancient Egyptians was caving the majority of their statues and obelisk that made of granite rock that has strength and resistance to erosion factors impact, especially in Upper Egypt, where the dry air and rare of rainfall that remained statues and obelisks for nearly four thousand years polished smooth.

But now if we see one of the obelisks that were transferred in the late nineteenth century to Europe in London and Paris or to America in New York, where rainfall most of the year, we find that the surface of the obelisk is no longer smooth and polish as it was in Egypt but affected under the new climatic conditions and became eroded and dull.

### Factors controlling chemical weathering:

#### (1) Acidic rains:

Water is one of the most chemical weathering factors especially that contains small amount of acidic dissolved matter to form acidic rain. It usually leads to the decomposition and decay of rocks as for example limestone rock is decomposed by completely dissolved under the influence of acidic rains that carry carbon dioxide. This process is called **Carbonizing or Carburizing process.**

#### (2) Oxidation process:

The oxidation process occurred by oxygen dissolved in water especially for minerals that has iron and magnesium in their mineralogical composition as in basalt rock.

**(3) Hydration process:**

The Hydration process means that addition water to the mineral composition or minerals that formed rocks and this process lead to chemical decomposition of rocks. Example **Anhydrate mineral** (anhydrous calcium sulphate) changed to **Gypsum mineral** (Hydrate calcium sulfate).

**(4) The difference between the conditions of formation mineral and the environment of surface conditions:**

The chemical weathering lead to change of mineralogical components of rocks to become equilibrium with the new surface conditions, and so we expect that the more difference between the conditions of surface minerals and environmental conditions have the possibility of change increases, and so we find that the firstly crystallized minerals from magma at high temperature and pressure in deep earth underground is more subjected to chemical weathering than those crystallized at the later stages of magma under low temperature and pressure.

As mentioned before granite the most common plutonic rocks is composed of three essential minerals: orthoclase (potash feldspar), mica and quartz. The three minerals show different effect towards chemical weathering.

- (A) **Feldspar minerals (orthoclase and plagioclase)** have vitreous luster are very weak under the influence of carbonic acid resulting from the dissolving carbon dioxide in rainwater and it decomposed into new mineral called **Kaolinite** (Aluminum silicate) which has an earthy luster.
- (B) **Mica mineral** especially **black mica** also has vitreous luster decomposed into **caly mineral** (earthy luster mineral).
- (C) **Quartz** is the last mineral to crystallize from the magma at a temperature lower than that of **Orthoclase** and **mica**. Also, its chemical composition and physical properties make it stable without decomposition.

**Conclusion:** The granite rock when exposed to chemical weathering the feldspar and mica minerals are decomposed to kaolinite or clay minerals and quartz remain without decomposition. According to the following equation (**equation for reading**).



Therefore, if we look at the surface of the granite rock after the decomposition, we find that

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quartz mineral is the only remain unchanged while others minerals that are associated with quartz in granite rock are changed into weak and unconsolidated minerals that accelerates the impact of mechanical weathering processes that go along with chemical weathering, so disintegrate and deformation of the surface layer of rock.

If we look at the result of chemical weathering process of metamorphic and igneous rocks consisting mostly of silicate minerals represented in feldspars and Mica and others minerals containing iron and magnesium mainly consists of a set of clay minerals found in the agriculture soil mixed with other products of weathering processes.

### **(B) Transportation and sedimentation:**

The processes of transportation occurs by number of factors like wind, rainfall, torrents, rivers, seas and underground water...etc. But these factors have disintegration effect on rocks and fragmented the rocks, also these factors are transporting and depositing factors, so they have deposition factor also.

### **Differential Erosion:**

Differential erosion happens when one of different transport factors passes or collide with rocks of different hardness and those rocks composed of hard beds overlying softer ones. The soft beds are more fragmented than hard rocks, as in the case of mushroom shape terraces by the effect of the wind, waterfalls and meanders by effect of rivers, coastal meanders by the effect of the waves in the sea.



**Differential erosion  
(Mashroom shape)**

### **(1) Wind**

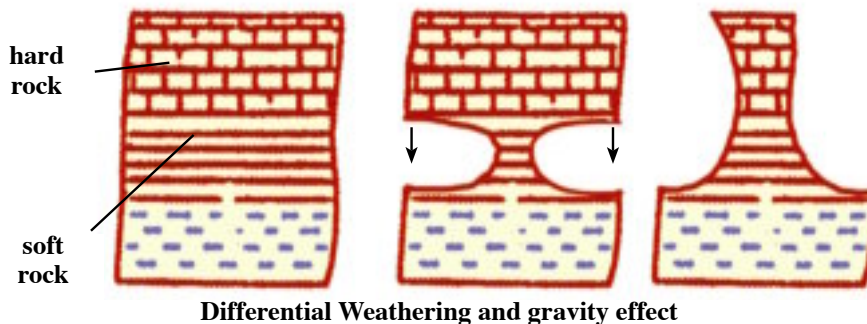
The wind has a strong influence in the desert areas where the earth's surface is free of plants so the rocks are easily to be affected by, and the Earth rock in fragmented shape by the effect of different erosion factor.

### **(A) Disintegration effect of wind:**

The effect of wind is differ according to what's the wind carry of sand and fragments of rocks or clay. The load or charge of wind classified into hanging (carried by air) or rolling on the earth's surface. The effect of wind disintegration depend on several factors, including wind intensity, size and shape and density of the granules, rock type and the degree of hardness and their affecting by climatic factors such as humidity, and the effect of the time factor.

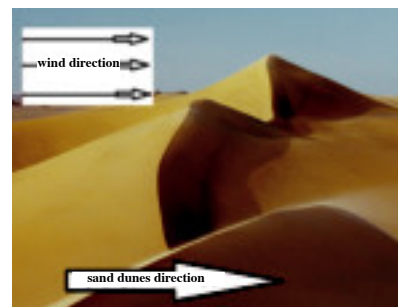
**(1) Effect of wind as it passed on a different hardness layers:**

When the wind loaded with sand pass on heterogeneous or different hardness of rocks include soft layers such as clay rocks topped with solid rock of limestone, which lead to erosion of the soft layers and remaining of hard rock that has dropped by gravity as in the case of mushroom shape **terraces** that's called **differential erosion**.



**(2) The effect of the wind as it passed on the irregularly shaped stones:**

Wind loaded by sand affect the shape of the gravel that has equilateral triangle or a pyramid shape and the front face of gravel will be polished.



**(B) Wind as an agent of deposition:**

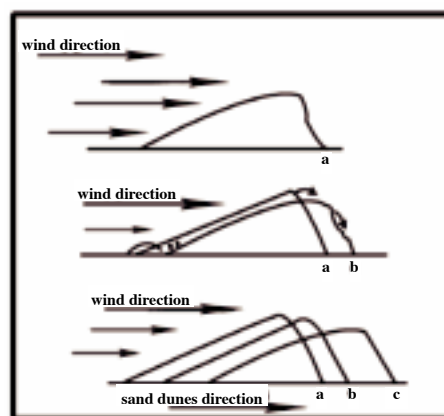
When the velocity of wind that carries sand grains decreases due to its crashed with hard rocks or a mountain and the wind will deposit its load in the form of sand dunes or ripple marks.

**(1) Sand dunes:**

Sand dunes consists of round grains of sand, vary in height from a few meters to tens meters or vary in different shapes including:

**A) Rectangular dunes or Longitudinal Dunes:**

They have rectangular shape and their direction is the direction of the prevailing wind, the rectangular dunes called El-Gharwd. Example Ghawrd Abu El-Mahariq which extends about 300 km from the northwest and to the southeast between Bahrayah oases and El-Kharjah oases in Western desert.



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### (B) Barchan Dunes: “Crescent dunes”

They take crescent-shaped dunes where Barchan dunes are slight decline in the direction of wind, and very strong decline in the anti-direction of wind, Barchan dunes are the most prevalent types of dunes.

### (C) The Coastal Dunes:

They are dunes that consists of consolidated limestone granules such as dunes that extended along the coast between Alexandria and Marsa Matrouh.

**Notes:** We also notes that the sand dunes have been moved by the wind and the rate of moving reach between five and eight meters on average in the year. This lead to the phenomena of desertification causes a great risk to the reclaimed areas and new urban communities.

### (2) Rains:

When the rains fall on the ground, some of which evaporates rising in the atmosphere, while others are passing in the depths of the earth forming the underground water or ground water , the third part is being running on the surface of the land to form running water like rivers. Rain has disintegration effect only. While its sedimentation effect it will be referred to the subject of rivers and ground water.

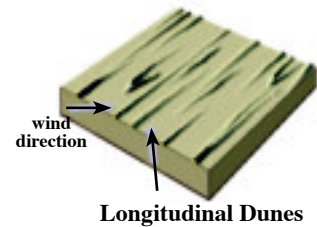
**The disintegration effect of rain is divided into:**

#### (A) Disintegration (degradation) mechanical effect:

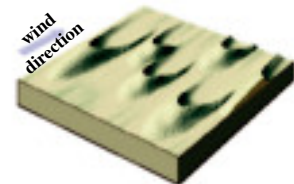
Where strong winds accompanied with rain helps to transfer the fragmented or disintegrate another part, for example carving of limestone rocks surfaces due to rainfall to form a set of grooves including low-rise grove as it is the case in the Sinai Peninsula.

#### (B) Degradation chemical effect:

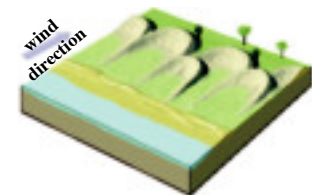
Where rainwater effect, including rains dissolved with oxygen and carbon dioxide activate the process of oxidation and carbonization.



Longitudinal Dunes



Barchan Dunes



Coastal Dunes



### (3) Torrents

#### Definition of torrents :

When heavy rain is falling over the highlands and mountains, water descend into narrow streams communicate with each made up the so-called El-Akhour (torrents streams) where torrent growing and increasingly in its size and speed until it reaches the river or the sea or flows into it as it found in Egypt, where torrents descend from the top Red Sea mountains of the Eastern Desert to flow into the Red Sea or the Nile Valley, leaving a dry streams on both of the slopes of the mountains or in the desert after discharge of water. The torrents have **degradation** and deposition (sedimentation) effect.



Torrents

#### Torrents as an agent of degradation:

Torrents carry all fragmented rocks like clay, sand and gravel or the large boulders of rocks if the stream is strong and this helps to sculpt and the stream torrents that is narrow but with the passage of time is increasing its depth and the work of torrents shows clear in the desert due to the scarcity of the plants.

#### Torrents as an agent of deposition:

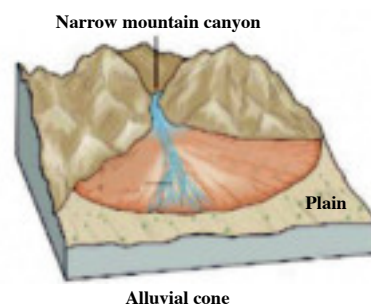
When the speed of torrents decrease when they leave Canyon and spread on plains surfaces, they deposit the carrying materials and the shape of deposit materials takes several forms:

##### (a) Alluvial cone (Alluvial Fan):

The Sedimentation take form of a half circle position, its center the outlet of the canyon (khawr).

##### (b) Dry Delta:

If the sedimentation begins with boulders and large gravel granules at the outlet area of the canyon and there is gradually decreasing in grain size of the gravel until it is finished with sediments of mud and sand at the end of the dry deposition is called **Dry Delta**.



## CHAPTER 5

### (4) Rivers:

Most of the rivers consists of permanent running water like streams and rivulets. Rivers upstream from heavy rain or ice-covered areas, river has a strong gradient at its upstream and it has a little gradient near the mouth of rivers. Rivers have degradation and deposition (sedimentation) effects.

#### (a) Rivers as an agent of degradation:

Rivers are considered the most important factors of erosion on the surface of the earth's crust. Also rivers are considered as the most important factors for the transfer of rock fragments of different sizes, the degradation effect of rivers depend on the speed of the water current and several other factors, including:

**(1) Speed of the current water and the river load:** the amount of material or sediments that river transfer them depend on:

- The capacity of river to carry sediments that depend on the slope of the river that controls the speed of the water and the amount of water in the river. Note that the speed of water is decrease on both sides of the river and at the bottom as a result of friction.
- Size and quantity of particles depends on the ability of the river to carry sediments where the size of sediments is increasing as the ability of the river to carry sediments increased. The load of the river into:

**(a) Dissolved load:** soluble salts carried by water during runoff such as sodium chloride.

**(b) Suspended load:** small grained size and light weight of the mud (silt and clay) move as suspended materials or grains in the water.

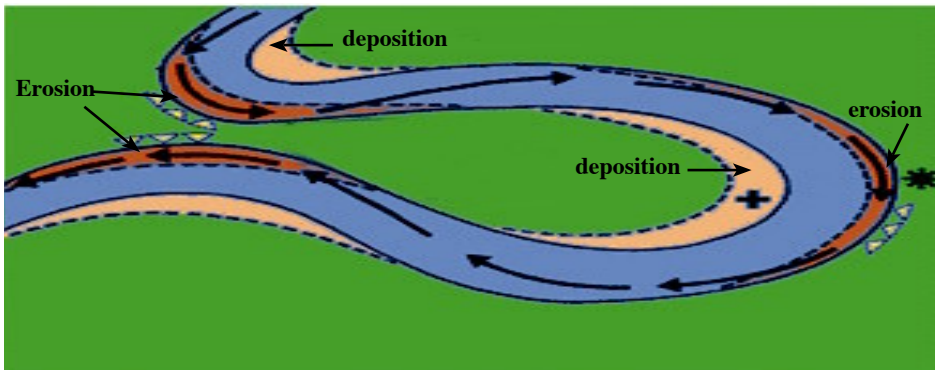
**(c) Medium sizes grains of sand:** going hanging near the bottom in the direction of the current water then roll on the bottom when the capacity of the river decrease to carry the granules.

**(d) Bottom load:** gravel granules roll on the bottom of the river in the direction of the water current, as well as we see those sliding blocks smoothing and become a round-faceted as a result of friction with the bottom. The load help to increase the depth and breadth (width) of the river.



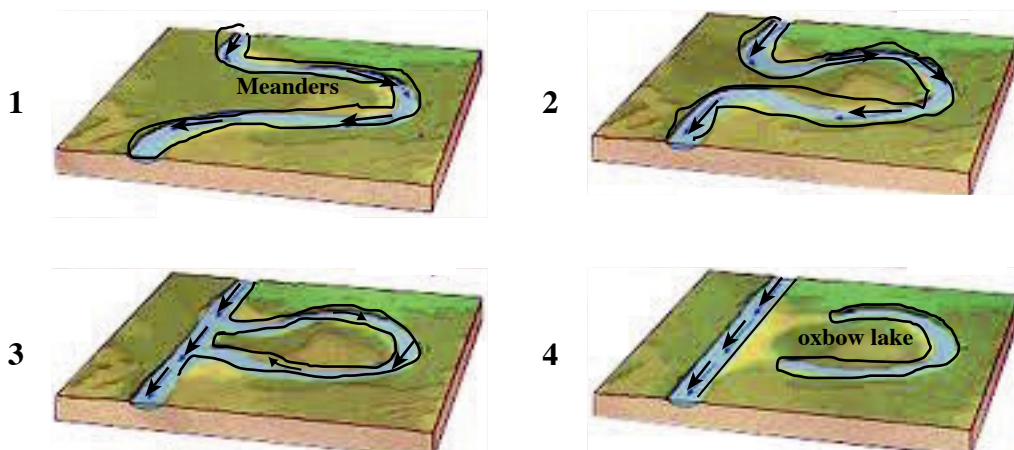
**(2) The different hardness of rocks on both sides of the river:**

The difference in hardness of rock layers between soft and hard in both two sides of river lead to erosion in one side more than the other side, which leads to the formation of **River Meanders or Meanders** as an example of differential erosion after then the stage



**Meanders Formation**

of increasing the curvature of the river occurred where increases in the erosion the outer side of the path of the water and increase of the sedimentation in the inner side of the river that side cut a new path, leaving the arc on the shape of **Oxbow Lake**. Thus, the turning of **Meanders to Oxbow Lake** considered as degradation and sedimentation effect of rivers.

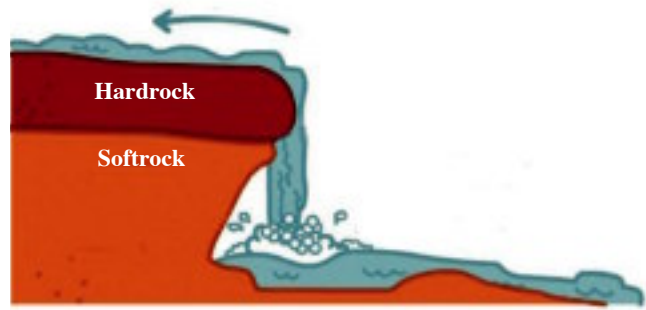


**Stages of formation of Oxbow Lakes**

## CHAPTER 5

### (3) Different hardness of rocks at the bottom of the river:

Water Falls are formed when the water passing over a rocky layers of different hardness, where the solid layer above the soft layer, the soft layer will be sharper (erode). The hard layer will be steep slope and high in elevation, so it's a normal watershed like differential erosion (Such as Niagara Falls between Canada and the United States).



Water Falls Formation

### (4) Climate as the climate has a role in the shape of water stream of the river:

(a) **If the climate was humid** in the heavy rainfall areas it helps other erosion factors like decomposition of various operations as gravity are also working on the erosion of groove lead to the widening of river stream.

(b) **In the dry areas**, the river is stronger so it keeps its load, it erode deeply carved river, as the case in the Colorado River in America.

### (b) The deposition (sedimentation) effect of the river:

The sedimentation effect of river starts by several factors:

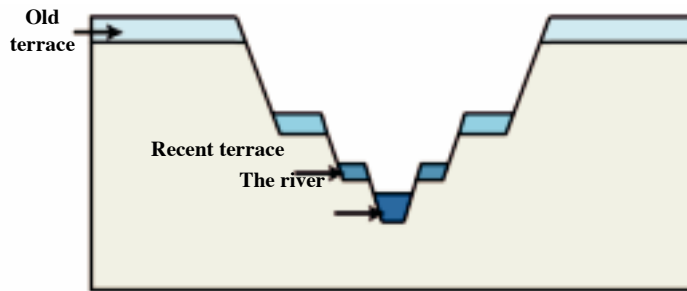
(1) **Current speed of water:** When the speed of current water of the river is decrease due to the presence of obstructions in the water stream, or decreasing the slope of stream, as in the areas of downstream, where the river loses the ability to transfer its load which lead to deposit of its load.

(2) **Volume of water:** The lack of volume of water in the river as a result of increasing evaporation or leak of water in the porous rocks or cracks inside the earth.

### (3) The downstream of river in static water:

#### (Formation of river terraces):

River terraces are formed due to change of water level at the time of flood, and notes that the gravel and boulders materials are found in the high valley area and in the middle of the stream and on both sides of the valley, and so with the water level change, so terraces of the river are formed. Note that the upper terraces is older than beneath terraces on the river. We can see these terraces on both sides of the River Nile in Upper Egypt, as well as Wadi Feeran the way to St. Catherine's in the Sinai.



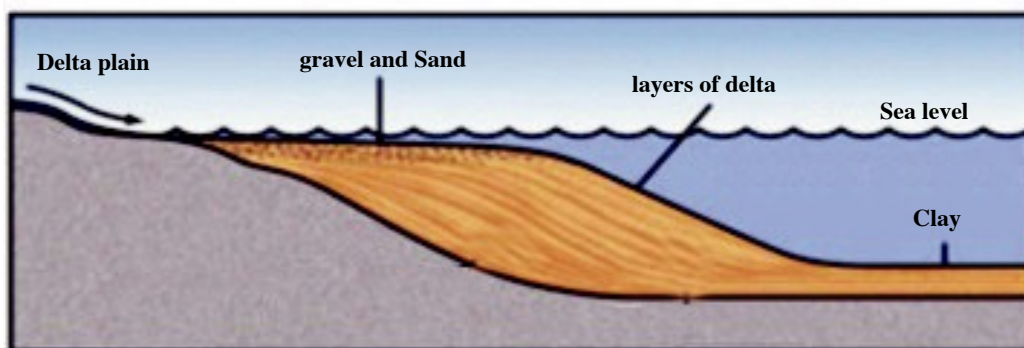
Formation of River Terraces

**Delta:**

Delta similar as *Latin* letter ( $\Delta$ ), Delta is formed when rivers joined with seas and lakes, the load of sediments that the river carry will be deposited, In order to be Delta formed it is necessary the sea is free of sea currents. When the sea has strong currents, and the bottom of the sea tends to drop and there is no Delta in this case but the river will be normal downstream only because the strong sea currents sweep the sediments that formed by the river. The river in the area of Delta plain may be branched into two branches or more as in the Delta of *River Nile*, in the past the River Nile branched into seven branches, all of them were downstream in the sea and then disappeared gradually these branches including the sediments where the river deposited it, now only remains Rashid and Damietta.



Satellite Image of Delta



Delta Cone

It should be noted that the coastal delta deposits are deltaic sediments in the delta region that extend more than ten kilometers within the Mediterranean Sea, the so-called *Nile Delta*

## CHAPTER 5

**Cone.** These sediments are classified and graded deposits within creasing depth of the sand and gravels near the beach, then silt and clay in the deeper areas containing mineral deposits of economic value, such as gold and diamonds and tin and limonite that's called **Black Sand**. **Black Sand** show in Egypt in the North of Delta area and on the coast from Rashid and Arish east and containing minerals of **Monazite** (containing radioactive uranium) Ilmenite and zircon (mineral of zirconium element) which are used in Ceramics industry.


### Action of the river at different stages:

Each river has a cycle includes various changes in the river and include several stages are a young stage, maturity stage and youth stage.


#### (1) Youth stage:

This stage characterized by drilling riverules, valleys and branches, the river is characterized by the fast stream and its irregular slope and erosion increases and less of sedimentation, which leads to the formation of lakes and waterfalls, wide of grooves to the valley sand the sector V-shaped narrow and this stage also characterized by appearance of River Capture, which arise from the disparity of branches in erosion and thus the water level of the section with more erosion less in the level of the other branch and is down stream of it. At the end of this stage it becomes a steep slope of the river.

#### (2) Maturity stage:

The valley expands to the fullest extent and its sector becomes wide  shaped. Both of erosion and sedimentation almost equal and there is increase of meandering of river, also increasing of Oxbow lakes and waterfalls disappear.

#### (3) Old stage:

In this stage the river characterized by low gradient which lead to decrease the erosion effect and increase of sedimentation and the area of river stream is called the peniplane, the river called an old stage and a sector of the river like a shape of an arc  and the curvature of the river decrease at the downstream area.

#### (4) Rejuvenation (Re-youth) stage:

There are geological factors lead to the river return to Rejuvenation (Re-youth) stage after it reached to an old stage that was occurred when tectonic movement arising takes place near the upstream area or volcanic eruption objected the river stream thus the speed of the river was increasing and the river begins to new erosion in its stream. Again the

river begin to deepen its stream while lateral erosion and corrosion or stop finally.

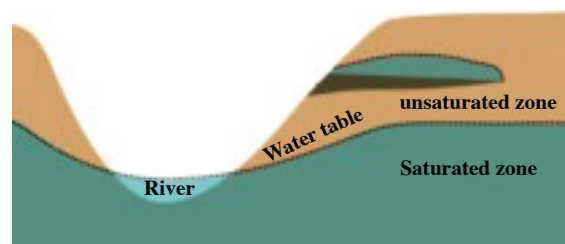
**Sector of river or profile:** It is noted that the sector shape or profile changes with the age of the river.

- River erode its stream strongly at the upstream area and the erosion and weathering factors help in these wet places and the shape of sector of the river is V-shaped.
- At the downstream area the level of the sector becomes close to the horizontal plane same as the sea level and river sector in the form of arc  $\cup$ .

### (5) Underground Water:

It is the water in the pores of the rocks under the surface of the earth and its source is rainwater or ice that seep into the ground through the pores of the rocks or cracks, gaps and joints. Some of this water is rising to the surface by capillary action or by absorption by plant roots.

The level of the soil water is called water table which is a water level that all the pores below, cracks and spaces are saturated with water and the depth of this level it differs: it's near the surface of the sea, rivers and places of rain and m far from the surface in dry areas.



Water Table

### Movement of ground water:

Ground water in a permanent movement and there are several factors controlling the movement of ground water including:

- (1) **Rock type:** include the size, shape, method of sedimentation and the cement materials of the grains.
- (2) **The porosity of rocks:** Porosity is the percentage of pores, cracks and spaces between the rocks and grains

Permeability of the rock: Permeability is the ability of the rock to pass water through the pores of the rock or how easy is the movement of water through the rock pores. (Porous Sedimentary rocks such as sandstone, sand and limestone is the best reservoir rocks to store groundwater, oil and natural gas).

- (3) The general inclination of the layers that containing ground water.
- (4) Different geological structure such as folds and faults, joints, dykes and sills.

## CHAPTER 5

### Geological effect of ground water:

### Geological effect of Ground water is divided into:

#### 1. Degradation effect of ground water

##### (a) Chemical degradation effect of ground water:

- The chemical degradation effect of ground water due to presence of carbon dioxide gas and acidic salts dissolved in water whose lead to dissolving of limestone rocks that lead to formation of caves.
- Also alkaline water or water mixed with organic acid lead to dissolve of silica that replacement the calcelica components of fossils or replacement the organic fibers of trees to form petrified woods (Fossilized trees)

##### (b) Mechanical degradation effect of ground water:

Mechanical degradation effect of ground water occurred due to saturation of porous rocks with ground water which leads to blocks of rocks to fall on the mountain foothill.

#### 2. Sedimentation effect of ground water :

(a) As a result of the dissolving of the limestone rocks by ground water that carries carbon dioxide, these solutions deposited inside caves and caverns to form :

- **Stalactites:** deposits of calcareous materials hanging from the ceiling of the cave.
- **Stalagmites:** deposits of calcareous materials grow from the floor of the cave.



Stalactites and Stalagmites

(b) Replacement of the silica by the limestone materials in the formation of fossils and place of fiber in the formation of Petrified trees and so this process is the work of degradation and sedimentation.

#### (6) Seas and Oceans

Seas and oceans affect everything that surrounds them from the earth's crust by continuous motion of that causing tidal waves as well as tide and ebb and ocean currents and the influence of the seas in the degradation process that less than sedimentation process.



**(a) Degradation effect of seas and oceans:**

The degradation effect of seas and oceans depend on the continuous movement of water and is influenced by several factors, namely:

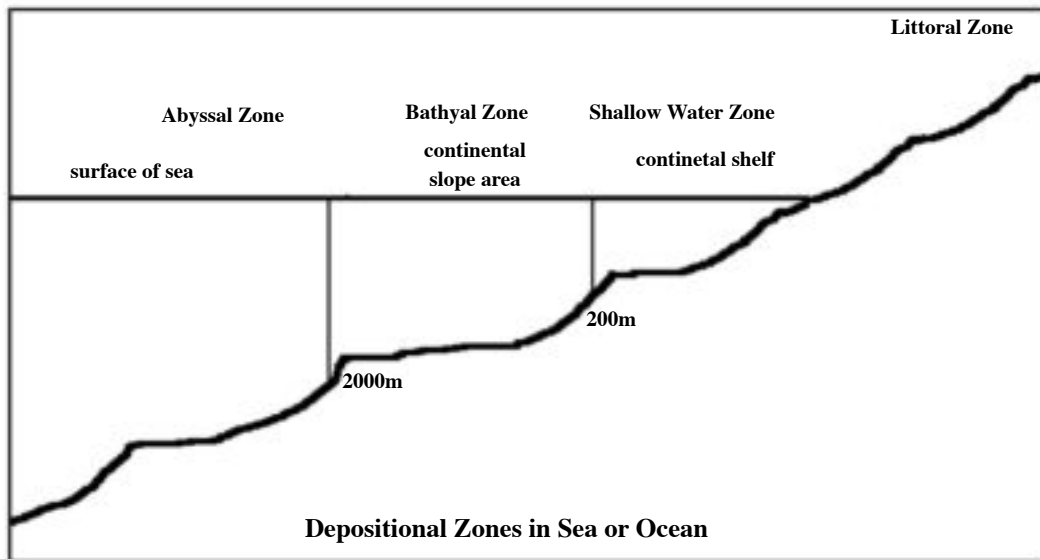
- (1) **Movement of the waves :** the waves arise as a result of wind blowing in a certain direction and the degradation effect of waves different according to the power of the wind and its direction where the force of waves in the ocean and the open seas are more power than enclosed seas as in the Mediterranean sea and be the effect of these waves is strongest when they are loaded with rock fragments that transferred to it, also waves lead to erosion of the beaches and transferring these fragments to the deep water of the sea or parallel to the coast to deposit in other areas and thus waves act as erosion factor and deposition (sedimentation).
- (2) **Difference in the hardness of the rocks:** as the degree of rocks resistance vary based on the kind of rocks where soft layers of rocks eroded and hard layers remain prominent. So meanders, gulfs and coastal caves are formed.
- (3) **Tide and ebb :** Tide and ebb like waves help on carry fragments of rocks away from the beach and as a result Stairs Samples graded fragments are formed and these use as indicator of the water level at the time of the tide and ebb.
- (4) **Ocean (sea) currents:** ocean currents formed by changing the density of the water by changing temperature in tropical areas than in the polar regions, as well as change the degree of salinity of water as a result of a difference in the evaporation rate, so cliffs are formed as a result of the marine erosion on the coast or costal caves and gulfs (bays).

**(b) Deposition (Sedimentation) effect of seas and oceans:**

Sedimentation in the seas and oceans include all fragments of rocks that transfer by rivers, wind and the various factors of rocks fragments and sedimentation have certain specifications where boulders and gravel deposited on the beach and smaller size fragments deposited far from the beach. So we find the deposition takes place at different depths for each depth, and these are the areas:

**(1) Littoral Zone (Beach area):**

The boulders, gravel and coarse grains sand are accumulate and affected by the movement of tides also arise of *spits and barrier*. *Spit* is an elongate ridge of deposit at sea area due to meeting of two streams are moving in opposite direction, so sand will deposit at the line of connection or friction between them, spit may be formed at the area of downstream of the river like spits that extend north of *Manzala Lake*. *The barriers* are spits at the bays area and it may plug (close) them to form a marine part semi-closed on the form of a lake like **Mariot and Edco Lakes**.



## (2) Shallow Water Zone (Continental Shelf):

It's the area of the continental shelf that extends from the beach area to a depth of 200 meters, it characterized by flourish life, it's water affected by the temperature of the atmosphere and sunlight, this sediments of this region are gravel and sand near the beach area and mud towards the inside except lime deposits that resulting from the accumulation of oysters animals after her death.

## (3) Bathyal Zone (Continental Slope area):

It's the continental slope area, its depth ranges from 200 to almost 2,000 meters, the bottom area of this zone is quiet, it's low temperature area, the light didn't pass to the bottom area, the sediments of this zone are fine grained organic calcareous silica sediments, and it is primitive remains such as **foraminifera, diatoms and radiolarian**.

## (4) Abyssal Zone:

It's the area at great depths and deeper than 2,000 meters and it's characterized by constant temperature almost close to 10°C. It's sediments free from rock fragments that transmitted by wind and rivers, the sediments containing red clay, which is of volcanic deposits, also this area contains fine grains organic sediments of limestone and silicic deposits that are remains of micro-organisms like **foraminifera and diatoms**.



### (7) Lakes:

Lakes are the basins of fresh or saline (salt)water and it's often disappear as a result of water evaporation or due more sedimentation or passing of water through the rocks pores.

Lakes arise near the shores of the sea as a result of grow of coral reefs or deposition of barriers that closed bays or arise on land as a result of sea regression or drop of sea water, then turned river stream and torrents to the sea, lakes arise also in the craters of volcanoes which subsided then filled with rain water and torrents.

### Lakes deposits divided into:

- (1) Saline lake sediments: include gypsum and halite (food salt) like Edco Lake, or sodium carbonate and magnesium carbonate as in the Wadi El-Natron lakes.
- (2) Freshwater lake sediments: include gravel and sand near the beach lake and fine grains of clay in the middle of the lake beside and freshwater snails.

### (8) The Soil And Their Components:

Soil usually consist of a mixture of mineral materials and the remains of decomposing organic materials and some fluids, gases and remains of living organisms. Soil arises from fragmentation of the surface rocks and erosion by weathering factors and the influence of different living organisms, the thickness of the soil depending on its affecting by several factors:

- Chemical composition and physical properties of the original rocks.
- The strength effect of different climate factors.
- The impact of living organisms.
- The time factor.

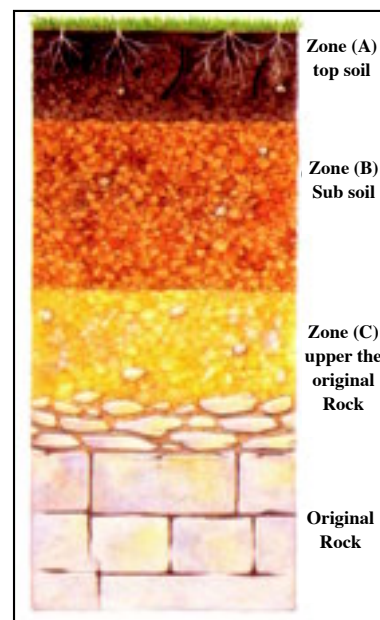
Soil has many benefits, it's appropriate layer for the growth of plants, store and purify the groundwater, also soil is a suitable medium for the analysis of dead organisms and soil is a suitable for life of many living organisms and insects.

### Mature soil:

It has been proven from extensive studies that mature soil was formed in a long period of time and consists of three main parts:

### Horizon (A) Topsoil:

This zone is characterized by an abundance of organic matter that resulting from the decomposition of living organisms.



LS in Mature Soil

## CHAPTER 5

### **Horizon (B) Subsoil:**

It's characterized by being oxidized and it may contain secondary deposits of sand and silt mixed with some mineral deposits, which were deposited from the above soil.

### **Horizon (C) upper the original rock:**

This zone is characterized by a little change from the original rock area and it is composed of coherent rocky material or fragmented formed from the soil and plant roots do not penetrate this layer.

### **Types of soils:**

- (1) **Residual Soil:** where it's formed in its place consist of the same bottom rock and it's characterized as being very similar to the original rock, which is located above it in the chemical composition and differ in the degree of similarity by differing the influence type of atmosphere. Also notes that this type of soil is characterized by gradually texture grains size until it reach the original rock. For example, we find the original rock topped by a cracking zone and sharp edged boulders then sharp edges grains then we find rough soil then surface soft soil.
- (2) **Transported soil:** it is the soil that disintegrated in its place then transferred to its current place and it's different in most cases from the above rock in chemical and mineralogical composition, so we find sometimes clay soil above sandstone rock, or sandy soil above limestone rock and also it differ as well as in the texture because there is no gradual texture and there are rounded angled pebbles. Always this soil and exposed to erosion and various transport factors.

## Exercises

1. Say what you know about: a terrace - torrent cone - Re-youth stage of rivers - El Gharwd.
2. Explain the effect of wind degradation (distingeration)?
3. What is meaning by: Stalactites- Stalagmites and how are formed?
4. What difference between the transfer process in both torrents and rivers?
5. Surface of the earth is the scene of various factors such as the act of demolition (degradation), deposition and transportation. Mention it in detail.
6. What is the soil and what are the kinds of it?
7. Define weathering? Mention the weathering types.
8. What is the mechanical weathering? Explain the factors influencing the mechanical weathering.
9. Granite is a plutonic rock. Answer the following questions :
  - (a) the mineralogical composition of granite rock.
  - (b) Explain the impact of chemical weathering on all minerals of granite rock.
10. Write in detail about the transportation by wind. What are the most important deposits of wind?
11. Compare between:
  - (a) Mechanical and chemical weathering.
  - (b) Hydrolysis and decomposition of rocks.
  - (c) The degradation effect of rain and the degradation effect of ground water.
  - (d) Barrier and spit.
  - (e) Geomorphology of the mature river and the young river.
12. Give reason (s):
  - (a) Some river have deltas and some have not deltas.
  - (b) We should not use coal as fuel in wet areas that characterized by presence of monuments that made of limestone rocks.
  - (c) Quartz mineral resists chemical weathering.
  - (d) Delta beach deposits has an economic importance.



**PART 2**

**CHAPTER 1**

**Environmental  
Concepts**

## Objectives

**After studying this chapter the student should be able to:**

1. Define the concept of the environment.
2. Identify the components of the environment where he lives on it.
3. Compare between ecology and environment.
4. Mention the aims of the environmental science.
5. Appreciate the role of the scientists of the environment.
6. Tend to protect the environment and save its resources.
7. Explain the relation between the living organisms and the three spheres (Atmosphere, lithosphere and hydrosphere).
8. Mention the characteristics of the ecosystems.
9. Explain why the ecosystem is complex.
10. Compare between the food chain in the marine ecosystems and in the desert ecosystems.
11. Illustrate the effect of light in the life of the living organisms.
12. Illustrate the effect of the temperature in the life of the living organisms.
13. Explain the difference of the salinity in different seas.
14. Explain the heat stability of the coastal areas than the tropical areas.
15. Explain why the sea water seems blue.
16. Explain some problems that face some living organisms in their environment.
17. Explain the relation between the abundance of nutrients and the increase of fish production.
18. Illustrate the reasons of some environmental problems in the 21st century.
19. Recognize concepts of scientific terms as:
  - \* Spore formation
  - \* Cyst formation
  - \* Hibernation
  - \* Aestivation Summer laziness
20. Explain the relation between the components of the ecosystem with the flow of energy and cycling of matter.
21. Draw a model to illustrate the cycling of matter and the flow of energy in the ecosystem.
22. Analysis some figures as energy pyramids and food webs.

## The Concept of Environment

The concept of environment is differed according to the one who deals with it .

There are many environments as agricultural, industrial, rural, urban and commercial, ...etc, but what is the scientific concept of Environment?

**Environment** is everything around man of living and nonliving components that affects him and is affected by him.

The concept of environment includes several physical, chemical, biological, social, cultural, economical and political aspects which interact with each other.

It includes three main components:

1. **Natural environment:** which man shares with other living organisms.
2. **Social environment:** which man shares with other people, and it includes the establishments that man had created to organize the relationships between community members and those establishments
3. **Technological environment:** which man made by his knowledge and progress e.g.: factories, schools, roads, irrigation and drainage nets, dams and reservoirs to reserve water and energy production centers, etc.

The concept of the environment is not restricted to the local environment only, but it is broadened to include the regional environment, universal environment and the whole universe, Thus the concept of environment is holistic.

### Environmental Sciences:

1. **Ecology :** It means the studies of what determines life and how the living organism uses what is available to him where he lives.

\* This word is composed of two Greek syllables. "Oikos" means place of living and "logus" means study , the German scientist "Haekel" announced this word in 1869.

2. **Environmental science:** it deals with the interaction between life and the components of the environment. This means that it deals with the application of information in different knowledge fields such as physical, chemical, biological, social and economical. It takes care of the preservation of the environment, its good investment and preventing its destruction. It also means protection and safety of communities from the harmful effects that occur due to nature, or as the result of abnormal deal of human with environment.



# CHAPTER 1

## The Biosphere:

We had studied that the component of Earth consisting of different spheres but there is a sphere that includes the atmosphere, hydrosphere, Earth crust and the living organisms that live on Earth surface

The biosphere is the area where life exists. It includes life deep in the deepest seas and oceans, up to the highest top of the mountains where there are life. Its maximum thickness does not exceed 14 km.

**The biosphere** includes all the living organisms and parts of Earth crust, the hydrosphere and the lower layers of the atmosphere where the suitable conditions for continuity of life is available.

**To get the benefits of the environmental components man should make three steps :**

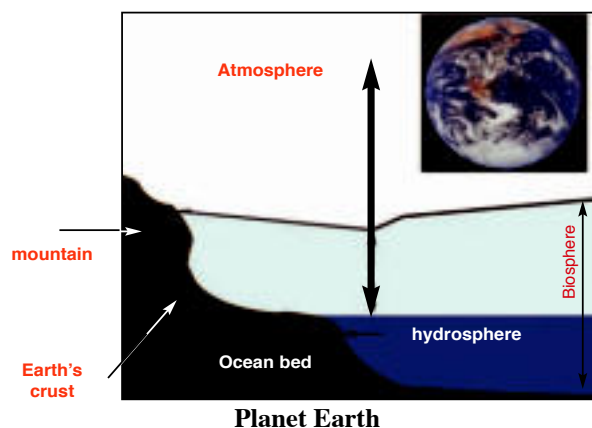
- First discover the benefit of this component.
- Then invent means to get this component and develops it.
- Finally work hard to make the component permanent resource or continuous wealth.

The unit of structure of the biosphere is the **ecosystem**. The forest is an ecosystem and also the desert. The oases, the river, the sea.... etc All of these ecosystems constitute the biosphere. The word ecosystem was introduced to describe all the living organisms and the nonliving components a certain area of nature and the interaction between the living and nonliving component.

The biosphere consists of several units or systems, all of them called an ecosystem, so the building unit of biosphere is the ecosystem. Examples of such systems: the forest, the desert, the oasis, the river and the sea .. etc.

The “ ecosystem “ is called to describe everything related to living organisms non-living components in terms of interactions and exchanges in a limited space of nature.

Ecosystem attracted the attention of scientists without ignoring the study of the individual living organism whether it is plant or animal and its effect on the environment. The outcome of the study of any living organism increases our understanding when studying the ecosystem.



**Planet Earth**  
The biosphere and its relations with other spheres

The challenge that faces ecologists now, is to know what goes on in the ecosystems and how these systems change with time. In fact, it is a great challenge as what happens in nature is very complicated and because the human is part of the ecosystem and he has an increasing effect on ecosystem. It is very important to study the ecosystems and its relationship with man as our lives depend on the safety of these systems.

### Characteristics of the Ecosystem:

Despite the differences between different ecosystems, they are all characterized by the following:

#### First: Multiple Components:

The ecosystem is composed of nonliving components that determine the kind of life that could possibly exist in the ecosystem and living components that affects ecosystem and is affected by it. All these components are characteristic factors of the ecosystem, and the meaning of this is that there are two types of factors :

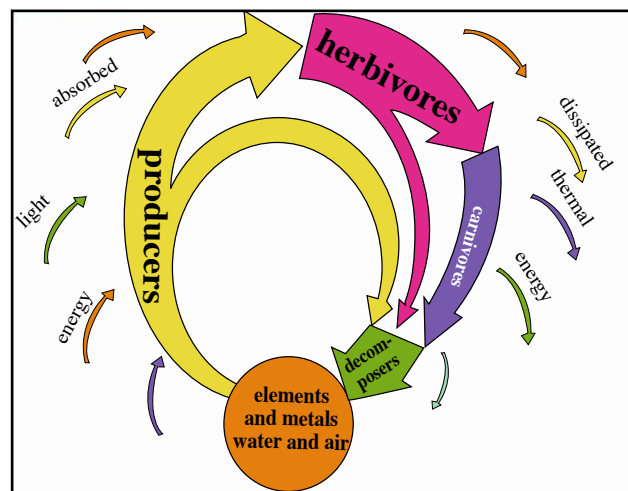
#### 1. Non-living Factors (nonliving) These include the following:

- a) Physical factors: These are the climate factors such as temperature, light, wind, relative location of the sea level and latitude.... etc.
- b) Chemical factors: These are the factors that deal with the chemical side as the effect of the increase or decrease in some chemical elements and compounds, the acidity and alkalinity and the soil salts... etc.

#### 2. Living Factors:

These include all the living organisms in the ecosystem and their effects on each other and on the environment. It is noticed that the living organisms in any ecosystem include three groups of organisms these are:

- a) **Producers:** These are the green plants that convert the solar radiant energy into chemical energy stored in the food through the process of photosynthesis. All other organisms depend on green plants in a direct or indirect way.



A model of the organisms and components of the ecosystem and its relationship with the flow of energy and cycling of matter

# CHAPTER 1

- b) Consumers:** These are the animals that depend on green plants for their food. Some of them feed directly on the plants (herbivores) and some feed on animals that fed on plants (carnivores).
- c) Decomposers:** These are microscopic organisms that taken from the dead bodies of plants and animals Their food. It decomposes these bodies extracting energy from it and leaving minerals and other components that go to the soil. As examples of these decomposers, the saprophytic bacteria and fungi. These represent the guard of nature in any ecosystem .Without them, the remains of the dead animals and plants will not be decomposed, and decomposers release compounds of elements (carbon, phosphorus, nitrogen, ..... and others) from the dead bodies to the soil where they are reused thus ensuring the continuity of life in the ecosystem.

All these factors - the living and non-living - are not isolated from each other but they all are in continuous interaction, and thus constitute a balanced entity and ensures great stability.

In the following we will deal with two of these factors such as light and temperature separately. However, it should always be remembered that any living organism in a certain ecosystem is affected by it and effected on it by different degrees and responds to all the factors at the same time.

## Second: Intricate Relationships:

Any ecosystem is complicated to a certain degree. This is because of its components of physical and chemical factors and variety of living organisms, and its mutual intricate relationships between these organisms on one side and between them and the nonliving factors on the other side. This means the presence of a food web in the ecosystem.

This complication is one of the basic factors in the safety of each ecosystem,as it limits the impact of ecological changes, but if the ecological systems were followed by a series of environmental changes, it will cause a disturbance in the balance and stability of the ecosystem for a long or a short period according to the causes of this change.

## Third: stability With the Ability to Change:

The stability of the ecosystem means its ability to return to its original situation after any change it is subjected to, without occurrence of a basic change in its composition.



Food Web

Ecosystems tend to stability, because the multiplicity of species in ecosystems increases the mutual relationship among them and thus increasing the stability of the ecosystem i.e. the natural biological balance inside it.

If a slight change happened in some of the factors, the ecosystem will be affected by change, but it soon goes to stability. But if the change is big, it lead to the disturbance of the present ecosystem balance and the beginning of new balance after this change .

#### **Fourth: Using The Wastes:**

One of the characteristics of the ecosystem is that it uses its wastes. If we take the marine ecosystem as an example we will find that fish excretes nitrogenous wastes used after decomposition as food by the algae on which fish feed. Thus these wastes do not stay in the sea water keeping its characteristics. Also, living marine organisms produce carbon dioxide gas in its respiration, which is used by the marine plants in the process of photosynthesis which produces - in addition to the organic substances the oxygen gas which is necessary for respiration. Thus the ratio of the two gases remains constant in the water.

- And now after studying the characteristics of the ecosystems we will study the effect of two non- living physical factors in ecosystem.
- Sun is the source of light and heat. Both of them are from the nonliving physical factors in the ecosystem. Light is the visible part from the solar energy but the heat is the senescing invisible part of it.

#### **1. Light and its Environmental Effect:**

Light is considered one of the most important factors affecting plants and animals as will be seen in the following.

##### **a) Light and Photosynthesis:**

Photosynthesis in green plants will not happen except in the presence of light. In the availability of light, chlorophyll absorbs the wavelengths between 390 and 780 nanometer, where the chloroplasts carry out food production. In this process, light energy is converted into chemical energy. This chemical energy is the source of food necessary for providing energy for the consumers and the decomposers. (the nanometer =  $10^{-9}$  meter)

##### **b) Light and tropism:**

Tropism is the localized movement of the plant without movement of the body due to growth in a direction determines the direction of the external stimulus of the plant. If the direction of growth is towards the stimulus, the tropism is positive. But if the direction

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of growth is in a direction opposite to the direction of the stimulus, i.e. far away from it, the tropism is negative.

You already know, that the plant stem is positively phototropic. This tropism is due to the elongation of the stem cells far away from the light more than cells that face the light. This is because the concentration of auxins (growth regulators) in the dark side is more than that in the lighted side and stem cells respond to growth in the dark more than in the light.

## c) Light and flowering in plants:

**During its growth**, the plant passes through two stages.

**Vegetative growth stage.** In this stage the embryo cells divide during seed germination where the root, stem and leaves are formed.

**The flowering and fruiting stage** which starts after a period of vegetative growth, the plant forms these flowers and fruits due to many internal reactions. These two stages are affected by the factors of the ecosystem. These factors may be favorable for the two stages or may be favorable for the vegetative growth only.

We will take the wheat plant as an example. Wheat is usually planted during October and November and flowered during March and April. But if it is planted during February and March, it grows vegetative without flowering due to the unfavorable environmental conditions to the internal changes necessary for the plant to reach the flowering stage.

It is obvious from this example that the photoperiod's suitable for planting is essential for flowering and fruiting after a suitable time and this is what is known as plant **photoperiodism**. It means the relation between the light period the plant is subjected to and the period of darkness that follows sequentially every 24 hours. According to photoperiodism, plants are divided into plants that need long light period followed by short dark period, plants that need the reverse conditions and a third group of plants which are not affected by the sequential light and dark periods.

## d) Light and the distribution of the living organisms:

Light is one of the important factors in the distribution of living organisms in water and land.

### 1. In the water

The depth to which the light reaches determines the presence of certain kinds of organisms. Algae, for example, differ among themselves in their needs for the kind and amount of light necessary for photosynthesis. Red algae, for example, need relatively small amount of light; therefore it can manufacture its food at 25 meter depth. Brown algae cannot

make its food at depths more than 15 meters. The algae that can fix itself at the bottom, and its other end is free, can grow at 120 meters deep, whereas vascular plants cannot live in fresh water at depths more than 10 meters. All of the above means that light controls the distribution of living organisms at different depths.

## 2. On land

It is appear clearly when we compare between two regions as the following:

**1. The desert area** is characterized by an increase in the amount of light accompanied with an increase in temperature and a reduction in the relative humidity and decreasing the number of living organisms and its adaptation with the circumstances of dryness and high temperature.

**2. The equatorial forest area:** is characterized by the reduction in light underneath the huge trees due to the density of its plants and an increase in the relative humidity rich in living organisms as plant and animals and they are adapted to environment. As a result of the difference in the ecological factors in these two ecosystems we find that living organisms in each system are adapted to cope with the conditions in which they exist.

### e) Light and the animal's activity:

Sunlight has a pronounced effect on the activity of animals. This activity can be divided to four photoperiods during the day. These are:

- **The dawn period:** In this period the activity of the night animals is reduced gradually. Then the animals go to their homes.
- **The day period:** In this period, the day animals become active.
- **The sunset period:** In this period, the activity of the day animals is reduced gradually. Then the animals go to their homes.
- **The night period:** in this period, the night animals are active.

Besides, it was also found that the moon light has a pronounced effect on animals living on the sea shores which are exposed to the tide. Some of the animals that become submerged by the flow tide remain inactive when the tide water is ebb tide.

### f) Light and the animals' migration:

**Migration** is a biological periodic phenomenon which occurs by the movement of certain animal population during certain times or seasons. It is characterized by periodical ecological characteristics which are repeated daily, seasonally, yearly or every few years. Migration also occurs due to internal physiological factors. There are several kinds of migrations; we will discuss two only of them.

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**Daily migration** We will study two examples, one of terrestrial migration and two of marine migration.

Terrestrial migration is clear in the wild animals that live in groups as the sparrow that migrate daily to its feeding place and return to its nest. Marine Migration occurs in seas and oceans where the living plankton move up to the surface or descend to the sea floor daily. The roaming Crustaceans for example, are affected by ultraviolet light, thus it keeps all day under a depth of about 27 meters and migrate to the surface during the night. The cause of migration in this case is the effect of light, and the reverse may occur with other organisms.

Some fishes leave the deep to the shallow waters to lay eggs during night and return to the deep waters during the day.

Thus, the respond of the aquatic animals, vary and this depends on the physiological state of the organism, the depth of water, the season and the state of the life history of the living organism.

**The seasonal migration** which can be observed especially in desert reptiles which are grouped in long tunnels under the ground in winter and gets out of it in the spring season and goes back to it the following winter also appears in birds where the length of the day time (its increase in spring and its shortness in autumn) is an important factor in triggering migration in a regular periodical way. It was proved that the day length affects the activity of birds which in turn affects the size of the sexual glands which increase by increasing the day length and decrease by its decrease.

## 2. Temperature and its Environmental Effect:

The effect of temperature on living organisms can be clearly realized when we compare between organisms' live in one of the poles and those live in the hot equatorial region or when we compare between the efficiency of growth and reproduction in the summer and winter seasons.

These activities are clearly affected if the temperature is less than zero or higher than 50°C. But there are some microscopic organisms that can tolerate temperatures below zero; and others that can tolerate temperature above 50°C. This is because the activity of the living organisms is determined by the range which the protoplasm can tolerate.

When the temperature becomes somewhat unsuitable in the medium where the organism lives either by increase or decrease, it goes to dormancy. This is very obvious in spore formation in bacteria and cyst formation in protozoa.

Some animals such as amphibians and reptiles revert to hibernation where the temperature of the medium where it lives is decreased. Other animals such as molluscs and insects



where they are subjected to higher temperature they revert to what is known as **aestivation (summer laziness)**.

In these cases, the animal passes through a period of dormancy where the biological activities of all the body systems stop except those necessary for keeping the animal live. Other animals revert to migration to other areas where the temperature is more suitable.

After we have studied the effect of two of the ecosystem factors, namely light and temperature, you can imagine the effect that the other factors can do to the ecosystem.

And now after studying the characteristics of the ecosystems we will study two examples; a marine ecosystem and another terrestrial one.

### 1. The Marine Ecosystem

The water of seas, oceans and gulfs covers about 72% of the earth's surface in what is known as the hydrosphere and it constitute a suitable medium for the growth of many plants, animals and microorganisms and due to the connection of the water of the seas and oceans, it constitutes a relatively stable environment compared to the terrestrial environments which vary in their physical, chemical, and biological conditions due to the separation of the terrestrial environment into continents and far away islands also it constitutes suitable environment for great variety of living organisms.

It is possible to study the seas as one continuous ecosystem. It is also possible to study it as smaller ecosystems as the coastal or deep water ecosystems or in a certain part of any sea or ocean according to the conditions in each of them. The marine ecosystem is generally governed by the same physical and chemical factors. The most important of which:

#### a) The salt content:

The concentration of the salts dissolved in the sea water varies according to the quantity of rain or falling water from river mouths of polar glacier and the extent of evaporation due to the prevailing temperature. The average concentration of sea waters is 35 gm/liter. There are some seas or gulfs where the degree of saltiness is increased to 40gm/liter or more as it is the case in the red sea and the Arabian Gulf. This is due to the increased evaporation, and the reduction in rain or river mouths. On the contrary, the salt concentration decreases in some seas to reach 20 gm/liter or less as is the case in the North and Baltic Seas due to the reduction in evaporation and the increase in rain and the number of rivers. Thus the concentration of the salts dissolved in sea water varies according to the climatic conditions.

Sodium chloride, magnesium Chloride and potassium chlorides, calcium bicarbonate and bromide and iodide salts are of the important dissolved salts in sea water and oceans, sea

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water also contains very small percentages of the salts of phosphate, nitrate, manganese, iron, copper, nickel and some radioactive elements.

## **b) The abundance of nutrients:**

Phosphate and nitrate salts are found greatly in surface water that helps in the formation of protein in the cells of marine plants which help in the growth and reproduction of these plants. These element cycles between the living organisms and the water in continuous cycles start with the liberation of these elements from the bodies of the living organism after their death and precipitation in the depth. As the water is moving and have upward currents of the plant life in the top water layers, and thus the animals that feed on them increase so fish is increased accordingly. Thus, the abundance of nutrients in any marine area is an indicator of the increase of fish production in it.

## **c) The temperature:**

Water has unique heat characteristics where the range of temperature change is small and occurs slowly. There, the difference in temperature between the ocean water in poles and the equatorial area controls the distribution of many organisms. The water temperatures is around 30°C in the warm seas near the equator and decreases gradually as we move north or south until it reaches the freezing temperature at the poles .

The water temperature also decreases gradually from the surface to the bottom. Once the surface water temperature reaches 3°C, (abnormal expansion differ than all other liquids) the water expands and its density is decreased and it floats to the surface where it freezes thus protecting the aquatic life from freezing

On the other hand, the temperature of the surface water changes according to the season, atmospheric changes, and the different climatic conditions. If we take a lake as an example, we will find the distribution of heat in its water differs by the season. In summer the surface water temperature is high and the deep waters are low and the reverse occurs in the winter. Sea waters store large quantities of heat which it absorbs from the sun-rays during the day and it leaks it at night to the space and the surrounding earth. This provides warmth to the coastal areas which are characterized by heat stability which is more than the tropical areas far away from the seas in which the temperature varies day and night and in the different seasons.

## **d) Light intensity:**

Light intensity in the seas depends on the amount of light that penetrates the sea water, some of this light is reflected, another part is absorbed and the rest passes according to the wavelength to certain depth. The red long waved light passes through the upper layers of

water whereas the short waved blue and violet lights penetrate the deeper water (the blue colour of the sea is due to these light waves).

Thus the surface waters are well illuminated at about 200 meters deep whereas the illumination decreases until nearly 500 meters, then illumination disappears after that until darkness prevails in the rest of the water column. The light which passes through the surface sea water plays an important role in the plant life which depends on it for carrying out photosynthesis, so it is present where light is found and disappears completely from the dark water. This also affects the distribution of the other living organisms which depend on these plants for their food.

#### **e) The water depth:**

The depth of the sea water varies from few meters at the shores and gulfs to ten kilometers or more in some oceans where deep canyons are found. But ordinary seas such as the Mediterranean, has a depth which reaches about 4000 meters whereas the red sea does not exceed 2500 meters in depth. The Arabian Gulf does not exceed 80 meters in its deepest parts.

#### **f) The water pressure:**

The pressure of the water column increases by one atmospheric pressure for every ten meters under the water in addition to the atmospheric pressure at the sea level. If a person wants to dive into the sea water to a depth of 20 meters for example, he will be exposed to a pressure which equals 3 times the atmospheric pressure. If he dived to 100 meters deep, he will be exposed to 11 atmospheric pressures and this is impossible to endure without the diving equipments. But the animals that live in the deep seas have bodies and physiological characteristic that enable them to bear this high pressure in addition to the ability to live in the conditions of deep waters as severe cold and complete darkness.

#### **g) The water movement:**

The surface water movement (waves) is affected by the wind direction, the tide and the location of the coast with respect to waterfalls and river mouths.

While water currents even it is vertical or horizontal are generated with specific routs directed by the earth rotation, temperature that changes water density and thus affects the distribution of the marine organisms.

The above mentioned factors are known as the non biotic factors.

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## Marine Food Chains:

The biotic factors in the marine ecosystem are clear in the food chains that link between the different marine organisms that live in this system and interact with its different factors.

### 1. Plankton:

In the surface water of the marine ecosystem and along the illuminated layer of the water column are found very small organism or mostly microscopic known as the planktons. These are carried by the waves without resistance due to its minute size.



Marine Food Chain

These divided into two groups which are :

- a) **Phytoplankton** a large group of plants that contain chlorophyll and thus absorb the penetrated light energy to build food substances and thus are considered as producers. These represent the corner stone in the production of food for the rest of the marine organisms.

As the first trophic level in the marine food chain. Similarly, the marine algae which are floating or fixed to the coastal rocks produce food and provide the marine animals with it as herbivorous food

- b) **Zooplankton:** there is a large group of protozoa, worms, small crustaceans, and different larvae which all feed on the phytoplankton's found near it in the surface waters. This is considered the second trophic level in the marine food chain.

### 2. Carnivorous group and it represent as many trophic levels:

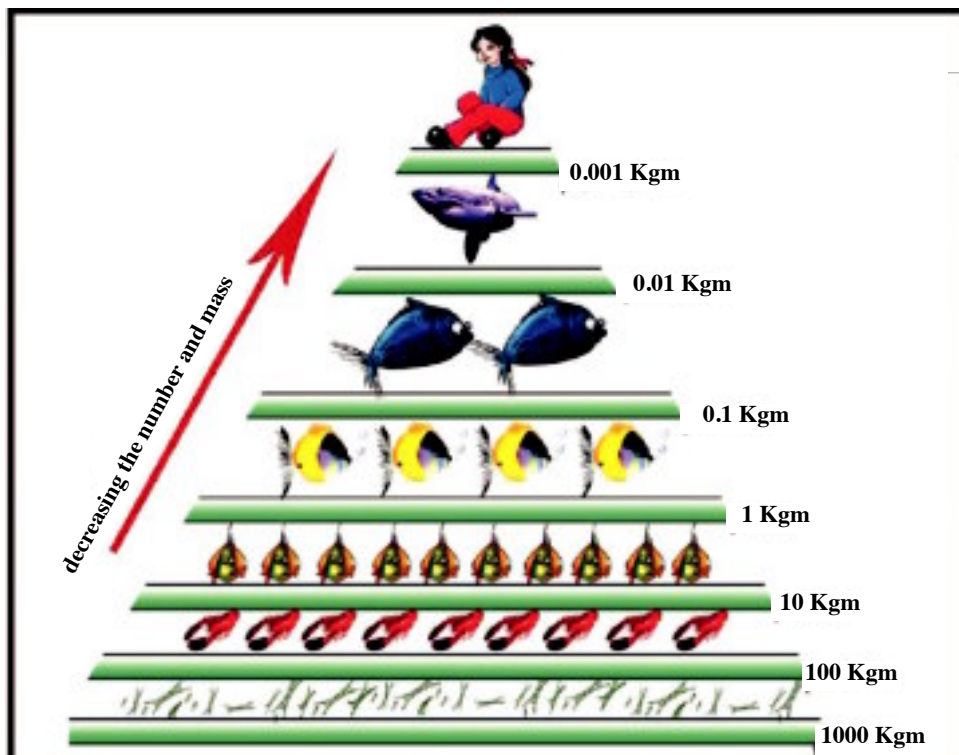
- The third trophic level includes several small fishes, crustaceans, and Molluscas.
- The fourth trophic level includes the big fishes that feed on the crustaceans and the small fishes.
- The fifth trophic level includes the larger fishes such as the sharks and marine mammals such as seals and dolphins and they share this level with marine birds such as seagulls, penguins and hawks.
- The sixth trophic level includes the large whales that feed on what it can get from these forms.
- The man is on the top of the marine food pyramid as he catches different fishes, sharks and whales.

### 3. Saprophyte group :

they are many other living organisms between previous trophic levels and it includes :

- Worms and fishes in deep water which feed on dead bodies and the remains of marine organisms which fallen from the surface.
- Bacteria and decomposing fungi: which analysis dead bodies and remains of marine organisms to its simple substances and return it to ecosystem and cycling the chemical compounds with water currents and waves motions to surface water to help in phytoplankton again.

Thus the marine food chain is completed which starts with producers then consumers and finally decomposers so chemical compounds rotates between living organisms and water . But the energy flow from the sun-rays and a ratio of it is transferred from one organism to another in the chain and another ratio is dissipated in the space through the respiration of the living organisms and their daily activities.



Marine Energy Pyramid

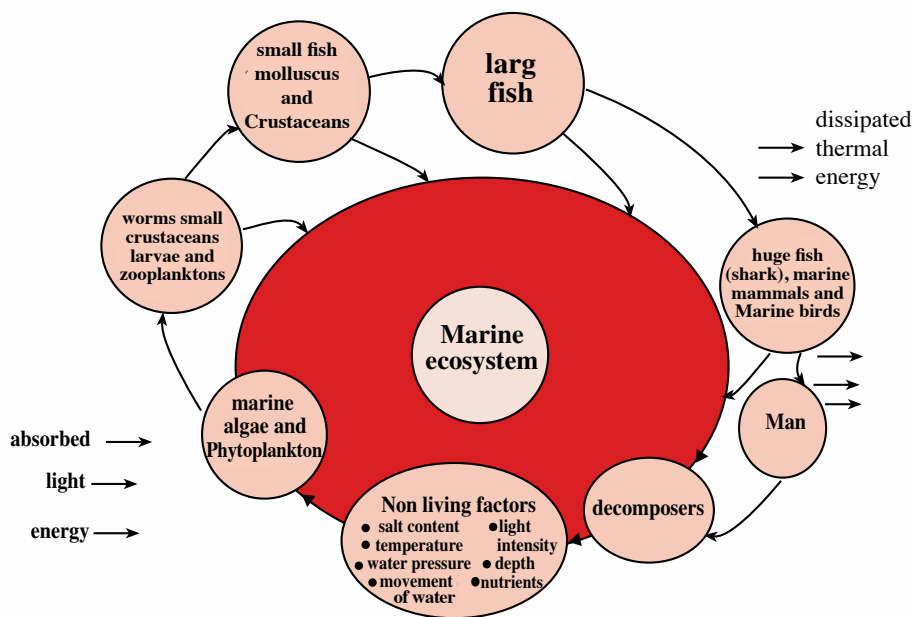
# CHAPTER 1

## Characteristics of marine food chain :

Most of the marine organisms are carnivores except few herbivores found among the zooplankton. Thus, marine life is characterized by its long food chains and the multiplicity of its trophic levels, this leads to the loss of a big ratio of energy lost during its passage from one trophic level to the other.

Scientists have estimated the loss of energy on moving from one trophic level to the other to be about one tenth. Thus, if we started with an amount of phytoplankton (fig. 5) that weight 1000 kilograms (on the assumption that it produces a certain quantity of heat calories), 100 kilograms only of it will move to the following trophic level in the zoo plankton. It will become 10kg in small fishes, it will become 1 kg in big fishes, it will become 0.1 in shark and 0.01 in whale and finally, it will be 0.001 kg in man if he fed on these forms.

In order to make good use of the productivity power of the seas, we should depend on the first trophic level in the chain and not on the second or the last. Thus research is going on to develop the phytoplanktons and zooplanktons and harvesting them and using it as food for man and his herds due to its availability and rapid growth.



Model of living organism and components of marine Ecosystem



### The Desert As A Terrestrial Ecosystem

We previously knew that the ground or terrestrial environments are more varied than the aquatic environments. The terrestrial ecosystems can be divided into a number of units of large ecosystems, which are distributed on the Earth's surface as wide bands that start at the poles by the very cold and humidity tundra with few organisms. It ends at the equator with the tropical forests which are very humid and very crowded with living organisms. Between these two regions there are many regions that are graded from the taiga forests to deciduous forests to the grassland and the desert.

The desert ecosystem can be studied as an example of the terrestrial systems. The desert occupies about 1/5 of all the land area. It is distributed around the latitude 30 above and below the equator in North Africa Central of Asia, the Arabian Island, and South America and Australia. These are arid very dry areas where the average rain is less than 25 ml/year.



**The desert regions in the world**

The Great Desert which extends from the Atlantic Ocean from the west and the Red Sea on the east, its area is estimated to be about 3.5 million square miles. It comprises mountainous rocky structures, sand dunes and sedimentary areas. Despite the hard life in the desert environment - where life is nearly disappear in some of its areas - many life forms, plant and animal are found in some of its areas. These organisms are adapted to endure draught and heat during the day or coldness at nights, abundance of storms and high light intensity ... etc.

In the desert ecosystem, the food chain starts with producers and followed by consumers and finally the decomposers as the following:



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## 1. The producers and it is the scattered vegetation which is of two kinds.

(1) **Temporary vegetation** in the form of annual plants appears only in the winter after the rainfalls and withers away by the arrival of draught in summer and disappears after leaving its seeds in the soil. Thus these are normal plants, not specialized for the desert life and their presence depends on the presence of water in the soil.

(2) **Permanent vegetation** formed of true xerophytes (desert) plants in the form of herbs, bushes and perennial trees which grow away from each other and are characterized by the increase in the ratio of the root system to the shoot system (whether in length, volume or weight). In some plants, this ratio reaches 80:3.5 meter.



Desert plants

Roots of these plants can be divided into two kinds. In the first, the roots extend vertically deep into the soil to absorb the deep ground water. In the other kind, the roots extend horizontally under the soil surface to absorb the dew drops that fall on the soil surface in the morning to make the most use of the scarce water in the desert. Xerophytes plants are also characterized by a thick cuticle cover to protect the plant from evaporation. The leaves are also reduced in size to keep the plant water from transpiration.



Aloe

## 2. The consumers which divided to two kinds:

a) **Herbivorous** : Many different kinds of desert insects such as grasshoppers and beetles, some reptiles that developed tight protective covering around their bodies to keep the water and some desert mammals such as rodents and dears which are adapted to this hard environment. Most of these animals are active during the night or early in the morning and hide during the day in ditches or humid tunnels. Its urine



Egyptian deer

is concentrated and its perspiration (sweat) is reduced very much to economize on water as some of these animals do not touch water all its life such as jerboas (fig. 7) which extract water from the seeds and the succulent plants on which they feed.

**b) Carnivorous :** Some snakes and foxes and other animals or carnivorous birds which depend on the blood of its preys as a source of water in the desert environment of the desert feed on these jerboas. The number of carnivorous animals in the desert is small in order to be balanced with the number of its productivity.

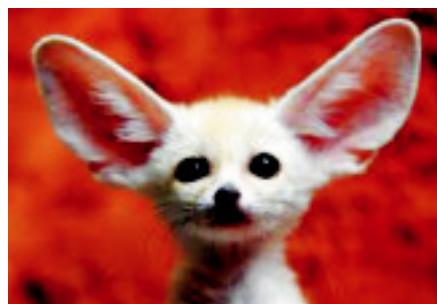
These carnivorous and their preys are characterized by sharpness in hearing, smelling, and seeing for survival in this environment.

These animals have big ears as it is the case with the fennec fox, so that it can collect sound waves from far distances in additions to their participation in the dissipation of the body heat.

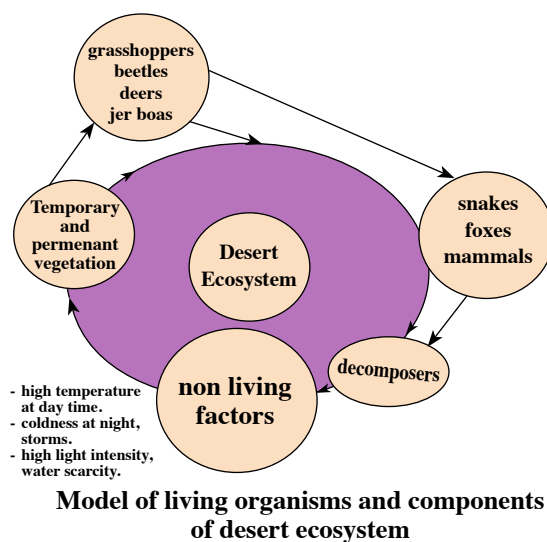
Thus, the trophic level in the food chain in the desert ecosystem reaches three or four levels and ends by the decomposers which give back to the system its elements, which circulate time and time, where the energy flows and dissipates as we mentioned in the marine ecosystem.



Jerboa



Fennec fox



## Exercises

1. Draw a diagram to show the Earth's spheres and its relation to the biosphere.
2. "Multiplicity of components is one of the characteristics of the ecosystem". Explain this statement.
3. Draw a model to show the relationship between the ecosystem components and both energy and matter.
4. What is the role played by light in the plant life in any ecosystem?
5. Explain how light affects the distribution and activity of animals and their periodical migration.
6. Describe how living organisms respond to unfavorable temperatures.
7. Write a brief note on each of the following:  
The intricate relation in the ecosystem - stability and ability to change - using the wastes.
- 8. Explain each of the following:**
  - a) The coastal areas have heat stability than the tropical regions.
  - b) The saltiness of the sea water varies according the prevailing climate.
  - c) The availability of nutrients in any marine area is an indicator for abundance of fish.
  - d) the marine plankton occupies two trophic levels in the marine food chain.
- 9. Give reasons for the following:**
  - a) a great proportion of the energy is lost in the marine food chains.
  - b) Man cannot dive to deep water without diving equipment.
  - c) the marine plankton are spread in the surface areas only.
  - d) The desert ecosystem has its own characteristic living organisms.
  - e) Some desert animals do not touch water throughout their life span.

**PART 2**

**CHAPTER 2**

**The Problem of  
Resources depletion**

## Objectives

**After studying this chapter the student should be able to:**

1. compare between renewable and non-renewable resources.
2. Mention the aspects of the environmental resources depletion.
3. Illustrate reasons of agriculture soil depletion.
4. Show the effect of single crop of agriculture soil.
5. Compare between the effect of using organic and chemical fertilizers on agriculture soil.
6. Explain the harmful effect of using pesticides on the living organisms which live in the soil.
7. Illustrate the reasons which lead to the deterioration of the natural grazing lands and its results.
8. Illustrate the reasons which lead to the deterioration of forests and its results.
9. Suggest the suitable solutions of the problem of shortage of fresh water.
10. Show the effect of over hunting on the environment.
11. Suggest the suitable solutions of the problem of mineral depletion.
12. Illustrate what is meant by fossil fuel as a non-renewable resource.
13. Suggest the suitable solutions of the depletion of fossil fuel.
14. Illustrate the concept of soil erosion and its harmful.
15. Mention the suitable methods to solve the problem of urban sprawl.

## The environmental resources depletion

You may remember from your previous study that the environmental resources are everything found in the natural environment from components which man has nothing to do with its presence or recreation, but he depends on it in his various life aspects like: food, houses and clothes. The environmental resources have many types as :

**The renewable resources** are those resources are constantly available in the biosphere because of its ability for continuity and renew unless man causes its extinction or its depletion and deterioration. Such as plants, animals, water, air and soil.

**The non-renewable resources** they are temporary resources that will disappear from the environment sooner or later and this depends on a wise use by man or his misuse of it such as oil, coal, natural gas and minerals as metal or non-metal.

The Problem of Resources Depletion and wasting the ingredient of the environment became an urgent problem that should be faced to stop it and to remedy its effect. There are several aspects of depletion and squandering such as: the misuse of the resources, soil erosion and urban sprawl on agricultural soil and the effect of these on decreasing the sources and the extinction of the living species. In the following we will deal with some of these aspects:

### The depletion of the natural resources:

The interaction between man and environment is as old as the appearance of the human race on the Earth planet. Since the settlement of man in the environment. And it satisfied his needs and desires. As a result of trying to satisfy the different human needs although the over population that lead to increasing pressures on the environment by depleting its resources.

Scientists became aware of the harmful effects of misusing the resources of the environment and realized the necessity of (economizing) rationalizing in its consumption. In fact, man exploited the environmental resources extravagantly to the extent that some of it are about to be depleted. Man started to suffer from the direct effects of his misusing of the natural resources. In the following we will mention some examples of this and its effect on the man and on the environment.

### First: the depletion of renewable natural resources:-

#### a) Depletion of the agricultural soil:

The agricultural soil in the Nile valley was formed through millions of years by the immortal river and the clay that it carries from the Ethiopian mountains (plateau). The Ancient Egyptians were one of the first nations that practice agriculture. At that time the



land was used to be cultivated only once a year after the flood of the Nile. And nowadays we commit many mistakes which cause Depletion of the agricultural soil such as :

### **1. The generalization of planting a single crop in the same soil:**

The man have learnt by experience not to plant the same crop for two successive years but it has to diversity what he plant.

And the biggest mistake we plant a single crop agriculture which aims to plant one crop on the same soil and repeating it for many years.

Although getting some economic benefits, but it is temporary because this attitude causes soil exhaustion and its lake of some essential nutrients for plant.

### **2. using chemical fertilizers:**

Many farmers now replace organic fertilizers by chemical fertilizers, and the first perished completely from large farms that depend on planting single crops. As the organic fertilizers have a major role in the natural environment as it activates living organisms in the soil and enters into the food chains thus giving the soil desirable physical characteristics. The using of the manufacturing chemical fertilizers led to the deterioration of the soil and made it more liable to erosion.

### **3. The overuse of pesticides and fungicides:**

The overuse of pesticides led to the disappearance of some useful insects that feed on the harmful ones leading to that the second one becomes agricultural pests. The falling of pesticides on the soil caused soil pollution and the death of earth warms which was aerating soil and make nitrogen available for nodular bacteria to fix it and by that nodular bacteria lost its morphological and functional features.

### **Solving the problem of farmers' unwise behavior in agricultural needs:**

1. Not planting one kind of crop for several consecutive years and following the agricultural cycles.
2. Controlling the use of chemical fertilizers and pesticides
3. Recycling the agricultural waste to organic fertilizers.
4. Transforming the organic matters in the garbage into organic fertilizers.
5. Using synthetic fibers instead of cotton fibers to save a larger agricultural area for planting grains.

### **4. Eroding the agricultural land:**

The agricultural land in Egypt was exposed to a big destruction process for rapid gain of money, which caused eroding and destruction of agricultural land. Eroding means the



removal of the upper layer of the soil to use it in brick manufacturing. Eroding destroys the soil that was formed through millions of years and make it unsuitable for agriculture at the same time the government is dedicating all efforts to increase the area of the agricultural land.

Since the area of the agricultural land in Egypt does not satisfy the needs of the population from the different corps, the process of eroding takes serious dangers. In addition of the fact that building the high dam prevented the precipitation of clay on the valley's soil, as it was used to happen yearly during the flood, we realize without any doubt the effect of this wrong behavior of man towards the environment.

### **Solving the problem of Eroding agricultral long:**

1. Manufacturing brick from clay, cement, sand and other substances instead of mud.
2. The government had issued laws that prohibiting eroding the agricultural land.

### **5. Spreading of urbanization (the urban sprawl):**

Since the beginning of this century the population in Egypt increased greatly. Till the rate of the population growth became more than one and quarter a million annually. And by the increasing in population the needs for food, clothing and housing is increased too and also the needs for services such as building schools hospitals and others. In order to make food available, the government started projects of agrarian reform. But the people crowded over the fertile green land to build houses and projects. Thus, for the area of land that is reclaimed on one side, an equivalent area of fertile productive land on the delta and valley was lost. Thus, the urban areas are increased on the expense of the surrounding agricultural land. Thus we can say that in return for the reclaimed areas with the help of the high dam, the Egyptian man has squandered(wasted) in return rich lands that were producing much more plants than the land which reclaimed. And in spite of the cost of reclamation processes. The spread of urbanization over the cultivated land has been responsible for the loss of almost 30.000 feddans annually from our agricultural land.

### **Solving the problem of spreading urbanization:**

1. Established a number of new cities in uncultivated desert land and establishment of industrial projects in these cities.
2. Provided these cities with the infrastructure, houses, schools and the different services.
3. The government had issued legislations that prohibiting building on agricultural land.

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### b) Overcutting of trees:

Trees have several benefits to the environment in which it is found.

In industrial areas it acts as natural filter for carbon dioxide gas, besides providing us with oxygen gas.

In agricultural areas, beside the previous effect, it acts as wind and torrents breakers to protect the other plants and it provides shade and wood.

In the forest, trees have other important benefits for the environment like it sheds its leaves periodically. These shedded leaves decompose forming (humus) which nourishes the soil and keeps its fertility. And it ensures almost a constant temperature for wild animals which find in the forest a shelter and a suitable place for its life.

Forests are renewable resources where man cuts lots of its trees to get both wood and cellulose necessary for paper and textile industry.

The over cutting of forest trees in the Middle East and North Africa led to the deterioration of the environment in these areas and exposing them to draught

It is clearly noticed the effect of draught on the natural vegetation and the cultivated plants and on the life of man.

**The badeffects of over cutting forest trees on man can be illustrated in the following:**

- a) Shortage in the amount of raw materials necessary for many industries such as wood, synthetic fibers and paper.
- b) Vagrancy (homeless) of the animals that live in the forest and that lead to its extinction.
- c) Deterioration the soil and the natural vegetation due to its exposure to draught factors.
- d) Exposing the areasaround the over cutting forests to the dangers of torrents and wind.
- e) The temperature degree get higher due to increasing of carbon dioxide gas percentage
- f) Destroying the ecological system.

Does this mean that we should not cut the forest trees and benefit from it? We are supposed to make use of the forest without squanderence

### **Solving over cutting problem:**

1. Cutting trees to a certain amount. Then we should plant instead new trees, thus conserving the forest as an ecosystem which is the most stable one.
2. Expanding in planting trees around each city and have a green belt around each city.
3. Recycling the agricultural and industrial waste instead of tree's wood that extracted from trees.

### c) Overgrazing :

The natural grazing provide food for cattle herds which a man raise it and depending on it as an animals' wealth which provide him with protein.

When the rate of grass growing less than the rate of animal consumption of grass then it will be overgrazing.

#### Overgrazing leads to:

- \* Vanishing plants are suitable for grazing and other plants will have the opportunity for growing and extension.
- \* Overgrazing leads to the deterioration of the natural vegetation which is always accompanied with the deterioration of the soil and the local climate.
- \* The erosion factors appear and the soil is exposed to severe drifting by water rain and wind.
- \* grazing lands become arid and dry and unable to absorb water rain especially at the slopes.
- \* Increasing the crawling desert phenomenon as it was happened in the north coast in Romanian ages.
- \* **Grazing in weed areas** leads to erodes the vegetation and the rule of species unpalatable or the complement their life cycle in a short period so the animal doesn't able to eat it.

Grazing will be organized when the grass growth rate is more than animals consumption rate to this grass.

#### The organized grazing

- \* It is good in reducing the percentage of transpiration and evaporating by removing parts of vegetative group.
- \* **Grazing in the area of shrubs and trees**, causing an increase in the number and size of these shrubs as a result of the removal of the weeds which compete it on the water.

Some examples of the degradation of natural pastures(grazing):-

- \* grass lands in The Egyptian north coast that was used for grazing sheep in the ancient times, but nowadays it is deteriorated and dried due to overgrazing and over population.
- \* The Saudi desert was transformed Due to over grazing through several centuries from an area covered with natural vegetation capable of regenerating itself continuously to a deteriorated area. Thus the country lost wide areas of grazing land.

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### **Solving the over grazing:**

1. The establishment of fish farms and crustaceans to provide proteins.
2. Recycling the agricultural waste to feed animals.
3. Recycling some secondary industrial wastes to fodder.

### **d)The over hunting of wild and marine animals:**

Sometime we hear about a lake or a river that became devoid of fish or that a species of fish disappeared from the sea. As a matter of fact 45 species of birds disappeared in the nineteenth and twentieth centuries due to chasing them with nets and advanced weapons. The extinction of animals is due to killing or hunting a group of it to the limit that the remaining ones are very few in number thus unable to continue reproduction and that is called overhunting.

And the reasons of killing and over hunting of animals in sea and on land are basically to the importance of these animals as food resource besides other reasons such as to get the clothing as the case of wild animals which decreasing in numbers to the limit that exposing it to become extinct

As in the case of the fur animals (the mink for example) and also as the first settlers in America those were killed millions of American buffalos (the beacon).

### **Solving over hunting problem:**

1. Establishing of natural protectorates to protect rare species that exposing to become extinct.
2. The establishing fish farms and crustaceans to provide proteins.
3. Issuing laws to criminalize hunting for specific species and seasons and in specific age to be able to reproduce.
4. Raise the awareness of the importance of living organisms in order to protect them and to participate in all international agreements.
5. Rationalization of cutting trees, fishing on land and in the sea.

### **e) Over consumption and pollution of water:**

Fresh water represents only 1% of the surface water on the Earth, since sea and ocean water represent 97% and the glaciers at the poles represent 2% This means that the amount of fresh water is very limited.

Which is the life of all living organisms in all ecosystems depends on it.

In Egypt, we depend on the water from river Nile. Also some other African countries depend on it. Thus some agreements were signed to allocate certain amounts of the Nile water to each country. Despite that, we are extravagant in using this water through irrigation by submersion and the unwise human use. and specially the Nile River- this vital artery- which is also exposed to many different pollutants as a result of throwing sewage and agricultural and industrial liquid wastes and detergents without treatment, if we add to this the increased number of consumers due to the over population.

Water resources in Egypt are considered the most important factor of the ecosystem and because of the limited water resources we must preserve it from consumption and pollution in all its form.

The government issues laws to protect the Nile from pollution with the awareness of all the people of the importance of preserving the Nile River.

### **Solving the over consumption of water problem:**

1. Rationalizing the consumption: by drip irrigation or spraying and using saving water for planting new area.
2. Not squandering water in personal use, using tap working by infrared rays to save water.
3. Treatment the house used water to irrigate the timber trees.
4. Search for ground water suitable for irrigation and human use and desalination of sea water and collecting rainwater.

### **Governmental efforts to combat pollution of the Nile:**

1. Determine the percentage of pollutants permitted to derange on the Nile.
2. Selection of pesticide and fertilizers that does not pollute water streams.
3. Force factories to treat industrial wastewater before derange it into the Nile.
4. Continuous inspection on the water streams and removes the causes of pollution.

### **Second the Depletion of non-renewable resources:**

#### **a) Mineral depletion:**

Minerals are non renewable resources that man exploits in different Aspects of his life activities. We all know the use of iron, copper, aluminum, zinc, gold, platinum and others that are found in the Earth's crust. But with increasing of population and progress of technology, the individuals' share of minerals (cars, equipment, tools, installations, metal coins... etc.) is increasing with very high rate that reaches almost triple the rate of population increase. So the suggestions of finding alternatives for minerals have an excuse now after the Studies

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have confirmed that the amount of minerals remaining in the earth is back down rapidly.

### **Solving the Mineral depletion problem:-**

1. Using (elastomers) plastic in manufacturing pipes instead of non-renewable metals
2. Using of feldspar in pottery and ceramics industry (cooking pots) instead of non-renewable metals.
3. Reusing the used car batteries after treating them.
4. Retreatment and reforming the plastic and glass products and reuse it.
5. Re-melting and reforming and reusing metal products that are not any suitable for use.

### **b) Depletion of the fossil fuel:**

Coal, oil and natural gas are non-renewable resources as they are found in limited amounts in the environment and they were formed in deep in the Earth millions of years ago, this means that what is consumed of them cannot be compensated.

In the last century, coal was on the top of the list as it was the fuel used in industry after the invention of the steam engine then it was replaced by Oil and natural gas and their uses are increased day after day for many reasons:

1. Their thermal value is higher than coal.
2. Oil has a fluid nature and natural gas has a gaseous nature which distinguished them from coal in these aspects their easiness of transporting and storing and loading ships, trains and airplanes by them.
3. Coal mining is more expensive than oil and natural gas.
4. Oil and natural gas became the core of life nowadays, oil is used daily in huge amounts in the internal combustion engine and also Natural gas is used as fuel in houses and factories.
5. Oil is not only an energy source, but recently there are many chemical industries basically depend on components or oil derivatives and it is called petrochemical industries, which produce most of what man need in his life and those product synthetic fibers, detergents, dyes, paints, packaging bags, medicine and other products which are essential for life and that have the higher economic return and less polluting to environment than using oil as fuel.

The consumption of oil and natural gas is increasing year after year. A report estimate shows that in the developed countries, the individual's consumption of energy increases by 3% yearly. And the developing countries started industrialization, and many of them have taken big steps in this field

Thus, the international consumption of energy is doubling every ten years.

So we mustn't depletion of coal, oil and natural gas and prepare ourselves scientifically and technically for the day that oilscarce before it completely depletion, which will cause many harms to Man.

Thus the scientists succeeded to get energy from water falls, solar energy, wind energy and tide energy and etc...Thus efforts are being expended towards how we can get benefits from them

### **Solving the problem of Depletion of the fossil fuel:-**

1. Rationalizing oil consumption and find suitable substitutes for it.
2. Using solar and wind energias as they are the most suitable energy that can be utilized in Egypt because they are available all the year instead of oil and natural gas because they are non-renewable resources.
3. Using coal instead of oil because it is more available and with solving the pollution problem.
4. Raised reactors for power generation from nuclear fuel using uranium instead of oil but this is still limited due to large costs and the many safety precautions to be taken to protect humans and the environment from its dangerous.
5. Manufacturing Cars work with electricity by using solar cells because they are saving fuel from oil and does not pollute environment.
6. Conversion of animal waste and agricultural waste to methane gas (biogas) which is used as fuel.
7. Re-using car oils after treatment.



### Exercises

**(1) Choose the correct answer:**

**1. Depletion is:**

- a) The continuous reduction in the natural non-renewable resources.
- b) Using the natural resources from time to time.
- c) Mining the metals and manufacturing them.
- d) Exploiting the forests and cutting their trees to use it.

**2. To preserve the ratio of the mineral elements in the soil we should:**

- a) Plough and irrigate the soil continuously.
- b) Use the insecticides.
- c) Not plant a single kind of crop.
- d) (a) and (b) together.

**3. If you are responsible for oil consumption. You will:**

- a) Work for more consumption to increase the profits.
- b) Keep it inside the Earth to use it in the future.
- c) Mine it in large quantities to export it.
- d) Mine it and rationalize its consumption to increase the time of its use.

**(2) Discuss the following statements stating your opinion about each:**

- a) some see the forest conversion to crop land to meet the needs of the growing population for food.
- b) The best way to rationalize water consumption is to raise its price.
- c) Some people prefer to use solar heaters instead of heaters that use electricity or biogas.
- d) some people see must stop the use of oil as fuel and use it produce petrochemical only.

**(3) What are the right or wrong of the following acts:**

- a) Planting one crop all seasons.
- b) Replacing chemical fertilizers by organic ones.
- c) Cutting the forest trees for planting ground.

**(4) How can we solve the problem of these resources:-**

- a) depletion of the agricultural soil.
- b) depletion of the fossil fuel.
- c) depletion of the fresh water.
- d) depletion of metals.



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طبع الممتن	٤ لون
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## **الشركة**

الحديثة للطباعة والتغليف

القاهرة: ٨ شارع سيبيه المصرى - ت: ٢٤٠٢٣٢٩٩ - فاكس: ٢٤٠٢٧٥٦٧ (٠٢)  
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