1 The Composition of the Earth

The earth occupies a unique place among the planets in the solar system as it is the only planet which sustains life. The reasons for the existence of life are the availability of air, water and solar energy.

The objective of this lesson is to examine in detail the composition of the earth which is our habitat.

Composition of the Earth

The area of the surface of the Earth is about 510 million square km *(www.universetoday.com)* and it is considered a very large system.

The earth system is composed of four sub systems. (Figure 1.1) They are the,

- Atmosphere
- Lithosphere
- Hydrosphere
- Biosphere

Figure 1.1
The Earth System

There is an interaction among these four sub-systems, For example,

- The water in the hydrosphere is added to the atmosphere through evaporation.
- That water falls again to the earth as precipitation.
- The bio-environment in the biosphere is composed of soil, air and water.
- The components of the bio-environment, has impacts on the hydrosphere, atmosphere and lithosphere.

Lithosphere

Lithosphere is the layer that includes the Earth's crust and the upper mantle. Continents and oceans are located in the lithosphere.

The lithosphere consists of two parts according to its structure. (Figure 1.2)

1. Earth's Crust
   - Continental crust
   - Oceanic crust
2. Upper mantle

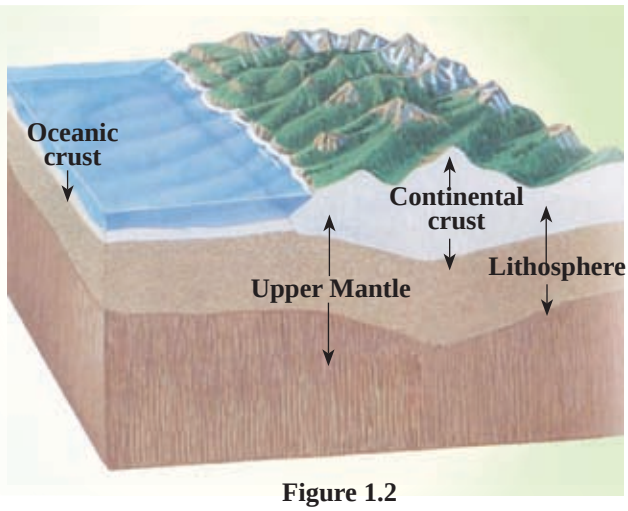


Figure 1.2
Structure of the lithosphere
Source- http://sci.gallaudet.edu/06/02/2014

The lithosphere is the home for living beings. Most of the human activities occur here. The living and non living resources which are found in the lithosphere are utilized to fulfil human needs.

When the resources found in the lithosphere are utilized by man, the lithosphere is affected in various ways. Examples of such effects are shown below.

- The occurence of land degradation due to excavation of land to obtain mineral resources.
- Intensification of soil erosion as a result of exposure of land due to clearing of forests .
- Changes seen in the surface landscape.
- Changes in the ground water level.
- Damage to certain layers of the lithosphere as a result of disposal of domestic and industrial waste.

Activities

1. Name the four main sub-systems that the earth is composed of.
2. Explain the inter-relationship that exists among the sub-systems with examples.
3. Illustrate the structure of the lithosphere using a diagram and name its parts.
4. Write three uses of the lithosphere.

Assignment

Prepare a leaflet including the followings.

- Unfavourable effects caused to the environment through human activities.
- The steps that could be taken to minimize them.

Atmosphere

The atmosphere is the thin blanket of air around the earth that consists of various gases. The atmosphere is held by the earth due to its gravitational pull. The most important layer of the atmosphere is the area that extends up to 120km from the surface of the earth. 50% of the total air content of the atmosphere is present in the region that extends up to 5-6km from the earth's surface. *(David Waugh-2000)*

The atmosphere is immensely important for the existence of living beings and plant life as it provides oxygen for respiration of living beings and the necessary carbon dioxide for the process of photosynthesis.

Table 1.1

Composition of the atmosphere

Name of gas	Volume %
Nitrogen (N_2)	78.09
Oxygen (O_2)	20.95
Argon (Ar)	0.93
Carbon dioxide (CO_2)	0.03
Ozone (O_3)	0.00006
Helium (He)	trace
Neon (Ne)	
Krypton (Kr)	

Source- *David Waugh (2000)*

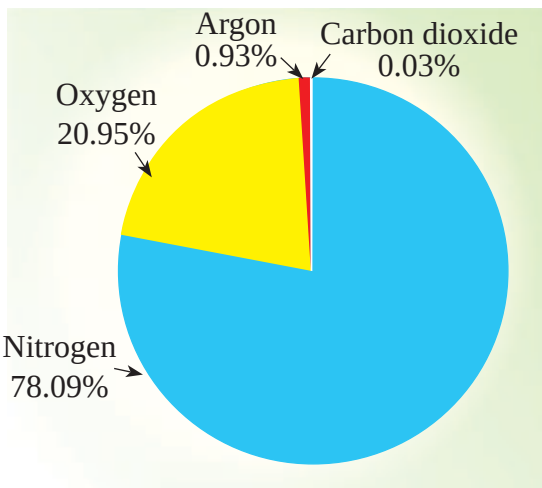


Figure 1.3
Composition of the atmosphere
(kinds of m aingas es)

The atmosphere mainly consists of various gases and it also contains water vapour, dust and salt particles. (See Table 1.1 and Figure 1.3).

As a result of different human activities and natural phenomena (Exhaustion of gases during volcano eruptions, release of methane from marshes etc.) natural gases like Carbon Dioxide, Methane, Carbon Monoxide, and Sulphur Dioxide are added to the atmosphere. This changes the composition of the atmosphere and may adversely affect the existence of life.

Structure of the atmosphere

The atmosphere is divided into four main layers on the basis of change of the temperature with the altitude.

1. Troposphere
2. Stratosphere
3. Mesosphere
4. Thermosphere (Figure 1.4)

Special characteristics of the layers of the atmosphere

Troposphere

- It extends up to 8-12 km from the surface of the earth.
- The temperature decreases with altitude. It is known as environmental lapse rate (normal lapse rate). The temperature decreases by 6.4^0C for every 1000m.
- All the atmospheric phenomena including precipitation, temperature, pressure, humidity, winds and formation of clouds occur within this layer.
- The processes that occur in the troposphere are very important for the existence of the biosphere.
- Normal aeroplanes fly in the area close to the upper boundary of the troposphere (Figure 1.4).
- The upper limit of the troposphere is called the **Tropopause**.

Stratosphere

- The upper boundary of the stratosphere extends up to 48-50 km from sea level.
- The increase of temperature with the increase in altitude is a special characteristic in this layer.

- The ozone layer which is very important for the existance of the biosphere is located between 20-30 km of this layer.
- The specific feature of the ozone layer is the absorption of the ultra-violet rays of the sun, that are harmful to living beings. The ozone layer prevents it from reaching the earth.
- The location of the ozone layer influences the increase of temperature in this part.
- Most of the meteorites that fall towards the earth from space burn up and get destroyed within the stratosphere. (Figure 1.4)
- Supersonic jets fly within the central region of this layer.
- The upper boundary of the stratosphere is called the **Stratopause**.

Figure 1.4
Layers of the atmosphere

Source-*http://ete.cet.edu/gcc/13/03/2014*

Mesosphere

- The upper boundary of this layer extends upto the altitude of 80 km from sea level.
- Within this region, the temperature decreases with altitude.
- There is no water vapour, clouds and dust particles in this region.
- The lowest temperature of the atmosphere prevails in this region. (-90^0 C).
- Electric phenomena occur in abundance in this layer.
- The upper boundary of the mesosphere is called the **Mesopause**.

Thermosphere

- The upper boundary of the thermosphere extends up to 120 km approximately.
- The temperature increases rapidly with the altitude.
- There is a high temperature in this layer. The temperature at noon is about 1100^0 C.
- The difference between the temperature of day and night is at a higher level.
- The volume of gases is very low.
- The upper boundary of the thermosphere is the upper boundary of the earth's atmosphere.

Activities

1. Define atmosphere.
2. Illustrate the four main layers of the atmosphere using a diagram. Write two features of each layer.
3. Write four uses of the atmosphere to man.

Assignments

1. Prepare a document including the human activities that cause pollution of the atmosphere and the impact of pollution on the physical and human environment.
2. Prepare a set of suggestions on actions to be taken to minimize air pollution.

Hydrosphere

The entire body of water on the surface of the earth in various forms is termed the hydrosphere. The total volume of water on earth is calculated as 1386 million cubic kilometers (Environmental Geography 1996).

Water is essential for the sustenance of all the bio systems. Water is utilized for drinking and domestic purposes as well as for agricultural, industrial and transportation activities.

Figure 1.5
Hydrosphere

Source- *www.earthssciencеeducation.com*

Distribution of water on the earth

Water can be seen in different forms on earth as follows (Figure 1.6).

- Ocean water (in oceans and seas).
- Surface water (on the surface of the land, rivers, streams, lakes and reservoirs).
- Ground water (water deposited under ground)
- Atmospheric water (Atmospheric humidity)
- Soil water (water in soil).

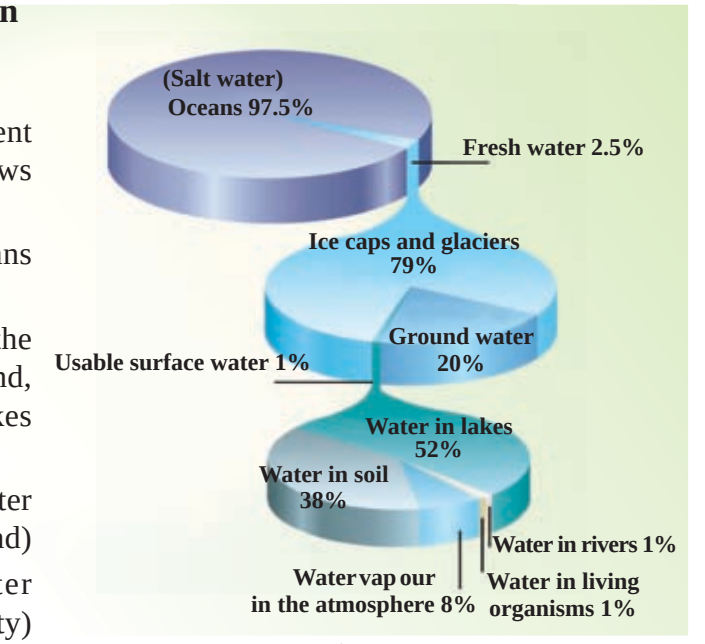


Figure 1.6
Distribution of Water
Source- *https//chandoo.org/wp/2014/03/13*

Out of the total volume of global water only 1% or a very limited amount of fresh water found on the surface of land, can be utilized by man. (Figure 1.6)

At present, the quality of water is deteriorating due to the impact of various human activities.

Some of the examples are,

- Addition and release of various chemicals and carbonic matter into the water used and released by industries.
- The mixing of fertilizers and chemicals added to soil in agricultural activities with the water.
- Addition of bacteria to ground water and surface water on the land as a result of the irregular disposal of waste matter and sewage.

Accordingly, the deteriorization of the quality of water causes harmful effects on the survival of living beings.

The Water Cycle

- The continuous process by which water is circulated throughout the earth and the atmosphere through evaporation, condensation, precipitation, and the transpiration of plants is known as the water cycle.(Figure 1.7)
- The atmosphere gets the water that is evaporated from the surface of the land and water bodies and also the water transpired from plants. This water which exists as water vapour in the atmosphere is subjected to condensation and returns to the earth as rainfall through the process of precipitetion.
- A part of the water received on the surface of the earth flows as surface runoff and another part of it is infiltrated into the land. The infiltrated water is stored in the earth as ground water and the springs and wells are fed by this infiltrated water.

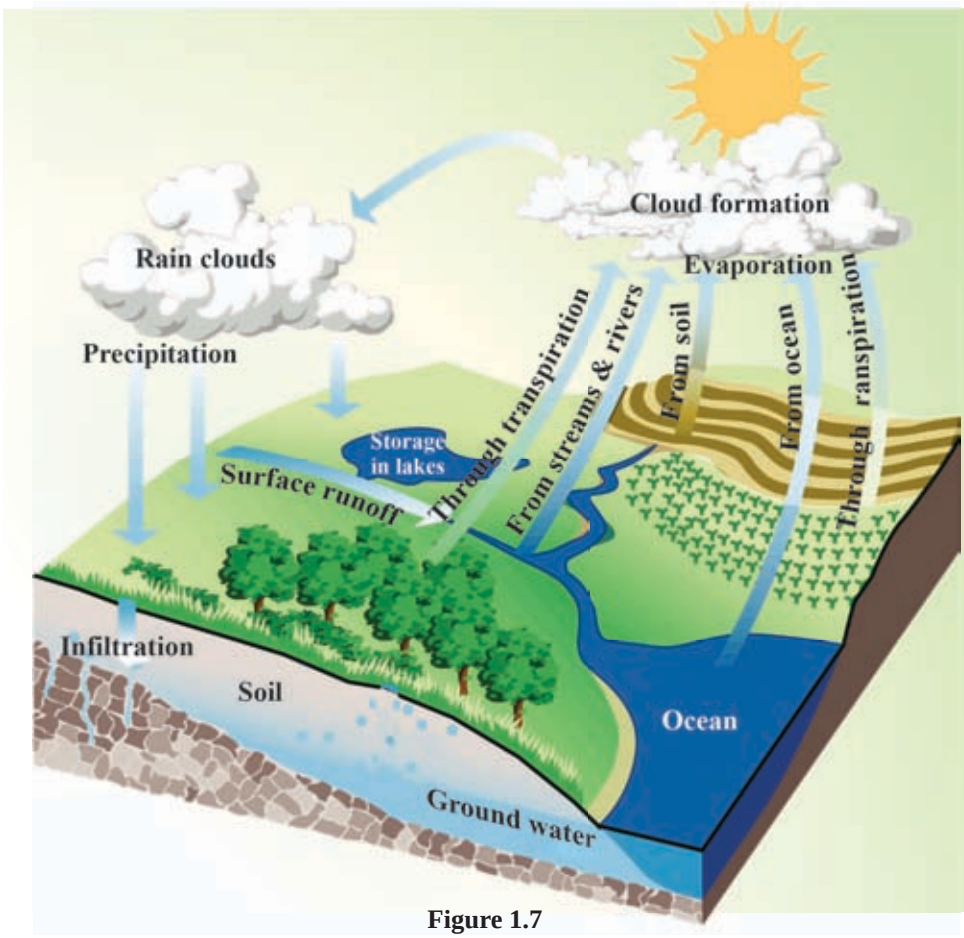


Figure 1.7

The Water Cycle

Source- *www.teamleaf.org 06/02/2014*

Activities

1. Name the various forms of water that exist in the Earth's hydrosphere.
2. Describe the distribution of water on the earth using a diagram.
3. "Out of the large volume of water found on the earth, only a small amount can be utilized by man". Explain this statement.

Assignments

1. Find information and prepare a list about the human activities that cause water pollution.
2. Design a poster under the theme "Let's contribute to sustainable conservation of water which is a precious resource".
3. "Due to wastage and the low quality of water, there may be a scarcity of drinking water in future". List the problems Sri Lankans will have to face in future regarding this issue and make a list of suggestions on how to minimize them.

Biosphere

The total ecological systems integrating plant and animal life which constantly interact with the Earth is termed the biosphere.The existence of the biosphere depends on the interaction of the atmosphere, lithosphere and hydrosphere with each other.

There are two factors that affect the processes in the biosphere.

1. Living components - (plants, animals and decomposers)
2. Non-living components - (solar energy, soil, water, climate)

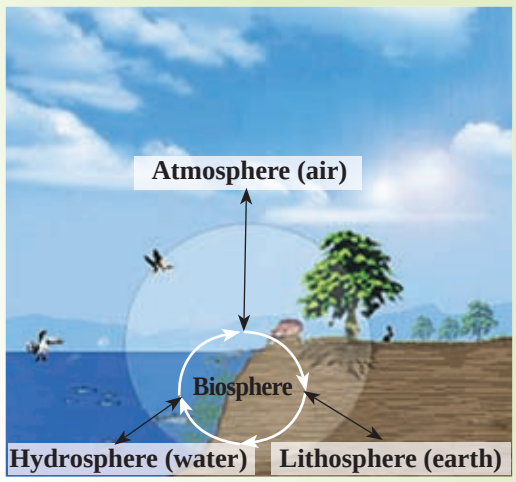


Figure 1.8

Biosphere

Source - *https//greenfoecast.com/06/02/2014*

The boundaries of the biosphere

- In the lithosphere - The layer in which the root system of plants spreads and where soil organisms live (2.5 m within the soil approximately).
- In the hydrosphere - The ocean bed in which sufficient amount of sunlight penetrates for the process of photosynthesis.
- In the atmosphere - The limits where birds fly (Approximately about 5000 m in the upper sky).

The process of photosynthesis which is necessary for the existence of man occurs in the biosphere . A process of interaction between plant and animal life is visible in the biosphere. Hence, plant life cannot exist without animals and animals cannot live without plants. At present, most of the human activities have become a strong threat to the biosphere. Accordingly, the equilibrium of the biosphere has been disturbed due to these human activities. For example, the loss of animal habitats due to the destruction of forests, destruction of the bio-systems, erosion of the surface soil and infertility of soil.

Activity

Briefly define the biosphere and state its boundaries.

Assignments

1. Design a poster on the theme "The wonders of the Biosphere".
2. Find information and write a report to show how human activities affect the existence of the biosphere.

The structure of the Earth

After the study of composition of the Earth, you would be able to understand the structure of the earth in this lesson.

The structure of the Earth is composed of three main layers.

1. Crust
   - Continental
   - Oceanic
2. Mantle
   - Upper mantle
   - Lower mantle
3. Core
   - Outer core
   - Inner core (Figure 1.9)

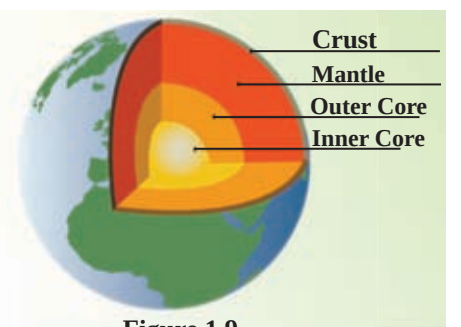


Figure 1.9
Structure of the earth
Source- *tec_001 www.bbc.co.uk06/02/2014*

The Special characteristics of the layers of the Earth's structure

The Crust

It belongs to the lithosphere and consists about 1% of the total land mass of the earth.

The thickness of the crust is not uniform. It extends with a thickness of 5km in depth in the oceans and 60 km in the continents.

It consists of rocks and contains a wide variety of useful minerals.

The uppermost thin layer of the crust consists of soil and it is continuously developed through the processes in the bio-environment. This thin soil layer is important for agricultural activities.

The crust is divided into two parts according to its location, composition and the density of rocks.

- Continental crust and
- Oceanic crust (Figure 1.10)

The continental crust consists of granitic rocks. This part is called the Sial layer as it is primarily composed of Silica (Si) and Aluminium (Al).

The oceanic crust consists of basaltic rocks. This layer is called the Simag layer as it consists primarily of Silica (Si) and Magnesium (Mg).

The Simag is the basic rock layer on which the Sial layer lies.

The boundary that separates the crust of the earth from the mantle is called the Mohorovicic discontinuity. (Figure 2.2)

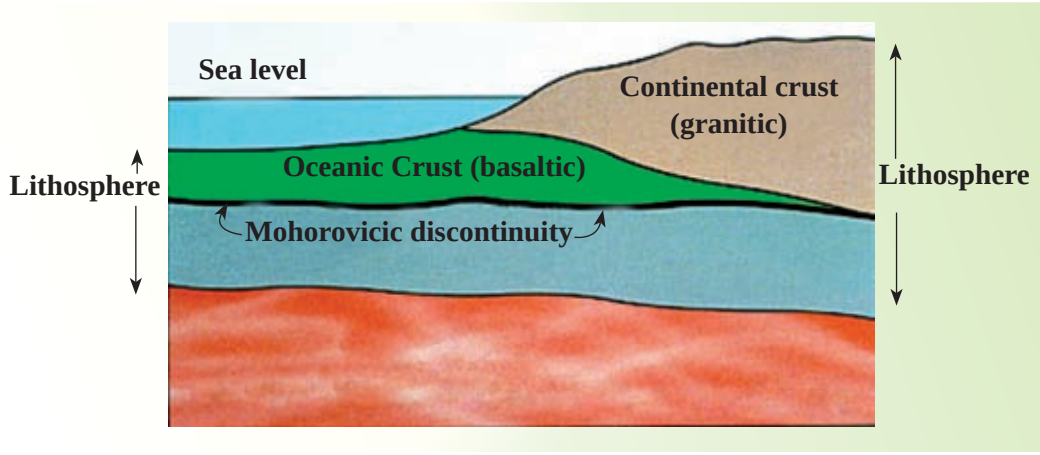


Figure 1.10

Continental Crust and the Oceanic Crust

Source- *Robert Gabler, James E Peteron, L. Michael Trapsso (2006)*

The Mantle

Mantle is the layer which is located between the crust and the core.

The mantle is a layer that extends to a depth of 2900 km from the surface of the Earth. This layer forms 2/3 of the land mass of the Earth.

The upper part of the mantle consists of Olivine and Silicate while the lower part is made up of Magnesium and Silicate.

According to the chemical composition and rocks, this layer is divided into two parts ; the upper mantle and the lower mantle.

The boundary that separates the mantle from the core is called the Gutenberg discontinuity.

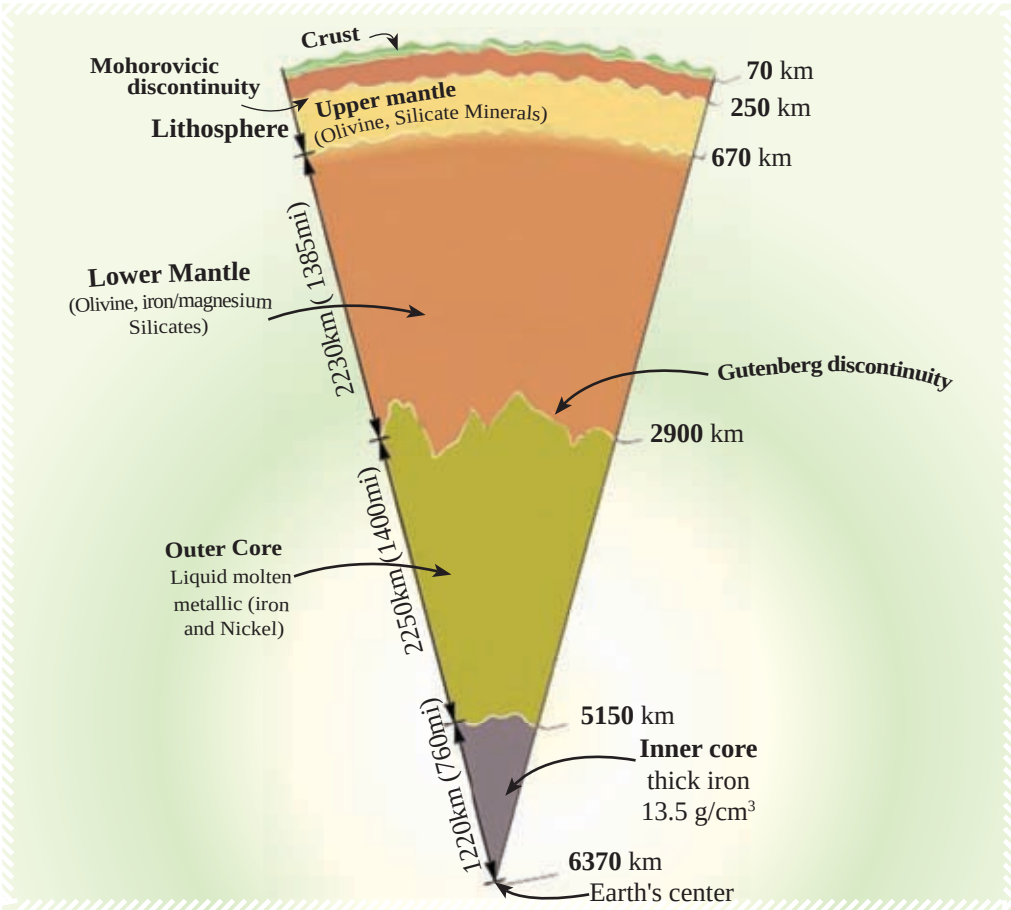


Figure 1.11

Cross section of the structure of the earth, depth and the composition of rocks

Source-*https/geoscience.wise.edu/06/02/2014*

The Core

The core is located below the mantle of the earth.

According to the composition, it is divided into two parts, namely the inner core and the outer core.

The outer core consists of liquid metal (Nickel and Iron) and it extends from the mantle to a depth of 2250 km.

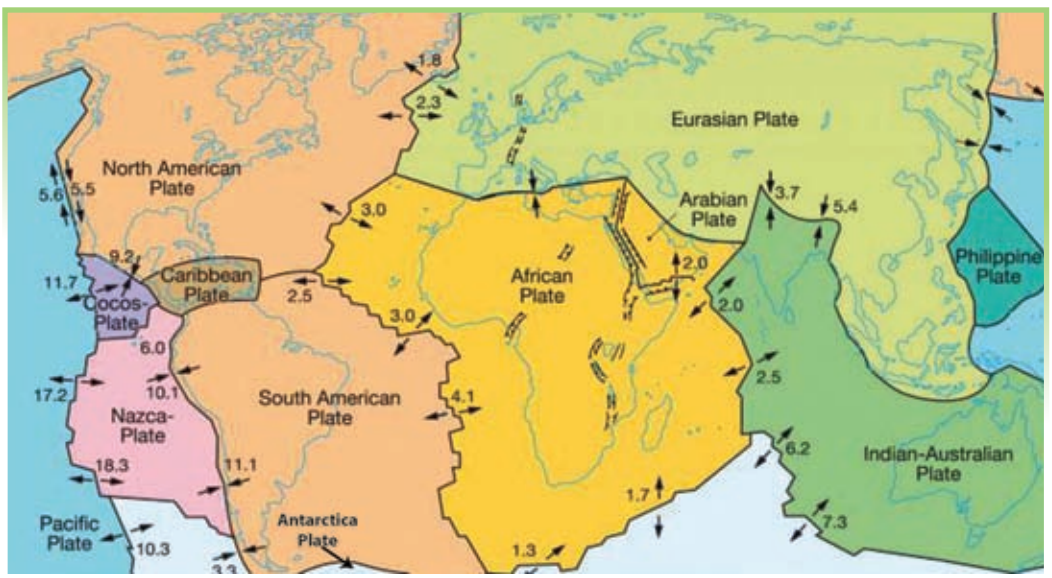
The inner core consists of a thick metal (Iron) layer and it extends to a depth of 1220 km from the outer core.

Tectonic plates

The lithosphere consists of a number of tectonic plates that move very slowly in relation to one another. The lithosphere consists of seven major tectonic plates and a few minor plates. (Map 1.1)

These tectonic plates move as a result of the convectional currents which are active in the mantle.

Tectonic plates in the lithosphere



Map 1.1

location of the tectonic plates of the earth

Source-*https/www.diercke.de/bilder/omeda/06/02/2014*

Activities

1. Draw a cross section of the structure of the earth and mark the three layers and their boundaries.
2. Write three main features of each of the layers in the structure of the earth.
3. Name five types of minerals contained in the crust, which are useful to man.
4. Mark and name the location of the major tectonic plates on a map of the world.
5. On which plates are the following countries located Sri Lanka, Japanese islands, Indonesia, Madagascar, British Islands, Greenland, Cuba and Brazil.

Assignment

Using an object like a rigifoam ball, create a model of the structure of the earth as indicated in figure 1.9.

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https//www.diercke.de/bilder/omeda/800/11630E 1 Erde plattentektoni.jpg -Lithosphere

https://chandoo.org/wp/2012/11/09/pie-of-pie-of-pie-chart/

Glossary

Lithosphere	- ශිලාගෝලය	- கற்கோளம்
Atmosphere	- වායුගෝලය	- வளிமண்டலம்
Hydrosphere	- ජලගෝලය	- நீர்க்கோளம்
Biosphere	- ජෛවගෝලය	- உயிர்க்கோளம்
Land degradation	- භූමිහායනය	- நிலம் தரமிழத்தல்
Evaporation	- වාෂ්පීකරණය	- ஆவியாக்கம்
Precipitation	- වර්ෂණය	- படிவு வீழ்ச்சி
Crust	- කබොල	- ஓடு
Mantle	- ප්‍රාවරණය	- மூடி
Exosphere	- බාහිරගෝලය	- புற மண்டலம்
Photosynthesis	- ප්‍රභාසංශ්ලේෂණය	- ஒளித்தொகுப்பு
Water vapour	- ජලවාෂ්ප	- நீராவி
Elevation/Altitude	- උන්නතාංශය	- எழுச்சி/ ஃ தரையுயர்ச்சி
Troposphere	- පරිවර්තීගෝලය	- மாறன் மண்டலம்
Stratosphere	- අපරිවර්තීගෝලය	- படை மண்டலம்
Mesosphere	- මෙසෝගෝලය	- இடை மண்டலம்
Thermosphere	- තාපගෝලය	- வெப்ப மண்டலம்
Laps rate	- පතනශීඝ්‍රතාව	- நழுவு வீதம்
Humidity	- ආර්ද්‍රතාව	- ஈரப்பதன்
Run-Off	- අපධාවය	- கழிவு நீரோட்டம்
Ultra-violet rays	- පාරජම්බුල කිරණ	- புறஊதாக் கதிர்கள்
Meteors	- උල්කාශ්ම	- விண்கற்கள்
Tropopause	- පරිවර්තී මණ්ඩලය	- மாறற்றரிப்பு
Stratopause	- අපරිවර්තී මණ්ඩලය	- படைத்தரிப்பு
Menopause	- මෙසෝ මණ්ඩලය	- இடைத்தரிப்பு
Season	- ඍතුව	- பருவகாலம்
Condensation	- ඝනීභවනය	- ஒடுங்கல்
Infiltration	- කාන්දු වීම	- மண் உறிஞ்சுதல்
Ground Water	- භූගත ජලය	- தரைநீர்
Outer Core	- පිටත හරය	- வெளிமையம்
Inner Core	- ඇතුළත හරය	- அக மையம்
Mass	- ස්කන්ධය	- திணிவு
Discontinuity	- අසන්තතිය	- தொடர்ச்சியற்ற
Tectonic Plates	- භූ තැටි	- புவித்தட்டுக்கள்
Convectional currents	- සංවහන ධාරා	- மேற்காவுகை