

UNIT

2

STRUCTURE OF THE EARTH

Unit Outcomes

After studying this unit, you will be able to:

- Describe the layers of the earth and components of the crust.
- Identify the formation, types and economic uses of rocks.
- Explain and use lines of latitudes and longitude and meridians of longitude.
- Construct a sketch map.

Competencies: After studying this lesson, you will be able to:

- Define the term map.
- Express the uses of a map.
- Draw a sketch map of Africa to indicate marginal information on a map.

Key terms

↔ Map

↔ Marginal information

↔ Cartographer

↔ Direction

A. Using a map

- What does a map mean?
- Discuss the uses of a map

When you were in grades five and six you have learnt about the horn of Africa in particular and eastern Africa in general. You have also learnt many features like water bodies, forests and grass lands. You have also discussed how you identify countries and cities on maps. You have further learnt how you can identify natural and human made features on maps.

Look at the following:



A map is a representation of part of the earth on a reduced scale.



Fig 2.1 Relief and Drainage Map Africa

- What is a cartographer?
- How does he make a map?



A cartographer is a person who is well trained to make map. Therefore, a cartographer is a map maker.

A cartographer prepares a map based on material gathered in the field or from air photographs. Originally, all the material shown on maps was based on information from ground surveys. Nowadays, the use of air photographs has both speeded up and eased the making of maps.

Case Study

Ethiopian cartographer

A cartographer in the Ethiopian mapping agency is one of the very important individuals in the making of different types of maps.

He is responsible mainly for the development of two major groups of maps

a) General purpose maps (Topographic maps)

These maps are made using different scales:

1:2,000,000, 1:250,000, 1:25,000, 1:2,000 scales

The areas covered are:

- Contours (height)
- Vegetation
- Settlement
- Hydrographic (water bodies)
Lakes, ponds, reservoirs, rivers and streams.
- Boundaries

b) Single purpose maps

These are maps based on single elements, such as: road maps, industrial site maps, agriculture maps, population maps, climate maps etc.

In addition to the above duties, the cartographer is also responsible for making national atlases (both analogue and digital).

Source: Interview made with the Avison of the Ethiopia Mapping Agency director.

Addis Ababa 2011.

You know also how colours are used to determine map features. You have learnt something about signs and symbols when you were in grade five and six.

Thus, the appearance, readability and usefulness of maps are determined by such considerations as:

- Scale
- Colouring scheme
- Lettering and
- Symbols used.

The accuracy of the map, however, depends mainly on the scale.

- **What does scale mean?**
- **Why should a scale be used to make a map?**



A scale is the ratio of a given distance on a map to the corresponding distance on the ground.

Can you show a very small portion of land on a piece of paper without using a scale? Your answer to this question should be no. Why? Because any portion of the land is too big to be shown on a piece of paper. Therefore, it is essential that you use a scale. Furthermore, scale helps you decide the amount of information you depict on a map.



Scale decides the amount of detail which can be shown. The larger the scale the more information can be shown on the map. The smaller the scale the more selected the information will be (see Fig. 2.2)

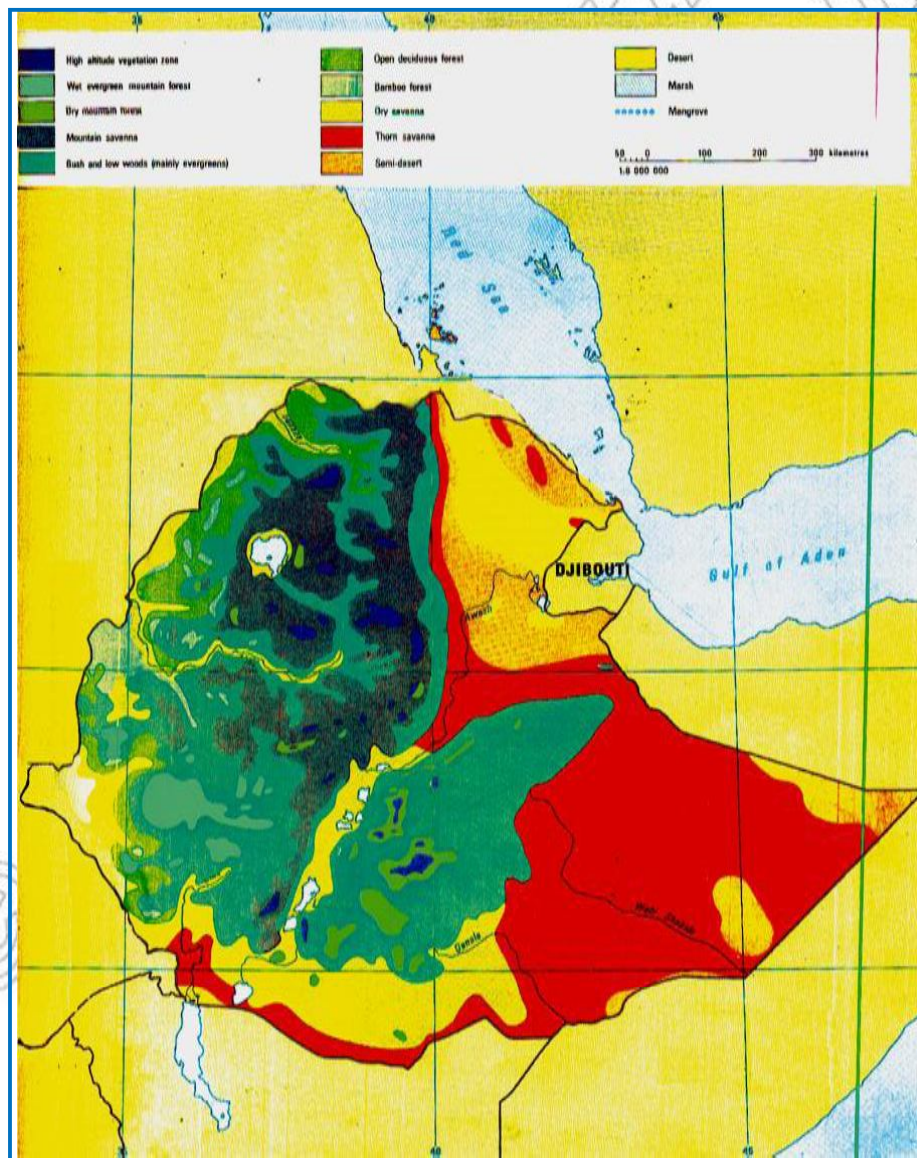


Fig 2.2 Natural Vegetation Map of Ethiopia drawn to scale

Do the following:

- Make the plan of your class on a piece of paper.
- Use appropriate scale.
- Ask your teacher how you can manipulate a scale.

- Can you mention some uses of map?
- Suppose you are a tourist, for what purpose do you think you use a map?

◆ Uses of Map**Ancient use**

Primitive societies used to draw simple maps in sand soil to show location of water hole, an excellent hunting ground and the way how to get there.

Modern use

Modern maps are used to show the location, distance, area and direction of a place.

B. Marginal Information

- What does marginal information mean?
- Discuss what points marginal information includes on a map.

When you study a map, you observe the outskirts of the map. These outskirts make up the margins of the map. Usually information is included on the margins of the map. The information includes terms that indicate different aspects of the map. All the terms included on the appropriate corner of the margin of the map are generally termed as **marginal information**.

In order to make proper interpretation possible, all maps must bear the following marginal information:

- title or heading
- scale
- compass direction
- key to symbols and colours
- date of publication

Thus, once you know these items of marginal information, you can read the information provided on a given map.

◆ Title or Heading

Every map is drawn on purpose. Therefore, every map has a name. The name is its title or heading. For example, a map of Africa may show the various types of vegetation available in different parts of the continent. The title of this map may be “vegetation map of Africa”. Can you cite another title of your own? Please try one (see Fig. 2.3).

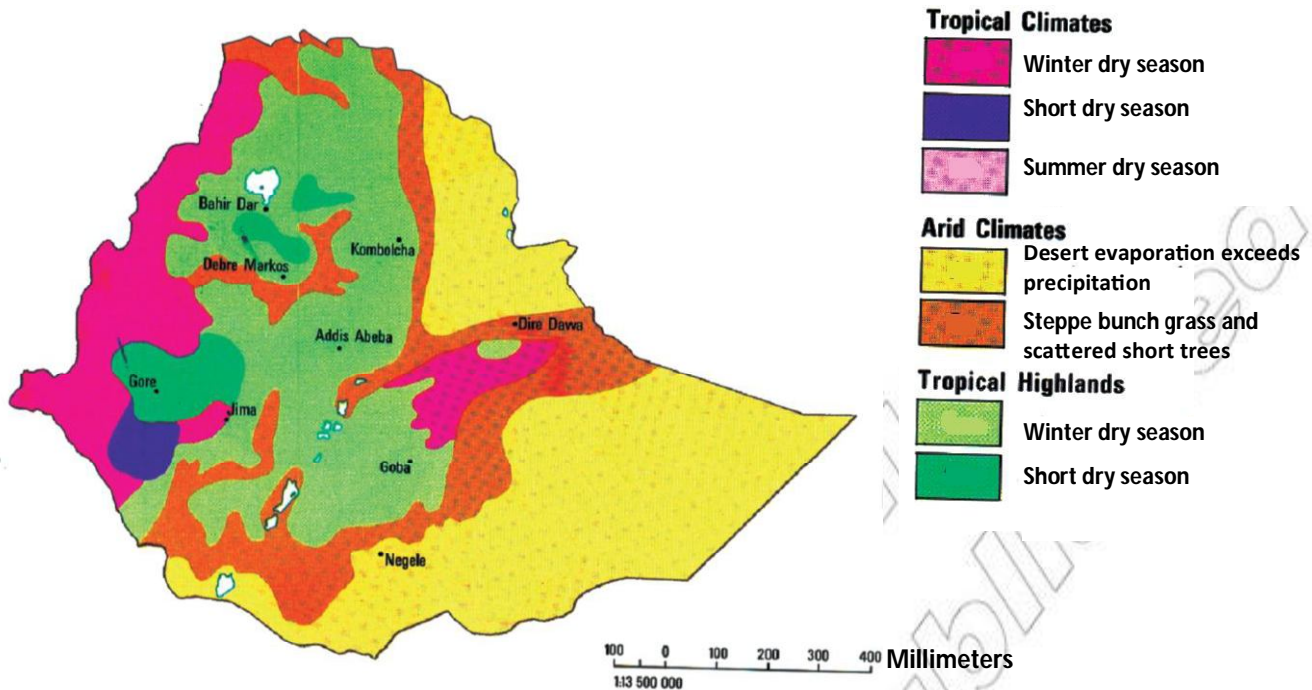


Fig 2.3 Climate regions of Ethiopia

Scale:

Any map drawn on purpose has a scale. What is a scale? You remember that you have learnt the meaning of scale in this section. Any information on the portion of the earth is reduced to a small example or model in order to plot it on a map with the help of a representative symbol or colour. Scale may be expressed in different ways, namely:

- Scale statement
- Representative fraction
- Graphic scale

Scale statement:

This is a way in which a scale is expressed in words.

Example: 1cm to 1km. (What does this mean?)

It means 1kilometer distance on the ground is represented by 1 centimeter distance on the map.

Representative Fraction:

This is another way of scale expression in ratio or fraction

Example: 1 : 100 or $\frac{1}{100}$ (What does this mean?)

It means 100 unit of measurement on the ground is represented by 1 unit of measurement on the map. This is the most frequently used type of scale on maps.

Discuss why this is so.

Graphic scale:

This is the third way of scale depiction on maps. It is a pictorial representation of a scale. Thus, it is known as line graph (see Fig. 2.4)



Fig 2.4 Graphic Scale

◆ Compass Direction

One of the methods of showing direction on a map is by compass direction. Compass direction is shown with the help of compass points. Compass points may be shown with four cardinal points and their subsidiary points (see Fig. 2.5.).

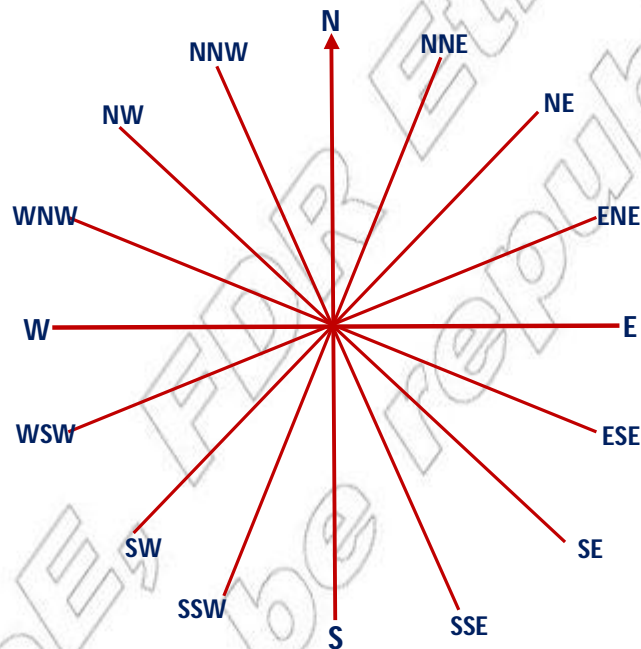


Fig 2.5 Compass points

◆ Key to Symbols and Colours

You can read a map effectively if you understand the meaning given to symbols and colours used on the map under key or legend (see Fig. 2. 6)

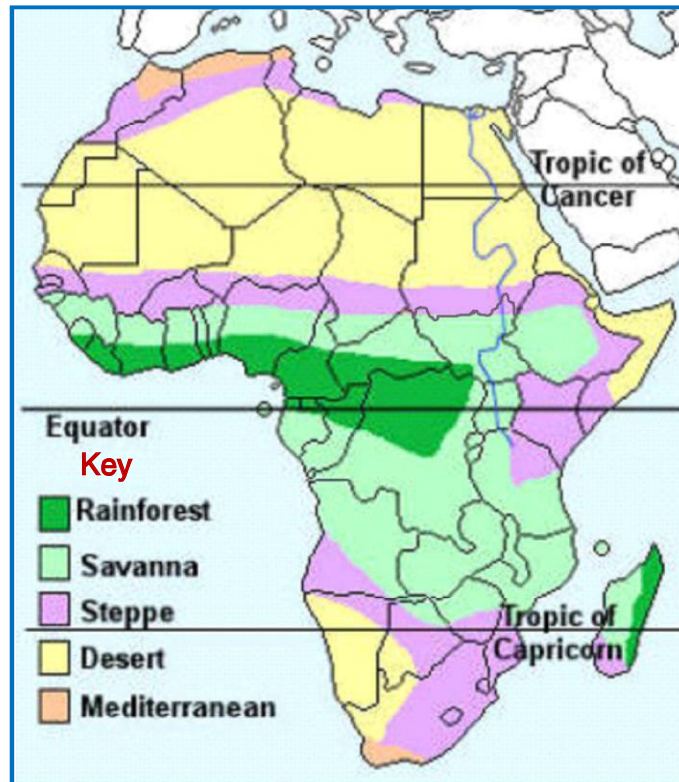


Fig 2.6 Map with key where symbols and colours are interpreted

◆ Date of Publication

As indicated earlier, maps are made on purpose. The purpose on which the maps made is time bound. Thus, you find date indicated on the margin of a map to indicate to you that time reference is important to connect the map to the past, the present and the future. In other words, date is essential in the sense that the map has comparative advantage in reference to passage of events in the course of time (See Fig. 2.7)

- **Indicate the marginal information used on the map.**
- **Explain to some extent what each information is used for.**

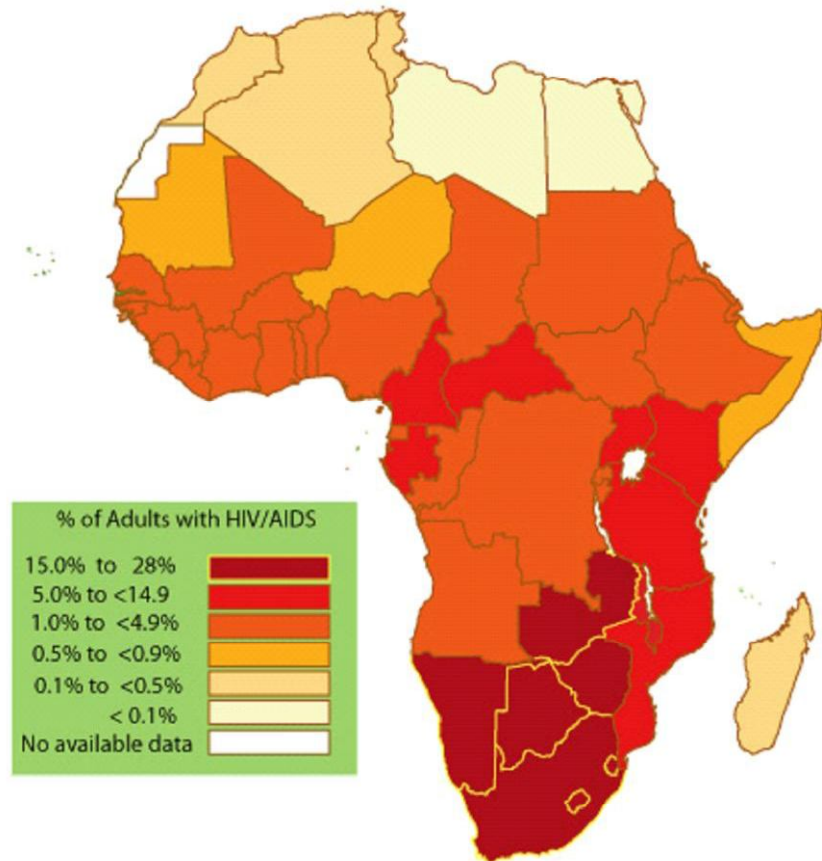


Fig 2.7 Estimated HIV infection in Africa in 2007 based on Statistics from the Joint UN Programme on HIV/AIDS

Lesson

2.1

Review

Activity 2.1 A

A. Questions based on facts:

- Who makes a map?
- Enumerate the items of marginal information.
- Discuss the advantage of marginal information.
- Compare and contrast ancient and modern uses of map.

B. Things to do:

- Draw the sketch map of Africa and show:
 - Marginal information
 - Cities, borders and rivers.



Competencies: After studying this section, you will be able to:

- Describe the layers of the earth.
- Point out the main materials which make up the crust of the earth.

Key terms

- Crust
- Mantle
- Core

A. The crust, mantle and core

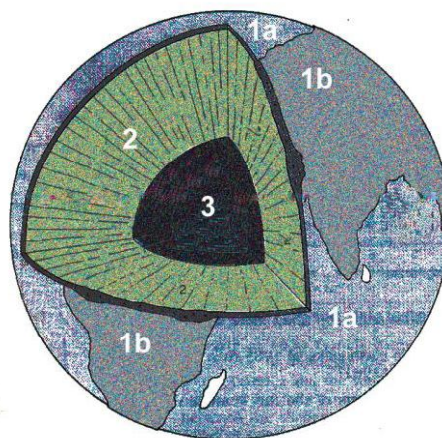
- How many different layers has the earth?
- Explain the different layers of the earth.
- Discuss which layer of the earth is the thickest and the hottest.

The earth is made up of three layers. These are the crust, mantle and core. See them on the diagram given below.

The **Crust** is the outer most layer of the earth. Relatively speaking, this is as thin as the skin of an apple is to its flesh. This is to say that the mantle and the core together have a bigger size as the flesh of the apple, while the crust has a smaller size as the skin of the apple. Do you know that the crust has two different sections? The sections of the crust are: oceanic crust and continental crust.

The **Oceanic crust**, which is sometimes known as **sima** is found under the oceans. It has an average thickness of 6 to 10 kms. At its deepest has a temperature of 1200°C .

The **continental crust** which is sometimes called **sial** approximately corresponds to the continents. It's thickness can be up to 65kms.



1 Crust
1a – Oceanic crust
1b – Continental crust

2 Mantle
3 Core

Fig 2.8 The two types of crust

The **Mantle** is the second layer of the earth with an average depth of 2900kms and a temperature that may reach 5000⁰c. It is usually found in a molten state.

The final layer of the earth is called the **Core**. It is the center of the earth having two sections namely: **the outer** and the **inner core**. The outer core is kept in a semi – molten state, while the inner core is solid in it's nature. The temperature at the center of the earth, at about 6371 km below the surface, is about 5500⁰c.

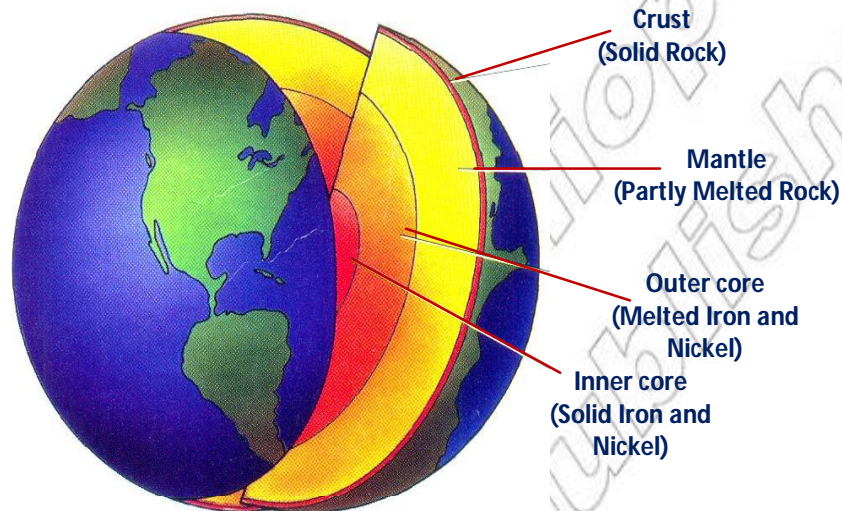


Fig 2.9 Layers of the earth

B. Main components of the crust

• What are the main components of the crust of the earth?

So far you have been studying the layers of the earth in general. Next you will learn about the materials of which the crust of the earth is made up of.

The crust of the earth is made up of surface cover of mainly sedimentary rocks underlain by crystalline rocks like granite and basalt. Because it is relatively cool, the crust consists of a band of solid rock at the surface of the earth. Furthermore, the crust of the earth is made up of different types of soil and underground water.

Lesson

2.2

Review

**Activity 2****A. Questions based on facts:**

- Name the three layers of the earth.
- Which of the layers is the outer most and the thinnest?
- What do we call the two different parts of the crust?
- Point out the main components of the three layers of the earth separately.
- Which layer of the earth is the deepest? How deep is it? What about its temperature?
- As one goes from the upper most layer of the earth down to the deepest, are temperature and pressure increasing or decreasing?

B. Things to do:

Draw the diagram of the internal structure of the earth and indicate

- The three layers of the earth.
- The depth and temperature of the three layers.
- The rock and mineral types available in each layer.

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Competencies: After studying this section, you will be able to:

- Identify the types and formation of rocks.
- Explain the economic uses of rocks.
- Verify the economic importance of rocks in Ethiopia.

Key terms

- ↔ Intrusive igneous rocks
- ↔ Extrusive igneous rocks

- ↔ Magma
- ↔ Lava

◆ The Formation of Rocks

- What is a rock?
- How many types of rock do you know?
- How does each type of rock formed?

You have learnt about the different layers of the earth and their main components in general and the crust in particular in the previous lesson. Now you will learn about the different types of rock and their formation. Then, what is a rock?

The crust of the earth is composed of rocks. Rocks are made up of minerals from such elements as oxygen, sulfur, calcium, carbon, aluminum etc.

Some rocks are made up of single mineral while others are from many. Most minerals are compounds of several elements.

Rocks are classified into three according to their origin and age. They are:

- Igneous rocks;
- Sedimentary rocks and
- Metamorphic rocks.

◆ Igneous Rocks

- What is the term igneous?
- What are igneous rocks made up of?

The name itself indicates that igneous rocks are made of molten materials. Because of the great pressure and heat all materials found inside the earth are in liquid or molten state. This material is known as **Magma**.

The magma is sometimes forced to come out on the surface. When **lava** overflows on the surface it gets cool and becomes hard. This is because of the cool temperature on the surface.

Lava comes out and gets cool fast or slowly. This results in the formation of different types of igneous rocks. Cooling lava contains crystals. When lava is cooled quickly, the rocks contain small crystals. Sometimes these are so small that they can be seen only using a magnifying glass. Some rocks that have cooled slowly contain large crystals. An example of this type of rock is granite. Rocks that do not have crystals are smooth like glass.



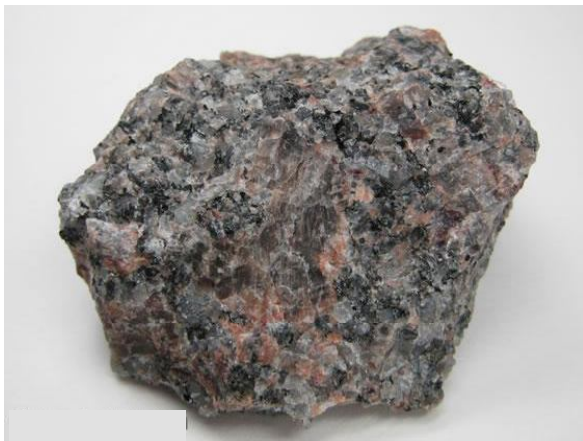
The term igneous derived from the Latin word “ignis” meaning “fire”.

- **What are the different forms of igneous rock?**

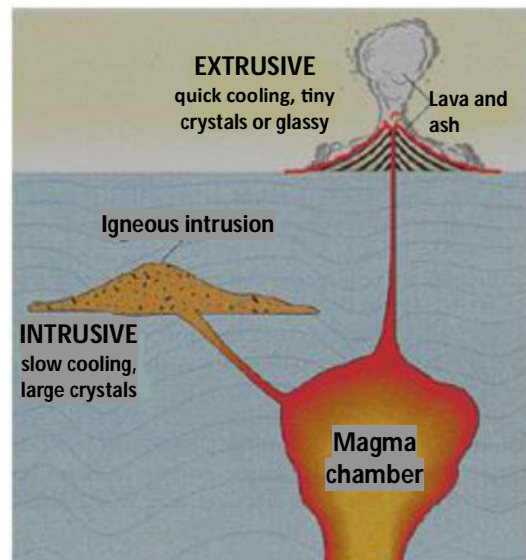
Igneous rocks are divided into two groups on the basis of their texture which has been determined by the speed of cooling.

- Intrusive rocks (plutonic rocks) are rocks which have cooled and solidified within the interior of the earth.

Examples: granite and gabbro



Granite



Plutonic rock

Fig 2.10 formation of Igneous rocks

- b) Extrusive rocks (volcanic rocks) are rocks which have cooled and solidified on the surface of the earth.

Example: Basalt, obsidian



Basalt



Obsidian

Fig 2.11 Extrusive rocks

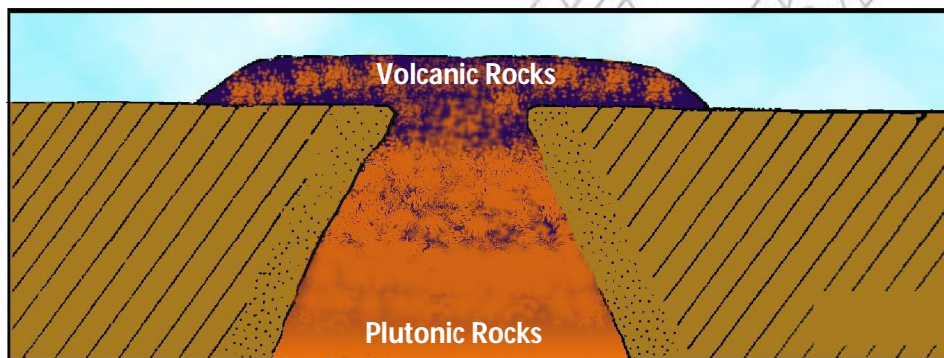


Fig 2.12 Types of Igneous rocks

◆ Sedimentary Rocks

- **What are sedimentary rocks?**

These are rocks derived from existing rocks by the processes of weathering and erosion. Sedimentary rocks would be formed as the igneous rock surfaces were fragmented and the rock particles carried to lower ground nearby or brought to the continental shelves of the oceans or reached some ancient lake floor. Here, the transporting agents of wind, ice, rivers, and the waves of sea would add layers until the deposits become consolidated by pressure and cemented rocks, therefore, show a layered arrangement or stratification.

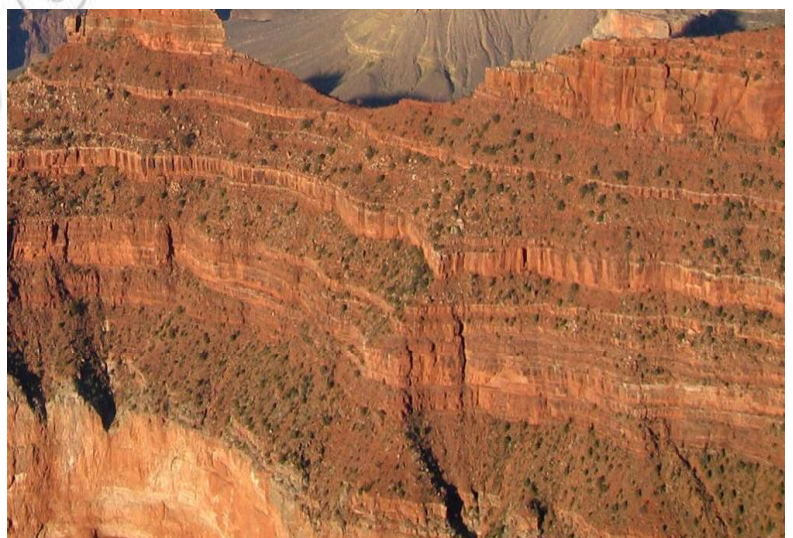


Fig 2.13 Layers of sedimentary rocks

In some areas plant and animal remains provide the basis of the rock; which include coal and shell.

◆ Metamorphic Rocks

- What are Metamorphic rocks?
- What is Metamorphism?

Metamorphic rocks are changed rocks. They can be formed from igneous or sedimentary rocks. Metamorphism is the transformation of pre-existing rocks, i.e. igneous and sedimentary rocks. The major agents of change are heat and pressure. The following are examples of metamorphic rocks:

Examples:

- Marble (from limestone)
- Slate (from clay)
- Gneiss (from granite)
- Quartz (from sand)
- Graphite (from coal).



Fig 2.14 Metamorphic Rocks

A second classification of rocks is based on the age of rocks as determined relatively by fossil content and more precisely in millions of years by the decay of radioactive minerals.

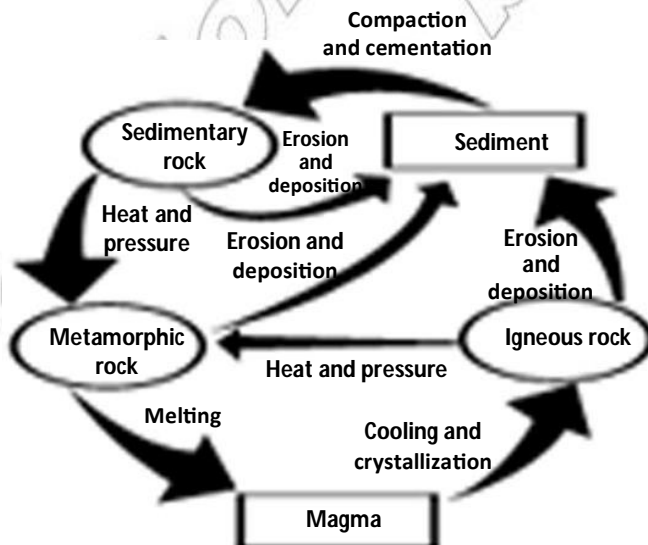


Fig. 2.15 Rocks formation process

Rocks of Economic Importance:

- What are the different uses of rock do you know in your locality?
- Which type of rock has the most economically valuable types of minerals?
- Can you list down some examples of the most valuable types of minerals?

Table 2.1 Economic use of rocks and minerals

Rocks	Associated minerals	Uses
Igneous Rocks	<ul style="list-style-type: none"> • Basalt, Granite, Sands 	Building and construction
Sedimentary Rocks	<ul style="list-style-type: none"> • Mineral fuels <ul style="list-style-type: none"> - Coal - Natural gas - Petroleum • Salt, Gypsum etc. 	Energy sources, construction and writing materials
Metamorphic Rocks	<ul style="list-style-type: none"> • Metallic minerals <ul style="list-style-type: none"> - Gold - Nickel - Diamond - Copper - Uranium - Iron - Platinum - Lead 	<ul style="list-style-type: none"> • Decorative, jewelry, materials • Construction • Electrical wire making, • Industrial machinery production.

As you can see in table 2.1 above, all rocks have different uses. The minerals of the igneous rock are very important for building and construction purposes. The minerals of the sedimentary rock are useful as energy sources, construction and writing materials. The minerals that are found in metamorphic rocks are mostly metallic in nature and are very valuable. They are put into use in a variety of ways- such as decorative, jewelry items, construction purposes, electrical wire making, industrial machinery production etc.



Lesson

2.3

Review

Activity 2.3 A**A. Questions based on facts:**

- How are rocks formed?
- What are the main components of rocks?
- Mention the names of the different types of igneous rock.
- Give some examples of minerals that are found in three different kinds of rocks.
- Why do we say the minerals in metamorphic rock are the most valuable?

B. Group discussion:

In groups discuss on the following fact

“It is possible to learn of past conditions by studying sedimentary rocks”.

Bring the points that you have agreed upon to your class, and invite your classmates for further discussion.

C. Individual work:

Visit your locality and collect sample rocks as much as possible. Then classify them into major types. Finally, state the basis for your classification.

D. Things to do:

- Define the following terms. Record the definitions in your note book.

- Rock	- Plutonic rock
- Soil	- Volcanic rock
- Magma	- Extrusive rock
- Lava	- Intrusive rock

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Summary

- A map is a representation of part of the earth on a reduced scale. It is made by cartographers.
- Primitive societies used to draw simple maps on sand soil to show the location of water holes, excellent hunting grounds and the way to go there.
- In the modern world, maps are used to show the location, distance, area and direction of a place.
- The first step in reading a map is to study all the information available in the margin of the map. These information include: **title, date, key, scale, direction, etc.**
- The earth is made up of layers with different thicknesses. The three layers of the earth are **crust, mantle and core.**
- The crust is the outer most part of the earth's surface, which is made up of mainly sedimentary rocks underlain by crystalline rocks like granite and basalt.
- Mantle consists of mainly of silicate rocks rich in iron and magnesium which are kept in semi – molten state.
- The core consists of iron and nickel. It has two parts, the outer and the inner core.
- The rocks that compose the earth's crust are aggregation of particles of various substances called **minerals.**
- A mineral consists of one or more chemical elements and has a definite physical state and chemical composition.
- Some minerals are found in combination with other minerals, while others occur as a single element.
- Some minerals are organic in nature.
- The main chemical elements found in rocks are oxygen, silicon, aluminium, iron, calcium, sodium, potassium, and magnesium.
- Rocks are classified in two ways: by origin and age.
- Igneous rocks are results of volcanic activities. They are of two nature: extrusive and intrusive.
- Sedimentary rocks are rocks derived from existing rocks by the process of weathering and erosion. Therefore, they are secondary in origin.
- Metamorphic rocks are changed rocks i.e changed either from igneous or sedimentary rocks.

Glossary

- **Cartographer:** is a person well trained in the making of maps.
- **Core:** is the central layer of the earth which is composed of a grid central core. It is divided into an outer and inner core. It contains largely nickel and iron.
- **Crust :** the outer surface or layer of the earth.
- **Direction:** may mean the course taken by a moving person or thing, or point towards which a person or thing looks or faces. It is showed by compass points and angular bearing.
- **Extrusive igneous rocks:** when lava and other materials reach *the earth's surface they are called* extrusive.
- **Intrusive igneous rocks:** materials injected into the crust are referred to as intrusive.
- **Lava:** when molten rock reaches the surface it is called lava.
- **Map:** a map is the representation of the earth's surface on a reduced scale.
- **Marginal information:** all the information included on the margins of a map.
- **Mantle:** an intermediate layer of the earth. It is found between the crust and the core layers of the earth.

UNIT

2

Review Questions

I. True / False questions

Direction: Write "True" if the statement is correct and "False" if the statement is incorrect in the space provided in front of each statement

- _____ 1. All rocks are made up of minerals.
 _____ 2. Basalt and granite are both igneous rocks.
 _____ 3. Continental crust is sometimes called sial.
 _____ 4. Maps are used as a tool of research.
 _____ 5. The core of the earth consists of iron and nickel.

II. Matching

Match column B with column A. Write the letter of the correct term on your paper next to the number of its matching definition.

Column A

- _____ 1. The ratio of a given distance on a map to the corresponding distance on the ground
 _____ 2. Intrusive rocks.
 _____ 3. Pictorial representation
 _____ 4. Date of publication
 _____ 5. Made up of minerals

Column B

- a) Plutonic igneous rocks
 b) Volcanic igneous rocks
 c) Marginal Information
 d) Scale
 e) Minerals
 f) Rocks
 g) Compass
 h) Graphic scale
 i) Representative fraction

III. Multiple choices

Choose the correct answer for each question from the given four alternatives.

- _____ 1. Another name of oceanic crust is:
 a) dyke b) sial c) sima d) vent
- _____ 2. Rocks are classified by
 a) origin c) size
 b) age d) "a" and "b"
- _____ 3. Identify the correct statement:
 a) When depth increases, temperature decreases inside the earth.
 b) The crust is the outer most layer of the earth.
 c) The low temperature of the interior of the earth makes the inner core solid.
 d) None of the above.

- _____ 4. Intrusive rocks are not usually observed on the surface of the earth because:
- They are laid beneath other rocks
 - They can't be seen by naked eye
 - They were not found in the earth's crust
 - They were eroded from their place of origin
- _____ 5. The inner core of the earth is
- | | |
|-----------|---------|
| a) solid | c) gas |
| b) liquid | d) none |
- _____ 6. Which one of the following shows the importance of minerals?
- | | |
|-------------------------------|-----------------|
| a) Home consumption | c) Construction |
| b) Raw materials for industry | d) All |
- _____ 7. One of the following is not a marginal information.
- | | |
|-----------|---------|
| a) Colour | c) Date |
| b) Title | d) Key |

IV. Fill in the blank space with the correct word or phrase

- Mineral fuels such as coal, petroleum and natural gas are associated with _____ rocks.
- Map makers are sometimes called _____
- It is impossible to read the signs and symbols used on a map without the _____ of the map.

V. Short answer questions

- What is a map?
- Discuss the possible uses of a map and who would use or make them.
- What are the major information obtained from the margins of a map?
- Discuss why these marginal information are important.
- Describe the layers of the earth.
- What is the depth and the temperature of the core?
- Define the terms extrusive and intrusive igneous rocks.
- Explain the economic uses of rocks.

VI. Things to do

- Draw an up – to – date political map of Africa showing all the marginal information.

Check List

Put a tick (✓) mark in each of the boxes for activities you can perform

I can

1. Define the term map.
2. Express the uses of a map.
3. Draw a sketch map of Africa to indicate marginal information on a map.
4. Describe the layers of the earth.
5. Point out the main materials which make up the crust of the earth.
6. Identify the types and formation of rocks.
7. Explain the economic importance of rocks in Ethiopia.