

## Geology Definition

**Geology** is the study of the earth (geo means earth, and logy (logos) means science). This is a very simple definition. Geology involves studying the materials that make up the earth, the features and structures found on Earth as well as the processes that act upon them. Studying how life and our plant have changed over time is an important part of geology. (Figure.1.1).



Figure.1.1: Plane of the ecliptic and earth's orbit

## BRANCHES OF GEOLOGY (EARTH SCIENCES)

**1. Physical Geology:** Physical geology is the fundamental study of the earth's lithosphere components like rocks, minerals, and soils and how they got originated over a period of time. Also, study the active geological processes on the earth's surface (*external processes*) like weathering as same as study a complex *internal Processes* such as plate tectonics and mountain-building.

**2. Historical geology:** Historical geology uses the principles and techniques of geology to reconstruct and understand the history of Earth. It is deals with the records of the events on the earth history (plants and animals of the past ages).

### **3. Paleontology:**

Paleontology (USA spelling) or paleontology (UK spelling) is the study of ancient plants and animals based on their fossil record. This includes the study of body fossils and trace fossils.

### **4. Petrology: Petra** means A Rock

Petrology is the scientific study of the rocks, their composition, texture their distribution and geologic processes of formation. It is concerned with all three major types of rocks: Igneous, Sedimentary and Metamorphic Rocks.

### **5. Structural Geology:**

Structural geology is the study of the deformation of the surface and subsurface of the Earth. This deformation reflects past changes in local and regional stress and strain, and can be used to reconstruct past crustal movements.

**Stress** is force per unit area. **Strain** is the deformation of a solid due to stress.

### **6. Economic Geology:**

Economic Geology is the scientific study of the earth's materials that are used for economic and industrial purposes. These materials include precious stones and base metals, nonmetallic minerals, petroleum and Coal.

### **7. Stratigraphy :**

Stratigraphy a branch of geology dealing with the classification, Nomenclature, correlation, and description of stratified rocks.

### **8. Petroleum geology:**

Petroleum geology is the study of origin, occurrence, movement, accumulation, and exploration of hydrocarbon fuels.

### **9. Geophysics:**

Geophysics is a core branch of geology. It is concerned with the physical properties of the Earth.

**Geophysical survey** data are used to analyze potential petroleum reservoirs and mineral deposits, locate groundwater, find archaeological relics, determine the thickness of glaciers and soils.

## **10. Crystallography:**

Crystallography is concerned with the study of crystals in terms of their appearance, their **composition**, **their** identification and the rocks and **minerals** they contain.

## **Why Study Geology:**

Before getting into important scientific concepts, we will look at some of the ways geology has and will continue to benefit you:

1. Supplying things we need.
2. Protecting the environment.
3. Avoiding geologic hazards.
4. Understanding our surroundings.

## **How Was Earth Formed?**

Approximately 4.6 billion years ago, the solar system was a cloud of dust and gas known as a solar nebula (A nebula is a large cloud of gas and dust particles) Gravity collapsed the material in on itself as it began to spin, forming the sun in the center of the nebula. With the rise of the sun, the remaining material began to clump up. Small particles drew together, bound by the force of gravity, into larger particles. The solar wind swept away lighter elements, such as hydrogen and helium, from the closer regions, leaving only heavy, rocky materials to create smaller terrestrial worlds like Earth. But farther away, the solar winds had less impact on lighter elements, allowing them to coalesce into gas giants. In this way, asteroids, comets, planets, and moons were created.

## **The earth**

Earth is a complex dynamic planet that has been changing continually since it formed some 4.6 billion years ago. These changes and the present day features we observed resulting from interactions among the various internal and external processes. Earth is a unique among the planets of our solar system in that it supports life and has oceans and water, atmosphere and variety of climates.

## **Solar system**

Solar system composed of the sun, nine planets, satellites of the Planets, more than 1500 asteroids and uncounted millions of meteors.

- **Sun** composed primarily of hydrogen and helium. It has a diameter of about (1,380,000Km.) it is more than 100 times the diameter of the earth. The planets revolve around the sun. In order of distance from the sun the planet are: **Mercury , Venus , Earth, Mars, Jupiter, Saturn, Uranus, Neptune and Pluto.**

- **Three others types of bodies** exist in the solar system: **Comets ( المذنب ), Asteroid ( الكويكب ) and meteoroids.**

- **A comet** is an icy small Solar System body that, when passing close to the Sun, warms and begins to release gases, a process called outgassing. This produces a visible atmosphere or coma, and sometimes also a tail.

- **Asteroid** are rocky worlds revolving around the sun that are too small to be called planets. They are also known as planetoids or minor planets. The mass of all the asteroids is less than that of Earth's moon.

- **A meteoroid** is a small body of debris in the Solar System, roughly ranging in size from a sand grain to a boulder. If the body is larger, it is called an **asteroid** if smaller it is known as interplanetary dust.

## ***Earth's Heat Energy***

The Earth can be visualized as a giant machine driven by two engines One **internal** and the other **external** both are heat energy

### ***1. Internal heat energy :***

The Earth's internal heat engine works because hot, buoyant material deep within the earth moves slowly upward toward the cool surface and cold denser material moves downward.

Moving plates, earthquakes, and volcanism are products of this heat engine.

**Note:** The biggest engine resources in the **Earth's interior** are in the mantle and outer core.

### ***2. External heat energy***

Heat engine is driven by solar power, heat from the sun provides the energy for circulating the atmosphere and oceans Glacial, water and Wind Erosion changing the landscape.

## Earth's Spheres أغلفة الأرض

1. **Atmosphere** : the gases that envelop the Earth
2. **Hydrosphere** : water on or near the Earth's surface
3. **Biosphere**: Is the layer of the planet where life exists.
4. **Geosphere**: the solid rocky Earth.

**Internal structure of the earth** التقسيمات الداخلية للأرض  
لماذا من المستحيل معرفة التركيب الداخلي للأرض من خلال الملاحظة المباشرة.

- Why It is impossible to know about the earth's interior by **direct observations**?

because of the huge size of the earth (The earth's radius is 6,370 km). and the changing nature of its interior composition.

And the rapid increase in temperature below the earth's surface is mainly responsible for setting a limit to direct observations inside the earth.

### **Sources of Information about the interior of the earth**

#### **Direct Sources:**

1. Rocks from mining area
2. Volcanic eruptions

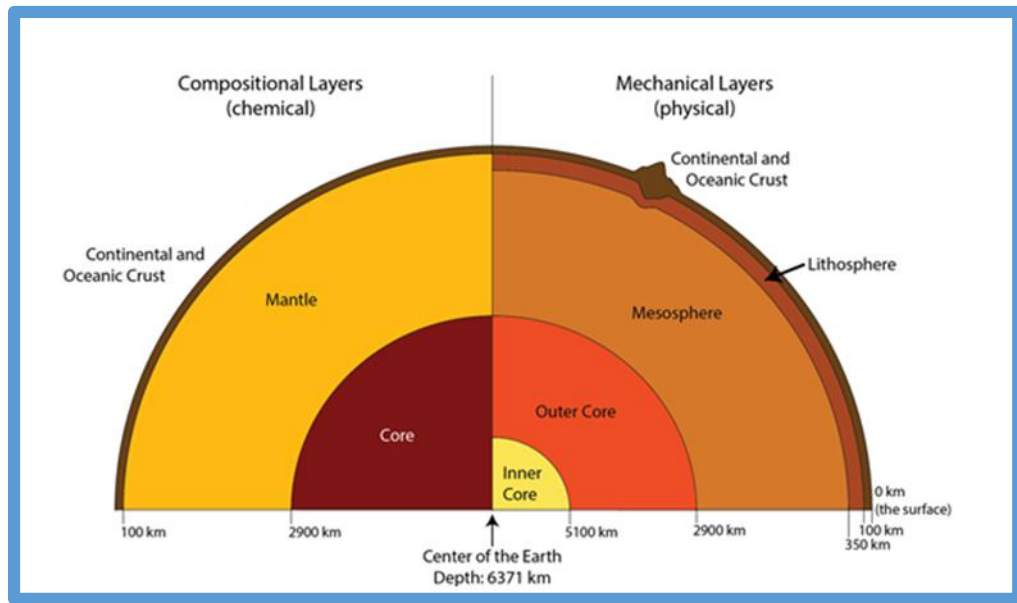
#### **Indirect Sources:**

1. Meteors they belong to the same type of materials earth is made of.
2. Seismic Waves
3. By analyzing the rate of change of **temperature and pressure** from the surface towards the interior.

### **The Earth's Structure** التركيب الداخلي للأرض

There are two Classification of the **Earth's Structure**

1. **Chemical compositions** التركيب الكيميائي
2. **Physical properties** الحالة الفيزيائية



**Diagram of the earth's interior**

التقسيمات الداخلية للأرض اعتماداً على التركيب الكيميائي :

Depending on **Chemical compositions** the earth can be divided into three main layers:

**Crust** القشرة  
**Mantle** الجبة  
**Core** اللب

### **The Crust**

It is the outer solid part of the earth, normally about 5-50 kms thick. It is brittle in nature. The thickness of the crust under the ocean (Oceanic crust) and continental areas (Continental crust) are different. Oceanic crust is thinner (about 5kms) as compared to the continental crust (about 30kms). Major elements of crust are Silica (Si) and Aluminium (Al) and thus, it is often termed as SIAL.

### **Continental Crust Vs. Oceanic Crust**

#### **Continental Crust**

Crust beneath the Earth's continents

Less dense and thicker than oceanic crust (less dense because it is high in Silicon & Oxygen)

Composed of Granite

### **Oceanic Crust**

Crust beneath the Earth's oceans

More dense and thinner than continental crust (More dense because it is high in Iron & Magnesium)

Composed of Basalt.

### **The Mantle**

The portion of the interior under the **crust** is called as **the mantle**.

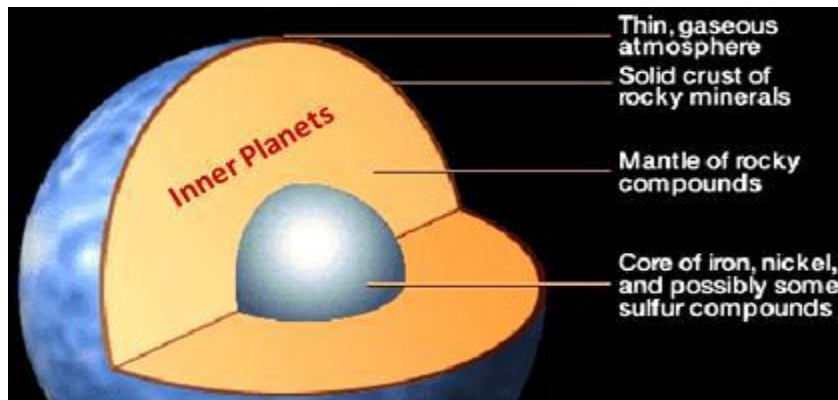
The discontinuity between the **crust and mantle** is called as the **Mohorovich Discontinuity or Moho discontinuity**. The mantle is about 2900kms in thickness. The major constituent elements of the mantle are **Silicon and Magnesium** and hence it is also termed as **SIMA**.

### **Core**

It is the inner layer surrounding the earth's center.

The core is separated from the mantle by Guttenberg's Discontinuity.

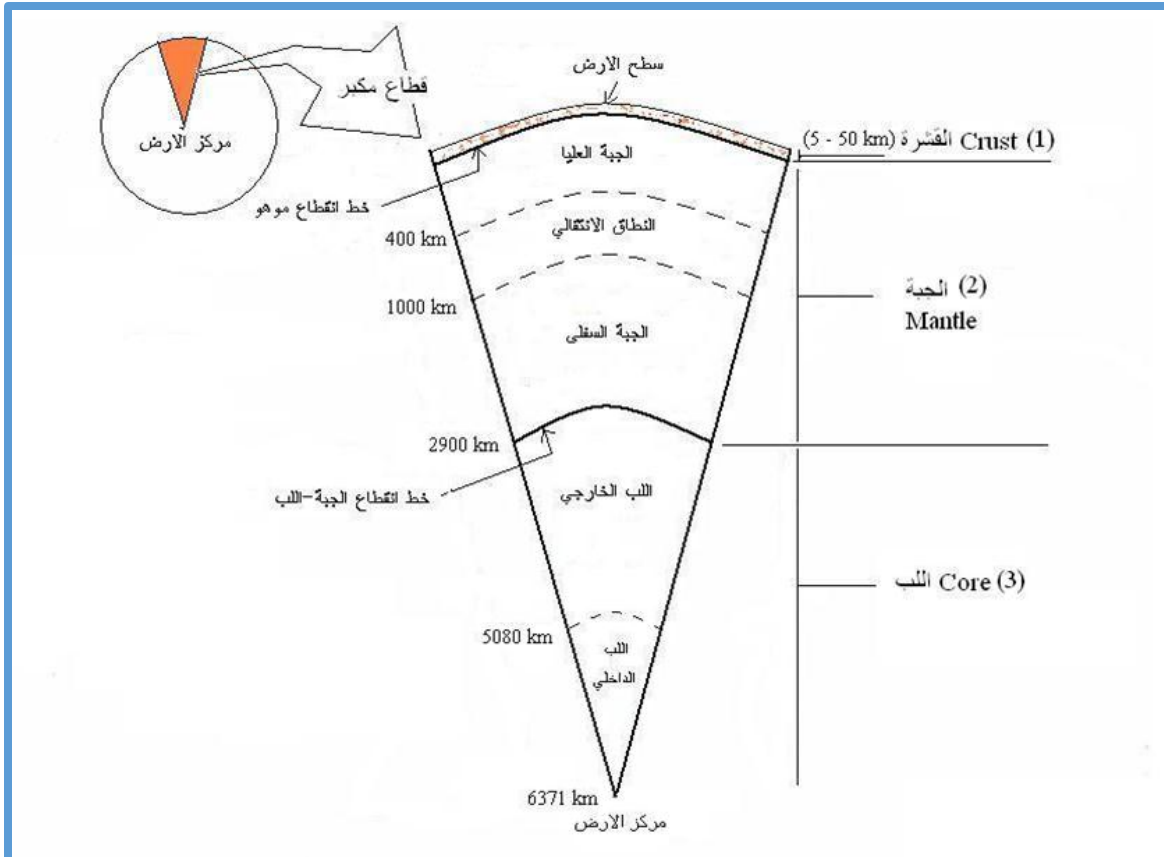
It is composed mainly of iron (Fe) and nickel (Ni) and hence it is also called as NIFE.



The composition of inner planets

Depending on **Physical Properties** the earth can be divided into three main layers:

**Physical Properties**      التقسيمات الداخلية للأرض اعتماداً على المكونات الفيزيائية



بالاعتماد على الخصائص الفيزيائية (الميكانيكية) للأرض تقسم إلى:

**1. Lithosphere** (depth between 0-100km)

The upper solid part of the mantle and the entire crust constitute the **Lithosphere**.

**2. The asthenosphere** (in between 100-350km)

is **a highly viscous**, mechanically weak and ductile, the upper mantle part which lies just below the lithosphere.

**The asthenosphere** is the main source of magma and it is the layer over which the lithospheric plates (continental plates) move (plate tectonics).

**3. The Mesosphere** (in between 350-2900km)

The **semi rigid** portion of the mantle which is just below the lithosphere and asthenosphere but above the core is called as **Mesosphere**.

**4. The Core** consists of two sub-layers: **the outer core (2900 – 5100 Km.)** and the **Inner core (5100-6370 km) .**



The inner core is in **solid state** and the outer core is in the **liquid state** (or **semi-liquid**).

### **Temperature, Pressure and Density of the Earth's Interior**

#### **Temperature**

#### **Temperature**

- A rise in temperature with increase in depth is observed in mines and deep wells.
- The molten lava erupted from the earth's interior supports that the temperature increases towards the center of the earth.
- The temperature at the center is estimated to lie somewhere between 3000 C and 5000 C, may be that much higher due to the chemical reactions under high pressure conditions.
- Even in such a high temperature also, the materials at the center of the earth are in solid state because of the heavy pressure of the overlying materials.

#### **Pressure**

Just like the temperature, the pressure is also increasing from the surface towards the center of the earth. which will be nearly 3 to 4 million times more than the pressure of the atmosphere at sea level. It is due to the huge weight of the overlying materials like rocks.

#### **Density**

Due to increase in pressure and presence of heavier materials like **Nickel and Iron** towards the center, the density of earth's layers also gets on increasing towards the center.