GEOGRAPHY

FORM THREE NOTES

STRUCTURE OF THE EARTH

Physical geography can be simply defined as the study of the structure of the Earth and the forces which affect it. These forces are categorized into two kinds: internal and external forces. **Internal forces** are forces which act within or beneath the Earth‘s crust. These forces result into various Earth movements such as vertical and horizontal movements, vulcanicity and earthquakes. **External forces** are forces which act inside the earth‘s surface and result into various geomorphic processes such as mass wasting and weathering. The earth is composed of inner and outer zones (layers). The outer layer of the earth comprises of the atmosphere, biosphere and hydrosphere, while the inner layer includes the crust, mantle and core

The Earth's Crust, The Mantle, The Core and their Respective Characteristics

Concentric Zones of the Earth

Identify concentric zones of the earth

The earth is composed of three internal, concentric layers of increasing densities. These layers are the **crust, mantle** and **core.** They are made up of different layers of rocks, with their densities increasing towards the centre of the earth. That is, densities of rocks that make up the earth increase as you move from the surface towards the interior

The Crust (Lithosphere)

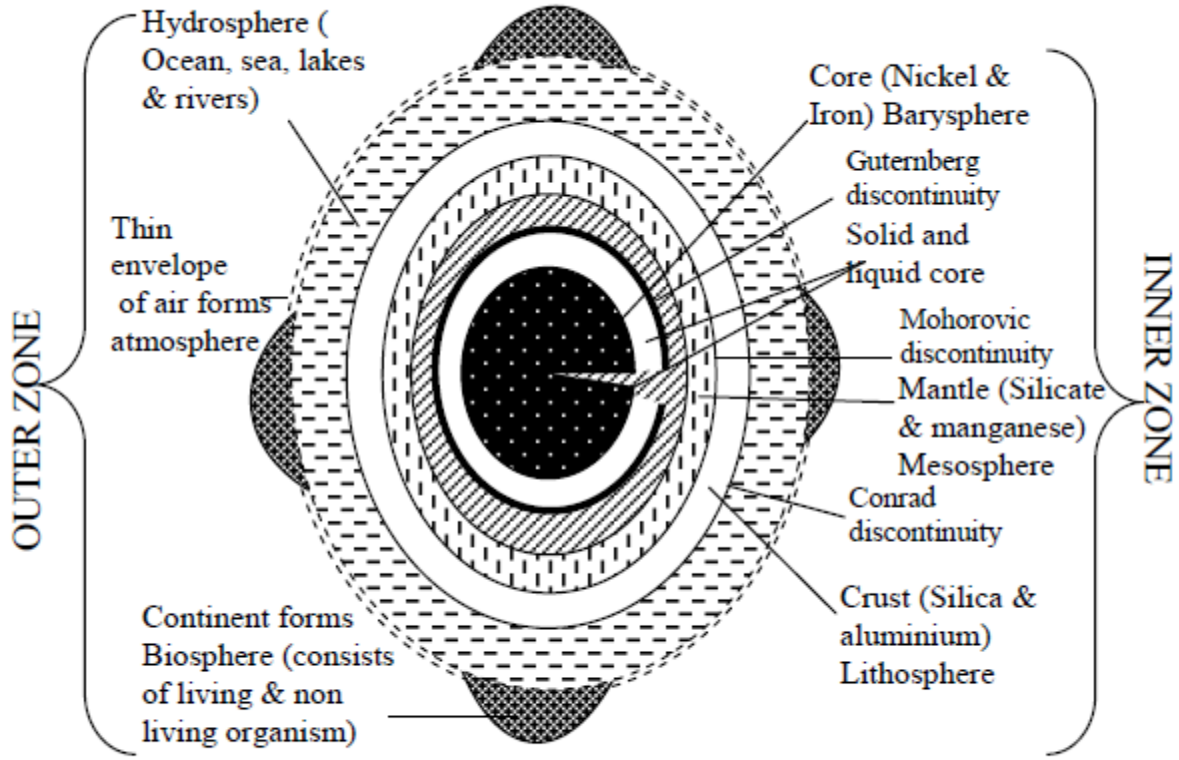
This is the outermost part of the earth. It consists of silica and aluminium (sial). It forms the upper layer of the continent and is mostly composed of granite rocks. The layer below SIAL is called SIMA. This layer is made of silica and manganese. It is a layer of basaltic rocks which are denser and underlies the continental block to form the ocean floor.

The Mantle (Mesosphere)

This is the layer below the crust. It is composed of iron and manganese. It lies between the crust and the core. The layer which separates crust and mantle is called Mohorovic discontinuity. The mantle is made up of very dense and hot igneous rocks, found in semi liquid states. It extends downwards 2900 km and the temperature ranges between 5000°C and 7000°C. The density of the mantle is 3 – 3.3 g/cm3. It is divided into two parts namely, the upper and lower mantle. The upper mantle is rigid and combines with the crust to form a layer called lithosphere. Below the upper mantle there is a layer called asthenosphere

The Core (Barysphere)

This is the innermost layer of the earth. It is composed of nickel and iron. Its diameter is approximately 2500 – 2700 km and its temperature is around 5500°C. The average density of the barysphere is about 5.2 g/cm3. Most geographers believe that the core is divided into solid and liquid core. The total mass of the earth is about 5.976 x 1021 tonnes.



Structure of the Earth

Structure of the Earth

The Variation in Density and Thickness of the Concentric Zones of The Earth's Crust

Account for the variation in density and thickness of the concentric zones of the earth's crust

ROCKS

A rock is an aggregate of mineral particles found in soft, solid or unconsolidated state. The earth‘s crust consists of rocks and rocks consist of a combination of different minerals. All minerals are formed from one or more of eight main elements. These are: oxygen, silicon, potassium, sodium, calcium, magnesium, iron and aluminium.

Rocks can be broadly categorized into three types. These are igneous rocks, sedimentary rocks and metamorphic rocks. These kinds of rocks are classified according to their origin, chemical composition and age.

The Characteristics of The Earth's Crust, The Mantle and The Core

Describe the characteristics of the earth's crust, the mantle and the core

Variations in characteristics of the three interior zones of the earth are the result of temperature and pressure as they increases from the surface to the center of the earth.Factors which accounts for such variations includes: pressure on the underlying materials, weight of the underlying materials, radioactivity, magma movement and heat generated during the formation of the earth.

Types of Rocks of the Earth's Crust

The Types of Rocks of the Earth's Crust

Identify types of rocks of the earth's crust

Igneous rocks

These rocks are formed when molten rock cools and solidifies. All igneous rocks originate inside the earth where they are under great pressure. Igneous rocks do not occur in layers and they don‘t contain fossils which are the chemically-changed remains of ancient plants and animals embedded in rocks. These rocks solidify either within the earth‘s crust and form intrusive features or outside the earth‘s surface and form extrusive features.

Igneous rocks are formed when the molten magma is forced out from the upper mantle to the earth‘s surface, where it cools and solidifies due to low temperature. Crystals form on cooling and the rocks are called crystalline rocks.

There are two main types of igneous rocks:

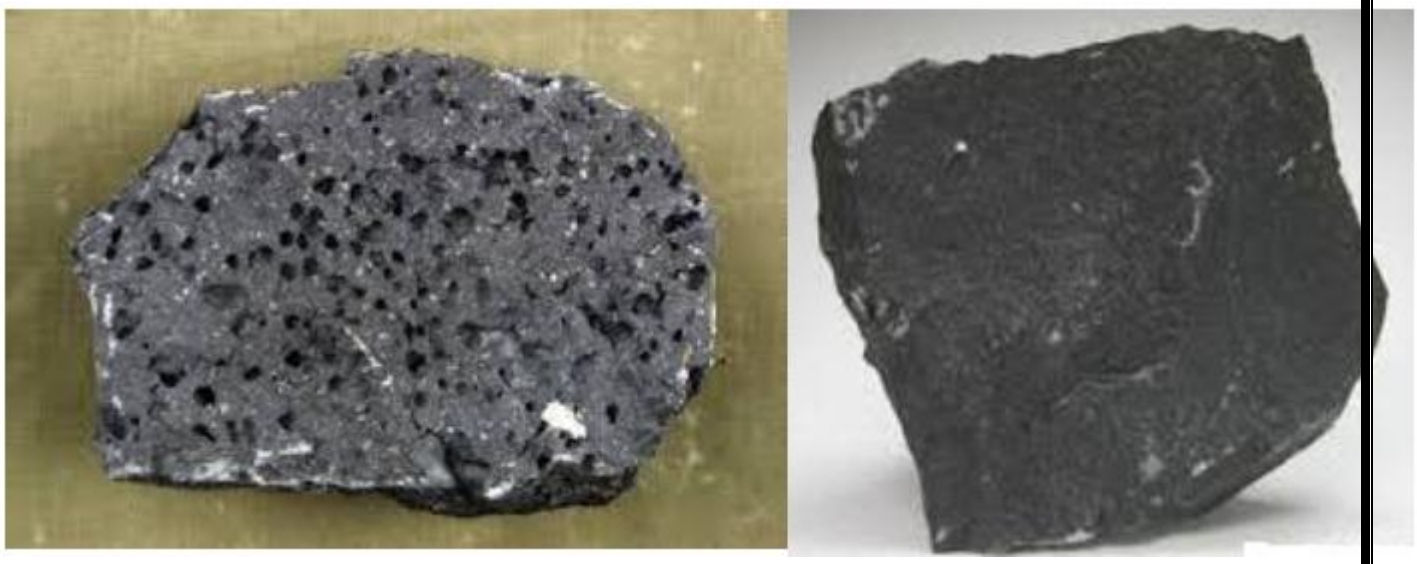
1. **Plutonic**: these have solidified deep in the crust and they are seen on the surface only after being exposed by prolonged erosion.
2. **Volcanic:** these have been poured on the earth‘s surface where they are called lavas.

Characteristics of igneous rocks

- Igneous rocks reflect light.
- They are not found in layers.
- They do not contain fossils.
- They are crystalline rocks.
- They are formed through cooling and solidification of magma.
- They can undergo metamorphic and weathering processes.
- They contain different minerals like iron, magnesium etc.

Many igneous rocks are found in Dodoma, Iringa and in the shores of Lake Victoria (Mwanza). The main examples are granite, gabbro, basalt and diorite. Some are found in Kilimanjaro and Rungwe (Mbeya) such as basalt, pumice, diorite, gabbro, syenite and peridotite rocks.

Granite



Basalt rocks

Sedimentary rocks

Sedimentary rocks are found in layers; they contain fossils and are very soft. These are weathered particles formed through deposition and lithification processes. Sedimentary rocks are formed when the sediments are accumulated, compacted and cemented together. The sediments are compacted by compression to form sedimentary rocks. These are called stratified rocks.

Characteristics of sedimentary rocks

- They are formed when particles or sediments are accumulated, compacted and cemented together.
- They contain fossils.
- They are found in layers (strata).
- They do not reflect light.
- They are non-crystalline rocks.
- They can undergo metamorphic process.

Types of sedimentary rocks

Mechanically-formed sedimentary rocks

These are formed through weathering process. When weathering agents erode and deposit rock particles, they are accumulated, compacted and cemented together to form sedimentary rocks. Examples of mechanically formed sedimentary rocks are clays, gravels and alluviums (all deposited by water), moraines, boulder clay and gravels (deposited by ice) and loess (deposited by wind); sandstones and shale.

Sandstone

Shale: Shale occurs in a wide range of colours that include: red, brown, green, grey, and black.

Chemically-formed sedimentary rocks

These are formed through chemical precipitation process. They include carbonate (as it is in stalactite and stalagmite), sulphate, chloride, etc. The main examples are gypsum, rock salt, lignite, dolomite, flint, borax, limonite, haematite, etc.

Dolomite

Organically-formed sedimentary rocks

These are formed through mineralization process of decaying and decomposition of dead organisms such as animals and plants. The remains of living organisms are accumulated, compacted and cemented together to form these sedimentary rocks. The main examples are chalk (limestone) and coral (formed from animals), and peat, coal and lignite (formed from plants).

Lignite rocks

Limestone

Chalk

Coal

Coral rocks

Metamorphic rocks

These are rocks which have changed their shape, size, appearance or chemical composition due to the contact of heat, pressure or both. This process is referred to as metamorphism. Any rock can be changed into a metamorphic rock. Examples of metamorphic rocks are slate, marble and granite.

Characteristics of metamorphic rocks

- They are very hard due to prolonged action of heat and pressure.
- Any type of rocks can be subjected to metamorphic rocks.
- They can undergo weathering process.

The main examples of metamorphism in rocks include the following:

- Sandstone to quartzite.
- Coal to graphite.
- Limestone to marble.
- Clay to slate.
- Granite to gneiss.

Slate

Gneiss

ROCK CYCLE

This is the cycle in which rocks tend to change from one type to another. For instance igneous rocks may change to metamorphic rocks or sedimentary rocks; sedimentary rocks to metamorphic or igneous rocks, etc. It is a relationship in which rocks tend to change from one type of rock to another.

Necessary conditions for rock cycle to take place

1. First, the molten rocks erupt from the interior of the earth and then cool and solidify to form igneous rocks.

2. Secondly, the igneous rocks are subjected to denudation process to form sedimentary rocks.

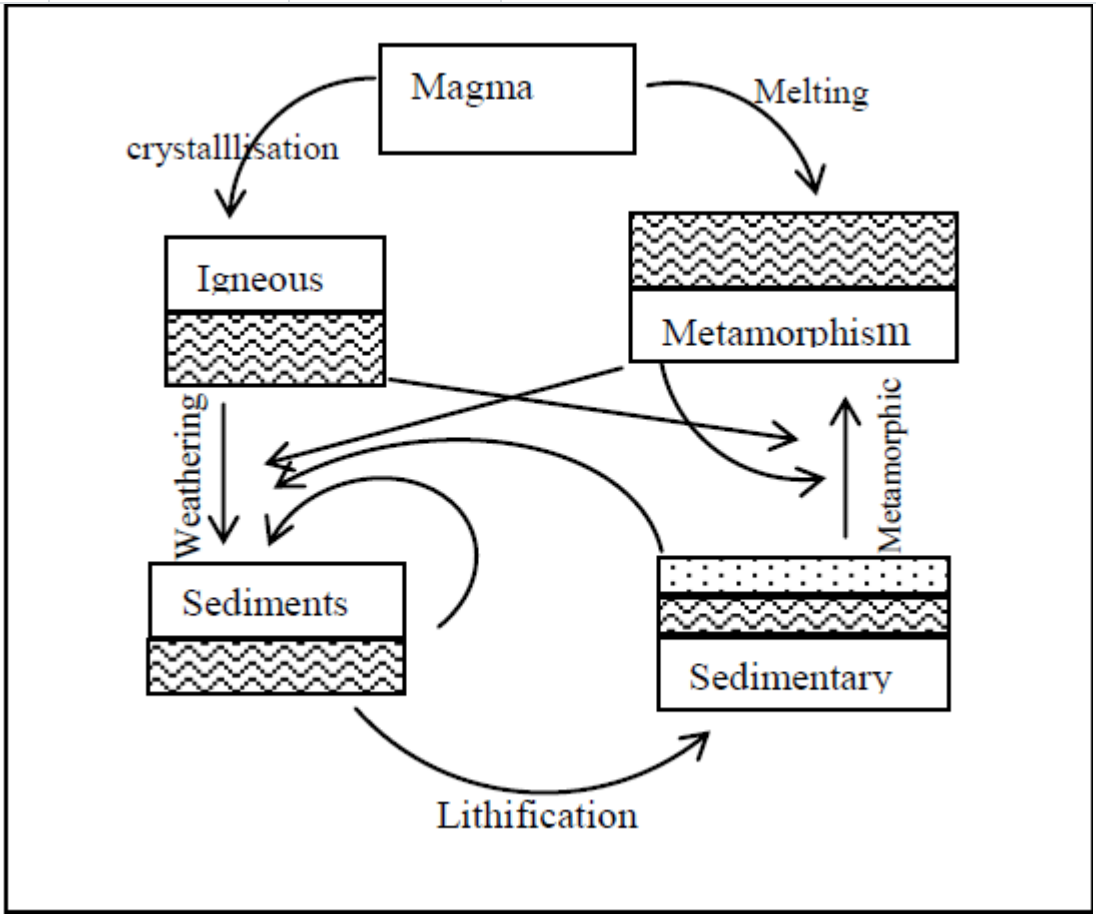
3. Third, either igneous or sedimentary rocks undergo metamorphism, due to prolonged heat and pressure, to form metamorphic rocks.

4. Fourth, metamorphic or igneous rocks can undergo weathering process through erosion and transportation of sediments which are further deposited in layers in the ocean or lake floors where they are cemented and consolidated to form sedimentary rocks and vice versa.

5. Fifth, metamorphic or sedimentary rocks can be subjected to heat and pressure where melting take place and later cooling, due to low temperature, to form igneous rocks.

Era	**Period**	**Years in millions before present**	**Major geological events in Africa**	**Man and animals**
Cenozoic	Quaternary	1	Glaciation of East Africa mountains.Formation of river terraces and raised beaches.	Age of man
	Tertiary	163	Formation of the Atlas mountains. Lava flows in Ethiopia.	Age of mammals.
Mesozoic	Cretaceous	135	Deposition ofmarine sediments in the Sahara and Southern Nigeria. Formation of Enugu coalfield.	Age ofreptiles
	Jurassic	180	Break-up of Gondwanaland and Marine invasion of East Africa coastlands and separation of Malagasy Island from mainland.	
	Triassic	230	Drakensburg lavas and formation of upper Karro beds. Volcanic activity in West Africa.	
Paleozoic	Permian	280	Formation of lower Karro beds. Formation of rich coal deposits in Tanzania and South Africa. Ice age in central and South Africa.	Age of amphibians
	Carboniferous	345	Cape fold formed.	
	Devonian	405	Marine invasion of Libya, the Sahara and Western Sudan. Continental basins formed by crustal warping	

	Silurian	425	Continental sedimentation in Zaire basin,Tanzania and South Africa, followed by intensive folding.	
	Ordovician	500	Extensive deposition of sediments.Formation of sandstones in Guinea, Mali, Volta basin and North West Ethiopia	Age of marine invertebrates
	Cambrian	600	Marine invasion of Western Sahara and Kalahari basin.	
Proterozoic	Pre Cambrian or Archarean		Glaciations of Africa South of Equator.Extensive metamorphism of oldest known fossilized, unicellular algae formed in Swaziland and Mali.	Algae



The rock cycle

Simplified geological time scale

The geological time scale is a chart for dating the history of the earth including rock span. It tries to explain the age of rocks as far back as 600 million years ago.

The simplified geological time scale

The Mode of Formation for each Type of Rocks and their Economic Importance

Explain the mode of formation for each type of rocks and their economic importance

The importance of rocks

1. Rocks are very important in the formation of soils which can be used for agricultural production.

2. Rocks are used for building purposes: some rocks such as limestone, sandstone, gravels and sand are used for building houses, construction of roads, etc.

3. Some rocks are used as sources of energy or fuel such as coal and petroleum (mineral oil).

4. Limestone is widely used for cement manufacturing. In Tanzania, cement is produced at Tanga, Mbeya and Wazo Hill.

5. Salt extraction: salt usually originate from rock accruing strata, for instance, in Tunisia and Morocco there are large deposits of salt.

6. Manufacture of chemicals: some rocks contain nitrate or phosphate, while others have potash. This kind of rocks can be used for making dyes, fertilizers and medicines.

7. Mineral deposits: mineral ores occur in veins of some rocks such as igneous rocks. The minerals are formed when the magma coos down. Valuable minerals extracted from rocks include gold, lead, tin, silver, diamond, copper, zinc, aluminium, calcium and manganese.

8. Some rocks are so impressive such that they attract tourist to come and view them. In so doing, the country earns a lot of foreign exchange.

9. Some rocks are used for decoration of houses as ornaments or they are grinded to produce powder which is used for decoration.

Simplified Geological Time Scale

The Geological Time Scale

Describe the geological time sale

The **geological time scale**(**GTS**) is a system of chronological measurement that relates stratigraphy to time, and is used by geologists,paleontologists, and otherEarth scientists to describe the timing and relationships between events that have occurred throughout Earth's history.

FORCES THAT AFFECT THE EARTH

The earth can be affected by two forces which may result into various landforms. Forces that act on the earth can be grouped into internal and external forces.

Forces Causing Earth Movements

The Forces Which Cause Earth Movement and their Origin

Explain the forces which cause earth movement and their origin

INTERNAL FORCES: These are forces which operate within the earth‘s crust. Internal forces include vulcanicity and earth movements, that is, horizontal (lateral) and vertical movements. These forces may result into formation of several landform features.

EXTERNAL FORCES: These are natural forces that operate on the earth’s surface. The forces mainly act on the earth’s crust or close the surface of the earth. Often the features produced by these forces are seen on the surface of the earth. They include mountains, volcanoes, moraines and valleys, just to mention a few

Radial/Vertical Movement

The Vertical/Radical Movement

Describe the vertical/radical movement

The earth is in constant motion and this movement results to a number of features such as mountains, plateaus and plains. Such features are due to both lateral and vertical movements. These movements exert great force of tension and compression which later results to very impressive features. Earth movements are either vertical or lateral.

The Resulting Features from the Vertical Movement

Identify the resulting features from the vertical movement

Vertical earth movements: These are up and down movements which cause the crustal rocks to fault. These movements result to a number of landforms such as plateaus, block mountains, rift valleys, basins, etc.

Lateral or Horizontal Movement

How Horizontal Movements Take Place

Explain how horizontal movements take place

Lateral earth movements: These are sideways movements of the earth's crust which cause the crustal rocks either to fold, fault or form joints. Features which are produced due to this movement are such as fold mountains, rift valleys, block mountains, etc.

Different Features Produced by Horizontal Forces

Identify different features produced by horizontal forces

Features associated with earth movements

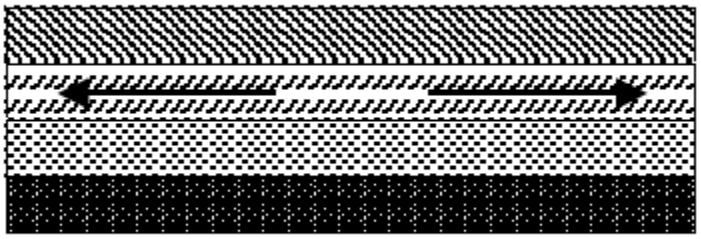
Rift Valley

Rift valley is a trough or hollow which may result from both vertical and lateral movements of the earth's crust. It is formed when two faults develop parallel to each other. It can develop either by tensional forces or compressional forces.

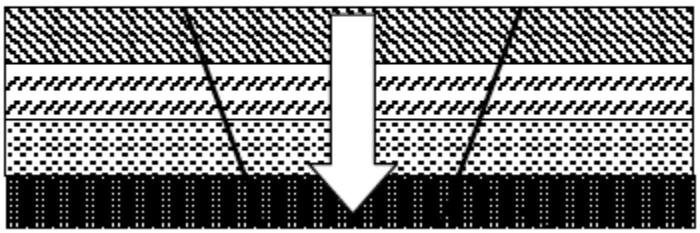
Formation of rift valley by tensional forces

This is formed when tensional forces move away from each other. These forces of tension produce faults and the block between two parallel faults subsides to form a rift valley.

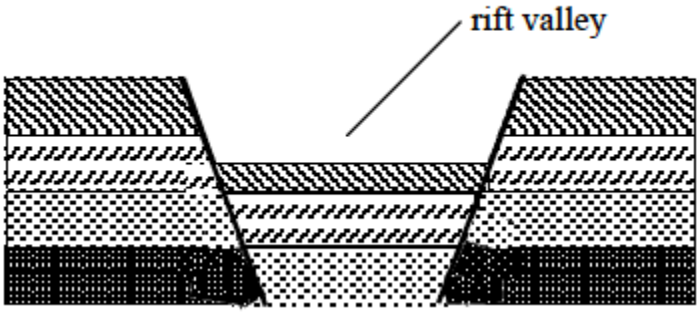
(a) Movement of tensional forces



(b) Submergence (subsidence) of the central block between the forces



(c) Rift valley formed

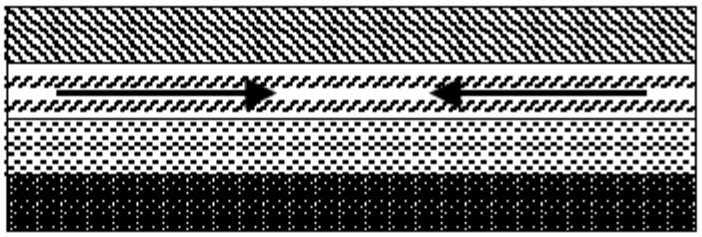


Formation of the Rift Valley by compressional forces

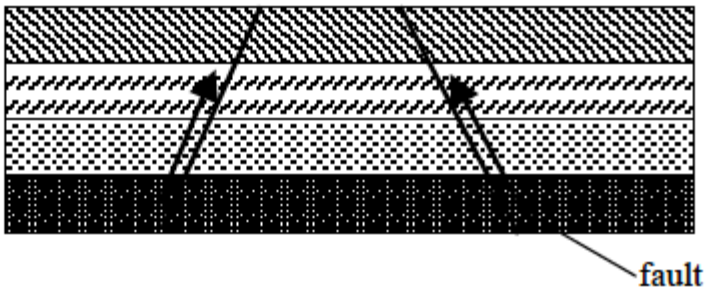
This is formed when horizontal forces act towards each other. These forces of compression produce faults on the outside of the two parallel faults and the pieces of land on either side are lifted up above the general level of the ground to form a rift valley.

Diagrammatically, formation of the Rift Valley occurs like this:

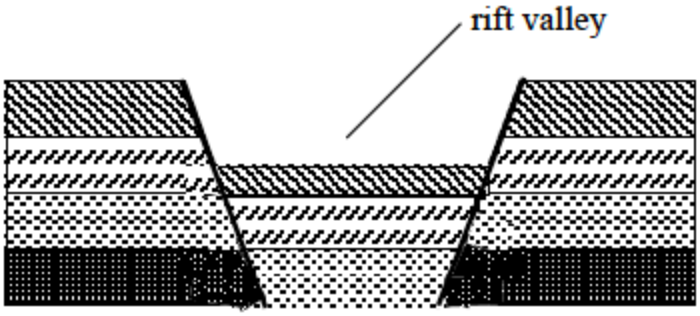
(a) Movement of tensional forces



(b) Uplifting of the land on the outside of the two faults



(c) Rift valley formed

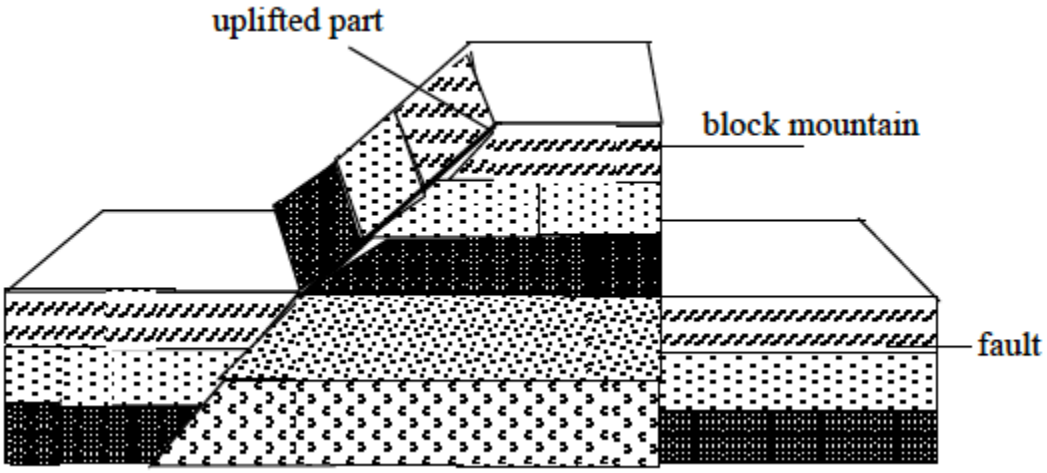


Examples of rift valleys include:

- East African rift valley – Africa;
- Jordan rift valley – Asia;
- Rhineland rift valley – Europe.

Block mountain (horst)

A block mountain refers to a table-like mountain formed due to the influence of faulting that leads to rising of crustal rocks. It is nearly a flat surface. A block mountain can be formed by either tensional or compressional forces. This is when the earth's movements cause parallel faults which results into uplifting of some parts.



Examples of block mountains are:

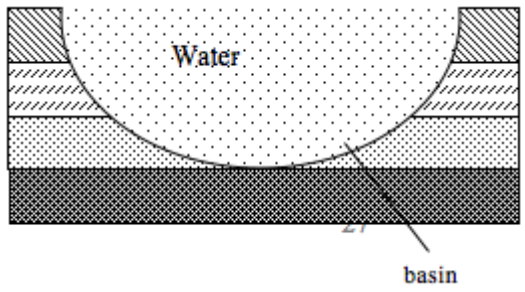
- Usambara and Uluguru, in Tanzania;
- Ruwenzori, in Uganda;
- Vosges and Black Forest, in Europe; and
- Mount Sinai in Asia.

Plateau

A plateau is a large, extensive uplifted part of the earth's crust which is almost flat at the top. The top of the plateau is mostly a plain. Plateaus were formed during Mesozoic and Jurassic eras. It was due to uplifting of the earth's crust. Such landforms include those of East African and Brazilian plateaus. High plateaus especially in tropical latitudes are used for agriculture and settlement.

Basin

A basin is a large, extensive depression on the earth's surface. Most basins are formed due to vertical movement of the earth.



Examples of basins include:

- an inland drainage e.g. Congo basin;
- Chad basin; and
- Amazon basin.

Vulcanicity

Difference between Vulcanicity and Volcanicity

Differentiate vulcanicity from volcanicity

This refers to all the various ways by which molten rock (magma) and gases are forced into the earth‘s crust and onto its surface. Vulcanicity therefore includes volcanic eruptions, which lead to the formation of volcanoes and lava plateaus and geysers, and the formation of volcanic features such as batholiths, sills and dykes, etc, in the earth‘s crust.

Causes of Volcanicity and Resulting Features

Explain causes of volcanicity and resulting features

There are two types of vulcanicity namely, intrusive vulcanicity and extrusive vulcanicity

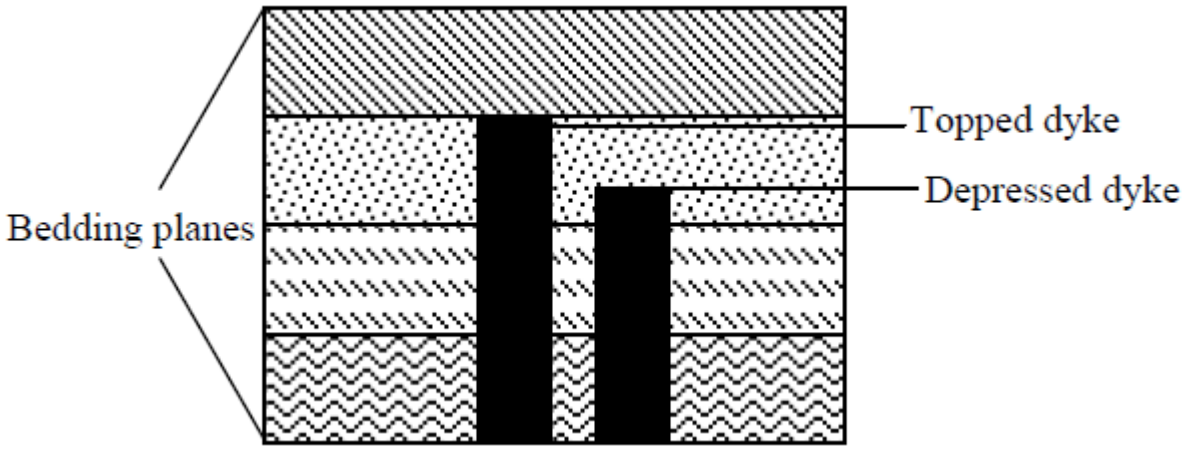
Intrusive (internal) vulcanicity

This occurs when the magma cools, solidifies and forms features within the earth‘s crust before it reaches the earth‘s surface. The features (landforms) formed by this process are sometimes termed as intrusive (internal) features.

The following are the landforms formed through intrusive vulcanicity:

Dyke

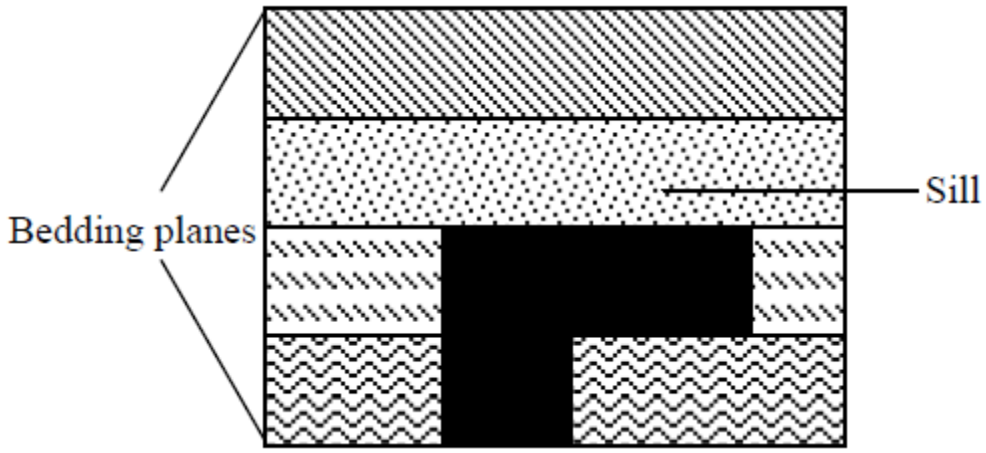
This is a wall-like feature cutting across the bedding planes. It is formed when magma cools and solidifies vertically across bedding planes. The dyke is termed as a small-scale intrusive feature. Sometimes the dyke may form a waterfall when exposed to the earth‘s surface due to denudation processes.



Examples of dykes are Mwadui dyke in Tanzania, Gabbro dyke in Lesotho, and Tyolo dyke in Malawi.

Sill

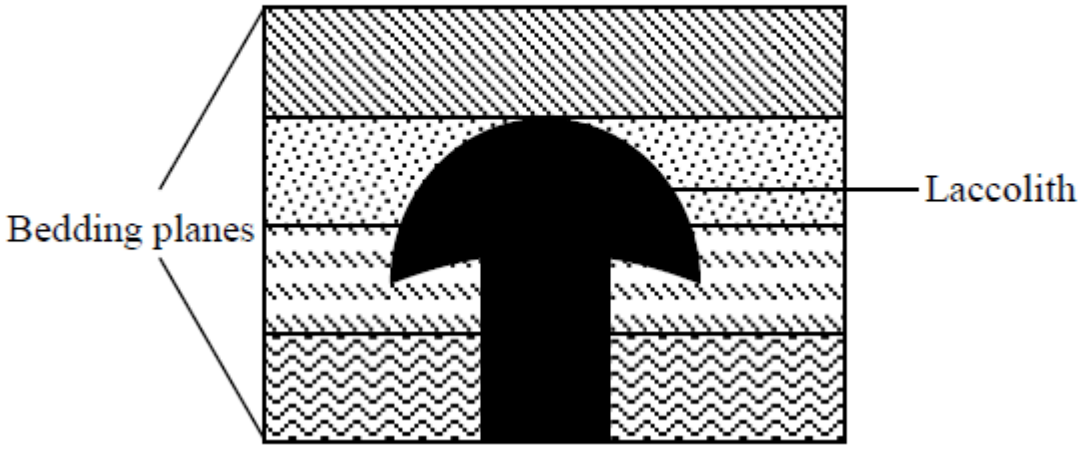
This is an intrusive feature which lies horizontally along the bedding planes. It is formed when magma cools and solidifies horizontally along a bedding plane. Like the dyke, the sill is termed as a small-scale intrusive feature.



An example of a sill is Fouta Djallon ranges in Guinea.

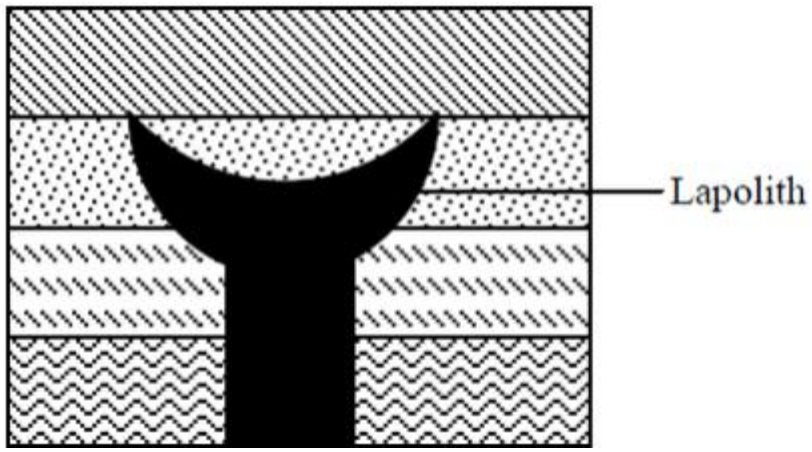
Laccolith

This is an intrusive feature which looks like a dome. It is formed when the magma cools and solidifies in anticline bedding plane. Sometimes it can be exposed to the earth‘s surface following denudation processes.



Lapolith

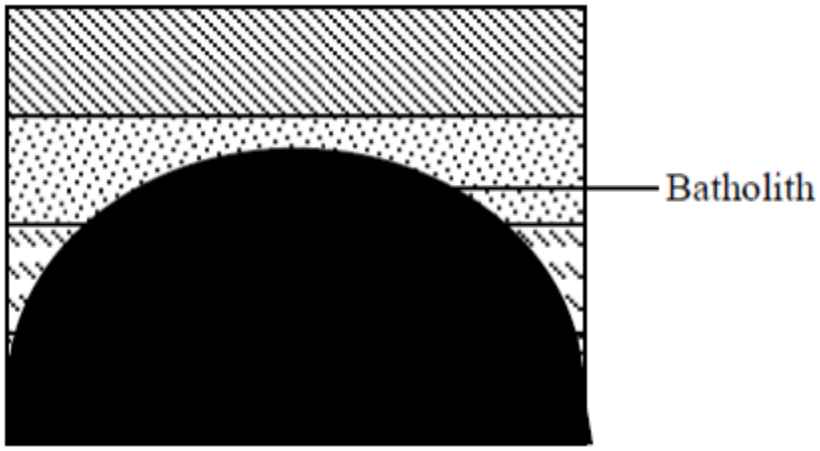
This is an intrusive feature which looks like a saucer in shape. It is formed when magma (molten rocks) cools and solidifies in a syncline bedding plane.



Examples of lapoliths are found in South Africa especially in Trans Vaal province.

Batholith

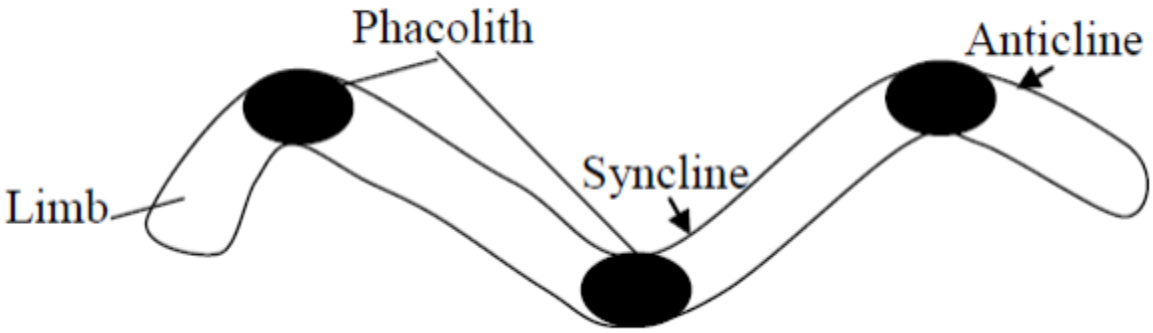
This is a very large mass of magma which cools and solidifies in the earth‘s crust. Sometimes if forms the root or core of a mountain. Batholiths are made of granite and they form surface features only after they have been exposed to the earth‘s surface by denudation. Sometimes batholiths resist erosion and form uplands.



Examples of batholiths are found in Zimbabwe, Tanzania, Zambia and Gabon (The Chaillu Massif).

Phacolith

This is a lens-shaped mass of igneous rock. It is formed when magma cools and solidifies at anticline and syncline in folded rocks.



An example of a phacolith is The Gordon Hill in UK.

Features Resulting from the Processes of Volcanicity

Classify features resulting from the processes of volcanicity

Eruption of magma, either intrusive or extrusive, results in the formation of features. Intrusive features are the result of cooling and solidification of magma inside the crust. The features formed includes dyke, sill, laccolith and batholith. Extrusive features include the formation of volcanoes, domes, craters and calderas.

Distribution of Major Volcanic Zones in the World

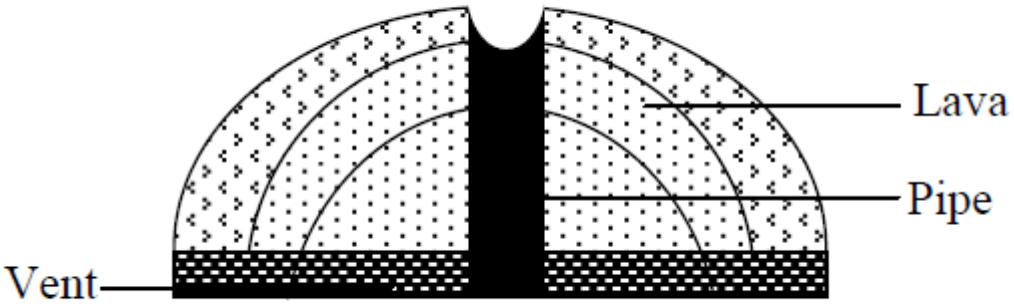
Locate the distribution of major volcanic zones in the world

Extrusive (external) vulcanicity

This is the type of vulcanicity that occurs when molten rocks reach the surface of the earth. When magma emerges at the surface it is called lava. This forms features called extrusive features of vulcanicity. The following are landforms due to extrusive vulcanicity:

Acidic lava cone

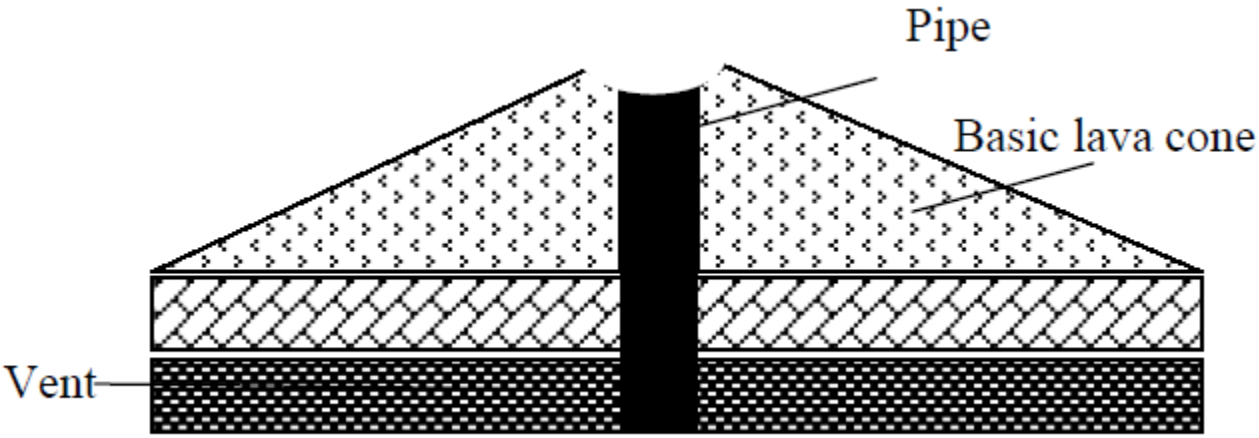
This is a cone made of viscous lava. Normally lava cones have high heights and break into small fragments. The acidic lava always cools faster than basic lava because is it viscous.



Examples of acidic lava cone include:Mount Kilimanjaro found in Tanzania (East Africa).Mount Kenya found in Kenya (East Africa).Mount Fuji found in Japan.Mount Vesuvius found in Italy.

Basic lava cone

This is a cone made up of basic (fluid) lava. Normally cones have gentle slopes and spread over a long distance.

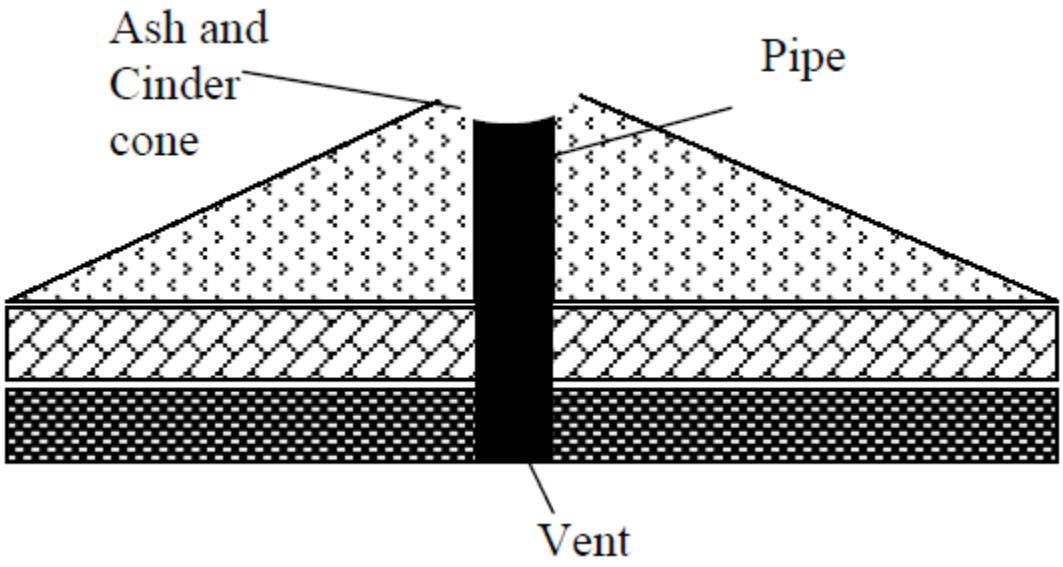


Examples of basic lava cones are Mauna Loa cone of Hawaii and basaltic dome of Nyamlangir, near to Lake Kivu in DRC.

Ash and cinder cone

This is a cone made up of ashes and stones that erupted from beneath (interior) the earth to form a concave cone. The slopes of a cone are usually concave due to the spreading tendency. Lava is

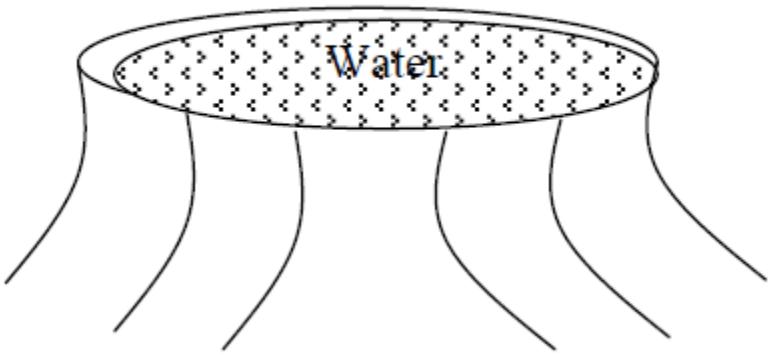
blown to great heights when it is violently ejected, and it breaks into small fragments which fall back to the earth and build up a cone.



Several ash and cinder cones occur just south of Turkana, in Kenya. These are Likaiyu and Teleki (both cinder cones), and Nabuyatom (ash cone).Other examples of cinder cones outside Africa are Volcano de Fuego, in Guatemala and Paricutin, in Mexico.

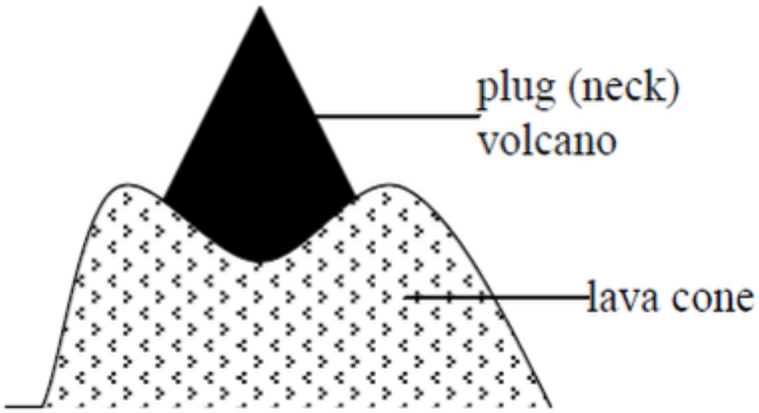
Crater

The crater is a small depression on the volcanic cone or mountain. It is sometimes filled with water to form a crater lake. It is formed when volcanic eruption ceases and leaves a hole on the basic lava cone. An example of a crater is Ngorongoro crater in Tanzania.



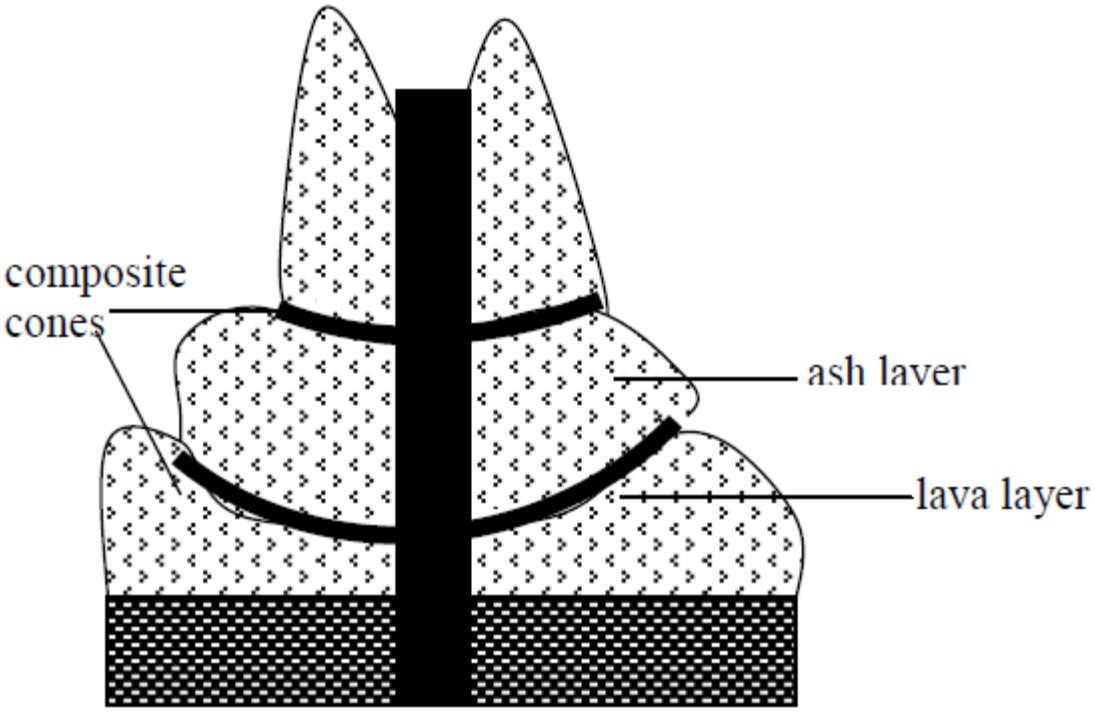
Volcanic plug

This is a big rock which plugs or blocks the top of the pipe. It is formed when lava solidifies quickly to block the pipe. Examples of volcanic plugs are Mount Palace in France and Hoggar mountains in Algeria.



Composite cone

This type of a cone is formed of alternate layers of ash and lava. The volcano begins each eruption with great violence forming a layer of ash. As the eruption proceeds, the violence ceases and lava pours out forming a layer on top of the ash.



Examples of composite cones are Mount Kilimanjaro, in Tanzania and Mount Cameroon. Other examples outside Africa are Vesuvius, Etna and Stromboli, all of which are in Italy.

Caldera

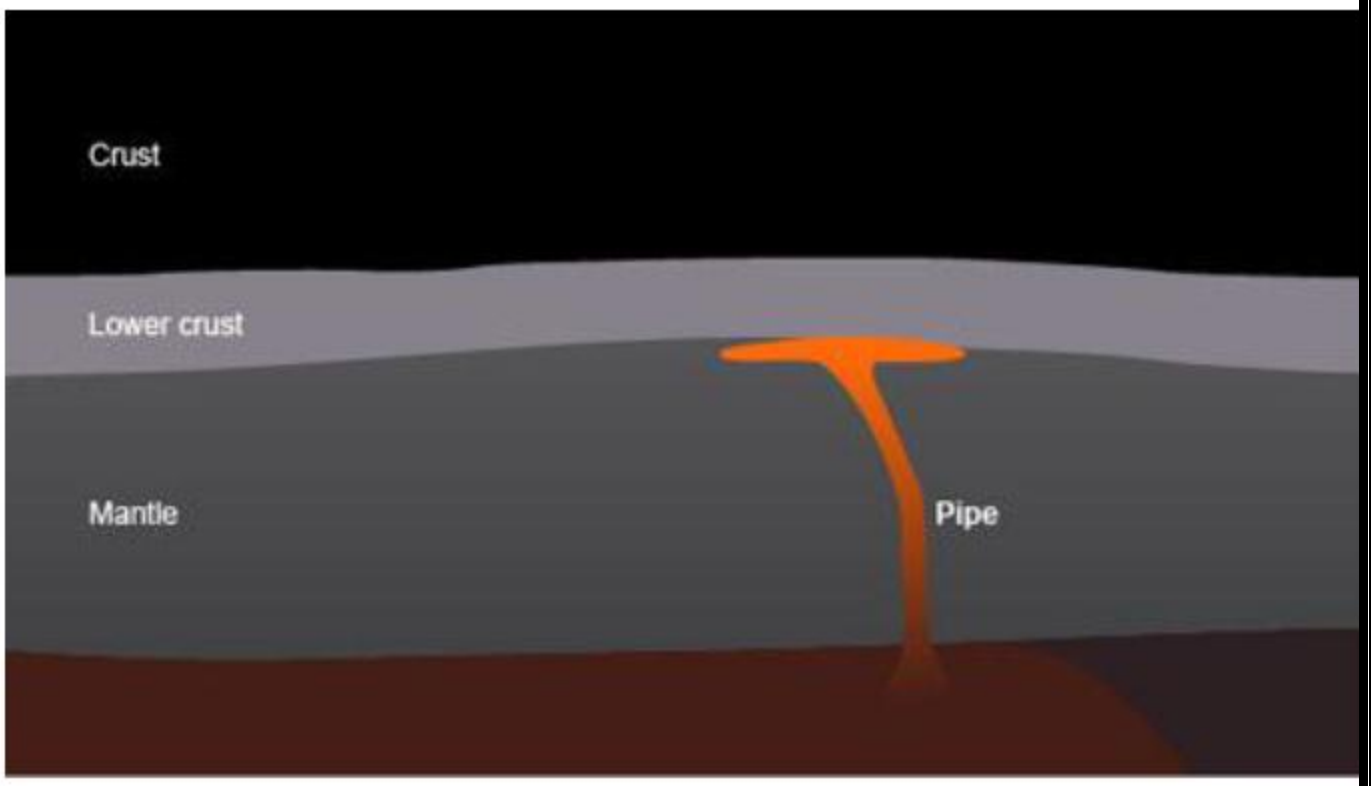
This is a large depression on top of a volcanic cone. It is formed when a composite volcano explodes so violently that its top is blown off and disintegrates into a mass of rocks and ashes, leaving the crater greatly enlarged. This huge crater-like depression is what we call a caldera. Sometimes a caldera can be filed with water to form a caldera lake. Lake Shala, in Ethiopia, is the largest caldera lake in the world.

Examples of calderas are:

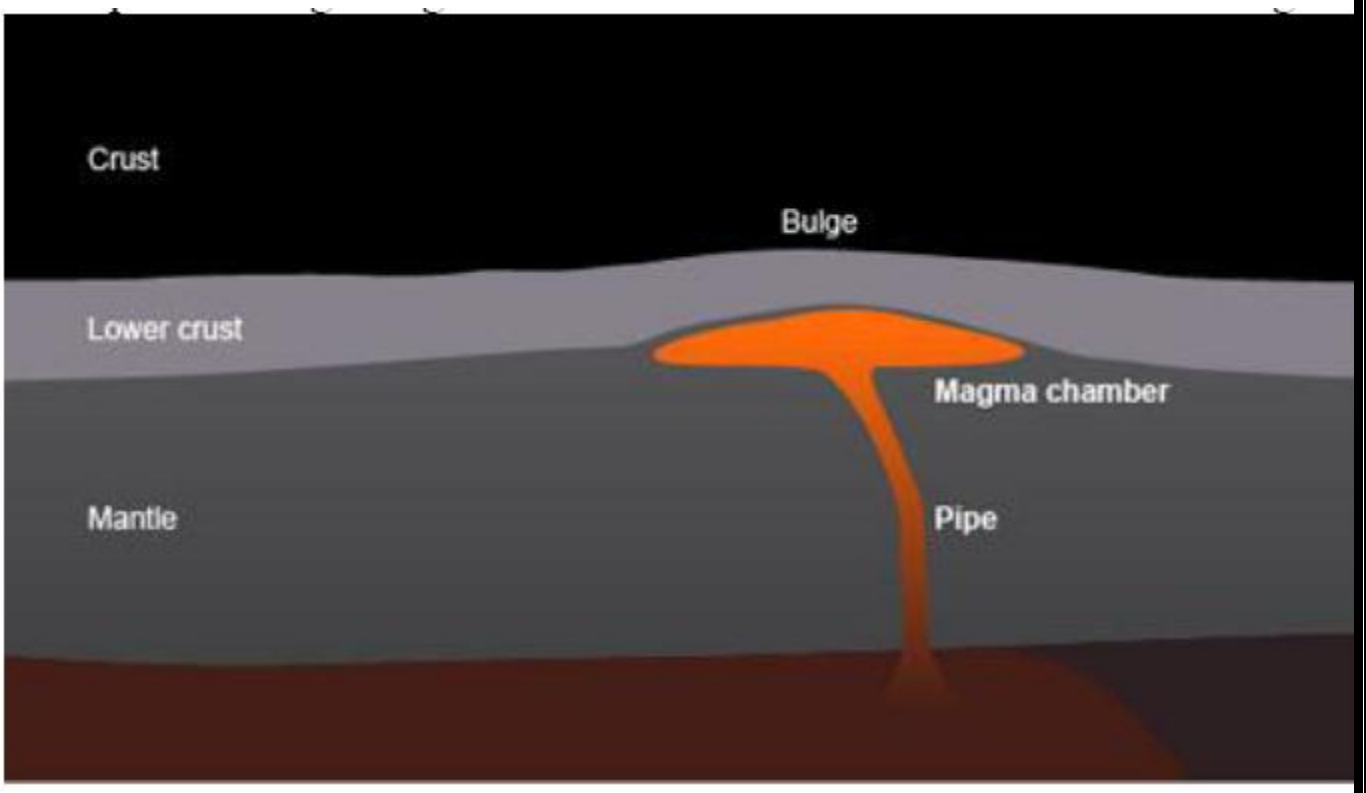
- Ebogar caldera, in Cameroon; and
- Longonot caldera, in Kenya, which lies in the Eastern Rift Valley, about 140 km south of Mount Kenya.

The stages in the formation of a caldera

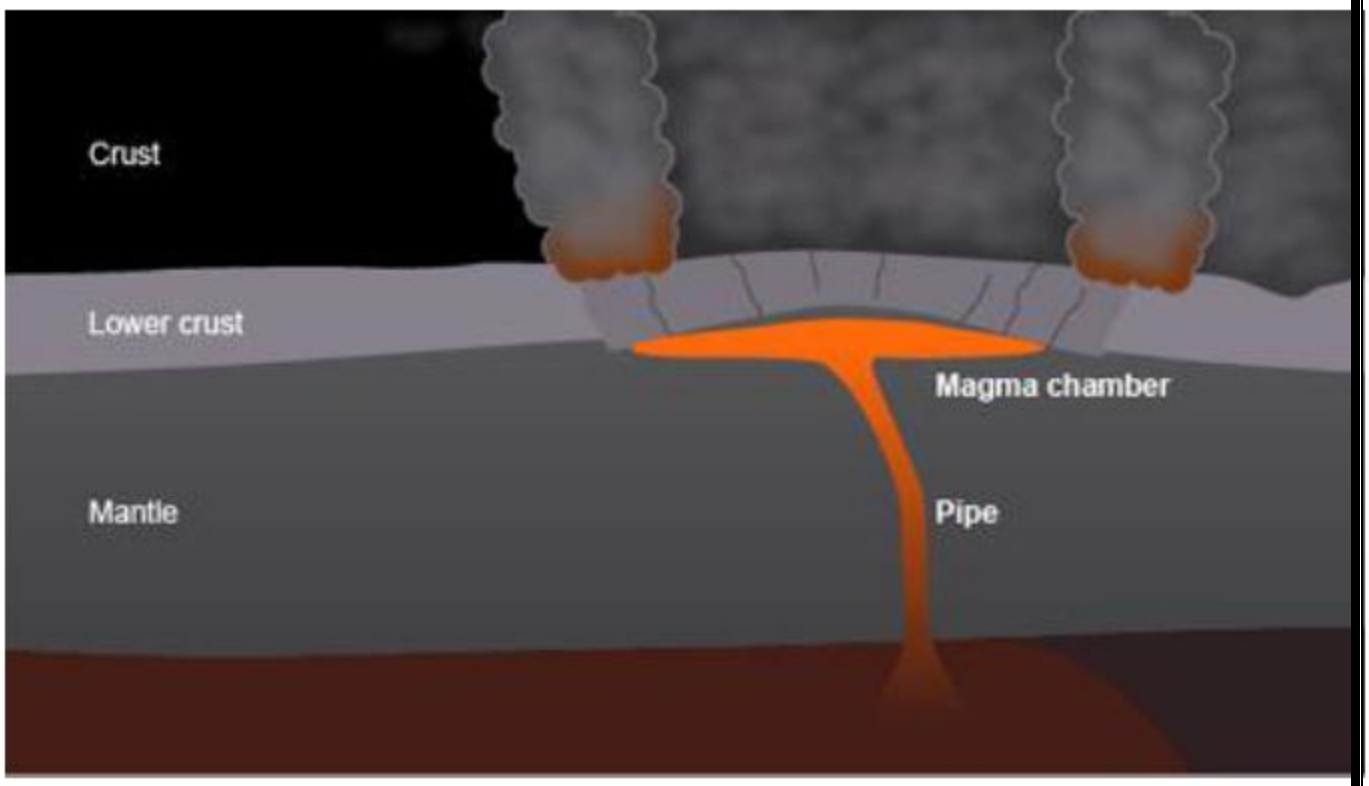
First stage:Magma cannot escape to the surface and collects under the lower crust.



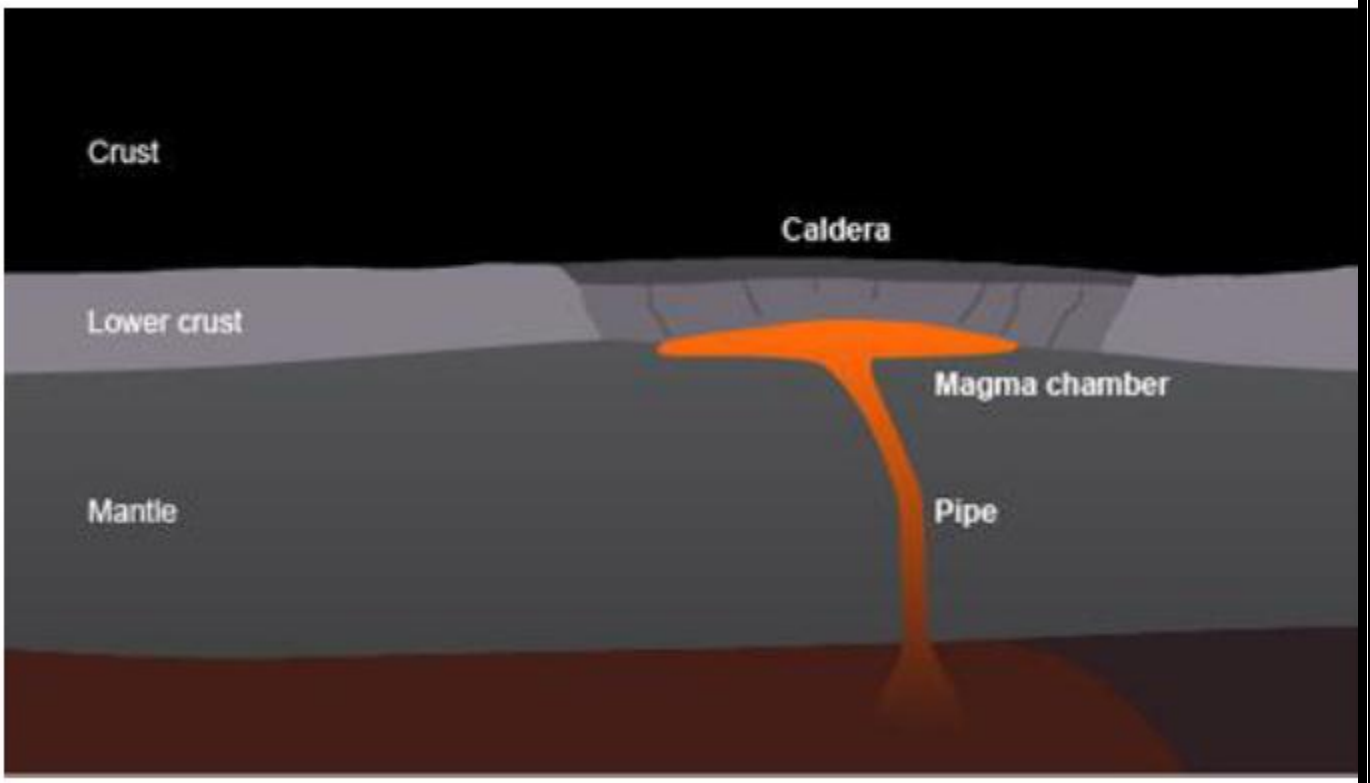
Second stage:An 'uplifted bulge' begins to form under the lower crust as the magma chamber enlarges.



Third stage:Cracks appear on the surface. Gas and ash erupt from the magma chamber through these cracks.



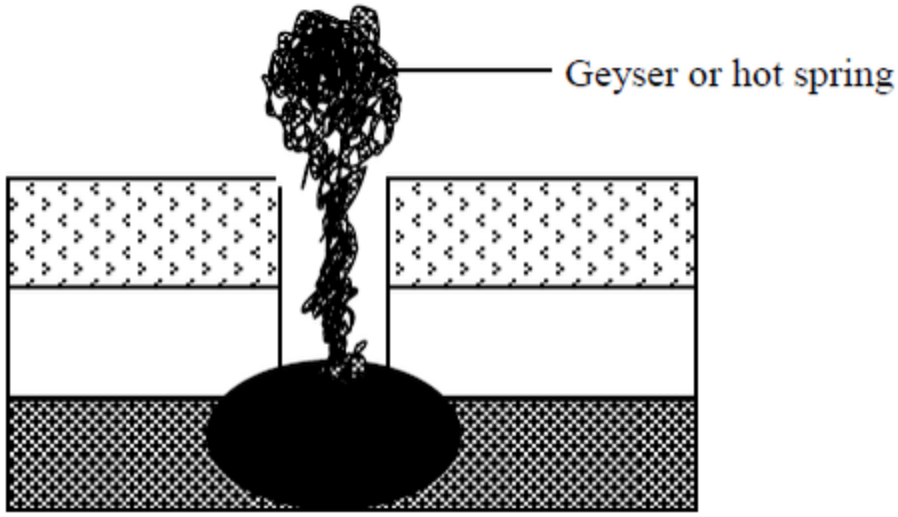
Fourth stage:The magma chamber collapses and a depression is formed. This is called a caldera.



Geysers and hot springs

1. A geyser refers to the forceful emission of hot water and steam from the ground to a high level in the air. The ejected water contains fine materials such as volcano mud, which later form fertile soils. Geysers are found in Iceland, North Island and New Zealand.

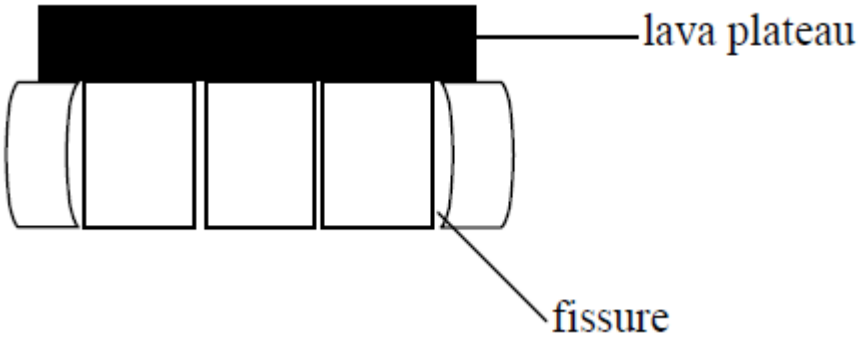
2. A hot spring refers to natural outflow of superheated water from the ground. It contains mineral substances in solution. Hot springs are found in Iceland, in Europe; and Kenya and Ethiopia, in Africa.



Hot springs are also found in Manyara National Park, Songwe, in Mbeya and in Nigeria.

Lava plateau

This is an extensive and flat landform which is formed when molten magma flows onto the earth‘s crust through fissure. Examples are found in Ethiopia highland, Bui plateau in Nigeria and Daccan plateau in India.



Distribution of major volcanic zones in the world

The distribution of volcanoes is as shown in the world map below. Most volcanoes are found in continents bordering the Pacific Ocean, an area referred to as Ring of Fire. The Ring of Fire is the name for the area around the Pacific Ocean where so many of the world‘s volcanoes are found. Besides volcanoes, there are also more earthquakes in Ring of Fire than the rest of the world. Many islands, like the Hawaiian Islands, are formed from volcanoes.

The Economic Importance of Volcanoes

Assess the economic importance of volcanoes

Vulcanicity results to features that are of economic value to man as outlined below:

1. The larva poured onto the earth‘s surface following vulcanicity forms a fertile soil upon weathering. This soil supports agriculture as well as forestry. Examples of fertile volcanic soils that resulted from volcanic activities are the rich acidic soils on the slopes of mounts Kilimanjaro, Kenya and Elgon, which supports the growth of coffee, banana, tea and other crops.

2. When the magma solidifies, it forms hard rocks that can be quarried and used to construct roads, bridges, houses and other infrastructures.

3. Spectacular features formed upon vulcanicity such as mountains, calderas, caldera lakes, cones, geysers and hot springs are interesting to look at. As such, they attract tourist and hence earn foreign currency to the country.

4. Vulcanicity brings minerals from deep the earth‘s crust to close or onto the earth‘s surface. Various minerals and gemstones are mainly found in the volcanic regions. Diamond in Mwadui is mined from the volcanic plugs and dykes. Gold and silver are associated with the Nyanza batholith in Kenya.

5. Geysers can be harnessed to generate geothermal electricity. Geothermal power is tapped from geysers in volcanic regions. In East Africa, geothermal power stations are established at Olkaria near Naivasha in Kenya.

6. Hot water from hot springs is pumped into homes during winter to heat up homes. This is done in cold countries like Iceland and New Zealand.

7. People use hot springs and pools of hot water as spas. They bathe in the water for the purpose of curing certain diseases.

8. Some crater lakes are a source of salts and other minerals while others support fishing activities, for example Lake Chala. Some lakes are a source of fresh water for domestic and industrial uses.

Earth-quakes

Earthquake, Epicenter and Focus

Define earthquake, epicenter and focus

Earthquakes refer to the sudden shaking or vibrations of the earth's crust due to sudden and rapid displacement of tectonic plates along the line of weakness (faults). It occurs mainly in volcanic eruption zones (see a map of volcanic zones above). The point from which the earthquake originates is known as focus and the intensity of earthquakes can be measured by using an instrument called seismograph. The point on the surface vertically above the focus is called epicentre

How Earthquake can be Detected

Describe how earthquake can be detected

The intensity and magnitude measure the strength of the earthquake. These are obtained by detecting the Seismic waves using instruments called seismograph or seismometer.

Intensity is a measure of how hard the earthquake shakes the ground. It is determined through the effects produced by the earthquake. Intensity varies from one place to another. While the intensity of a specific earthquake varies, its magnitude does not vary. So it is important not to confuse magnitude with intensity.

The scale which measures the intensity is called Mercalli scale. It ranges from undetectable, moderate, strong to major catastrophe. Magnitude refers to the total amount of energy released and it is given on the Ritcher scale. This scale ranges from 0 to 8.9.

The Causes and Effects of Earthquake

Explain the causes and effects of earthquake

Causes of earthquakes

- Faulting of the lithosphere caused by tectonic movement where one plate slides over another plate.
- Vulcanism can cause occurrence of the earthquake. This is due to the fact that the magma moves under the influence of intense pressure from within the earth's interior.

- Mass wasting like land slide and rock fall can cause occurrence of earthquake, but this is for local scale.
- Falling objects from the atmosphere such as meteorites may lead to the shaking earth's crust.
- Man's influence through his activities such as mining using explosives like dynamites and transport vessels like trains and heavy trucks.

Effects of earthquakes

1. They can cause loss of life and property. An earthquake is a natural disaster. Whenever it occurs, it causes a lot of disturbances including loss of life and properties. For example, the earthquake that hit Toro in Uganda in 1966 killed 157 people, injured about 1300 people and destroyed about 6000 houses. The earthquake which occurred in California–Mexico border in 1975 caused damage running into millions of dollars and injured 100 people on both sides of the border where most of them suffered cuts from flying glass and debris. And the earthquake that occurred in Northridge in the San Fernando Valley in California in January 1994 killed 61 people and caused damage estimated at ten to thirty billion dollars. This damage includes the cost of structures that collapsed such as California Highway, when the earthquake turned the flyover to ruins.
2. They can displace parts of the earth's crust vertically or laterally.
3. They can raise or lower parts of the sea floor. The Agadir earthquake in Morocco in 1960 raised the sea flour off the coast. In some areas the depth of the sea decreased from 400 m to 15 m after the earthquake.
4. They can raise or lower coastal rocks. In the Alaskan earthquake of 1899, some coastal rocks were raised by 16 m.
5. They can cause landslide and open up deep cracks in the surface rocks. The El Asnam earthquake in Algeria, in 1954, destroyed an area of radius 40 km and opened up deep cracks up to 3 m deep.

The possible Areas where Earthquake is likely to Occur on the World Map

Locate the possible areas where earthquake is likely to occur on the world map

Precautionary measures to avoid high damage from earthquakes

- Refraining from building high-rising structures on the land vulnerable to earthquake as well as strengthening buildings by using reinforced concrete, steel frames, deep foundations and light roofs.
- Geologists should detect epicentres and tell the people to evacuate the places likely to be affected by earthquakes.
- To avoid constructing very large water bodies like Kariba dam which can cause the earthquakes due to the weight of water and other materials.
- Discouraging the use of explosives like dynamites in breaking the rocks during mining and construction operations.

External Forces

These are natural forces that operate on the earth's surface. The forces mainly act on the earth's crust or close the surface of the earth. Often the features produced by these forces are seen on the surface of the earth. They include mountains, volcanoes, moraines and valleys, just to mention a few.

Mass Wasting

Define mass wasting

Mass wasting, also known as **slope movement** or **mass movement**, is the movement of the weathered materials downslope due to gravitational forces accompanied by rain action.

Types of Mass Wasting

Identify types of mass wasting

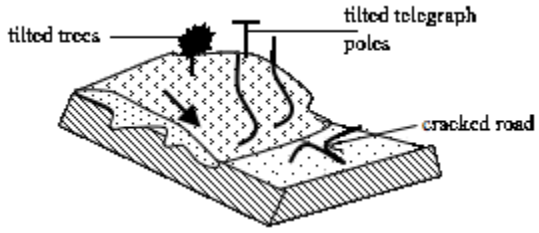
Types of mass movement are distinguished based on how the soil, regolith or rock moves down the slope as a whole. Based on this factor, mass wasting can be categorized or grouped into two types. These are **slow** and **rapid** mass movements, each with its own characteristic features, and taking place over timescales from seconds to years.

Slow mass movement

This is the movement of soil at very slow speed, water acting as the lubricant. Slow mass wasting is categorized into several types. These are as follows.

Soil creep

Soil creep is the slow movement of the soil downhill afterit gets soaked by water. This process is very slow andits evidence is provided by tilting of trees and falling of buildings and fences.



Sol creep is activated by any process that loosens the soil, making it easy to move gradually down the slope. The following factors influence soil creep:

a. Alternate heating and cooling of the soil particles.

b. The freezing of water in the soil causing frost heaving.

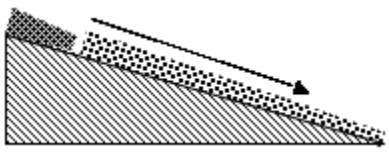
c. Removal of the soil further downthe slope.

d. Percolation of water into the soil, acting as a lubricant.

e. Ploughing of the soil, a factwhichmakes the soil loose and more mobile.

Talus Creep

This is also a very slow mass movement of screes. It is very common on sides of mountains, scarps and valleys. It takes place due to the processes of thawing and freezing and is more pronounced in high latitude regions.



Rock creep

Individual rock blocks may move very slowly down a slope. It occurs commonly where individual rock blocks are lying over clay materials. In the presence of moisture, the clay surface becomes slightly slippery. The rock blocks may creep slowly down the slope under the influence of gravity.

Solifluction

This is the slow movement or flowing of weathered materials, especially when mixed with water and gravels. It is limited on highlands and cold regions.

Rapid mass wasting

This involves the movement of materials in form of mudflow,land slide, rock fall and earth flow.

Earth flow

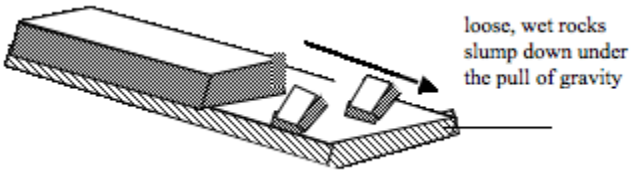
This type of movement occurs in humid regions. The materials on the earth's surface gets so saturated with water that it gains much weight, and starts to move down the slope under the influence of gravity.This normally occurs on the slopes of the hills or mountains. The removed earth material leaves a shallow scar on its place of origin and it creates terraces or mounds in its destination.

Mudflow

Mudflow is the movement of a large mass of unconsolidated rocks down the slope when saturated with water. It flows in semi liquid state. It is common in desert slopes, which are not protected by a cover of vegetation. This occurs, for instance, during a torrential storm when more rain falls than the soil can absorb.

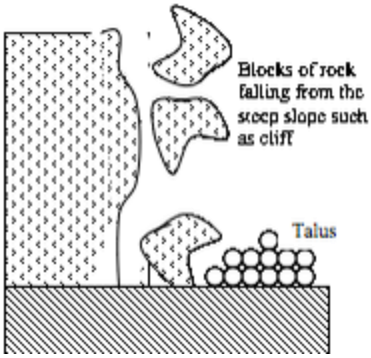
Land slide

This is the rapid movement of surface rocks and soil down a steep slope such as a cliff face. It includes slumping and sliding of materials. During the movement, the block tilts and leaves holes. It is common inwell jointedlimestone rocks, shale or clays. The common forms of landslides are slump, debris slide,rock slide, rock fall, debris fall and avalanche.



Rock fall

This is thefree-fallingof a single mass of rock, common on steep slopes of mountains and along scarp slopes of the sea. This is the most rapid of all mass movements. If a rock fall occurs repeatedly, for a long time, the broken rocks collect at the bottom of the slope in a mound called*talus*.



The Factors which Cause Mass Wasting

Describe the factors which cause mass wasting

Mass wasting is caused by a number offactors whichinclude the following:

1. **Gradient or slope:**When the gravitational force acting on a slope exceeds its resisting force, slope failure (mass wasting) occurs. Mass wasting is very common and severe in areas with steep lands as compared to flat or moderately flat lands.
2. **Weathering:**Various processes of weathering weaken and loosen the rock, hence accelerating the process of mass wasting. For example, oxidation of metallic elements and hydration of the minerals in rocks create lines of fracture and, consequently, the onset of mass wasting.
3. **Amount of water present in the rocks:**Water can increase or decrease the stability of a slope depending on the amount present. Small amounts of water can strengthen soils because the surface tension of water increases soil cohesion. This allows the soil to resist erosion better than

if it were dry. If too much water is present the water acts as lubricating agent, reducing friction, and accelerating the erosion process, resulting in different types of mass wasting (i.e. mudflows, landslides, etc.). Water also increases the mass of the soil, this is important because an increase in mass means that there will be an increase in velocity and mass wasting is triggered. This is due to the fact that water lowers resistance of the soil material to gravitational forces and this facilitates movement.

4. **Vegetation:**The roots of plants help bind the soil particles together making the soil resistant to agents of erosion and weathering. A compact soil cannot be eroded easily by running water, animals, wind or other agents of erosion. This makes the soil hard to break and hence resistant erode. Mass wasting processes, such as soil creep, cannot occur easily in soilswell-coveredwith vegetation. Also the mass of vegetation cover blocks and prevents movement of the eroded material.Plants remove water from the ground via absorption. This reduces the amount of water in the soil and hence the bulkiness and weight of the soil. By so doing, they reduce the quantity of water in the soil. And because water lubricates the soil particles, enabling them to move, reducing this water means minimizing mass wasting.The sliding of bedding planes over each other is also reduced.

5. **The nature or type of the rock materials:**Clay soil is compact and resistant to various types of soil erosion agents and mass wasting as compared to sandy soil, which is normally loose and easy to remove and transport by water, gravity, wind, etc. Thus, mass wasting may be more severe on sandy soil than its counterpart clay soil under similar prevailing conditions.

6. **Overloading:**When the soil accumulates in one location as a heavy mass of the rock material, it can be moved either by action of gravitational force or application of just a little force. Landslides occur as a result of the soil accumulated on a sloping land to an extent of exceeding the resistant force of gravity. Movement occurs when the gravitational force exceeds the resistant force of soil material.

7. **Earthquakes:**Earthquakes cause sections of the mountains and hills to break off and slide down. Earthquake tremors tend to loosen the soil material and make it easy to be removed and transported. It can accelerate rock falls, landslides and soil creeps.

8. **Human activities:**Theactivities of man such as cultivation, burning, mining, transportation, animal grazing, etc, removesthe soil cover or leads to shaking of the soil. These activities leads to loosening of the soil particles and hence making it ease to remove and carry

away. Quarrying by undercutting the slope creates a vacuum underneath the soil. This accelerates the earth movement in the form of landslide, soil creep and mudflow, especially when accompanied by tremors cause by earthquake or heavy vehicles passing nearby.

9. **Climate:**Climate has a great influence on mass wasting. Areas that receive heavy rains often experience mass movements, such as landslides and soil creep, more often compared to dry areas. On the other hand, a little amount of rainfall does not wet the soil and so cannot cause the soil to move.In cold regions, alternate freezing and thawing triggers mass wasting. When the water in the soil freezes it expands. This causes the soil to be lifted up. In the due course, the rock particles are split apart of broken down. This entire process causes movement of the soil material down the slope.

10. **Vulcanicity:**Volcanic activity often causes huge mudflows when the icy cover of a volcano melts and mixes with the soil to form mud as the magma in the volcano stirs preceding an eruption.

The Effects of Mass Wasting to the Environment

Assess the effects of mass wasting to the environment

Mass wasting has significant effects to the environment. The following are some of the effects of mass wasting to the environment:

1. **Formation of scars and bare land:**When a large mass of soil moves, such as it occurs in landslide, the process leaves behind a large portion of eroded, bare and unproductive land. This land is often not easily colonized by plants, a fact which stimulates further erosion on the bare scar. Scars are very common on slopes of mountains such as mounts Kilimanjaro, Kenya andRwenzori.

2. **Soil erosion:**When mass movement takes place, the load often removes almost all the vegetation on its way. This exposes the land to agents of erosion such as wind, animals, water, ice, waves, etc. Also the place from which the material has been removed forms a scar upon which water, ice and other agents of erosion can act and remove the soil, further leading to gullies, depressions and gorges.

3. **Formation of new landforms:**The materials removed and transported to a distant location may form hills at their destination and form scars and depressions at the place of origin.

4. **Formation of lakes:**Materials of landslide can block ariver bedand valley, preventing downward movement of water. The blocked water accumulates on the upper side of a river valley to form a lake. Examples of such lakes include LakeBujukuin theRwenzoriMountains,Nyabihohoin Uganda andFunduziin South Africa. Lake San Cristobal in Colorado, USA, was formed when mudflow dammed (blocked) a river in the San Juan Mountains.

5. **Diversion of a river course:**The landslide material can block the naturalriver bed, forcing the river to divert and form a new route. This makes the river leave its usual flowing course, and form a new course. The direction of flow of the river is thus changed. This happened in the Rif Atlas Mountains of Morocco in 1963 when a mudflow pushed the course of RiverRhesana100 metres to the east.

6. **Formation of a fertile soil:**If the removed material comes from a fertile land, it can form a fertile soil at the place of destination, where fertile soil never existed, and encourage agricultural activities to take place.

7. **Damage to property:**Different categories of landslides may cause various damages to property and can adversely affect other resources. The effects of landslide are dangerous because they destroy everything in their path. Roads are blocked, hampering traffic flow. Homes, buildings and other infrastructures are destroyed. The water mains, sewers and power transmission lines are disrupted. Oil and gas production and transportation facilities are ruined.Farms are also destroyed by various forms of mass wasting.

8. **Loss of life:**As human populations expand and occupy more and more of the land surface, mass movement processes become more likely to affect humans. The table below shows the impact of mass movement processes on human life over the last century.

Year	Location	Type	Fatalities
1916	Italy, Austria	Landslide	10,000
1920	China	Earthquake triggered landslide	200,000
1945	Japan	Flood triggered landslide	1,200

1949	USSR	Earthquake triggered landslide	12,000-20,000
1954	Austria	Landslide	200
1962	Peru	Landslide	4,000-5000
1963	Italy	Landslide	2,000
1970	Peru	Earthquake related debris avalanche	70,000
1985	Columbia	Mudflow related to volcanic eruption	23,000
1987	Ecuador	Earthquake related landslide	1,000
1998	Nicaragua	Debris avalanche and mudflow triggered by heavy rains during Hurricane Mitch	~2,000
2001	El Salvador	Earthquake-induced landslide	585
2006	Philippines	Rain triggered debris avalanche	>1100
2009	Taiwan	TyphoonMarakottriggered landslide	397
2010	Gansu, China	Rain triggered mudflows	1287
2013	Northern India	Heavy rain triggered landslides	5700

Weathering

Weathering

Define the term weathering

Weathering refersto a processeswhere by rocks disintegrate into small particles due to the agents of weathering such as water, ice, wind, wave, etc. The process results from the forces of weather, that is, changes in temperature, frost action and rain action.

Types of Weathering

Identify types of weathering

The main forms of weathering include:

- Mechanical weathering;
- Chemical weathering; and
- Biological weathering.

Mechanical weathering

This is also referred to as physical weathering. It is a type of weathering caused by changes in temperature. It is common in areas where there are extreme changes in temperature such as hot deserts, arid and semi arid regions.

Mechanical weathering include the following types:

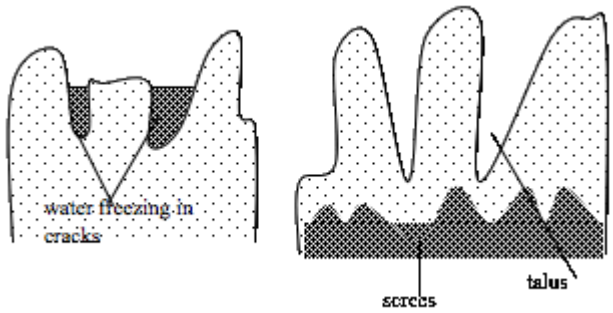
Exfoliation

Thisprocess occurs due to temperature change. During theday timerocks expand due to high temperatures and contract during the night due to low temperatures.Alternate heating and cooling set up powerful internal stress in the top layer of the rocks.The stress produces fractures which cause the outer layer to pull away leading to the cracking and disintegration of rocks into small particles.

The peeled off rock fragments fall to the bottom of the standing rocks and are subjected to further alternate expansion and contraction and disintegrate to even smaller fragments. The fragments collect at the base of the standing rocks to form mounds of steeply sloping rock fragments called*talus*or sometimes*screes*, but the term is better used for angular rock particles produced by the action of frost. The rocks that remain standing as exfoliation takes place are called*exfoliation domes*. Exfoliation domes occur in desert, semi-desert and monsoon regions. There are many exfoliation domes in the Egyptian, Kalahari, Sahara and Sinai deserts.

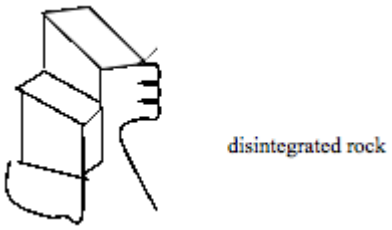
Frost action

This is common in temperate regions where temperature falls up to freezing point. When temperature falls (freezing point) water collects in the rocks and it freezes, its volume increases causing the crack to deepen and widen. Usually it involves the freezing of water in the cracks during the night and thawing (melting) during the day in mountainous areas.This action of thawing (melting) and freezing of water in the cracks causethe rocks to shatter (break) into angular fragments which form screes and talus. After thawing the cracks deepen further.



Alternate wetting and drying

This usually occurs in tropical regions. These areas have seasonal rainfall and they get rain during summer season and during winter season they are dry. This causes the blocks to disintegrate.



Differences between Weathering Processes

Differentiate weathering processes

Chemical weathering

Chemical weathering involves the decomposition of some of the minerals contained in a rock. Some rocks decompose when they come into contact with water (H_2O), or oxygen (O_2) and carbon dioxide (CO_2), two of the gases that make up air.Chemical weathering includes the following processes:

1. *Oxidation*– This happens when oxygen combines with a mineral. It takes place actively in rocks containing iron, when oxygen combines with iron to form iron oxides. This process is often preceded and accompanied by hydrolysis.The new minerals formed by oxidation are often easily attacked by other weathering processes.

2. *Carbonation*– This process occurs when hydrogencarbonate ions react with a mineral to give a solublecompound whichcan be carried away in solution. Hydrolysis often accompanies carbonation.

3. *Solution*–This refers to dissolution of a mineral with a chemical substance.Rain watercombines with both atmospheric carbon dioxide and oxygen to form weak carbonic acid. $CO_2(g) + H_2O(l) \rightarrow H_2CO_3(aq)$.So when the rain reaches the ground it consists of a weak acid called weak carbonic acid. This acid helps to dissolve many insoluble minerals into minerals soluble in water, and which can be carried away in solution. When rain containing weak carbonic acid falls in a limestone region, it reacts with limestone (calcium carbonate) and dissolves it into soluble calcium hydrogen carbonate, which can easily be carried away in solution.$CaCO_3(s) + H_2CO_3(aq) \rightarrow Ca(HCO_3)_2(aq)$In limestone regions, the rocks are dissolved and produce features like grike andclint(trough and ridge).

4. *Hydration*– This is the process in which some minerals absorb water and swell up, causing internal stress and fracture of the rocks.

5. *Hydrolysis*– This process involves the reaction of hydrogen (in the water) with certain mineral ions (in a mineral). This gives rise to the formation of different chemical compounds that can be easily weathered through other weathering processes.

NOTE: Usually two or more chemical weathering processes take place at the same time. Chemical weathering is most marked in hot wet regions.

Biological weathering: When plants grow on rocks, their roots penetrate into rockjoints whichlater force the rocks to break apart. Also man contributes much to rock disintegration through farming activities, mining, quarrying and construction. Macro- and microorganisms also disintegrate rocks through burrowing and by mineralization process. Bacteria, for example, in the presence of air, break someminerals whichare dissolved in the soil. Plants also absorb minerals from the soil by their roots. Decayed vegetation produce organicacid whichremain in the soil. All of these actions help to weaken the rocks.

The Significance of Weathering

Assess the significance of weathering

Weathering is important to man in the following ways:

1. Weathering leads to soil formation. Soil is formed through the process of weathering of rocks. Various forms of weathering lead to rock disintegration and hence formation of the soil. The soil is an aggregate of organic and inorganic particles formed by different processes of weathering.

2. Weathering may shape the rocks into attractivefeatures whichcan attract tourists and hence earn the country and communities the much needed foreign exchange. An example of a feature that can attract tourists is the Bismarck Rock on the south shore of Lake Victoria.

3. The processes of weathering weaken the rocks such thatthey can be easily acted upon by agents of erosion. The process helps to shape the earth and produce various landforms. This, in turn, influences the type of human activities that can take place in an area. So the process is very important in supporting life.

4. When the rocks are weathered they become weak and hence easy to exploit, e.g. by quarrying. This process also helps to break up large rocks into small fragments such as sand, which is used for construction purposes.

5. Weathering serves as carbon sink.Any process that reduces the amount of carbon dioxide from the atmosphere is termed as**carbon sink**. Some processes of weathering involve absorption of carbon dioxide from the atmosphere. This helps to remove excess carbon dioxide from the atmosphere. Limestone and other carbon-based sedimentary rocks are important carbon sinks.

Erosion and Deposition by Running Water, Ice, Wind and Wave Action

The Concept of Erosion and Deposition

Define the concept of erosion and deposition

River refers to a mass of water flowing through a definite channel over a landscape from river source to river mouth. River source is the place where a river starts. It may be in the melt water from glacier e.g. river Rhome (France), a lake, e.g. Lake Victoria, the source of river Nile, a

spring e.g. Thames (England) or it can be formed following steady rainfall e.g. river Congo. River mouth can be anywhere a river pours its water, e.g. a lake, ocean or sea.

How Agents of Erosion and Deposition Operate on the Landscape

Examine how agents of erosion and deposition operate on the landscape

The river has three functions as it flows through its channel. These are river erosion, transportation and deposition.

River erosion

Erosion of a river operates in three ways, that is, head ward, vertical and lateral erosions.

- *Heard ward erosion*– this is the cutting back of the river at its source. It is through this erosion that a river increases its length.
- *Vertical erosion*– this is erosion by which a river deepens its channel.
- *Lateral erosion*– This is the wearing away of the sides of a river by water and its load. It is responsible for widening of a river valley.

River erosion involves four related processes. These are abrasion (corrasion), attrition, corrosion (solution) and hydraulic action.

- *Hydraulic action:*This is the process whereby the force of moving water plucks and sweeps away loose materials, such as silt, gravel and pebbles. Materials plucked by hydraulic action are responsible for bank caving and slumping.
- *Corrasion (abrasion):*This is when the load of the river rubs against the bed and sides of the river channel. This causes wearing away of the sides and bed of the river. The amount of load determines the nature of erosive power and rate of erosion. This is a source ofpot holesin the river bed.
- *Attrition:*This is when the rock fragments in a river's load are broken into small fragments due to collision against one another as the load is carried downstream along the river channel. As the river moves along its course, its fragments get progressively smaller because of disintegration and wearing away.
- *Corrosion (solution):*River water dissolves certain minerals leading to dissolution and disappearance of some rocks, e.g. limestone, rock salt and chalk.

River transport

This is the process which involves carrying away of the weathered and eroded, loose materials from one place to another. The materials carried out by river is called load. River transports its load in four ways. These ways are as follows:

1. *Saltation*– this is the process in which small pieces of the rock fragments are carried by a river while bouncing on theriver bed.
2. *Traction*– this is the dragging or rolling of large boulder such as pebbles along itsriver bed.
3. *Suspension*– This involves transport of fine or light materials like silt and mud, which are carried in suspension forms. This is common when the river flow is too strong.
4. *Solution*– this involves moving some materials that dissolve in water, which are carried away in solution form.

A river transports its load until it has insufficient energy to transport it any further. When this happens, the load is deposited.

River deposition

A river deposits its load when its volume and speed decrease. A river volume decreases when:

1. itenters an arid region especially a hot desert;
2. itcrosses a region composed of a porous rocks e.g. sand and limestone; and
3. duringthe dry seasons or in a period of drought.

A river speed decreases when:

1. itenters a lake or sea; or
2. whenit enters flat or gently slopping plain such as a valley bottom.

Deposition takes place when the river has insufficient energy to carry its entire load. The first part of the load that is dropped consists of boulders and pebbles. The last part to be dropped is the fine sediment, called*silt*. Deposition takes place at any point in a river's course.

THE LONG PROFILE OF A RIVER

The long profile of a river is the line following the course of a river from its source to its mouth. Three courses or sections of a river can be distinguished. These are:

- The upper course.
- The middle course.
- The lower course.

The upper course/section

This is the first stage of a river. It is sometimes called the youth or torrent course.Its characteristics are as follows:

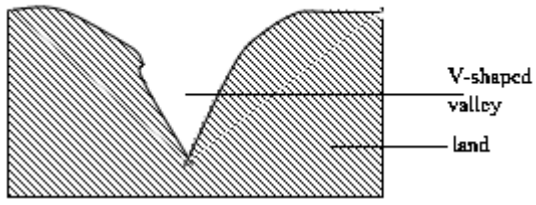
1. It is the river source.
2. The speed of a river is high.
3. Most of the works of the river include vertical erosion.
4. The cross-section of a river valley in this section of a river is V–shaped.
5. The slope of a profile is very steep.
6. It is sometimes utilized for hydroelectric power (H.E.P) generation.

Erosional and Depositional Features for each Agent

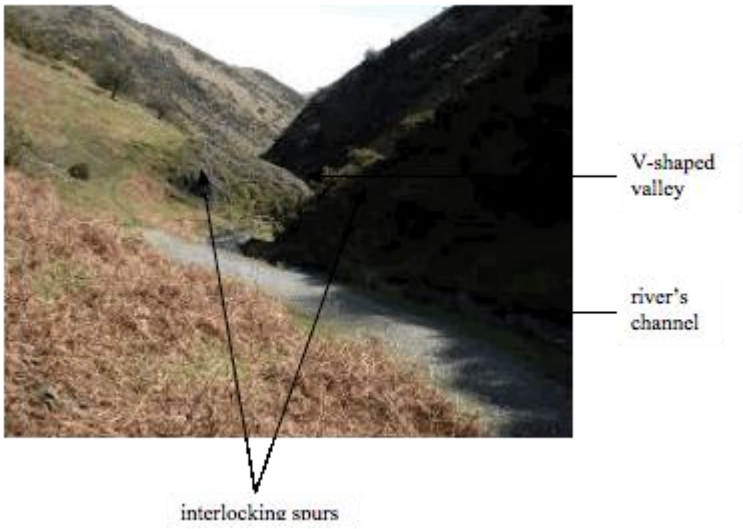
Examine erosional and Depositional Features for each Agent

The main features of the upper section are deep and narrow, V-shaped valley; a steep gradient; pot holes on the river bed; interlocking spurs and waterfalls and rapids, often with plunge pools.

- *V–shaped valley*: this is a deep, narrow valley at youth/first stage of a river.



- *Pot holes*:These are circular depressions on theriver bed. They are formed when pebbles carried by the swirling water cut circular depressions in the river's bed.
- *Interlocking spurs:*An**interlocking spur**, also known as an**overlapping spur**, is one of any of a number of projecting ridges that extend alternately from the opposite sides of the wall of a young,**V-shaped valley**down which a river with a winding course flows. Each of these spurs extends laterally into a concave bend of the river such that when viewed either upstream or from overhead, the projecting ridges, which are called*spurs*, appear to "interlock" or "overlap" in a staggered formation like the teeth of a zipper.As the river erodes the landscape in the upper course, it winds and bends to avoid areas of hard rock. This creates**interlocking spurs.**

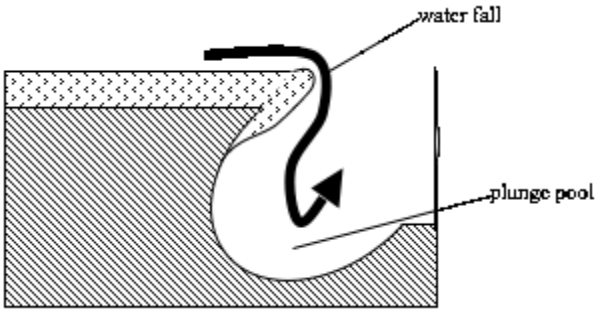


- *Waterfalls and rapids-Waterfall:*A**waterfall**is a place where water flows over a vertical drop in the course of a stream or river. A waterfall is formed when there is sudden change or drop in the bed of a river. Although waterfalls can occur in almost any part of a river's course, they are most common in the upper course. Examples of waterfalls are Owen Falls in Uganda, Victoria Falls in Zimbabwe and The Livingstone

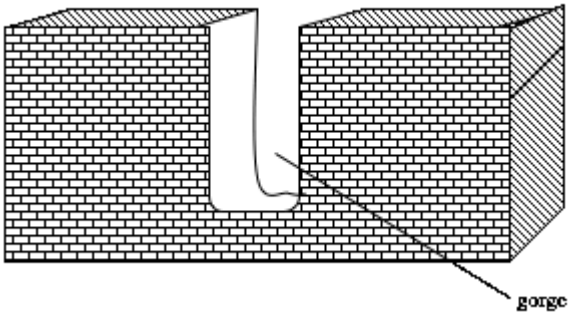
The Yosemite Falls in USA

- *Rapids:*These are sections of a river where theriver bedhas a relatively steep gradient, causing an increase in water velocity and turbulence.Rapids are characterised by the river becoming shallower with some rocks exposed above the flow surface. As flowing water splashes over and around the rocks, air bubbles become mixed in with it and portions of the surface acquire a white colour, forming what is called "whitewater".Rapids occur where the bed material is highly resistant to the erosive power of the stream in comparison with the bed downstream. Very young streams flowing across solid rock may be rapids for much of their length.

- *Plunge pool:*This is a large depression formed at the base of a waterfall.



- *Gorge:*It is a steep, narrow and elongated valley. A gorge often is formed when a waterfall retreats upstream, e.g. a gorge found in Victoria Falls.



The middle/maturity stage/section

This is the second stage of a river. The main features of this section are bluffs and waterfalls and rapids.

The characteristics features of the middle course of a river valley

1. The speed of a river is fairly low.
2. Most of the work of a river is transportation.
3. The cross–section of a valley in this section is an open V.
4. The slope of a relief is gentle
5. The volume of a river increases.
6. Lateral erosion predominates.

Features associated with the middle course of a river valley

1. *Bluffs:*These are steep slopes of the truncated spurs in middle course where interlocking spurs turn into bluffs.
2. *Waterfalls and rapids:*Waterfalls and rapids can also be found in the middle stage of the river valley. This is mainly caused by riverrejuvenation which increases erosive activity and transportation, hencedevelopment of waterfalls.

The old/lower stag

Third is the third stage of a river. The main features of the lower section of a river valley are a flood plain; braided river; ox-bow lake; levee and deferred tributary and delta.

Its characteristics are as follows:

1. It is the river mouth.
2. Always there are gradient falls or slope falls.
3. The main work of a river is deposition.
4. The cross–section of a valley is a U–shaped valley.
5. The speed of a river is decreased.
6. The river valley is very wide.

The Importance of Erosional and Depositional Features to Human Beings

Assess the importance of erosional and depositional features to human beings

Some features resulting from erosion and deposition are very important to human beings in the following ways: Loess form very fertile soil in desert land, water falls attract tourists, headlands in coastal areas are natural ports. Coastal features form breeding places for fish, coral reefs are used as building materials and for settlement.

Artificial Forces

The Meaning of Artificial Forces that cause Earth Movements

Explain the meaning of artificial forces that cause earth movements

These are forces that are caused by human beings through their activities such as farming, mining, setting up settlements, road construction, transport, etc. In the previous sections we learned about the natural forces that affect the earth. We saw that the forces act on and within the earth. These forces occur naturally with little or no human intervention.

In this section, we shall deal with forces that occur as a result of human actions, hence called artificial or man-made forces. Man is considered as an agent of denudation, that is, he takes part in destruction or removal of some parts of the earth's surface. This shows that man can modify natural landforms and, therefore, acts as the agent of weathering, mass wasting, erosion, transportation and deposition on the earth's surface.

Human modification of the land helps loosen large chunks of earth and cause them to slide downhill. Man produces forces that affect the earth through the following activities:

- **Removing vegetation:**A slope with lots of vegetation is less susceptible to mass movement than a bare slope.Bare, exposed soil is very easily eroded, and can contribute to mass movement activity.Vegetation: helpshold soil, loose rock, andregolithtogether by its roots; reducesthe direct erosive impact of rainfall and other precipitation; activelyreduces ground moisture by using it to contribute to plant growth; and produceslitter and organic products (leaves, twigs, grasses, fruits) that help stabilize the soil.

- **Mining:**In the course of mining, man uses machines to dig the soil and blast rocks. These activities results to earthtremors whichloosen the soil particles making then vulnerable to removal by agents of weathering and denudation. Blasting also causes fractures in rocks, a fact which makes them less stable and resistant to shear and stress. If this happens, especially on steep slopes, the probability of occurring landslide is very high.
- **Farming activities:**Farming involves digging the soil by using farm implements such as hoes, tractors, harrows, spades, etc.These activities involvesbreaking up the soil and rocks by the implements. In this way, crop cultivation directly leads to weathering and erosion. Overstocking (keeping many animals in just a small piece of land) also leads to soil erosion. This is because overstocking is usually accompanied with overgrazing, an act which removes the vegetation cover. This triggers soil erosion and other weathering processes.
- **Building and construction:**Breaking up the soil for construction of houses and other infrastructures can dramatically increase the potential of mass movement. These processes involve tearing rocks to get room for setting up infrastructures such as roads, railways, airports, seaports, etc. This leads to destruction of the soil, hence triggering mass movement, weathering and erosion.
- **Fishing:**Fishermen in less developed countries sometimes use weapons such as dynamites to kill and catch fish. Tremors produced by these illegal fishing tools can cause fracturing of the coastal rocks. This causes both weathering and erosion.
- **Navigation:**In some few cases, marine vessels accidentally crush onto stones in water, peeling or breaking then into pieces. This leads to rock disintegration, a typical form of weathering.
- **Transport:**Vibrations from machinery, traffic, weight loading, stockpiling of rock or ore from waste piles and from buildings and other structures loosen the soil and make it prone to soil erosion and weathering.
- **Construction of dams and canals:**Construction of dams, such as theMteradam in Tanzania and canals such as the Suez Canal in Egypt, involves removing a large junk of rock. This breaks up the soil, leading to weathering and soil erosion.
- **Warfare:**The use of atomic bombs and other heavy weapons in war leads to destruction of the soil.During times of war, heavy and destructive weapons such as atomic bombs, shells, rockets and grenades are dropped or fired towards the enemy. When these weapons fall on land,

they detonate and blow up a large mass of the earth, causing weathering and erosion.Military equipment such as tanks, heavy trucks and caterpillars break up rocks over which they pass. At the same time, they loosen the soil and carry away some of it as they move along.

The Causes and Effects of Artificial Forces

Describe causes and effects of artificial forces

Apart from the effects caused by natural forces that affect the earth, man-made (artificial) forces have an effect of creating artificial landforms and features on the earth's surface. These include the following features:

1. Man-made lakes such as LakeCahoraBassain Mozambique, Lake Volta in Ghana, LakeKaribain Zambia (the world's largest artificial lake and reservoir by volume) and Lake Nasser in Egypt.
2. Man-made rivers in the form of canals such as Suez and Panama Canals.
3. Wells and boreholes
4. Roads, harbours, railways, airports, bridges, etc.

SOIL

Soil Formation

Soil

Define soil

The term soil is derived from the latin word "solum" which means ground. Therefore can be defined as the uppermost surface layer of loose or unconsolidated material which overlies the crystal rocks and on which plants grow.ORSoil is the natural body of mineral, organic and nutrient constituents which result from the interaction of the country rock with the environmental factors of climate, topography, plant and animal life.

Factors for Soil Formation

Describe factors for soil formation

Soil formation (pedogenesis) is principally initiated by the weathering of the parent rocks. Weathering can be chemical or mechanical. But the type of soil and rate of soil formation depend on a number of interacting factors (interplay of factors) in a particular environment, hence soil is the product of its own environment.

Soil continuously changes. The changes are generally slow but in certain circumstances, especially where human activities are involved, the changes can be rapid. The study of soil involves understanding the factors responsible for its formation. These factors are parent materials, climate, living organisms, topography and time:

1. **Parent Material (Rock):**This is the most important factor in soil formation since it determines the type of soil formed, soil colour, soil depth, the rate of soil formation, soil structure, soil texture, porosity and mineralogical composition or its fertility. It also influence soil maturity, such that if the rock is hard, It takes a long time for soil to mature while the rate of maturity is fast where the parent rock is soft. The fast maturity of soils, formed from soft rock is due to the fast rate of weathering process. Mature soil are deep and productive while immature soils are shallow and less productive.

2. **Living Organisms (Biotic):**These include the influence of plants, animals as well as human beings. Vegetation influence both chemical and mechanical weathering leading to the development of the soil profile. Also vegetation contribute to soil fertility by adding humus in the soil after dying and decomposing. Some plant roots (legumes) have nodules with bacteria that fix nitrogen into the soil. Plants roots modify the soil by increasing porosity, improving the soil depth and aeration.Micro - organisms are active in decomposition of the organic matter to form humus. Burrowing animals facilitate weathering process by loosening the soil particles. Lastly man's activities like cultivation, break up the rocks into smaller fragments. Man also adds humus to the soil which contribute to soil profile development.

3. **Climate**: The important variables under climate include temperature, precipitation and wind. Temperature affects the rate of decomposition of organic matter, it contribute to soil profile development through weathering as well as the rate soil development. Where there is high temperature, soil development tends to be fast due to the fast rate of weathering, and where temperature is low, there is also a low rate of soil development due to the low rate of weathering process. Precipitation also affects soil profile development. In some areas soil is eroded, leading to soil profile destruction while in areas deposition leads to positive soil development due to accumulation of weathered materials and organic matter. Rainfall adds moisture, which facilitate both chemical and mechanical weathering and hence soil profile development. Wind has both positive and negative impacts on soil profile development. It can erode the soil through deflation leading to soil degradation or it can deposit some materials at the edge of the desert to form the soil called loess.

4. **Relief (topography):**The role of topography in soil formation is mostly indirect. It influences climate and vegetation. It controls the rate and nature of weathering, removal and deposition (redistribution) of the soil parent materials. The most important aspects of topography as a factor of soil formation are slopes; altitudes, aspects and location along the slope. Soil erosion is rapid on steep slopes and less on gentle slopes.Therefore on steep slopes soil profiles are shallow while on gentle slopes they are expected to be deeper. Also leaching are more pronounced in the upper-slope areas leading among other things to well-drained soil.Altitude affects soil mainly through the action of climate and vegetation. Altitude lowers temperature and increases precipitation. Thus leads to zonation of climate, vegetation and soil along hillsides. In terms of aspects, the side that receive more sunshine tends to have well developed soil than the

side which receives low amount of sunshine since isolation accelerate plants growth and the weathering process.

5. **Time**: The time factor may be associated with the age of the country rock especially those on which soil have been directly formed. It may also be associated with the duration of the operation of soil formation process, that is whether the soil has sufficient time to form mature profiles and associated characteristics or not. When soil formation has taken a long and enough time, soil tends to be more mature, they are usually deep and well developed.

The Importance of Soil

Assess the importance of Soil

The following is importance of soil formation

1. **Medium for plant growth.**Soil is where most plants grow. Soil provides anchorage for the plants as well as protection of roots from damage.It is where or a medium through which water, air and nutrients are made available to plants. The well-aerated soil facilitates the absorption of water and nutrients from the soil by plants.
2. **Soil support animal life.**As soil support plant life it also support animal life because plants are the source of foods to animals and this is most for herbivores. Also some animals eat soil as food in form of salt licks for example pregnant women who lack some minerals in their bodies.
3. **Soil provide habitat for living organisms.**In the soil there are some animals living there example burrowing animals like rodents, earthworms and termites
4. **Provide sites for agricultural activities.**The fertile soil promotes agriculture activities, both animal husbandry and crop cultivation. This is because soil supports the growth of pasture for animals.
5. **Provide settlement.**Soil influences distribution of settlement for example the areas with good fertile soil are densely populated compared to the areas with poor soil.
6. **Soil provide building materials**Soil is used in making bricks, tiles and white wash. All these materials are used in building houses, bridges etc. Also soil is used directly in road construction

7. **Source of minerals**There are some minerals found in soil that can be extracted for commercial purposes. Also it is used to manufacture fertilizers as it contain minerals for example the fertilizers that contain phosphate e.g. In Minjingu (Manyara) region.

8. **It provides raw materials for pottery and ceramics.**Soil is used in making pots and these help to provide income to those who engage in this activity.

Soil Composition and Properties

Soil Composition and Properties

Illustrate soil composition and properties

Soil is made up of the following components

- Organic matter (humus)
- Inorganic matters (minerals)
- Soil water and soil air

Organic matter (humus)

This form 5% of the total volume and is made up plant and animal remains. Humus is formed as a result of decomposition of animal/plants remains.

Importance of humus

- It improves the structure of the soil
- It regulates the soil temperature.
- It leads to higher agricultural production.

Inorganic matter (minerals)

This forms 45% of total volume and is made up of minerals from the parent rock. Minerals constitute some nutrients needed by plants for growth.

Soil water

This forms 25% of the total volume. It is one of the important soil constituents. It is derived essentially from rainfall especially from infiltration; Too much water in the soil leads to leaching and hence loss of nutrients.

Importance of water to soil

- It regulate the soil temperature
- It control the chemical process like chemical weathering as well as mechanical weathering
- It helps in the solution and transfer of nutrients in the soil.

Soil Air

This forms 25% of the total volume and constitutes the soil atmosphere from which plants and animals obtain oxygen for their metabolism. Air accelerates oxidation and biological activities and aerated soil lead to good production while poor aerated soil will lead to poor production.

Soil Profile and Characteristics

Soil Profile

Define soil profile

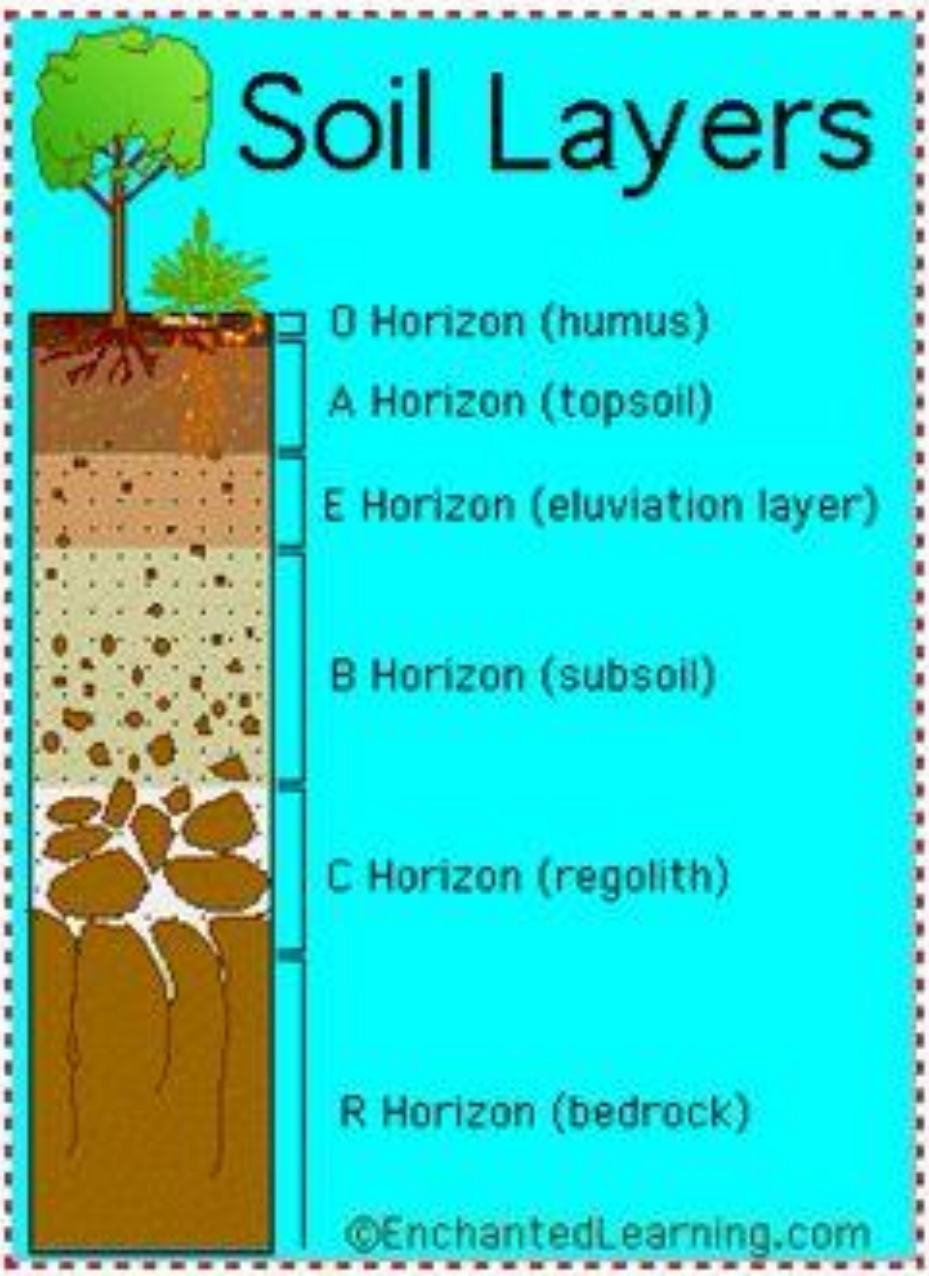
Soil profile is the vertical section of the soil from the surface to the parent rock characterized in distinct layers (horizons), usually of different textures and colours. Ideal soil profile has horizons A, B, C.

Soil Profile and its Characteristics

Illustrate soil profile and its characteristics

Physical properties of the soil include soil profile, soil depth, soil colour, soil texture and soil structure

Chemical properties of the soil includes soil P.H, carbon exchange and leaching.



- A – Horizon – Is the top most layer which include organic matter to form Ao. This horizon varies in colour from place to place example dark to grey. It is also called the zone of eluviation from which the materials are washed down through leaching.

- B – Horizon – Is also called the zone of accumulation or illuviation. In this layer materials washed from the A – horizon are deposited or accumulated. Accumulation of washed down materials lead to formation of another layer called Hard Pan.Horizon A and B are also referred to as Solum (soil) such that A – horizon is the top soil and B - horizon is the sub soil

- C – Horizon is the partially weathered parent rock from which the soil develops. It is underlain by D – Horizon which is a fresh non - weathered parent rock.

Simple Soil Classification

Soil According to Textural Groups

Classify soil according to textural groups

SOIL DEPTH

Soil depth is the variation of soil from place to place due to materials influenced by the nature of the rock as well as duration of the soil forming processes. Soil is shallow especially in steep slopes due to erosion and in areas where the underlying rock is hard. Other places have deep soil due to soft parent rocks.

SOIL COLOUR

Soil colour is determined by the mineralogy composition from which the soil is derived and organic matter content. It varies from one place to another. Soil colour can be used for classification and description of soil of a certain place. The colours are grouped into:

- Dark (Black, grey, dark grey and dark brown)
- Bright (yellow, orange, red, redish brown)
- Light (whitish – grey, white)

Some soil can have one colour throughout like red earths and yellow brown.

SOIL TEXTURE

This refers to the degree of coarseness or fineness of the soil materials especially soil mineral particles. It can also be referred to as variation in the particle size.According to soil texture, soil can be classified as

1. Course sand 2 to 0.2 mm diameter

2. Fine sand 0.2 to 0.02 mm diameter
3. Silt 0.02 to 0.00 mm diameter
4. Clay less than 0.002 mm
5. Loan soil i.e. mixture of sand, clay and silt

IMPORTANCE OF SOIL TEXTURE

1. It influences the soil porosity, permeability, compaction, and structure
2. It influences plant growth
3. It influence cultivation during the agricultural activities
4. It influences soil resistance against erosion
5. It influences soil fertility

SOIL TEMPERATURE

Soil has certain degree of temperature and this tend to vary from place to place due to the variation in the climatic conditions. In cold areas like Tundra regions soil is also cold this is due to the small amount of insolation received there. In tropical areas soil are warm due to high intensity of insolation heating the surface.

IMPORTANCE OF SOIL TEMPERATURE

It controls biochemical and chemical processes especially the decomposition of organic matter and plant growth.

- It determines the existence of micro- organisms in a certain area.
- It controls the amount of moisture in the soil

SOIL POROSITY

This refers to the total volume of pores or spaces between particles of the soil materials in undisturbed soil.

Soil porosity is influenced by

- Soil texture – The finer the particles the greater will be the total surface area. Hence the soil with fine particles like clay has greater porosity.
- Structure of the soil also influences permeability.

SOIL STRUCTURE

This refers to the arrangement of soil particles into aggregate compound particles. Individual undisturbed soil is called ped. The aggregation of soil particles produce peds of different shapes and sizes when aggregation is absent as in loose sand soil, the soil is described as structure less. Strongest of the soil is influenced by its organic matter.

IMPORTANCE OF SOIL STRUCTURE

- It determines water retention capacity and aeration
- It is an indicator of soil fertility or sustainability for agricultural activities
- It influences plant growth by influencing the root penetration and water retention

CHEMICAL PROPERTIES

SOIL REACTION (PH)

Soil reaction is the term used to describe the degree of acidity and alkalinity in the soil and it results mainly from climate. This degree of acidity and alkalinity in the soil is expressed in the PH.

PH is the value which is measured in terms of the hydrogen ion concentration.PH scale runs from 1 to 14.The PH 7 is neutral.Any condition below 7 is acidic and any condition above 7 is alkaline.

IMPORTANCE OF SOIL PH

- It helps in determining the selection of crops and agricultural distribution
- It affects plant growth such that where there is too much acidity there will be poor plant growth. This is because the increase of acidity leads to the increase in leaching which affects soil structure.

LEACHING

This is another chemical property of soil referring to the process in which nutrients are washed down in solution from the top- soil layer. During leaching process the bases are washed down leading to concentration of hydrogen ions which in turn cause the increased acidity in the top soil.Leaching is very effective in wet conditions.

SIMPLE HYPOTHETICAL PROFILE FOR MATURE SOIL

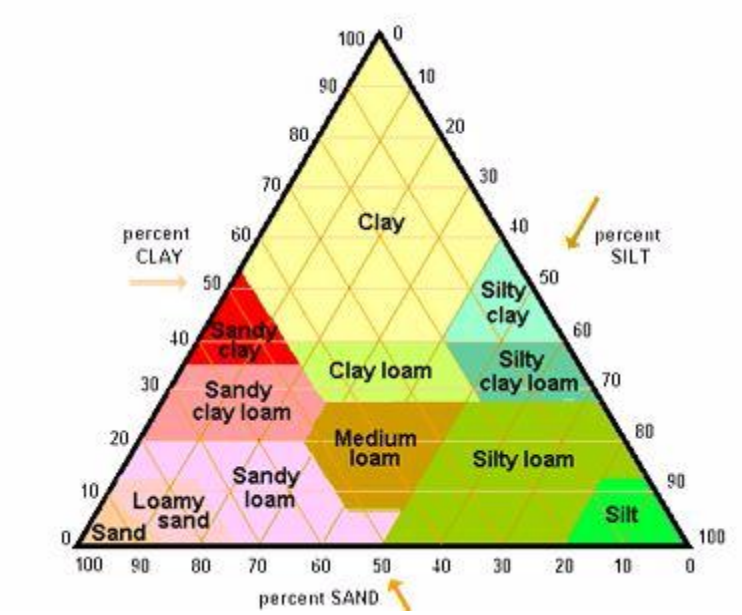
The soil profile varies from one place to another depending on the variation in environment conditions.

For example under deciduous forest, soil with little organic matter can be produced (brown earth or brown forest soil) while in mid latitude grasslands deep black earth soil (chernozem) is formed.Chernozem has a lot of organic matter. In the desert area the soil profile usually lack the Ao horizon due to scarcity or absence of vegetation.

SIMPLE SOIL CLASSIFICATION

Soil classification refers to the grouping of soils according to specific characteristics, such as properties or factors like climate also soil can be classified according to the age, texture and colour. One common classification is that based on texture.

According to the soil texture triangle, there are three main textures namely sand, silt and clay. This is based on the size of their particles as discussed earlier. The percentage content of each one of these determines the type of soil according to texture. Note that sandy soil have sand content of over 45%, clay soil have above 27% while silt soil have silt content of above 40%.



Soil Texture Triangle

- **SAND:**This soil consists mainly of coarse and fine sand and contain very little amount of clay such that it is not sticky when wet and is loose when dry, percentage of sand is above 85, that of clay is up to 10 and silt is up to 15. When such soil is rubbed, it does not leave any film on the fingers.
- **LOAMY SAND:**This consist most of sand but with sufficient clay such that it gives it a slight plastic quality when it is very moist. When it is rubbed between fingers it leaves a slight film of fine material, sand particles account for 70% to 90%, clay up to 15% and silt up to 30%
- **SANDY LOAM:**This soil has high percentage of sand between 43% and 85% with clay content of up to 20% and silt up to 50%. It moulds easily when it is sufficiently moist but does not stick easily to the fingers.
- **LOAM:**In this soil, sand and silt dominate with an average of 40% each while clay account for about 20% on average. It moulds easily when it has sufficient moisture and does stick to the fingers to some extent.
- **SILT LOAM:**It has a high percentage of silt of between 50% and 87%, sand between 13% and 50% and clay up to 27%. It is moderately plastic and not very sticky it has a smooth soapy feeling due to high content of silt.
- **SAND CLAY LOAM:**This has over 45% sand, up to 28% silt and clay between 20% and 35%. It can be a bit sticky because of the clay content but quite porous because of the sand.

- **CLAY LOAM:**Sand content between 20% and 45% silt between 15% and 53% clay between 27% and 40%. This one has sticky distinction when moist because of clay.
- **SILT CLAY LOAM:**The amount of sand is between 27% and 60%, silt between 40% and 78% and clay between 27% and 40%. The high silt content makes it smooth and has a soapy feeling. It is less sticky than clay loam or silt clay.
- **SILT:**This have over 80% silt particles, up to 20% sand and less than 12% clay. It is predominantly smooth and has a typical soapy feeling of silt.
- **SANDY CLAY:**Sand between 45% and 65%, silt up to 20% and clay between 35% and 55%. In the presence of sufficient moisture this soil is plastic and sticky clay and sand are dominant.
- **CLAY:**The proportion of sand goes up to 45%, while that of silt is up to 40% clay account for above 40%. The soil is sticky when moist and has a plastic feel. It can be rolled into threads when moist and can be moulded into different shapes. And can retain fingerprints.
- **SILT CLAY:**Sand up to 20%, silt between 40% and 60% and clay between 40% and 60%. This soil is composed of almost fine particles throughout. It is smooth and has to some extent the soapy feel of silt but has a degree of stickiness because of the high proportion of clay.

Soil Erosion

Soil Erosion

Define soil erosion

In this subtopic there are various concepts to be discussed, these are definition of the term, agents of soil erosion and how they work, types of soil erosion and its effects on social and economic activities. Also, demonstrating ways of controlling soil erosion through the application of various conservation techniques.

Soil erosion is the wearing away, detachment and removal of soil materials from one place to another place through agents like water, wind and ice.

How Agents of Soil Erosion Work

Examine how agents of soil erosion work

There are several agents of soil erosion these are water, wind and ice.

WATER

Water is the most important agent of soil erosion , the erosion by water involves the following:

- **Splash erosion**caused by moving water from rain, this tends to remove some of the materials from one place to another.
- **Sheer erosion**which involves the removal of the uniform cover of the soil by surface run-off on gentle slopes.
- **Rills erosion**that leads to the formation of small channels called rills on the surface.
- **Gully erosion,**that leads to the formation of deep troughs called gullies due to severe under cutting
- **River erosion,**takes place in the specific Chanel called river valley

WIND

Wind is another agent of soil erosion. It takes place in arid and semi-arid or where soil is loose. The soil in such areas is dry, loose and unprotected because of the scarcity of vegetation. It is turned into dust which is then blown away by wind.

Types and Effects of Erosion to Social and Economic Activities

Describe types and effects of erosion to social and economic activities

There are main two types of soil erosion which are normal geological erosion and accelerated soil erosion

NORMAL GEOLOGICAL EROSION

Is the wide spread type of erosion that occurs wherever there is a natural flow of energy and matter on the earth's surface without man's influence. It is fortunately very slow and so not normally injurious to the soil cover of the world.

ACCELERATED SOIL EROSION

Is the type of erosion associated with man's activities (man included). It is spectacular (very destructive) therefore it has attracted man's attention. Its side effects include physical loss arising from the reduced crop yield and total crop failure and or wasted efforts and money spent on unsuccessful soil conservation projects.

EFFECTS OF SOIL EROSION

Soil erosion leads to the followings effects both socially and economically:

- Pollution of water bodies due to the introduction of materials eroded from the surrounding areas.
- Loss of fertility which in turn causes the reduction in yields or total crop failure
- Migration of people from areas affected to the areas which have not been affected by erosion.
- Over flooding of the rivers as a result of the creation of the small channels leading to the river system.
- Deforestation as a result of the death of plants due to the loss of soil
- Loss of habitat as a result of deforestation caused by the loss of soil
- Soil erosion can lead and accelerate rock weathering by exposing the underlying rock to the weathering agents like temperature
- It leads to the cost incurred in during the process of conserving the soil, which has been eroded.
- Soil erosion can destroy transport and communication systems like roads, railway lines and telephone posts
- It can lead to the destruction of houses, rendering people homeless.

Population Growth and Rate of Soil Erosion on the Quality of Life

Relate population growth and rate of soil erosion on the quality of life

As discussed above we can see that soil erosion can affect the quality of life of the people positively and negatively.

- When the region is severely affected by the soil erosion, where crop production is impeded, when useful soils are carried away, the region experiences shortage of food. This causes famine and malnutrition. With inadequate nutrition child mortality rate goes up and population growth is impeded.

- When the foundation of existing buildings and roads are eroded. Accessibility to areas is made difficult. Such areas are isolated in terms of social services such as hospitals and education. The general health and welfare of the people become poor leading to increase in mortality and lowering of population.

- When life becomes unbearable in the rural areas because of severe soil erosion, able-bodied persons especially men migrate to urban areas to other better areas in search of employment. This reduce population in the affected areas as well as the required man power to develop the areas.

The ways of Controlling Soil Erosion through the Application of Various Conservation Techniques

Demonstrate ways of controlling soil erosion through the application of various conservation techniques

The following are the some of the central measures that can be taken to control erosion:

- **Afforestation and Reforestation:**Afforestation is the planting of trees where no forest has been known to exist.Reforestation is the planting of trees on land that previously had a forest.
- **Control of bush fires:**When open grassland are burnt the soil is directly exposed to agents of erosion.
- **Controlled open grazing:**Overgrazing which is another cause of soil erosion should be avoided by mulching the number of livestock kept on any piece of land.
- **Erecting brushwood barriers:**On land where gullies have developed, barriers of brushwood or even stone walls can be constructed across the gullies to help trap the soil.
- **Construction of cut-off drains:**Cutoff drains are open trenches which are dug across the slope and soil is heaped on their down – slope sides to form a kind of ridges. These drains prevent large amount of water that might have resulted in formation of rill, gully and sheet erosion from down the slope.

- **Constructing of dams and weirs:**These are structure that are built across river's valley for the purpose of controlling a river flow or for retaining water in a large reservoir within the valley. They may be made of earth's (earth dam) and stone (rock fill dam).
- **Use of artificial waterways:**An artificial waterway is a small channel that is constructed down a slope and into which surface run-off collects. Normally water from cut-off drains as well as from terraces should be discharged into rivers or into non-erodible areas such as stony grounds.

ELEMENTARY SURVEY AND MAP

Meaning and Types of Survey

Simple Land Survey

Explain the meaning of simple land survey

Surveying is the science of measuring and record distances, angles and heights on the Earth's surface to obtain data from which accurate plans and maps are made.

Surveying is also the art and science of making or taking measurements both linear and angular on the Earth's surface at different positions for the purpose of producing a plan or map.

*Angular measurement*means measuring the distance from a given reference point to an observed object. The distance is measured in a clockwise direction from North.

*Linear measurement*is the distance measured along the surface of the ground such as a horizontal distance.

Purpose of surveying

1. To prepare maps and plans
2. To calculate areas and distance

Types of Simple Land Survey

Explain the types of simple land survey

Surveying can becategorisedinto various types or branches depending on its purpose, function and nature. Thetypes or branches include:

a. **Topographical survey:**This kind of survey is carried out for the purpose of preparing topographical maps.

b. **Geodetic survey:**This kind of survey is carried out with the aim of knowing the Earth's shape and size (the Earth's configuration)

c. **Cadastral survey:**This kind of survey is conducted with the aim of preparing a legal document such as house plans, town or city boundaries, etc. It is mainly used for ownership purposes.

d. **Engineering surveys:**This kind of survey is conducted for the building and construction layout of railways, bridges and roads.

e. **Geological survey:**This kind of survey is conducted with the aim of knowing the distribution of rocks and minerals under the Earth's surface.

f. **Topographical surveying:**This kind of survey is carried out for the purpose of preparing topographical maps.Topographical maps are those maps whose contents include both man-made features such as linear features (roads, railways, telephone lines, water systems, and electricity poles) and natural features such as rivers, oceans, mountains, etc.The topographical survey has the following ways or methods of conducting the survey: 1.*Chain*or*tape*survey; 2. The*prismatic compass*survey; 3. The*plane table*survey; 4. The technique of levelling.

Chain Survey

Chain/Tape Survey

Describe chain/tape survey

It is a method of Surveying in which no angles are measured but only linear measurement is taken in the field by using a chain or tape measure.It measures a series of straight lines on the ground with a chain or tape measure and all fixed points relative to the*line of traverse*either by right angles (*offsets*) or*tie lines*.

Types of Equipment used in Chain/Tape Surveying

Explain different types of equipment used in chain/tape surveying

Chain

- The*chain*is made up of steel wire which is divided into*links*and*togs*(rings) to facilitate folding.
- It is sometimes used as a unit of measurement
- It has brass handles at both ends for easy handling. The*link*is 0.2m or 200mm in diameter.

- The length is 20m or 30m.

Tape

- *Steel tape*
- *Linear tape*

A*tape*is made from fiberglass or a steel strip and is 10m, 20m or 30m in length graduated in 10mm divisions and numbered at each 100mm (10) divisions.It is used for measuring short distances

Ranging poles

*Ranging poles*are made up of wood or light metal and measure about 2m long at the top. The equipment has steel shades on its legs so it can be stuck into the ground. Ranging poles are painted red and white so that they can be easily seen even from a distance. They are used for making stations.

Arrows

*Arrows*are made of steel wire of diameter 4mm and their ends are bent into a circle where red cloth is tied to facilitate visibility. They are used for showing points on the ground.They are also used for counting the number of chains while measuring a chain line.

Pegs

*Pegs*are made of wood 40mm square by 50cm long and are used for permanently marking positions during survey

Surveyors' band

The*surveyor's band*is made of a steel strip which is rolled into a metal frame with a winding handle. It is 30m, 50m or 100m long. Is used in projects where more accuracy measurement is required.

Cross staff

The*cross staff*is made of metal or wood with*eye slips*at right angles and is used to measure right angles from the line of traverse

Notebook

*Notebooks*are used during field work to record data obtained. The notebook should be of good quality and 150mm x100mm in size

A hard pencil and a rubber

Hard*pencils*are used for drawing in the field and a*rubber*is used to erase mistakes or errors which are made. A pencil should be HB or HHB.

Chain/Tape Surveying Activities at School Level

Practice chain/tape surveying activities at school level

Methods and procedures involved in chain survey

- A survey team involves three people, the*leading chainman*or*leader*, the*follower*and the*booker*.
- The chain is thrown to extend it and disentangle any knots
- The leader takes ten arrows and a ranging rod, and the follower takes a ranging rod
- The follower erects his ranging rod/pole at the first*base point*and places a brass handle of the chain against the ranging rod.
- A leader straightens the chain and inserts an arrow at end of the brass handle. Offsets and tie lines can now be taken.
- The leader drags the chain so that the follower's end is on the leader's arrow; the follower moves to another point and places his ranging pole behind the arrow. This procedure is then repeated.

The importance and usefulness of chain surveying

1. It is suitable for small areas of fairly open ground.

2. It is used to fill in details on a map whose large features have been surveyed by other methods.

3. It is used in mapping small areas of flat or near-flat ground and associated objects, for example paths, roads and railways.

4. It is used in adding detail to existing plans or large maps.

Advantages of chain surveying

1. It is the simplest method of surveying through the old method.

2. It is suitable for surveying clear areas.

3. It tends not to attract attention.

4. It is suitable for surveying a flat surface on the Earth's surface, for example a school compound.

5. It can be read easily and quickly.

6. It can withstand wear and tear.

7. It can be easily repaired or rectified in the field.

Disadvantages of chain survey

1. It is a slow method of surveying.

2. It is the oldest method of surveying

3. It is not suitable for surveying large areas.

4. More difficult areas cannot be chain surveyed.

5. Errors may be encountered due to the use of many chains and other reasons.

6. It is time consuming.

7. They are heavy and take too much time to open or fold.

8. They become longer or shorter due to continuous use.

9. When the measurement is taken in suspension, the chain sags excessively

The Importance of Survey

Explain the importance of survey

Importance of surveying

1. It help to prepare a topographical map which shows the hills, valleys, rivers, villages, towns, forests, etc. of a country.

2. It helps to prepare a cadastral map showing the boundaries of the fields, houses and other properties.

3. It help to prepare an engineering map which shows the details of engineering works such as roads, railways, reservoirs, irrigation canals, etc.

4. It help to prepare a military map showing the road and railway communications with different parts of a country.

5. It helps to prepare a contour map to determine the capacity of a reservoir and to find the best possible route for roads, railways, etc.

6. It helps to prepare a geological map showing areas including underground resources.

7. It helps to prepare an archaeological map including places ancient relics exist.

MAP READING AND MAP INTERPRETATION

Concept of Map Reading

The Concept of Map and its Importance to Social Economic Activities

Explain the concept of map and its importance to social economic activities

Map reading is the process of identifying features on a map by using symbols and signs or names. This technical work requires certain skills that any map reader must possess.

Map interpretation refers to interpretation of the symbols and signs used on map into ordinary language by indicating the features they represent and draw logical conclusions from the information as represented by the symbols.

Importance of map reading

Map reading is very important to social and economic activities. Maps are drawn for different purposes and once drawn they can serve as databases from which various information can be obtained and used for a myriad of social and economic benefits.

a. Geological maps provide information about the type and distribution of rocks in an area. This knowledge is of great help to builders who can use it to find out where to obtain certain rocks for construction. This knowledge can also be used by mineral prospectors to locate possible areas where they can obtain mineral. The information on soil types can be used by civil engineers to establish the stability of the on which to build roads and other structures.

b. Relief maps provide information to many people in many ways. For example, civil and architectural engineers need to know relief of an area so that they can plan in advance how to overcome relief barriers in their construction plans. It also important to large scale farmers as

they need relief to plan for the extent of farms and also to determine the possibility of mechanization (use various machines in agricultural production).

c. Drainage maps are useful to civil engineers as they can use them to get prior knowledge on how to construct bridges, roads, railways and other infrastructures. It is also useful to agriculture as such maps indicate possible sources of water for irrigation of crops, watering livestock and for other general farm uses.Weather and climate maps are useful especially to people interested in agriculture. They provide information on the kind of crops to be grown and the type of livestock to keep in a certain area.

d. Vegetation maps show the distribution and type of vegetation in a region. This gives a clue on the kind of social and economic activities that can be carried out in an area.

e. Soil maps are very useful to agricultural officers as they can use the information about soil types to advise farmers on the type of fertilizers to use, soil requirements and proper soil management practices.

f. Maps provide information on the relationship between phenomena or events. For example, maps showing the location of volcanoes also indicate the connection between volcanoes and earthquakes. Earthquakes are very common in areas with numerous volcanoes. This will give people crucial information on the possibility of occurring vulcanicity so that they can avoid setting settlements on such hazardous areas.

g. Maps provide background information as compared to present work. For example, maps showing distribution of forests in the past may be compared to the present maps to draw conclusion on the extent of vegetation change through deforestation, afforestation or reforestation.

h. Maps provide valuable information for statistical analysis. Therefore, they are very useful to researchers and any field of study.

Essentials of a Map

Identify essentials of a map

Essentials of a map are the necessary prerequisites that a map should have. All maps in general require the following qualities or essentials:

1. ***Title*** – The most basic component of a map is its title. The title should refer to everything the map covers. It could be a basic name of a country, such as "Tanzania," or it could be more extensive, such as "Water Tables in the Western Saharan Desert." The title should clearly state what the cartographer's intentions and goals are; it should be specific, and it should not include irrelevant information.

2. ***Scale*** – shows the relationship between map distance and ground distance. For example, the scale 1:100000, indicates that one centimetre on the map represents 100,000 cm (1 km) on the ground.There are three types of scales: (a) Statement scale – this is a map scale stated in words or it is a verbal scale. The words "one centimetre to one kilometre" is an example of a statement scale. (b) Representative fraction – this is a means of expressing the relative size of a map or drawing by a fraction or ratio e.g. or 1:100. This means that one unit on the map represents one hundred units on the ground. (c) Linear scale/graph scale – this is a line showing the distance on the map that represents a given distance on the ground. A linear scale is divided into two parts: Primary section – it is placed on the left-hand side of the linear scale. Secondary section – this is placed on the right-hand side of the linear scale.

3. ***Key*** – every map must have a key. The key is a vital tool in understanding and interpreting the map. The key should explain every feature or symbol contained on the map. It should reveal what every marking means and sometimes provide additional information. For example, a city may be represented by a large black dot of a certain size on a map, and the key may explain that this represents a city with a population greater than one million people.

4. ***Margin/boundary/frame*** – it is essential that all maps be enclosed in a frame for neatness.

5. ***North direction/compass orientation*** – this is the direction towards the North in those maps drawn to grid system. All maps must have a compass orientation. Because the primary purpose of a map is to provide and insight into directions, a map has to be able to show which way is which on a compass. Most maps have "North" at the top and "South" at the bottom, but all maps should have an official representation of the compass orientation.

6. ***Date*** – to give context to a map, the date of publication should be present. As maps are continually updated with additional information and improved accuracy, it is important to know the time when your map was published. For example, viewing a map of Tanzania published in 1980 might still be useful but will not be as accurate as one published in 2014.

Reading and Interpreting Topographical Maps

Features on a Map

Recognise features on a map

Topographical maps are types of maps which describe the physical (natural) and man-made (artificial or cultural) features of a given area. The physical features include relief, vegetation, and drainage, among others. Some of the cultural or artificial features are roads, railways, cities, towns, dams, schools, and many other structures built by man.

Relief features

Relief refers to the physical landscape as shown by the configuration of the surface of the earth that is brought about by landform features. The methods of showing relief in topographical maps include the use of spot heights, trigonometrical stations, contour lines and form lines.

Spot height

This is a point on a map with its exact height above a known level e.g. from the sea level. The position and height of the points have been determined by surveyors. The spot height is marked with a dot followed by the numbers indicating height of the land for example .750. The units of height, whether in metres or feet, are quoted in the key of the map as well as below the linear scale.

Spot heights are useful as a guide to the general relief of the area. The map user can easily determine the high points of the area especially where the area represented on the map is an undulating plain or plateau.

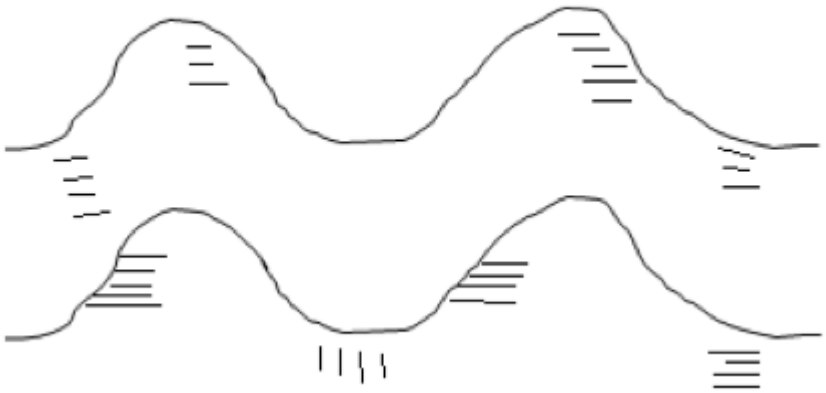
Trigonometric station (point)

This is a point on a map with its exact height fixed usually on a hill top, mountain peak or other visible positions. They are the highest points on any locality. The trigonometrical points are commonly marked by a triangle followed by the numbers indicating the height for example Δ725

On the map, the height of each station is written against a symbol. The units of height are not indicated but can be deduced in the same way as spot heights.

Hill shading

Hill shading is a method of representing relief on a map by shading hills as if light is shinning on them.



Hill shading

Hill shading depicts the shadows that would be cast by high ground if light were shining from a certain direction.

Layer colouring/tinting

Layer tinting/colouring is a method of showing relief by colour. A different colour is used for each band of elevation. Each shade of colour, or band, represents a definite elevation range. The key is printed on the map margin to indicate the elevation range represented by each colour. However, this method does not allow the map user to determine the exact elevation of a specific point—only the range can determined.

Hachures

Hachures are short, broken lines used to show relief. Hachures are sometimes used with contour lines. They do not represent exact elevations, but are mainly used to show large, rocky outcrop areas. Hachures are used extensively on small-scale maps to show mountain ranges, plateaus, and mountain peaks.

Hachures are also used to show the direction and steepness of slopes. The lines are drawn to follow the slope of the land or in the direction in which water would run on them.

Hachures

Contours and form lines

Contour lines, sometimes called isohyepes, isoline or isopleth are lines drawn on a map joining all places with the same height above sea level. The value of each contour line is written on it. They are normally drawn in thick brown colour.

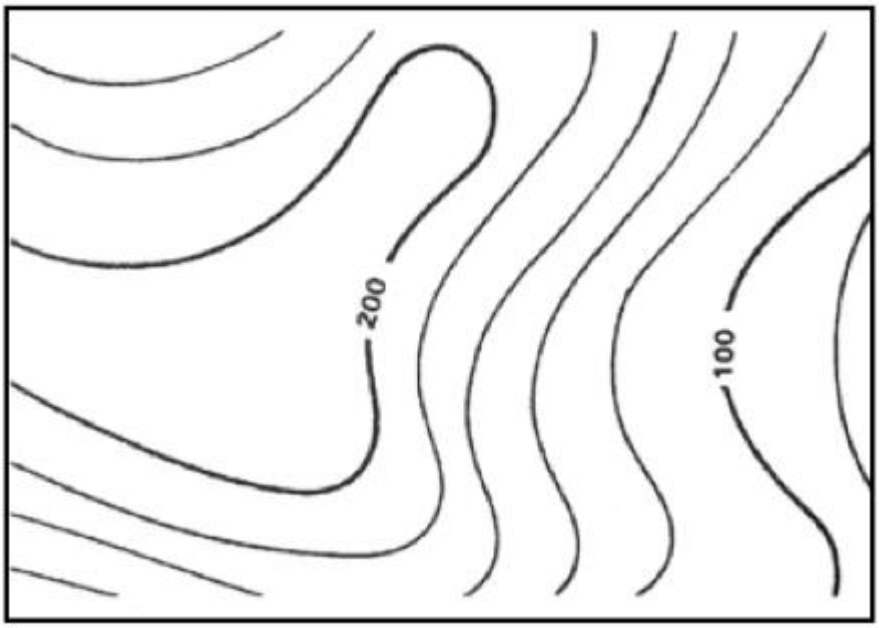
Form lines are lines on a map which join points of approximately the same height above sea level. These are used as "fill-in" lines to show out the nature of the slope (form) of the land and the various landforms, hence the name "form lines". They are drawn by estimating the height of the land with the help of spot heights and trigonometrical stations as well as the contours.

They are usually drawn in thin brown lines and their values are not normally shown on them. Contours and form lines are the main methods of showing relief on topographical maps. For practical purposes, form lines are also regarded as contours. On maps of scale 1:50 000, they are normally drawn in brown colour. Spot heights and trigonometrical stations are also used alongside contours.

Contours do not cross one another for the simple reason that a single point cannot have two different heights. If contours appear on a map to be merging, it is an indication of a very steep slope that is vertical or nearly vertical. The contour of higher value obscures those below it.

The **contour interva**l is the difference in height between any two successive contours. It is also known as the **vertical interval** (V.I.) of the map. On the 1:50 000 maps of East Africa, the contour interval is usually twenty metres (20 m). This information is indicated in the key accompanying each a map and also indicates the units of height used on the particular map.

The contour interval is constant for all areas of a given map. Contours are very useful as they help in identifying various landforms, including type and trend of slope of the land. The shape formed by a collection of contours enables us to identify different types of landforms. The succession of contours enables us to see the changes in relief.



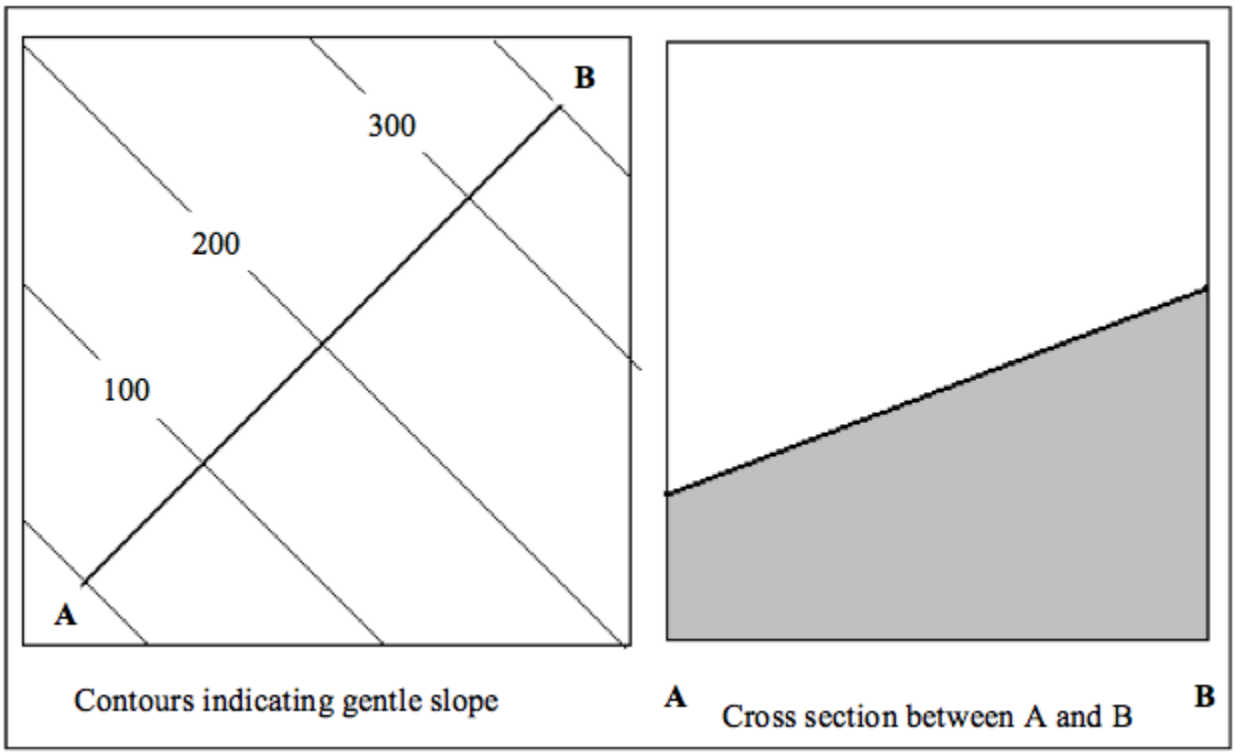
Contour lines showing changes in relief

Slopes

A slope the inclination or slant of the land. This inclination varies considerably, resulting in the following types of slopes:

Gentle slope

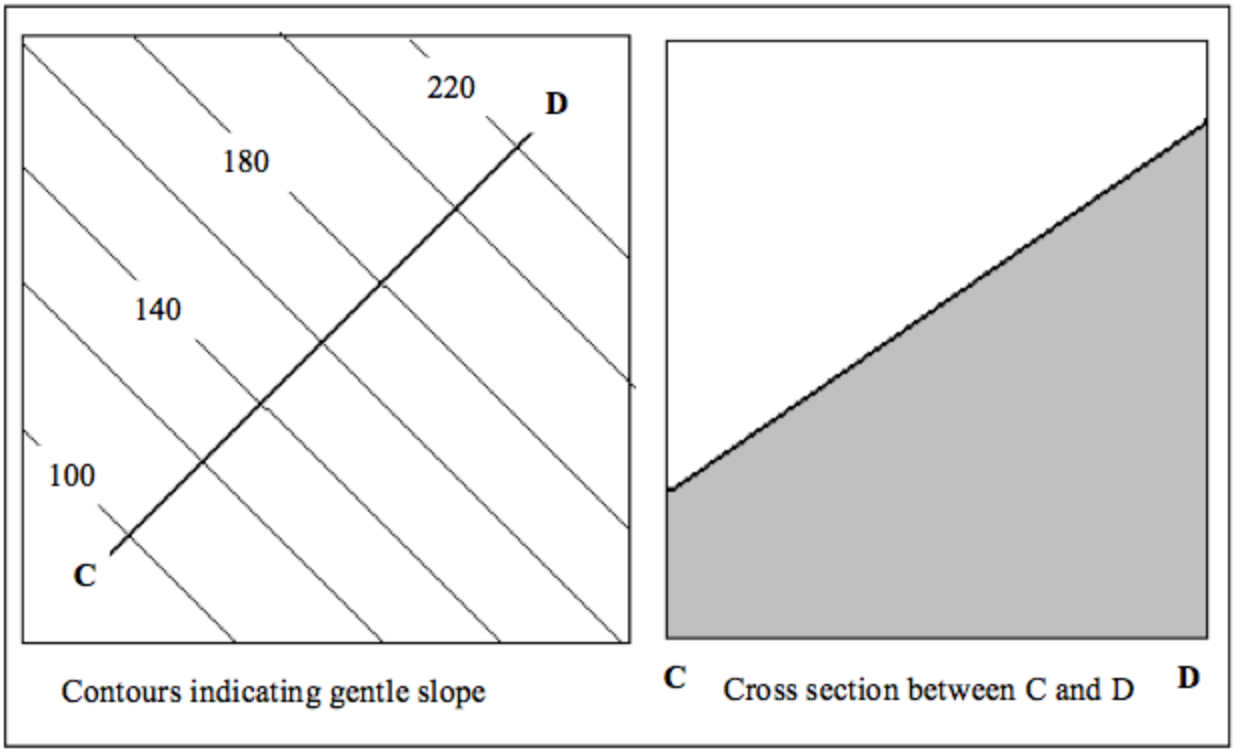
This is shown by contours that are evenly spaced and drawn far apart. On a 1:50 000 topographical map, the space between two successive contours is more than 1.5 cm.



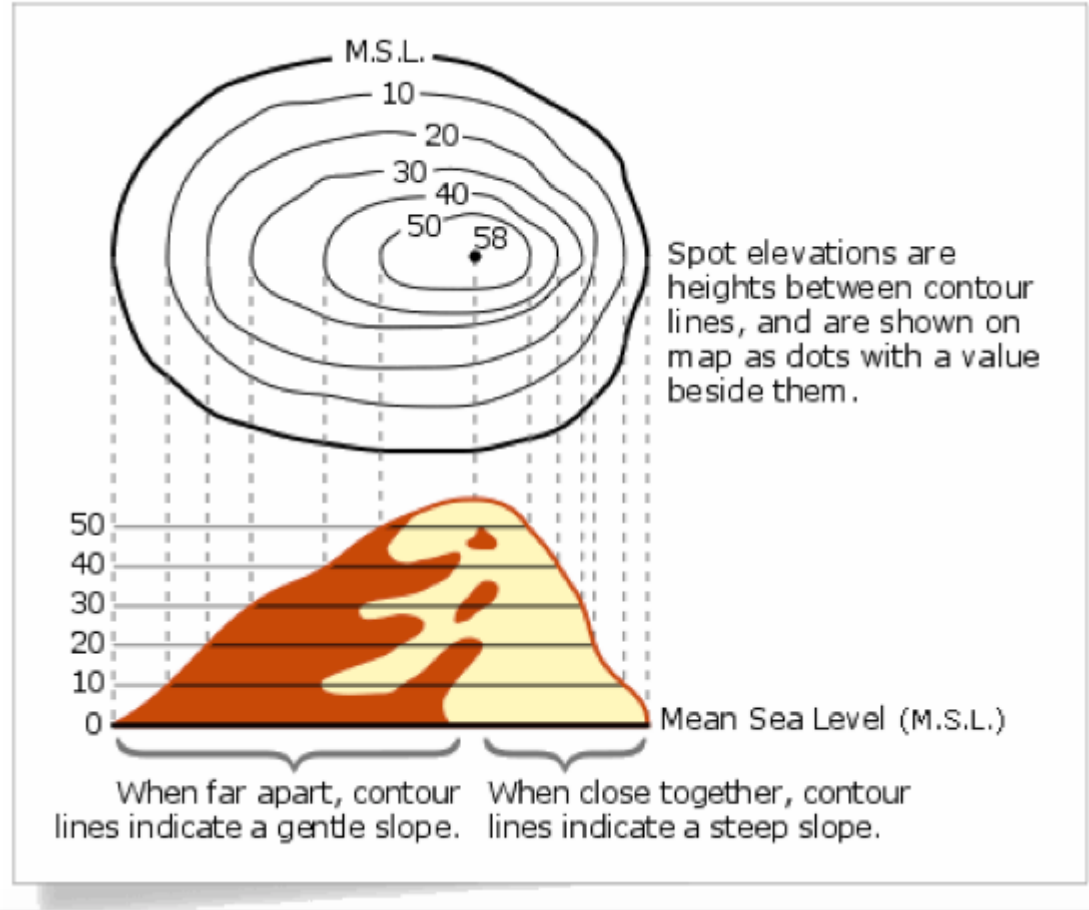
Gentle slope

Steep slope

A steep slope is shown by contours that are drawn very close together. The closer the contours are, the steeper the slope. The space between any two successive contours is less than 1.5 cm.


220
D
180
140
100
C
Contours indicating gentle slope
C
Cross section between C and D
D

Steep slope



Diagrammatic representation of gentle and steep slope

Regular slope

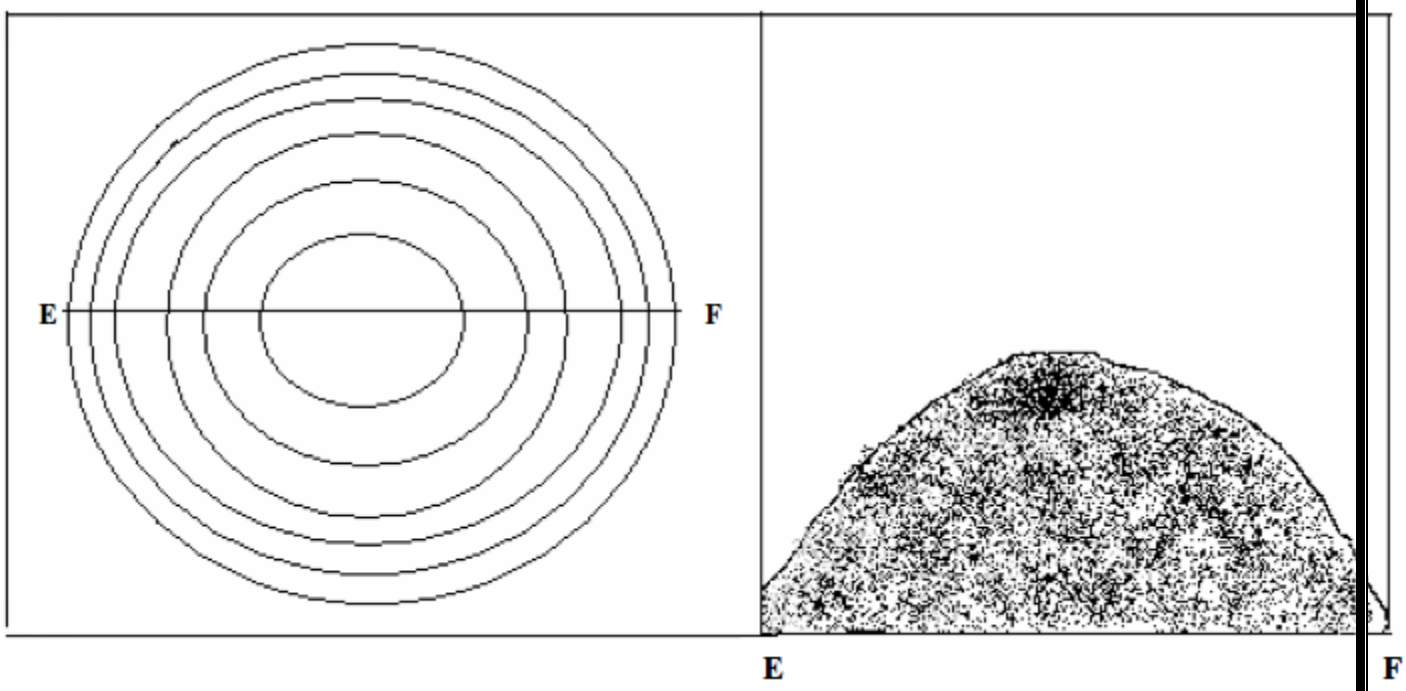
This is an even or a constant slope. It is shown by contours that are evenly spaced, that is at relatively regular intervals. A regular slope can be gentle or steep. The surface of the land would look smooth.

Irregular slope

This is also known as uneven slope. It is indicated by unevenly spaced contours. It too can be gentle or steep. They indicate a rugged landscape.

Convex slope

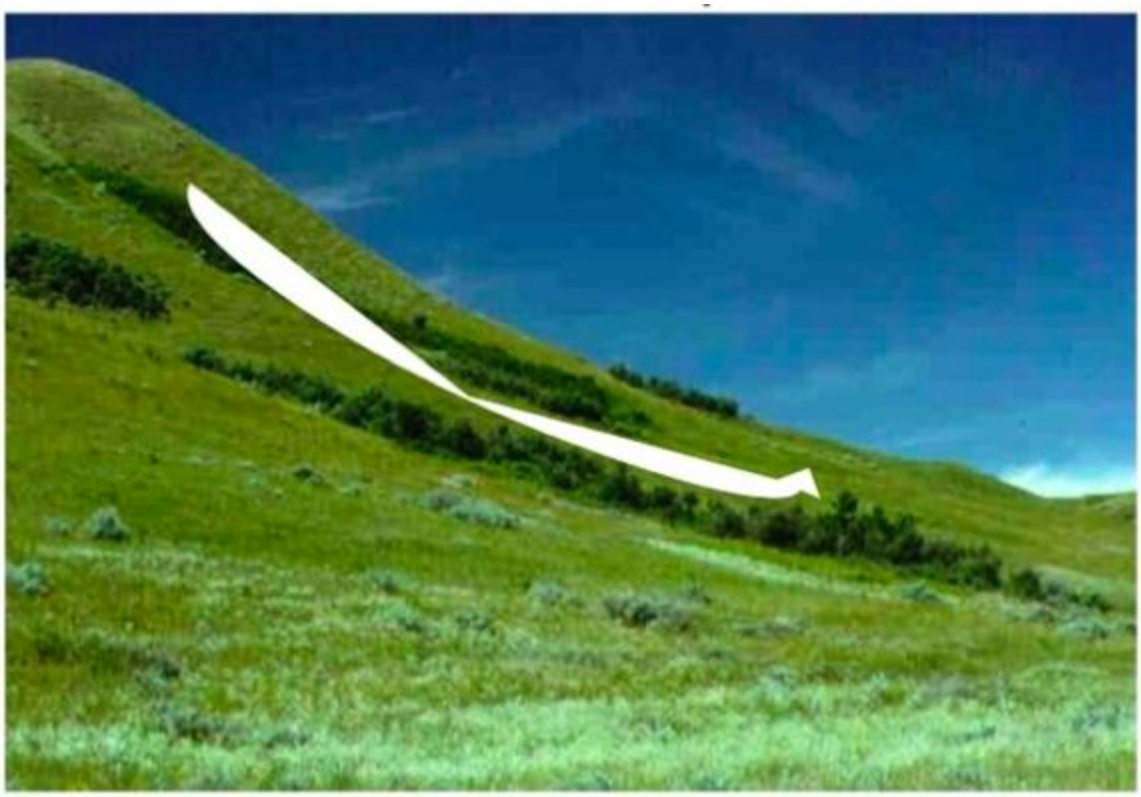
This type of a slope is indicated by contours that are closely packed on the lower slope (indicating steep slope) but become more widely spaced on the upper section of the land (indicating gentle slope). The slope curves outwards like the surface of a convex lens. It is steeper towards the bottom and gentle towards the top.



Convex slope

Concave slope

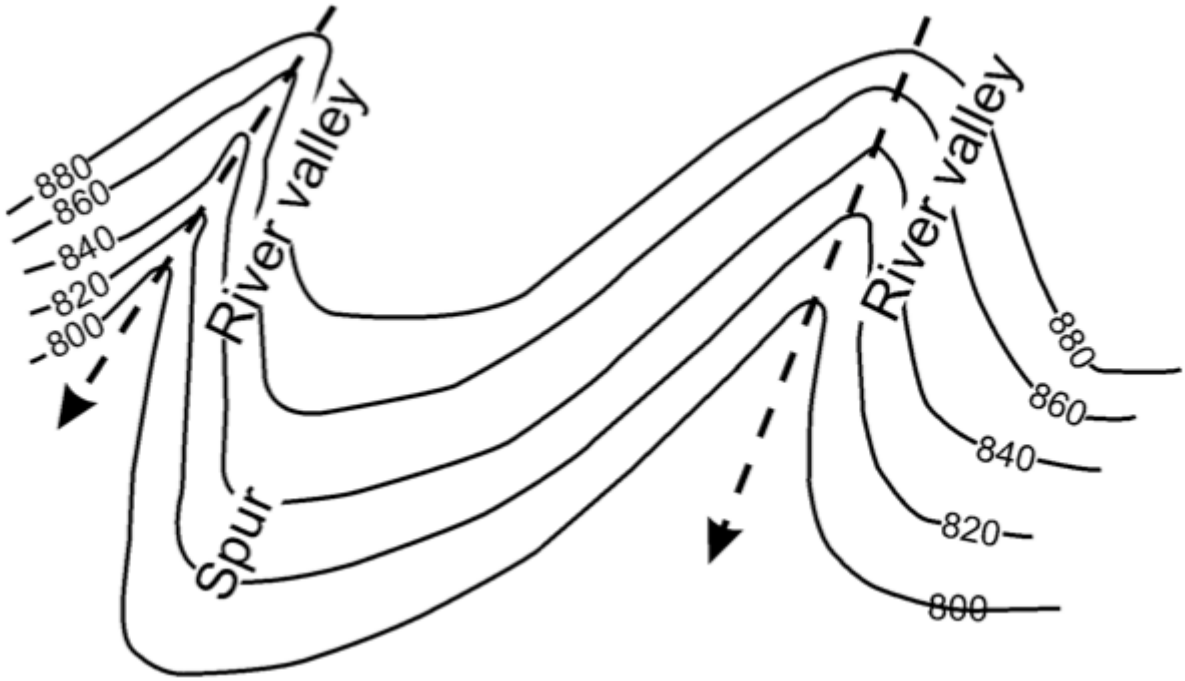
A concave slope is represented by widely spaced contours (indicating gentle slope) on the lower slope and closely packed contours (indicating steep slope) on the upper part of the slope. On this type of slope, the land is steeper on the higher ground and gentler on the lower ground. The slope curves inwards, just the opposite of the convex slope.



Concave slope

Valley

A valley is an elongated depression sloping towards a drainage basin such as a sea, lake or swamp, and which may contain water or may be dry. On a topographical map, the contours indicating a valley form a ‘V-shape’. The apex (sharp end) points towards the higher ground and contours open out towards the lower ground. The pattern of contours also shows valleys at different stages of development. A valley in its youthful stage is shown by contours that are close together. The gap between contours becomes progressively wider as the valley reaches its mature stage and eventually the old stage.



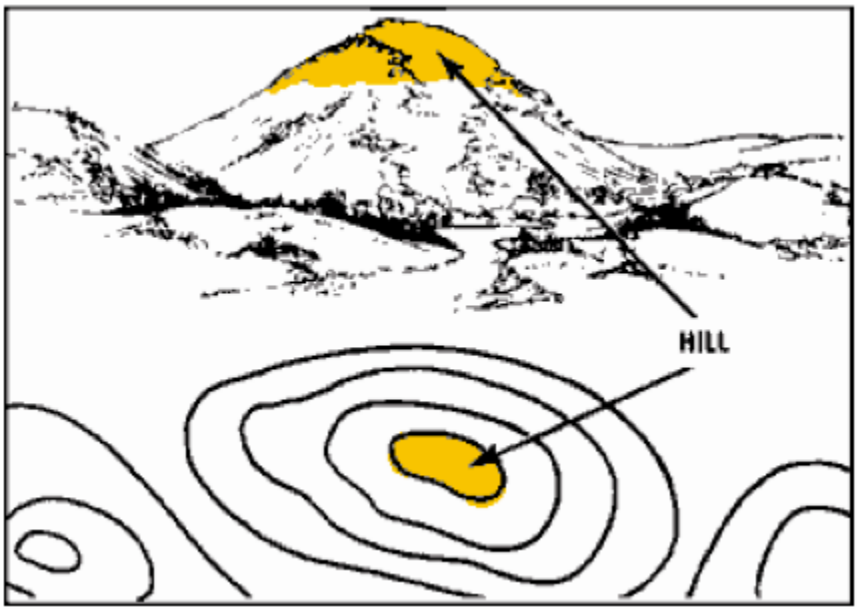
Some valleys may have rivers flowing in them as indicated by arrows in the figure above.

Spur

A spur is also known as salient. It is a prominent projection of raised land from higher ground, such as a hill or mountainside into lower land. Then spurs sometimes interlock, and hence the name interlocking spurs. Spurs are depicted by contours that form a similar pattern to that of valleys. The difference is that in the case of spurs, the apex of the 'V-shape' of the contours points towards the lower ground and the 'V' opens towards the higher ground (see the figure above). By studying the values of the contours, one can tell which the higher ground is and which the lower ground is. But if the values of contours are not provided, the shape of the 'V' alone can suffice to provide this information.

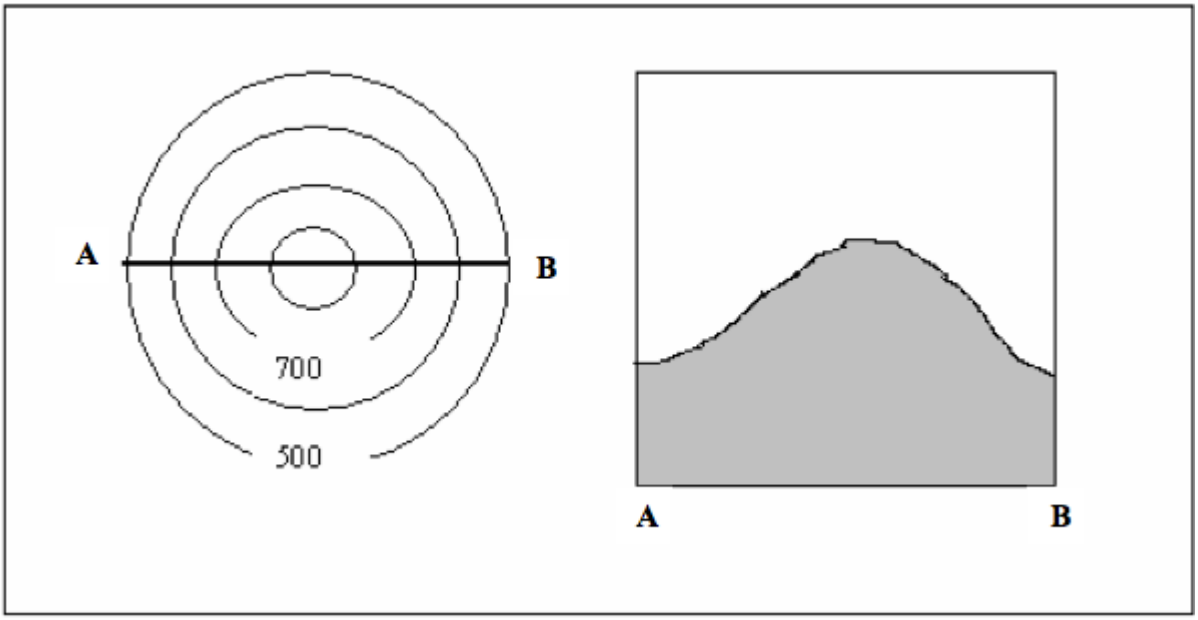
Hill

A hill is an upland that rises above the general relatively low ground but it is of less height than a mountain.



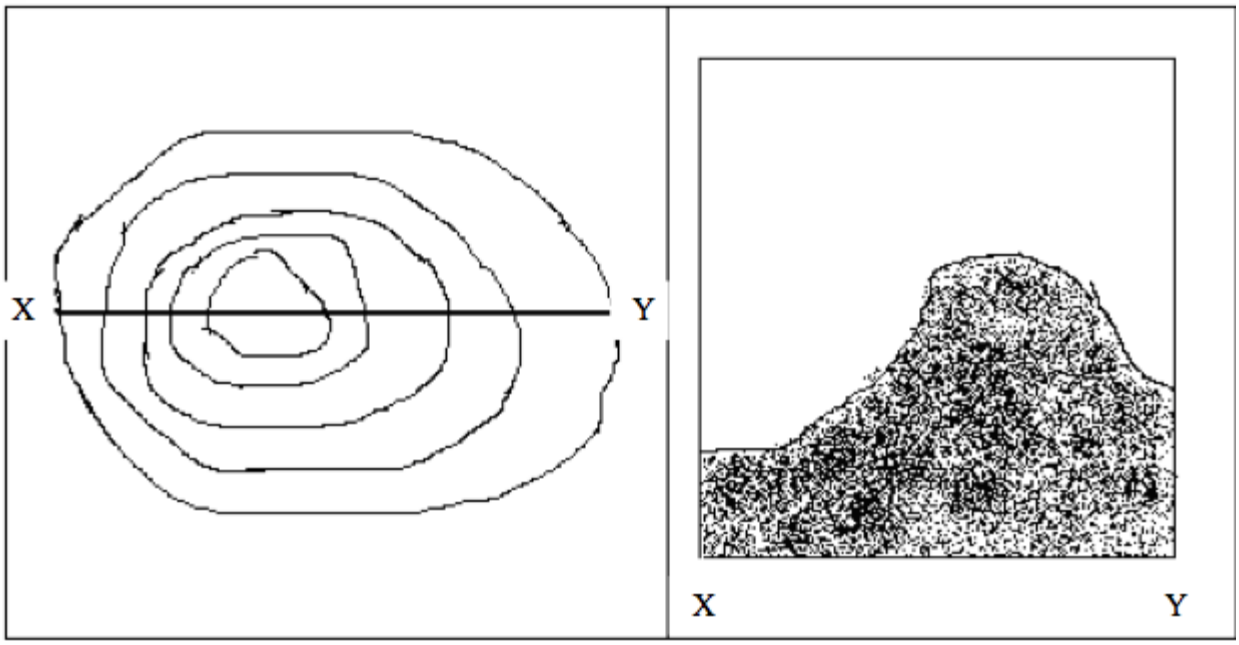
The shapes of hills are quite variable. Some appear to have a regular shape while others are irregularly shaped.

Regular hills look evenly shaped and tend to be conical in shape. On topographical maps, these are depicted by a group of concentric contours that give a hill a rounded shape.



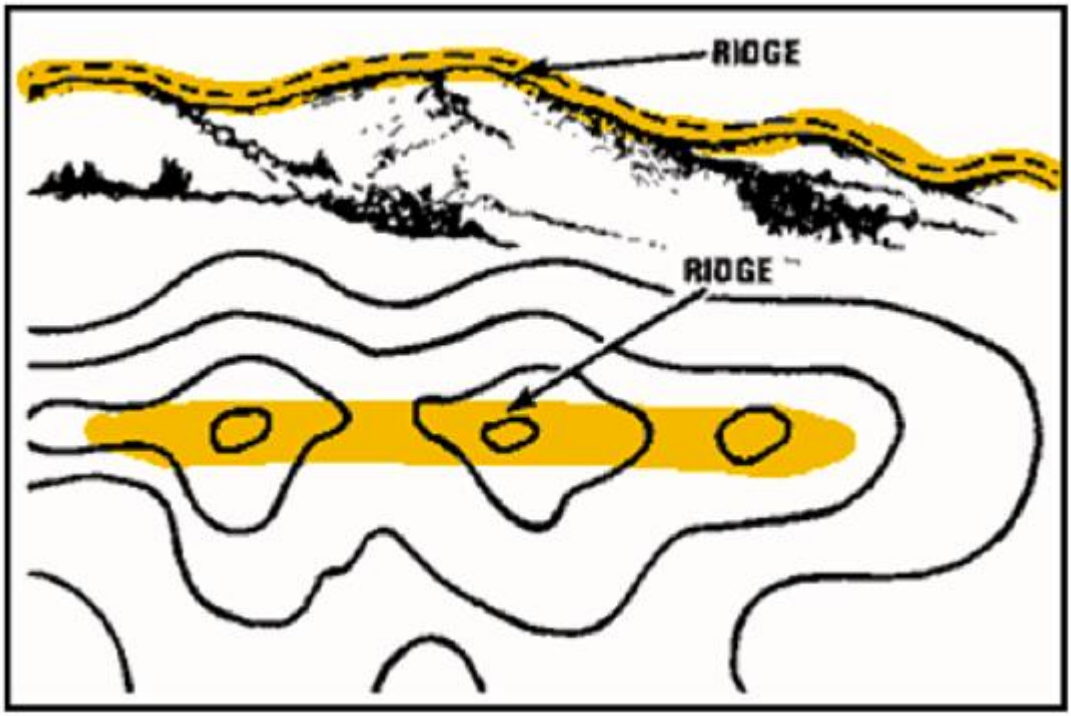
A regularly shaped hill

Some hills are irregularly shaped. This may due to erosion, the presence of a massive rock outcrop or due to other geomorphological processes.



Ridge

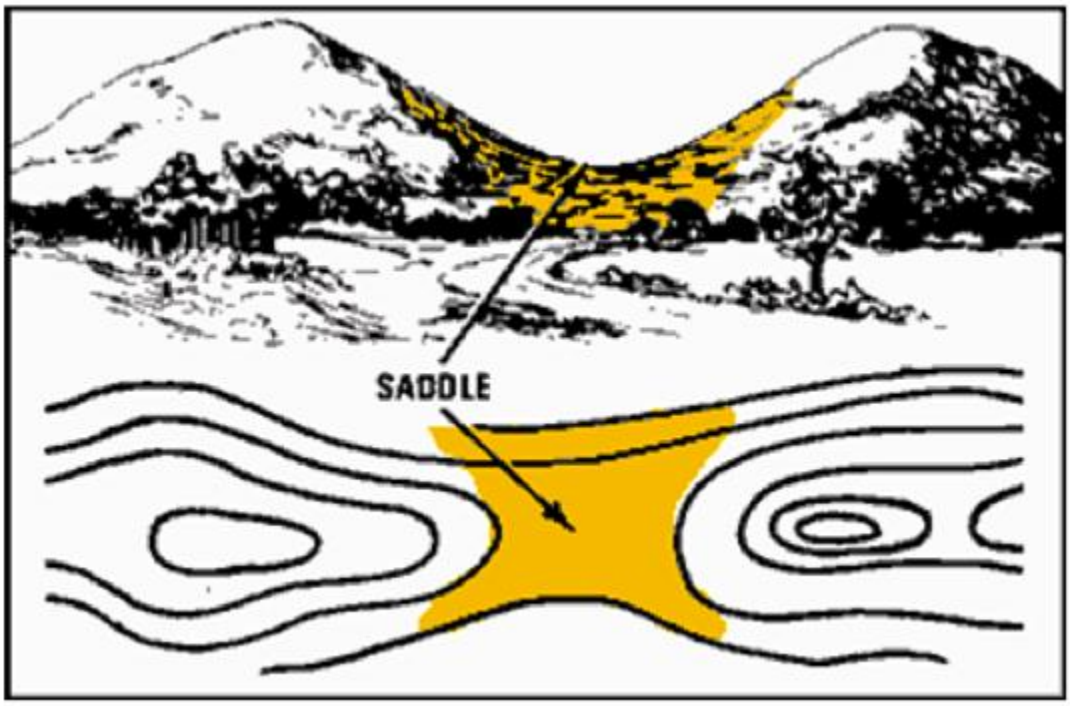
A ridge is a fairly narrow and elongated hill or range of hills with steep slopes on all sides. The top of a ridge may have a number of peaks formed by hills that form a range. Some ridges are watersheds that separate rivers which flow in different directions or parallel to each other. On topographical maps, ridges can be identified by closely packed and elongated contours that drop on all sides into lower ground. The upper part of a ridge is called brow. Before reaching the top of the ridge, there is usually a section of gently sloping land called a shoulder.



Col, saddle and pass

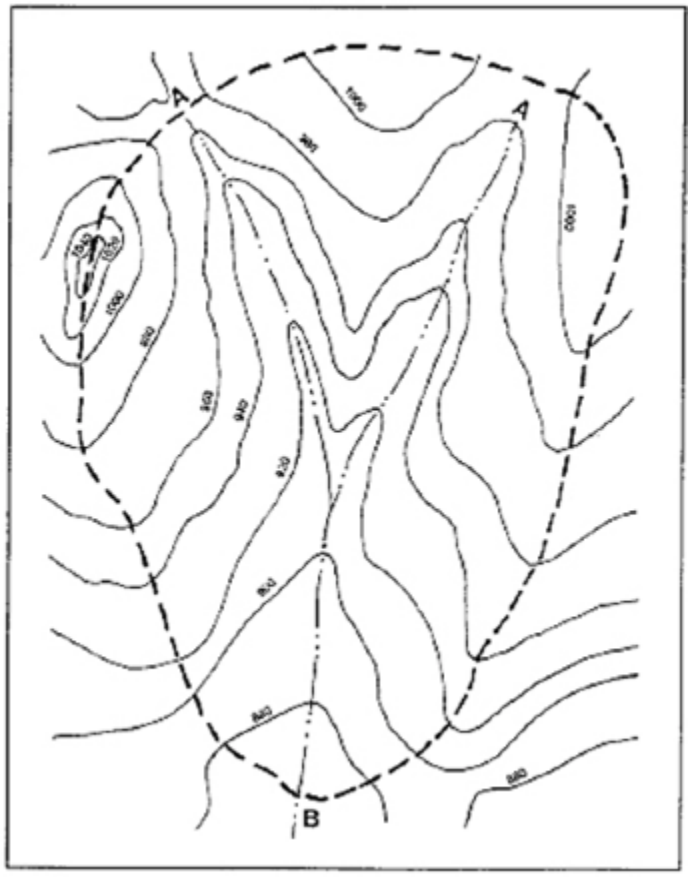
A col is a small depression on a ridge or in a hilly area, which is located between adjacent peaks of hills. In the position of a col, there are no contours drawn. A saddle is described as a broad flat col in a ridge between two mountain peaks. The term saddle is sometimes used interchangeably with col. Their only difference is that a saddle is wider than a col, that is, the two mountain summits separating a saddle are far apart while those separating a col are very close.

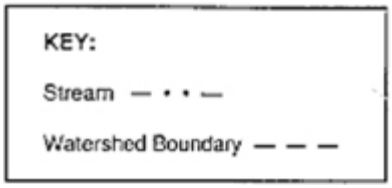
A pass is a fairly narrow but deep gap in a mountain range or between high hills in a low land. It is like a deepened saddle or col. Its name originates from the fact that travellers across a hilly or mountainous country would use such a gap for easy crossing from one side of the hills to the other.



Watershed

A watershed is a line separating headstreams, i.e., river sources that flow to different river systems. It is a boundary line. On a ridge, it would be the crest of that ridge. On topographical maps, a watershed is not indicated by contours. Its position can be deduced and traced along a line that passes above the last contours of the ridge. Its position can also be determined by examining the direction of flow of rivers originating from that highland.





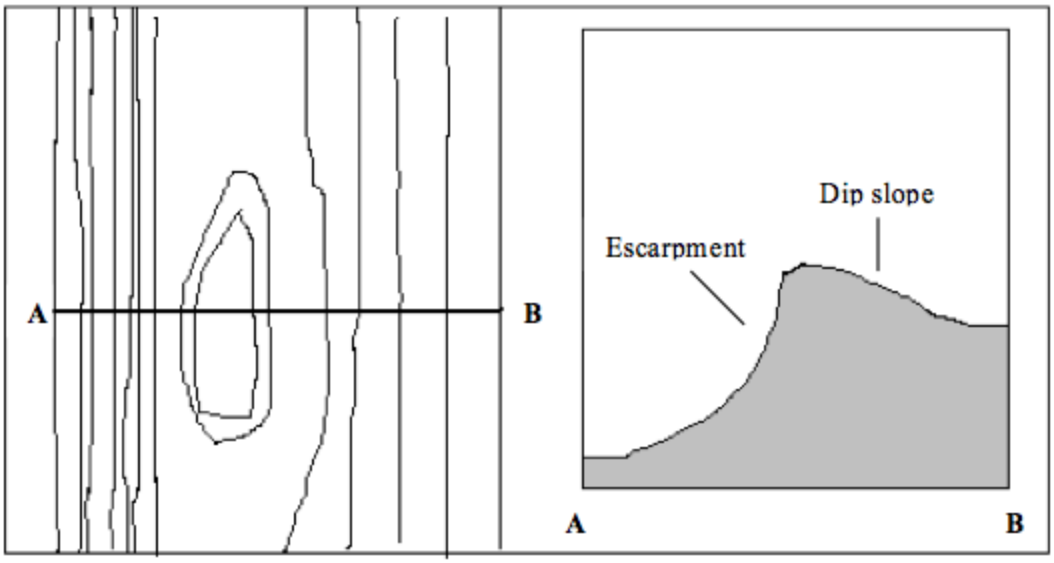
Watershed

The diagram shows two streams (A) that have joined together to form the main stream (B).

Escarpment

An escarpment is a very steep side of an elongated highland. If it is formed through the process of faulting, it is called a fault scarp. Loosely, the name is used to refer to the whole highland with very steep slopes on one side, a plateau on top and gentle slopes on the opposite side. On topographical maps, an escarpment is shown by closely packed contours on the scarp side that forms a scarp slope, and more widely spaced contours on the opposite side, called the dip slope.

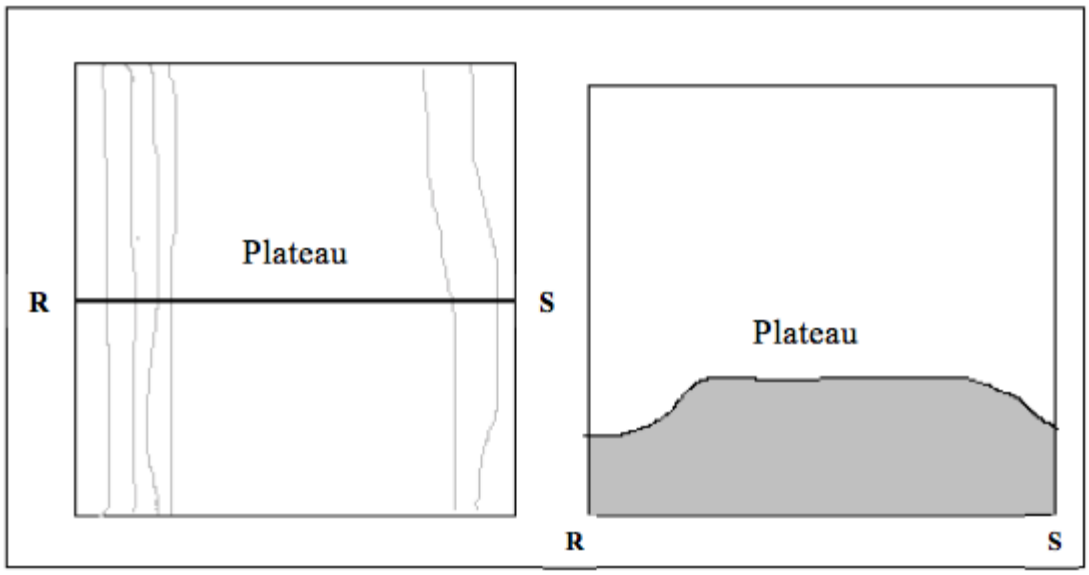
The steep side forms a concave slope while the dip slope is fairly even. The tops of some escarpments form plateaus while others, especially the smaller ones, form ridges.



Escarpment

Plateau

This is an upland covering a considerably large area, and whose top surface is almost flat. It is bordered by steep slopes that lead to lower ground or may rise into the surrounding mountains. On a topographical map, a plateau is shown as a wide area surrounded by a common contour of the same height or two contours that are of the same height on both sides.

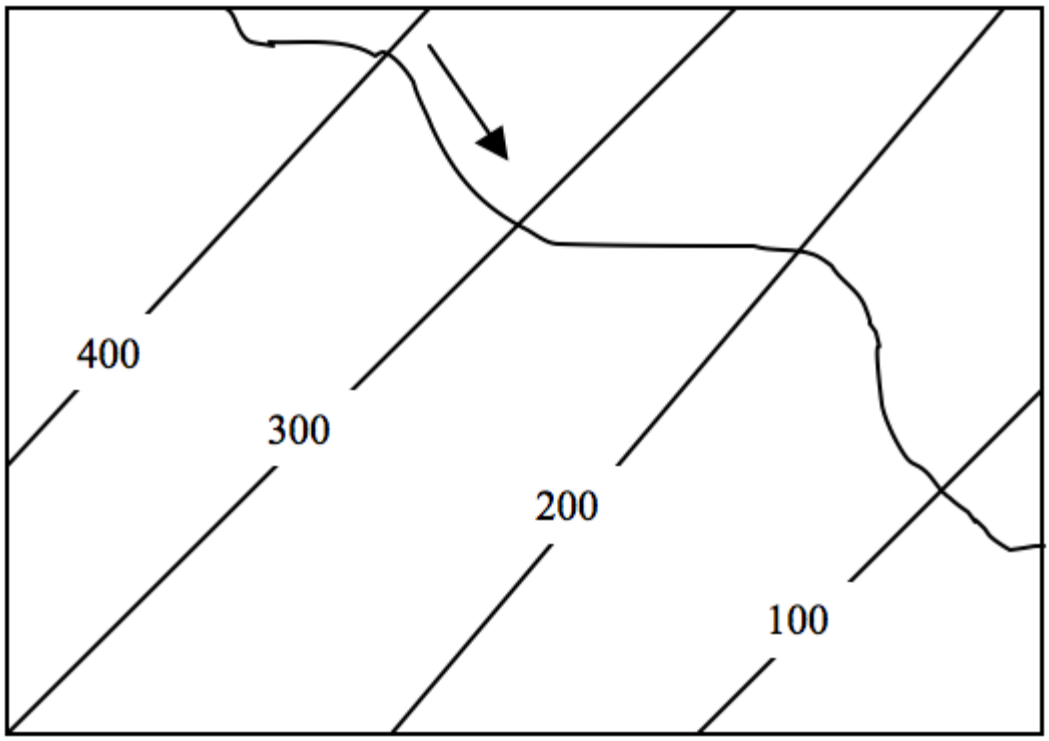


Plateau

Plain

A plain is a continuous tract of relatively flat land covering a broad area of lowland. Some plains may be raised but the slopes are very gentle. Plains occur as lowlands and at the bottoms of valleys but also on plateaus or uplands at high elevations.

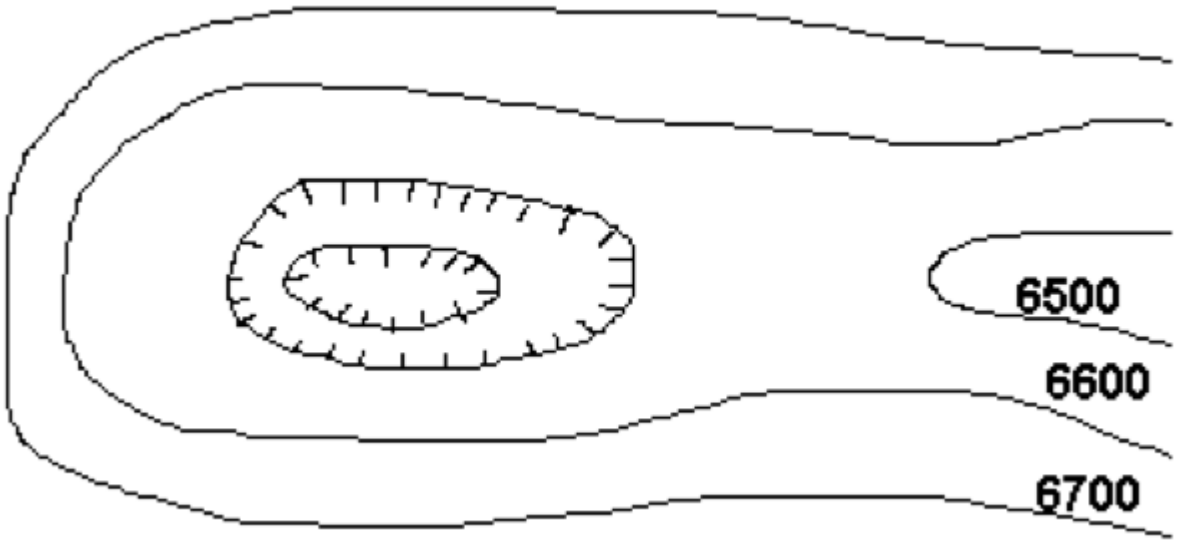
On topographical maps, a plain is shown by contours that are very widely spaced. Some rivers, if present, may be seen to have meanders.



Plain

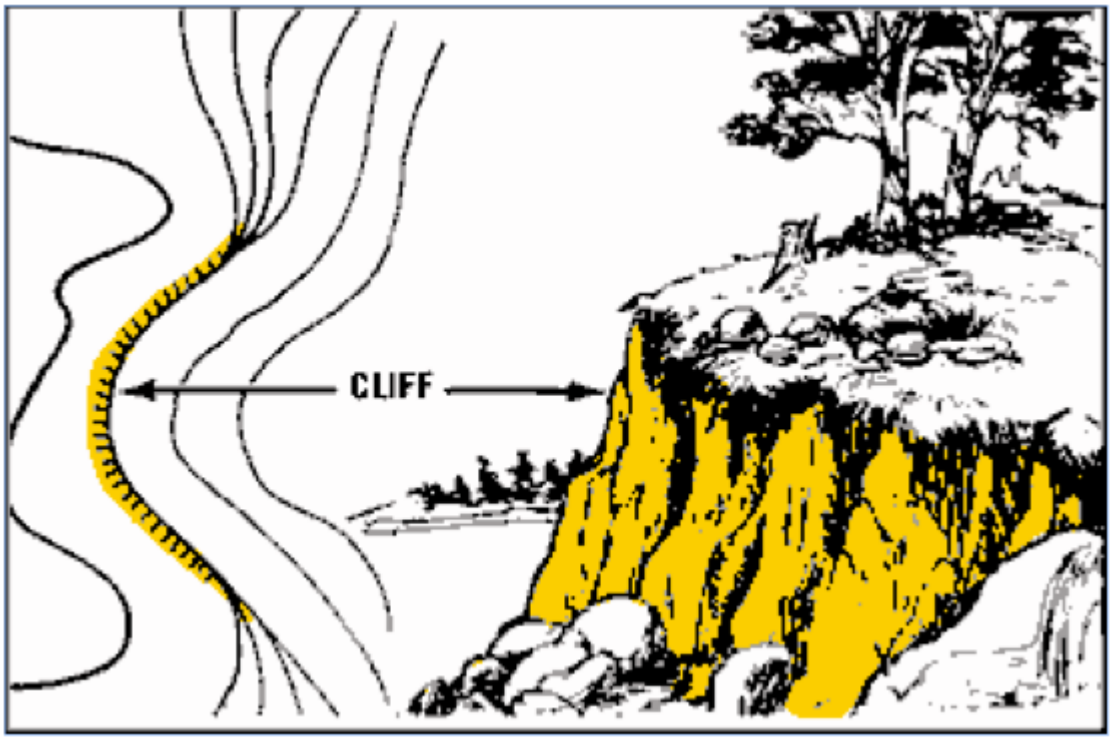
Depression

A depression on a contour map is shown by contour lines with small marks pointing towards the lowest point of the depression. The first contour line with the depression marks and the contour line outside it have the same elevation.



Cliff

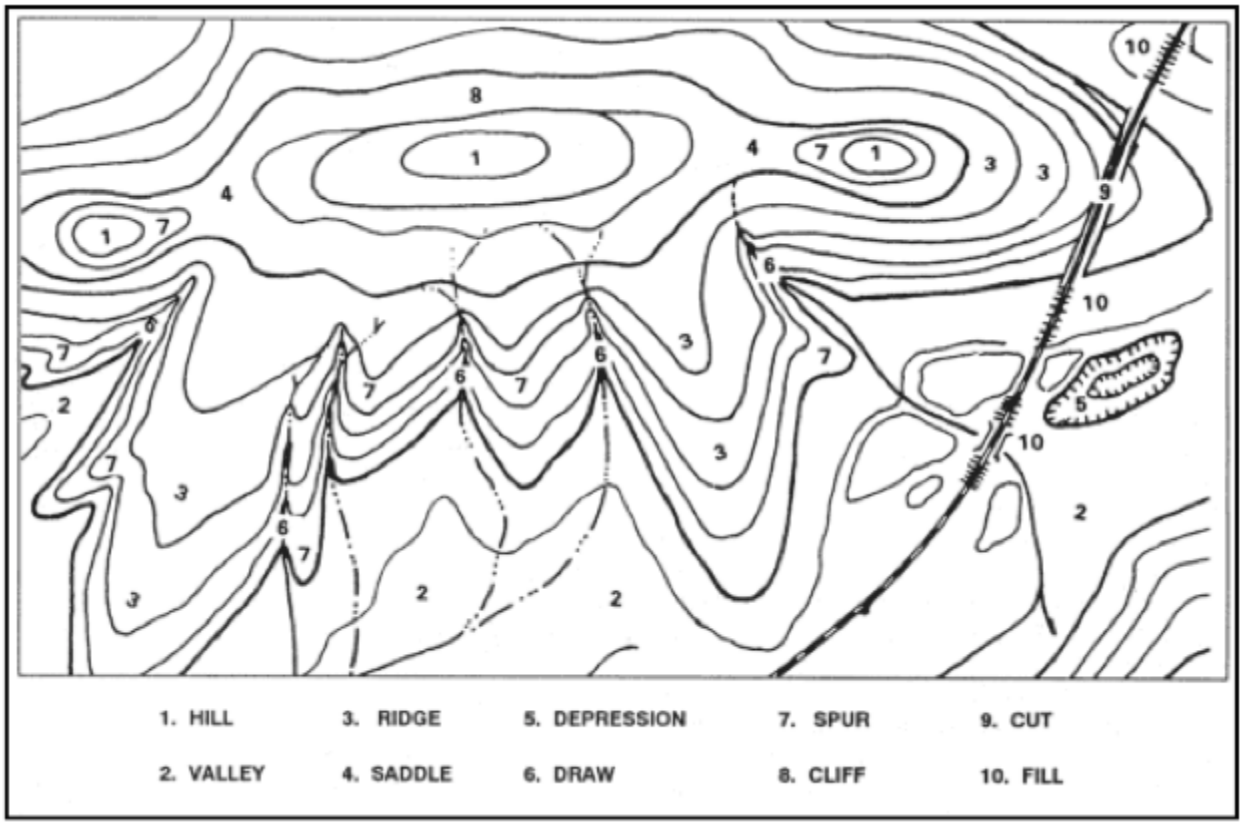
A cliff is described as a steep rock face that is vertical or nearly vertical. Cliffs are common in mountainous or hilly areas and along the shores of lakes and seas. On topographical maps, cliffs are shown by contours that are so closely packed that they appear to merge into one another. To emphasize the presence of the cliff, a special symbol is drawn on top of the contours as shown in the figure below.



Cliff

Summary of the relief features

The following diagram summarizes some relief features shown by contour lines on topographical maps. The summary can be used as a quick reference when revising representation of relief features on a map.



Some relief features are usually shown in the key. The following key shows some of the symbols that are used to depict various relief features on topographical maps.

Feature Name	Symbol
Bridge	
Bridge; swing, draw, lift	
Footbridge	
Ship anchorage; Ship base	
Falls	
Rapids	
Direction of flow arrow	
Dry river bed	
Stream - intermittent	

Sand in water or foreshore flats	
Rocky ledge, reef	
Flooded area	
Marsh, muskeg	
Swamp	
Well, water or brine; Spring	
Rocks in water or small islands	
Water elevation	
Horizontal control point; Bench mark with elevation	
Precise elevation	
Contours; index, intermediate	
Depression contours	

Cliff or escarpment	
Sand	
Moraine	
Quarry	
Cave	
Wooded area	
Orchard	
Vineyard	

Sports track	
Swimming pool	
Stadium	
Golf course	
Golf driving range	
Campground; Picnic site	
Ski area, ski jump	
Electric facility	
School; Fire station; Police station	
Church; Non-Christian place of worship; Shrine	
Building	
Service centre	
Customs post	

Coast Guard station	
Cemetery	
Ruins	
Fort	
Airfield, position approximate	

Information from Maps

Generate information from maps

Description of relief

It is important to be specific when describing the relief of an area represented on a map. The following steps should be followed:

1. Provide a general description of the relief of the area. State clearly whether it is mountainous, hilly, a plateau, lowland, valley, etc. State the general altitude of the area by mentioning the possible lowest and highest points and their actual or approximate heights as well as their specific locations on the map. You can get this information from contour lines, spot heights or trigonometrical points. It is important to give as accurate height as possible.

2. If distinct relief regions occur on a map, the area should be divided into distinct regions, e.g. highland, plateau, lowland, swampy area, etc. Each area should then be described in detail by mentioning the features present in the respective area. Describe the slopes and ranges in their heights, the nature of slopes, types of slopes, general direction of the slope and the landforms found in the area as well as their characteristics.

3. Locate the relief or landform features present in the area and describe their distributions and locations on the map. These features can be located by using grid references, points of the compass or the nearest named places. In case of slopes, describe the type and direction of slope and comparative steepness or gentleness. Use the appropriate terms for describing types of slopes e.g. regular, convex, concave, gentle, etc.

VEGETATION

On topographical maps, only selected types of vegetation are shown. These are forests, thicket, bamboo, riverine trees (also known as galleric or riverine forests), woodland, scrub, scattered trees, palms and swamp vegetation.

The specific swap plants such as mangrove trees, swap trees, marsh plants and papyrus can be deduced from the type of swap shown on the map.

The symbols on the map that are used to represent various vegetation types are often interpreted in the map key.

Describing vegetation

When describing natural vegetation on a topographical map, first identify and name all types of vegetation shown on the map. Then describe each vegetation type separately. Indicate the location of each type of vegetation by using the grid reference or compass direction. For

example, one may state “There is a dense forest on the eastern area of the map and mangrove trees along the river.”

If some vegetation types are named on the map, e.g. “Nyandarua Forest”, use the name given to locate the position and type of vegetation. The area covered by particular vegetation should also be estimated and given.

It is important to find out the reason for the particular distribution. These reasons are deduced from the information given on the map, which is referred to as evidence. For example, an area with large permanent rivers indicates that the area receives high rainfall. This may be the reason for the existence of dense forests in the region.

DRAINAGE

Drainage is the natural or artificial removal of surface and sub-surface water from an area. Drainage also includes other features such as lakes, swamps, canals, and ponds which are related to water. However, water tanks and cattle dips are not features of drainage because these features are built by people who also fill them with water. These constructed drainage features are also called hydrographic features. Map makers use blue as the conventional colour for water features.

Rivers and streams

These are referred to as water courses in some maps. They are shown by blue lines. The size of a river is indicated by the size of the blue line. The thicker the line is, the bigger the river. The very thin lines represent streams. The names of some rivers are written in blue print along the lines representing the rivers.

Permanent rivers are shown by continuous blue lines while the broken blue lines represent intermittent (seasonal) rivers. If a river appears to abruptly end somewhere on the land, it means that it disappears into the ground at that point. This implies that at that point where it disappears then rocks are probably very porous or are limestone type or there is a fault line. Normally, a river ends in another river, a swamp, lake or sea. Rapids and waterfalls, like river valleys, are relief features found along a river course and are therefore not in the category of drainage features.

The symbols used to show them on small rivers are not the same as those used on large rivers. These should be carefully studied. The presence of waterfalls and rapids may indicate presence of alternating hard and soft rock along the river.

They may also imply presence of protruding resistant rock outcrops on the river bed or sudden change in the slope of the river bed.

Lakes

A lake is a body of water occupying a sizeable basin, depression or hollow in the ground. It is bigger than a pond. A lake with no indication of water flowing out of it is regarded as an area of inland drainage.

Natural lakes are shown using a light blue shade of stipples. Seasonal lakes are indicated by a series of broken, blue, short lines with the word "lake" written on them or by the name of the lake. Man-made lakes (reservoirs) are shown by a dark blue tint behind a black line that cuts across the river.

Sea

A portion of an open sea is represented by a pale blue colour that is shaded with stipples. Its coastline is indicated by a blue line.

Swamp

A swamp is a wetland with its associated vegetation. Swamps are common where the ground forms a shallow depression. There are various types of swamps and they are shown by different symbols which can be identified in the key. The different types of swamps shown on 1:50000 maps of East Africa are:

a. Mangrove swamps – these are found in the shallow parts of the sea shore, and around sea inlets.

b. Tree swamps – water-logged areas that have a significant number of trees and some other smaller plants growing in them. There are some water-logged areas where trees are so many that they form a forest. Such a forest is called a swamp forest.

c. Papyrus swamp – dominated by papyrus reeds. These are common on plateaus and lowlands.

d. Marsh – an area that experiences temporary flooding, and the land is usually wet and poorly drained. It is characterized by plants such as rushes, reeds and sledges, with occasional water-tolerant trees. At the coast, where flooding is due to water, it is called a salt mash.

e. Bog – spongy water-logged area with a surface layer of decaying vegetation. The papyrus swamp, marsh and bog are all shown by the same symbols on a 1:50000 scale topographical map of East Africa.

f. Seasonal swamp – a very shallow basin and flat area of ground that become flooded during the rainy period for some months, but which dry up during the dry season. On a topographical map, they are shown by a group of broken blue lines.

Ponds, waterholes, boreholes, wells and springs

- A*pond*is a small mass of stagnant water that is commonly found along courses of small rivers. Most ponds are constructed by people but some occur naturally. They are shown as dark blue areas on topographical maps.
- A*waterhole*is a shallow and broad pit that traps rainwater. Some waterholes are natural while others are constructed by people to provide drinking water for livestock or wild animals. For coloured map sheets, the letters "WH" against a small blue circle is the common symbol for this feature. If an alternative symbol is used, it can easily be identified in the key.
- A*borehole*is a deep hole drilled in the ground for the purpose of obtaining underground water. The initials "BH" against a blue circle are used to represent it on a topographical map.
- A*well*is a hole, larger than a borehole, which is dug in the ground for obtaining underground water that is fairly close to the surface. This is shown by a blue circle and a letter "W" or letters "We" against it.
- A*spring*is a place where underground water flows out from the ground to the surface naturally. It is indicated by a blue circle and letter "S" or letters "Spr" against it. New editions of topographical maps may have these symbols modified.

Note: These symbols are clearly indicated in the key of the map. It is advisable to always study the key before proceeding to identify and interpret the various symbols drawn on the map. Some modifications of the symbols may be expected. So you should not get confused by cramming the symbols off head.

Irrigation canals

An irrigation canal is a channel that is dug in the ground for the purpose of carrying water from a river, well or lake to a farm. On maps, they are shown by blue lines that are usually written against them.

Ditches and drains

These are trenches that are normally constructed in water-logged areas for the purpose of draining water from the land. On a topographical map, they are shown by straight blue lines with some of them having definite angles. The ward “ditch” or “drain” may be written against the line.

Though water tanks, cattle dips and wind pumps are connected with water, they are not drainage features but are cultural features for saving water. The presence of many permanent rivers, streams, lakes and swamps is an indication of high amounts of rainfall received in the area. On the contrary, if many of these features are seasonal, it implies that the area receives low rainfall. Numerous waterholes, boreholes and irrigation canals in an area may also be an indication that the area receives low rainfall and that it experiences water shortage.

Description of drainage

When describing drainage, one should first identify the various drainage features and name them. Describe each feature in turn by describing the distribution of that feature in the area represented and locate it on the map. State the general quantity, volume or size of the feature and describe the characteristics of each, for example, seasonal permanent, big or small, etc. when describing rivers, it is important to comment on the stream density, general direction of flow of the rivers, the sizes of rivers and stage of development, i.e., youthful, mature or old-age. Identify river drainage patterns as well.

Information from Maps in Relation to Daily Activities

Interpret information in relation to daily activities

Human (artificial) features on topographical maps reflect human activities taking place in the area covered by the map. Many human activities are in the form of “land use” which refers to the ways in which land is utilized in the area. The human activities represented on topographical maps include the following:

Agriculture

Agriculture is the cultivation of crops and/or rearing of livestock. In modern times, the term has been expanded to include fish farming, beekeeping and poultry farming.

On topographical maps, crop plantations are shown as light, green shading. A letter indicating the name of the plantation crop may be printed over the shade e.g. “S” for sisal, “Su” for sugarcane and “C” for coffee. These symbols are also indicated in the key.

The name of the crop could also be indicated by the plantation name e.g., Tungi Sisal Plantation. If the name of the crop is not indicated on the plantation, it may be identified using other indicators on the map. For example, the presence of a tea factory, coffee factory or decorticator may imply the plantation crop is tea, coffee or cotton, respectively. In the absence of any indicator of a crop that might be grown on the plantation, there is a possibility that the plantation may be that of trees, i.e., natural or planted forest. Small-scale farming activities are not shown directly on the map. However, they may be deduced from symbols, factories or stores. The presence of a tobacco processing factory or tobacco store implies that tobacco is grown in the area. The presence of flour mill or posho mill indicates that maize is grown in the area.

A ginnery implies that cotton is grown in the area. A cereals board may imply that people in the area grow grain crops such as maize, millet, wheat, etc.

Livestock rearing is indicated by the presence of cattle dips, grazing grounds, cattle markets, ranches,, stock holding grounds, waterholes, a water tank in an isolated place, a slaughter house office or abattoir, a butchery, veterinary office, dairy farm, creamery and dairy farming schools, and many others. Any evidence that relates to livestock rearing is enough to draw a conclusion about livestock farming.

Based on the type of crops grown in an area, one can draw conclusion on the type of climate experienced in that area. For example, tea and coffee are usually grown on an area that experience high rainfall and with moderate temperatures. Crops such as sisal, millet and cassava indicate that the area receives low rainfall and experiences high temperatures.

Likewise, the type of livestock kept in an area can be useful in making conclusions about the climate of that area. Dairy farming indicates that the area has cool climate and receives high amounts of rainfall. Beef cattle farming, pastoralism, ranching and camel rearing all indicate that an area receives low amounts of rainfall. This may be a clear indication that the area experiences a dry climate.

Forestry

The presence of forests and forest reserves on a map indicate that forestry is practised. The presence of forestry can also be indicated by features such as forestry training school, forest station, or forest guard post. The presence of sawmills within or near a forest indicates that lumbering may be taking place in the area.

Fishing

On topographical maps, the presence of water body does not indicate the presence of fishing activities. In conjunction with the presence of a water body, we have to look for the following evidences to conclude, beyond reasonable doubt, that fishing activities are taking place on the water body shown on the map:

a. The presence of the symbols of fish traps at the edge of a water body.

b. The named places such as fishing village, fish ponds, and hatcheries near a water body. We can also look at the presence of Fisheries Departments, fish markets, Fishing Cooperative Society, a fish processing plant, etc.

Mining

Mining activities are often indicated by a particular symbol that is included in the key. Words such as “Gold Mine” may also be used to conclude that mining activities are taking place in that particular area. Mining, however, should not be confused with quarrying.

Quarrying

Quarrying is the activity involving excavating stones, sand or soil from the ground. A special symbol with the word “quarry” written against it is used on topographical maps to indicate where quarrying is carried out. This is different from mining and that is why both activities are shown by different symbols.

Trading

This is a commercial activity involving buying and selling of commodities. On topographical maps, it is indicated by letters “TC” which are initials for Trading Centre in areas where there are settlements. Other evidences of trading include shops, markets and petrol stations.

Transportation

This involves the movement of people, goods and animals from one place to another. It is evidenced by the presence of transportation infrastructures such as roads, railway lines, footpaths, tracks, airports, seaports, pipelines, etc. The symbols representing these structures are often provided in the key.

Communication

This refers to the means of conveying or exchanging information. The evidence of communication services and activities includes the presence of a wireless station, post office (PO), telegram (Tg), telephone (T) and telephone lines, and a satellite station.

Industries

These are evidenced by the presence of manufacturing and processing factories or industries in an area. They may be shown and named on maps. Examples of industries include sisal and tea processing factories, coffee pulping plant, floor or posho mill, bakery, creamery, cement factory, motor vehicle assembly, fruit processing factory, sawmill, ginnery or simply the word “factory” or its abbreviation “Fcty” are all evidences of industrial activities.

Tourism

Tourism may indicated by such features as camping site, hotel, recreational grounds, game reserve, national park, museum, historical monument, tourist resort, historical sites and nature reserve.

Administration

Various administrative activities can be identified from abbreviations on the map. These are given in a list in the margin of the map. They include provision of security as evidenced by the presence of a Police Station or Police Post, judicial services as evidenced by the presence of courthouse, and other administrative offices such as District Commissioner (DC) and Regional Commissioner (RC).

Other human activities

Besides the activities described above, there are other activities that people engage in on daily basis. These include teaching and provision of other education services indicated by the presence of school, college, university or training institution.

Health services are indicated by the presence of a hospital, dispensary, health centre or medical laboratory.

Religious services are indicated by the presence of church, mosques or temple. Recreational services are evidenced by the presence of golf clubs, golf courses, stadium or other recreational grounds.

Description of human activities

When describing human activities in a given area on a topographical map, the following steps should be followed:

a. Identify each activity and support it with evidence form the map.

b. Describe the distribution of the activity in the area of the map using conventional methods.

c. Give reasons, using available evidence, for the distribution of and factors that may appear to favour the activity.

INTERPRETATION OF SETTLEMENTS

A settlement is a place where people dwell. On topographical maps, settlements are depicted by dots or blocks, which may be black or grey in colour. Dots are identified in the key as huts or houses. They represent semi-permanent structures that are typical of rural settlements in Africa.

Black squares or rectangular blocks depict permanent buildings like those built of stones or bricks and roofed with iron sheets or tiles. A collection of these permanent buildings in one area is shown as a solid block. This represents a town or an area with permanent buildings.

Description of settlements

Settlements are described based on their concentration or alignment. In terms of concentration, they may describe as follows:

- Dense – when there is a high concentration of individual blocks or dots in a given area.
- Moderate – when f individual blocks or dots are neither high nor low.
- Sparse – when individual blocks or dots are few and spread over a wide area.

On the basis of alignment, settlements can be described as follows:

Nucleated or clustered

In this pattern, settlements are in groups or clusters. The reasons why settlements are concentrated in a particular area include the following:

a. A limited land for settlement.

b. Security and defence – in rural areas people may need to live in groups for collective defence.

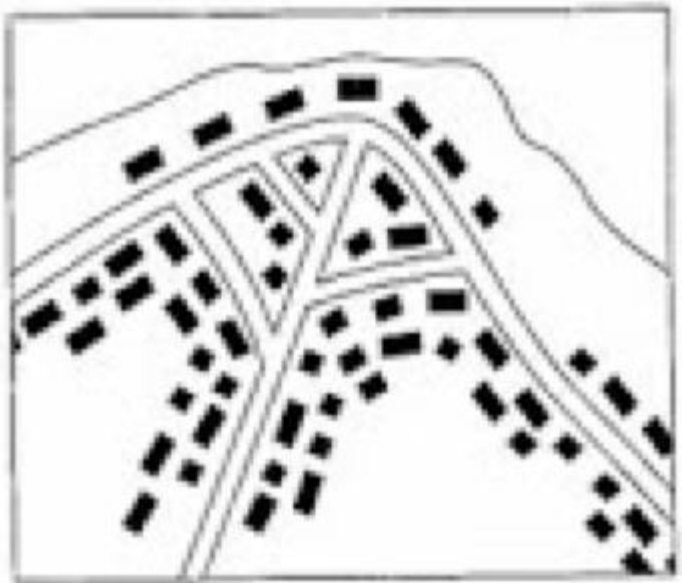
c. Availability of social services such as educational, health, transport, and communication facilities

d. Availability of economic opportunities like mining, trade, employment, etc.

e. Conducive climatic conditions which favour a better living such as the absence of diseases or disease vectors such as tsetse flies, mosquitoes, etc.

f. Fertile soils which favour agricultural activities.

g. Government policies – the government's land policies can also have a lasting effect on location of settlements. For certain reasons, the government can set up policies which prohibit establishment of settlements in particular areas.



Nucleated settlement

Scattered or dispersed

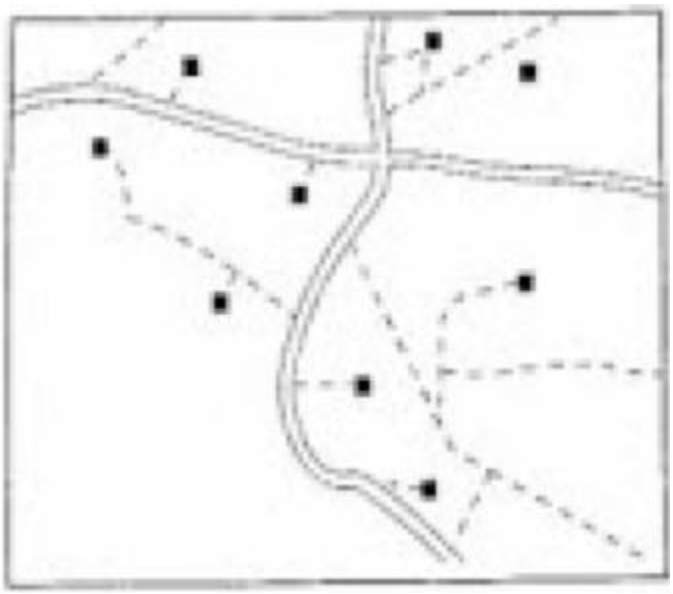
In this pattern, the settlements appear to be randomly dispersed over the area. It is typical of rural areas where people own individual pieces of land and set up their own dwellings anywhere on their lands. It can be found in new settlement schemes. The distribution may be any of the types discussed above. The factors behind this type of settlement include the following:

a. Readily available land for settlement without any restrictions.

b. A fertile soil that attracts a large population. The land is sub-divided into small plots.

c. Availability of water within easy reach by families.

d. Generally reliable security over a wider area. There is therefore no need for group defence measures.



Scattered settlement

Linear

In this pattern, settlements are set up in a line form along certain features such as roads, railways, coastlines, etc. Some of the factors leading to development of this pattern include:

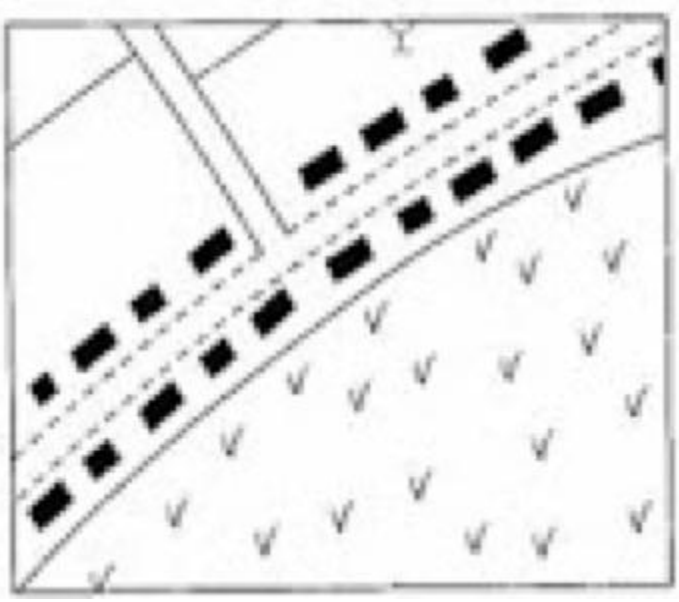
a. Presence of a road, motorable track or footpath for easy transport.

b. Presence of a river that may provide water for domestic and commercial use.

c. A coastline or shoreline that is favourable for fishing.

d. Suitable terrain, e.g. the foot of an escarpment where the slope is gentle and where they may be scarp springs for water.

e. Infrastructure planning like in plantations where settlements are set up in lines.



Linear settlement

Besides describing the distribution of settlements in terms of the density and patterns, the factors that influence their distribution should be identified by examining the map carefully. Such factors include relief, vegetation, drainage, transport and other economic activities as may be found indicated on the map.

Note: The description of settlement as dense, moderate or space is often termed as forms of settlement and description as scattered, linear or nucleated is termed as settlement patterns. So, one should not confuse the two terms when referring to settlements.

PHOTOGRAPH READING AND INTERPRETATION

Types of Photographs

Types of Photographs

Identify types of photographs

A photograph is an image or a picture of an object which is recorded by a camera and then printed on a paper. Photograph interpretation is a process of reading, measuring and interpreting photographs for obtaining reliable information about natural or human features and their environment. In other words, photograph interpretation can be defined as analysis and examination of photographs so as to be able to identify natural or artificial features.

Photographs are classified according to the viewpoint or position from which they are taken. They can be taken from the ground or from the air. This then basically gives us three major types of photographs namely, horizontal, oblique and vertical photographs.

Horizontal or ground photographs

These are photographs that are taken from the ground when the camera is at the same level as object(s) being photographed. There are two categories of horizontal photographs as described below:

Horizontal close-up photographs

These are categories of horizontal photographs in which the camera focuses on a particular object such as a house. The object of focus is shown very clearly. On the other hand, objects in the background are obscured, and generally, the background is not seen clearly.

Horizontal general-view photographs

These are photographs that focus on a wide area of the field. Several objects are clearly shown in these photographs. Objects close to the camera appear larger than those far away from the camera. The area whose objects are obscured from the camera by those objects close to the camera is called the dead ground.

Horizontal general-view photograph

Oblique photographs

These are types of photographs that are taken from an angle, usually from the top of a hill, tower or cliff. There are two categories of oblique photographs as described below:

Ground oblique photographs

These are taken when the photographer is standing in elevated ground, such as top of a hill, building or cliff, and holds the camera at an angle pointing towards the lower ground. The photograph can also be taken when the photographer is standing at the bottom of an elevated ground, with the camera pointing towards the higher ground (See the photograph below). So, whether the photograph is taken from the top or bottom of an elevated ground, the resulting photograph is called ground oblique photograph. In this kind of photograph, the images closer to the camera are larger than those far away.

Ground oblique photograph

Aerial oblique photographs

These photographs are taken from the sky with the camera tilted at an angle towards the ground. The photographer may take the photograph from a helicopter or low-flying aeroplane. These photographs cover quite a large area of land. They are similar in many ways to the ground oblique photographs. Objects near the camera appear slightly larger than those far away.

An aerial oblique photograph which does not cover the horizon is called a low aerial oblique photograph, while that which includes the horizon is called a high aerial oblique photograph.

LOW aerial oblique photograph

HIGH aerial oblique photograph

Vertical photographs

These photographs are the ones that are taken from the air with the camera directly above the scenery, pointing vertically to the ground. The camera focuses on specific features on the ground though the area surrounding those features is also shown.

Vertical aerial photograph

Differences between Ground, Vertical and Oblique Photographs

Differentiate between ground, vertical and oblique photographs

A photograph has three parts as described below:

a. Background – the area farthest from the camera.

b. Foreground – the area nearest to the camera.

c. Middle ground – the area between the background and the foreground, which is at middle distance from the camera.

Each of the three parts of the photograph can further be sub-divided into three parts to give nine combinations which form the nine minor parts of the photograph as shown in the table below:

Left	**Centre**	**Right**
Left background	Centre background	Right background

Left middle ground	Centre middle ground	Right middle ground
Left foreground	Centre foreground	Right foreground

For easy description of locations on a photograph, it is appropriate to use these divisions. It is inappropriate to use such terms as ‘top’ or ‘bottom’ when referring to areas or parts of a photograph. Also it is not acceptable to use points of the compass such as ‘east’, or ‘north’ unless there is sufficient information to enable one to determine the compass directions of the photograph.

Reading and Interpreting Photographs

Features Presented on Photographs

Read features presented on photographs

The same as reading maps, reading a photograph means studying and identifying the various objects shown on the photograph. Interpreting a photograph means examining the objects or a combination of objects shown on the photograph for the purpose of judging their significance. It involves translating the information by describing the features shown in the photograph. Photograph interpretation involves the following:

a. Determining the title of the photograph.

b. Estimating time and season the photograph was taken.

c. Estimating direction or position of the photographer.

d. Estimating the size of the features.

e. Identifying and interpreting physical features.

f. Identifying and interpreting human activities.

g. Suggesting possible location of the scenery in the photograph.

Determining the title

A suitable title of the photograph can be obtained by studying the photograph carefully. The information obtained in the photograph determines the choice of the title.

Features shown on the photograph can be natural or man-made. It is important to study the photograph carefully and identify these features.

Photographs show landscapes, activities on land, water surfaces or sky or a combination of all of these. The information contained in the background, middle ground and foreground should be carefully studied. Such information, when combined with one's geographical knowledge can be used to establish the title of the photograph.

Estimating time and season

If we know where the photograph was taken, it may be possible to tell the time of the day when the photograph was taken. If it was taken in the tropics on a sunny day, long shadows imply that the time of the day was either early morning or late afternoon. If the shadows are short, it implies that the time of the day was just before or afternoon. In the temperate regions, both in the southern and northern hemispheres, the sun never gets overhead at noon. It remains at an angle. The shadows are also shortest at noon and point northwards in the northern hemisphere and southwards in the southern hemisphere. Therefore, based on the knowledge of the zones of the earth and the movement of the sun, one can tell when the photograph was taken and be able to determine a part of the hemisphere on which it was taken.

We can also draw conclusions about weather, season or even climate of the area at the time the photograph was taken. A bright clear sky with dry vegetation may suggest a dry period or season. Thick vegetation, young crops and or flowering plants in the field and a sky full of cloud cover or rain suggest a rainy season or period. In temperate regions, clear sunny conditions with healthy vegetation and flowering plants or plants with fruits indicate a summer season. Plants with young leaves, others in bloom and fields full of grass could be an indication of spring season. Foggy sky with leafless trees and some snow on the ground is an indication of winter season.

The type of clothing worn by people appearing in the photograph and the nature of houses can be a clue to the prevailing weather or the type of climate. When people appear to be wearing heavy

clothing with faces almost completely covered, hand gloves and heavy boots, it is an indication of cold weather, likely to be winter in temperate regions.

When the weather is hot, people wear light clothing and some may even wear broad-rimmed hats. If people are seen basking in the sun by the swimming pool it also indicates a warm sunny, hot weather. When houses appear to have slanting roofs, it is an indication that the region experiences a lot of precipitation, either rainfall or snow. Slanting roofs facilitate easy flow of water or snow from the roof of the house. Simple houses with flat roofs indicate a region that experience little precipitation or that is dry in most of the year.

Activities going on in the field could also suggest the type of a season. If people are seen planting crops, it is planting season. The rainy season is either near or it has just started. If people are seen weeding, it is the growing season for crops and there is reduced rainfall.

If people are photographed harvesting the crop, it is the harvesting season and is probably dry season because harvesting normally takes place during dry season with a few exceptions. The time of the year could also be indicated by a combination of phenomena in the photograph.

Maize harvesting

Estimating direction

This refers to identifying the position of the photographer after studying the relative sizes of objects in the photograph. It is possible to estimate the direction on a photograph using shadows. This is possible if the time and place where the photograph was taken are known. For example, if a photograph shows a tree whose shadow is on the right and it is indicated that it was taken within the tropics and in the morning, then the photographer was facing south. The sun and the shadow are always in the opposite sides of the photograph. If the sun is in the east, the shadow will always be cast westwards and vice versa. If the shadow is pointing towards you and the photograph was taken in the afternoon (meaning that the sun was in the west), the photographer was facing westwards. With such information, it is then possible to fix compass points on a photograph.

The other alternative for identifying the position of the photographer or cameraman is by observing the size of objects in the photograph. The objects close to the photographer appear larger those far away. The objects apparently appear to decrease in size as their distance from the photographer increase. Therefore, the part of the photograph showing huge objects is the place close to where the photographer stood. Study the photograph below carefully and keenly. Can you tell the position of the photographer?

Size of images gives a clue on the photographer's position

Estimating the size of features

Due to perspective nature of photographs, especially with regard to the ground general view photographs, it is not ease to measure and calculate possible distances from them. It is, however, possible to work out approximate sizes of objects using familiar objects in the close-up photograph such as a person, ruler or coin. This gives an impression of the relative sizes of the objects and from this we can be in a position of estimating the size of a given object in a photograph.

That is why, we normally see a coin, hammer or ruler or any known object placed against rock strata to give us an idea about the size of the rock.

We see a person standing against a cliff or tree so that we can use that person to estimate the height of the cliff or tree. This is done by first estimating the height of the person and comparing it with the height of the object and then estimating how many times the tree is taller than the person. In this way, we can estimate the height of crops such as tea, coffee and sisal.

A ruler placed against the face of a rock can be useful in estimating the thickness of the rock layer. Since the length of the ruler is known, its actual length as it appears in the photograph can be used to estimate how many ruler lengths there are in the whole rock layer.

It is difficult to determine distances and areas accurately in photographs. This is because objects in a photograph are not of uniform size and height. Objects in the foreground always appear larger than objects of the same size in the background.

Natural and Manmade Features in the Fore, Middle and Background of the Photograph

Identify natural and manmade features in the fore, middle and background of the photograph

Many physical features shown in the photograph can be identified and interpreted. These features include relief, drainage, and vegetation, among others.

Relief

Before interpretation of other physical features, it is important to first identify relief features on the photograph. Start by giving a general idea about the area shown in the photograph. In describing landscape and landforms, it is important to go even further and describe the forces and processes that are responsible for their formation and modification. This is an essential aspect of relief interpretation. Relief features in the photograph may include the following features:

Flat landscapes

These landscapes occur both in lowland and highland areas. They are called plains in the lowlands and plateaus in the highlands. Plains altitudes are less than 500 metres while plateau altitudes are more than 500 metres above sea level.

It is impossible to tell the average area of the land directly from a photograph. However, other features appearing in the photograph, such as part of the sea, crops and other economic activities may be used in estimating the altitude. Where there is an accompanying topographical map of the area, it would then be easier to state the height of the land from the map.

Where there is no sufficient information to tell the height of the land, relief may be described as flat. One can then suggest that it is probably a low-lying plain or a plateau surface. Some flat areas may be described as flat lowlands or highlands.

Hilly areas

A hilly landscape is shown on photographs as having varied relief of hills and valleys that are not isolated on a flat landscape. Where hills appear to have the same height across the entire landscape, such a landscape is probably a dissected plateau. Streams have cut valleys across former flat land and some interlocking spurs may be visible towards valleys. Ridges, escarpments and conical hills may easily be identified according to their appearance.

Mountainous relief

This kind of relief stands at an altitude of more than 2000 metres above sea level. As such, not all rising features identified on photographs are mountains. The relief of mountainous areas is characterized by very steep slopes often with no human settlements. The slopes may have vegetation covering them, which could be forests.

At much higher levels, snow might be seen. The type of trees growing could give a clue about the altitude of the land. If there are crops growing or animals reared, these could also give a clue as to the altitude. Certain crops such as wheat and apples are high-altitude crops. Likewise, animals such as merino sheep and dairy cattle are also reared in high-altitude areas within the tropics.

Identifying relief features on vertical aerial photographs is not straight-forward. The following guidelines could assist in identifying different types of relief:

1. Flat areas would appear as areas with light colour tone except in regions covered with dense vegetation such as forested areas. Rivers may have big meanders while roads, footpaths and railways are generally straight, with gentle bends in some places.

2. Hilly areas could be identified by examining river streams. The streams could be joining one another and getting wider downstream. Hilly areas are the source of rivers. The colour tone in hilly areas is generally dark.

Drainage

Drainage features such as rivers, lakes and seas may easily be identified in all types of photographs. Different aspects of rivers can be studied on a photograph. These include the shapes of river valleys, stages of development and various features. Based on the presence of certain features, one can tell the nature of the rock over which the river flows. For example, the presence of rapids and waterfalls is an indication that the river is flowing over steep land. River meanders are an indication that the river is in it mature or old-age stage. Interlocking spurs indicate that the river valley is made of alternating layers of hard and soft rocks.

A meandering river

Drainage patterns are easier to identify on vertical aerial photographs. The colour tone of areas covering deep water appears darker than those of shallow water. The various functions of the river can also be identified.

Vegetation

Photographs show all types of vegetation in the photographed area. Planted (artificial) and natural forests appear to be distributed unevenly, with planted forests usually in clear straight lines. In planted forests trees tend to be of the same type, size and height because they were planted at the same time.

The plant characteristics that may appear on the photograph can be used as a guide to the general types of vegetation, for example savannah or semi-arid vegetation. The following guidelines should be used when describing vegetation on a given photograph:

Identify the types of vegetation, for example, forests, thickets, grasslands and swamp plants. Describe the plants, giving details such as height, shape and appearance of leaves. Where possible, give the names of species of plants, e.g. jacaranda, cacti, eucalyptus trees, etc. Planted vegetation should be distinguished from the natural ones by their characteristics. Proper interpretation of vegetation calls upon application of geographical knowledge outside the photograph as well.

A planted forest

Soil

A clue on the type of soil in a photographed area may be given by the types of crops grown and appearing on the photograph. Rice, for example, grows well in clay soil. Tea and coffee require volcanic soil. Coconuts and cashew nuts thrive well in coastal regions with sandy soils, and a variety of horticultural crops thrive in loam soils.

Proper interpretation of the soil requires an application of one's general knowledge of geography learnt in classroom as well as knowledge from other disciplines.

Climate

Weather and climate are not shown directly on photographs. Features contained in a photograph can be used to make conclusions about the climate of a photographed area. The type of crops grown and vegetation on the photograph can be used as a clue to establish the climate of a place. Vegetation types and crops can also provide evidence about the season or climate of a place. For example, the presence of many cacti signifies an arid or semi-arid region, and hence a desert or semi-desert climate.

Crops such as sisal are grown in hot areas that receive low rainfall while sugarcane thrives in warm to hot climate with high rainfall. The type of clothing people in the photograph are wearing can give an indication about the weather and possible climate.

Interpreting Features Presented on the Photograph

Interpret features presented on the photograph

Human activities on a photograph are depicted by various forms of land use. The uses of land may in form of agriculture (crop cultivation and animal husbandry), forestry, settlement, wildlife conservation, mining and construction of infrastructures, among other uses.

Agriculture

This includes crop cultivation and livestock rearing. It is practised at subsistence and commercial levels. It is easy to identify agricultural activities on ground photographs. To be able to identify these features on vertical aerial photographs, it requires close examination of the features.

Some evidences that can be used to establish the kind of agricultural activities taking place in an area shown on the photograph are summarized in the table below:

Type of farming	**Evidences to look for**
Subsistence crop farming	• Some houses are permanent while others are temporary • The land is often divided into small plots owned and cultivated by individual farmers • Mixed farming is practised • Simple farming tools such as hoes, mattocks, pangas and rakes are used • Fields are separated by hedges
Subsistence livestock farming	• Indigenous and exotic animal breeds are kept • Animals are grazed on grassland or semi-arid vegetation • Large herds of local cattle (zebu), goats and sheep
Commercial livestock farming	• Large fields divided into paddocks • Presence of cattle sheds near farm houses • Windmills for water supply • Presence of water tanks, ponds or reservoirs in the dry areas • Evidence of livestock infrastructures such as cattle dips or spray races, abattoir, cattle bomas, slaughter slab, etc. • High grade exotic or crossed cows with large udders • Milking parlour with milking machines, and milk processing plants • Indoor grazing units
Commercial crop farming	• Presence of cash crops on an extensive area • Evidence of modern farming methods, e.g. farm machinery • Facilities for collecting crops, e.g. sheds and stores • Presence of access or feeder roads within the farm
Plantation farming	• A single crop covering extensive stretches of land, e.g. sugarcane, tea, coffee, sisal, wheat • Processing factories • Presence of storage facilities, e.g. silos • Many labourers in the fields

	• Nucleated settlement within the farm. These are usually for the workers' housing • Presence of a network of roads crossing the farm – to facilitate mechanization and haulage of inputs and produce to and from the farm, respectively

Not all the listed evidences in the table for a single type of farming will be available on a single photograph. However, information available may suffice to draw conclusions about the type of farming.

Apart from the types of farming, there are other aspects to be considered when describing and interpreting photographs. These include:

- farming characteristics and the areas where such a type of farming is practised;
- the advantages and limitations of the type of farming;
- the effects of each type of farming to the environment; and
- the government policy on each type of farming.

Subsistence farming

Livestock husbandry

Sugarcane plantation

Settlement

A settlement comprises of a group of buildings in an area where people live and carry out social and economic activities. However, some settlements are made up of institutional, industrial and commercial buildings most of which may not comprise of living houses. Settlements may be of two types, namely, rural and urban settlements.

In photographs, rural settlements can be indicated by the following features:

a. Many semi-permanent and a few permanent buildings such as grass-thatched houses or iron-roofed houses with mud or brick walls

b. Evidence of farming, cattle herding or fishing activities

c. Unplanned or unevenly distributed dwellings or presence of villages Planned settlements in rural areas are associated with institutions or plantations.

Rural settlement

Urban settlements can be identified by the following features:

a. Permanent buildings, which dominate the area

b. Regular street patterns

c. Buildings with several storeys

d. Many large buildings and warehouses indicating an industrial area

e. High numbers of people (if they are shown on the photograph)

f. Many motor vehicles on the road, which may lead to traffic jams

g. Port facilities such as docks, cranes, warehouses and containers

Urban settlement

Not all the listed evidence above will be found on a single photograph. However, there should be sufficient evidence to lead one to make a distinction as to the type of settlement. Settlement patterns can be easily recognized especially from the ground oblique and aerial photographs.

Industrial and mining activities

Various features signalling the presence of industrial and mining activities may also appear on a photograph. It is important that one is familiar with a wide variety of photographs on which these features are shown.

The following evidence can be used as a guide in identifying industrial and mining activities on a photograph:

a. Factory buildings with tall chimneys that might be issuing a lot of smoke into the air

b. Nucleated settlements in the neighbourhood, likely to be the labourers' houses

c. Tall chimneys emitting flames and a network of pipes with large tanks in the distance could indicate an oil refinery

d. Large warehouses close to a building that looks like a factory

e. Large open pits, large excavators and lorries carrying loads of rocks could indicate open cast mining

f. A large area with derricks (oil rigs) could point to an oilfield where oil is mined

Lumbering

Lumbering activities could be indicated by the presence of the following features/activities:

a. People cutting trees using manual or power saws

b. People loading timber onto lorries or tractor trailers

c. Logs floating down the river

d. Logs piled near a saw mill

e. Large forest clearings with tree stumps and piles of logs

A pile of logs

Transport and communication

Various forms of transport and communication appear differently on photographs. Modes and means of transport can also be identified on a photograph. The following are some of the clues on transport:

a. Motor vehicles and roads

b. A railway line with or without a train; or just the presence of a named railway station

c. A large tamaracked or murram road with buildings on one side, a control tower. Aeroplanes may be seen, or just the presence of a named or symbolized airport may be indicated on a photograph.

d. Presence of ports, boats, ships or large water bodies

e. Animals carrying loads on their backs

Facilities for communication may be indicated by the presence of telephone lines, telephone booths, satellite dishes, buildings with masts and wires connecting the masts, post office, radio or television station, newspapers or newspaper stands, etc. Other human activities represented on photographs can also have relevant clues that enable one to identify the presence of given communication facilities.

APPLICATION OF STATISTICS

Concept of Statistics

Statistics

Explain the concept of statistics

Statistics is the study of collection, analysis, interpretation, presentation, and organization of data. Data refers to crude or uninterrupted information.

In applying statistics to, for example, a scientific, industrial, or societal problem, it is necessary to begin with a population or process to be studied. Populations can be diverse topics such as "all persons living in a country" or "every household in a village". It deals with all aspects of data including the planning of data collection in terms of the design of surveys and experiments.

Types of statistics

Two main statistical methodologies are used in data analysis, namely, descriptive statistics and inferential statistics.

a. **Descriptive statistics** summarizes data from a large sample using indexes such as the mean or standard deviation. Descriptive statistics are distinguished from inferential statistics (or inductive statistics), in that descriptive statistics aim to summarize a sample, rather than use the data to learn about the population that the sample of data is thought to represent.

b. **Inferential statistics** draws conclusions from data that are subject to random variation (e.g., observational errors, sampling variation). Descriptive statistics are most often concerned with two sets of properties of a distribution (sample or population): (i) **Central tendency** (or location) – this seeks to characterize the distribution's central or typical value. (ii) **Dispersion** (or

variability) – this characterizes the extent to which members of the distribution depart from its centre and each other.

Types of Statistical Data

Differentiate types of statistical data

When working with statistics, it's important to recognize the different types of data. Data are the actual pieces of information that you collect through your study. For example, if you ask five of your friends how many pets they own, they might give you the following data: 0, 2, 1, 4, 18. (The fifth friend might count each of her aquarium fish as a separate pet). Not all data are numbers; let's say you also record the gender of each of your friends, getting the following data: male, male, female, male, female.

Most data fall into one of two groups: numerical or categorical.

- **Numerical data.** These data have meaning as a measurement, such as a person's height, weight, IQ, or blood pressure; or they're a count, such as the number of stock shares a person owns, how many teeth a dog has, or how many pages you can read of your favourite book before you fall asleep. Statisticians also call numerical data ***quantitative data***. Numerical data can be further broken into two types: discrete and continuous. *Discrete data* represent items that can be counted; they take on possible values that can be listed out. The list of possible values may be fixed (also called *finite*); or it may go from 0, 1, 2, on to infinity (making it *countably infinite*). *Continuous data* represent measurements; their possible values cannot be counted and can only be described using intervals on the real number line. For example, the exact amount of gas purchased at the filling station for cars with 20-gallon tanks would be continuous data from 0 gallons to 20 gallons, represented by the interval [0, 20], inclusive. You might pump 8.40 gallons, or 8.41, or 8.414863 gallons, or any possible number from 0 to 20. In this way, continuous data can be thought of as being uncountably infinite. For ease of recordkeeping, statisticians usually pick some point in the number to round off.
- **Categorical data:** Categorical data represent characteristics such as a person's gender, marital status, hometown, or the types of movies they like. Categorical data can take on numerical values (such as "1" indicating male and "2" indicating female), but those numbers

don’t have mathematical meaning and you couldn’t add them together. Other names for categorical data are ***qualitative data***, or ***Yes/No data***.

- **Ordinal data**: These data mixes numerical and categorical data. The data fall into categories, but the numbers placed on the categories have meaning. For example, rating a restaurant on a scale from 0 (lowest) to 4 (highest) stars gives ordinal data. Ordinal data are often treated as categorical, where the groups are ordered when graphs and charts are made. However, unlike categorical data, the numbers do have mathematical meaning. For example, if you survey 100 people and ask them to rate a restaurant on a scale from 0 to 4, taking the average of the 100 responses will have meaning. This would not be the case with categorical data.

Statistical data can be expressed in different levels or scales of measurement. These are:

a. ***Nominal scale***: This type of scale has qualitative property such that one my decide to express the data as ‘excellent’, ‘good’, ‘fair’ or ‘poor’ and maybe use grades, e.g. A, B, C, D and so on. Nominal scale may also include numerical values. For example one may decide to let 1, 2, 3 and 4 stand for ‘excellent’, ‘good’, ‘fair’ or ‘poor’ or vice versa.

b. ***Ordinal scale***: This scale involves ranking, so it is also qualitative in nature. The data involves rank orders or positions among events or objects. These statistics attempt to provide quality or position. For example, if Chacha scored 5% in Geography Test while Tibaijuka scored 95%, then we can say that the former ranked number 19 while the latter ranked number 1 out of 20 students. Sometimes, values such as ½ of the class scored below 50% in Geography may be included in the ranking.

Scale	**Properties**	**Examples**
Nominal	Indicates a difference, without any implied ordering	Religion: 1=catholic; 2=protestant; 3=Jewish; 4=Muslim; 5=other
Ordinal	Indicates a difference, and the direction of the difference(e.g., more or less than)	Attitude on a subject:1=strongly disagree, 2=disagree; 3=don't care / don't know; 4=agree; 5=strongly agree
Interval	Indicates a difference, with directionality and amount of	Temperature in CelsiusOccupational Prestige (12-96)

	difference in equal intervals	
Ratio	Indicates a difference, the direction of the difference, the amount of the difference in equal intervals, an absolute zero	Temperature in KelvinIncomeYears of schooling

c. ***Interval scale***: This type of scale employs truly quantitative values and allows the use of mathematical operations such as adding, subtracting, multiplying and dividing. At no time is zero present in this scale. For example, the range of temperature in which rice grows well is 25°C and 45°C; most livestock keepers get between 10 and 15 litres of milk per cow per day.

d. ***Ratio scale***: This is a type of scale that is used to make comparisons between values or quantities. For example, Ms Iku harvested 50 sacks of maize which is twice Mr Aritamba obtained from the same acreage because the former applied fertilizer and good farming practices while the latter did not.

Variables

A variable is anything or characteristic that data may have, or an attribute which changes in value under given conditions. Variables include population size, age, sex, altitude, temperature and time.

There two broad types of variables, namely, independent and dependent variables.

a. ***An independent variable*** is a variable factor which influences the changes of other variables or outcomes. The independent variable is also known as **manipulated** variable. This is the factor manipulated (controlled) by the researcher, and it produces one or more results known as *dependent variables*. There may be more than several dependent variables, because manipulating the independent variables can influence many different things. For example, an experiment to test the effects of a certain fertilizer, upon plant growth, could measure height, number of fruits, and the average weight of the fruits produced. All these are varied analyzed factors, arising from the manipulation of one independent variable, the amount of fertilizer.

b. ***A dependent variable*** is an outcome or result that has been influenced by other variables. A dependent variable does not influence or change other variables. The dependent variable responds to independent variable. It is called *dependent* because it "depends" on the *independent*

variable. In any research, you cannot have a dependent variable without an independent variable. Any alteration in the independent variable will change the dependent variable.For example, you might be interested to carry out an experiment to determine the influence of the concentration of phosphorus fertilizer on maize growth. To conduct this experiment, you grow maize in similar conditions of soil and atmospheric environment but vary the quantity of fertilizer in each test (*independent variable*). Then you measure the height of maize plants (*dependent valuable*) after a certain interval of time to find out the influence of the fertilizer on maize growth. The value of the height you will obtain will obviously depend on the amount (concentration) of the fertilizer applied. And, in this case, you will obviously get different heights depending on the quantity of fertilizer applied.

Graphical Data

Present data graphically

After data have been collected, the next step is to present the data in different ways and forms. Some of the forms in which the data may be presented include charts, graphs, lists, diagrams, tables, essays, graphs, histograms, and even sketches.

Line (linear) graphs

Line graphs have unique properties that distinguish them from other graphs. The properties of line graphs are as follows:

a. The graphs are drawn by plotting a dependent variable against an independent variable and points are joined by a line.

b. The values on the y-axis start at point zero.

General procedure for drawing line graphs

a. Get the required data for plotting the graph.

b. Identify the independent and dependent variable. Statistically, the independent variables are placed on the x-axis while the dependent variables are placed on the y-axis.

c. Decide on the vertical scale depending on the graph space and values of the independent variable available.

d. Decide on the horizontal spacing of the graph according to graph space available.

e. Draw and divide the vertical and horizontal axes depending on the respective scales.

f. Plot and join the points to get the graph.

g. Write the title of the graph you have drawn.

h. Indicate the scale of the graph.

i. Show the key for the graph if need be.

Line graphs can be sub-divided into:

a. Simple line graphs

b. Group (comparatives) line graphs

c. Compound line graphs

d. Divergent line graphs

Simple line graph

Presenting the statistical data by a simple line graph is the most common and popular method. The simple line graphs are easy to construct and interpret. They have many uses which include showing temperature, farm outputs, population, and mineral production, among others.

Construction procedure:

The graph can be drawn after getting the required data. Consider the following table which shows the average monthly temperature recorded in a certain weather station:

Average monthly temperature for station X

Month	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec
Temp (°C)	23	24	26	28	29	28	26	26	26	27	26	25

The following procedures may be used:

1. Identify the variables. The dependent variable is temperature and the independent variable is months.

2. Determine a vertical scale. Assume that the graph space available is 6 cm vertically. Vertical scale = maximum value of the divided by the graph space availablee.g. 30°C/6 cm = 5°C per centimetre. Therefore, in the vertical axis (x-axis), 1 cm will represent 5°C

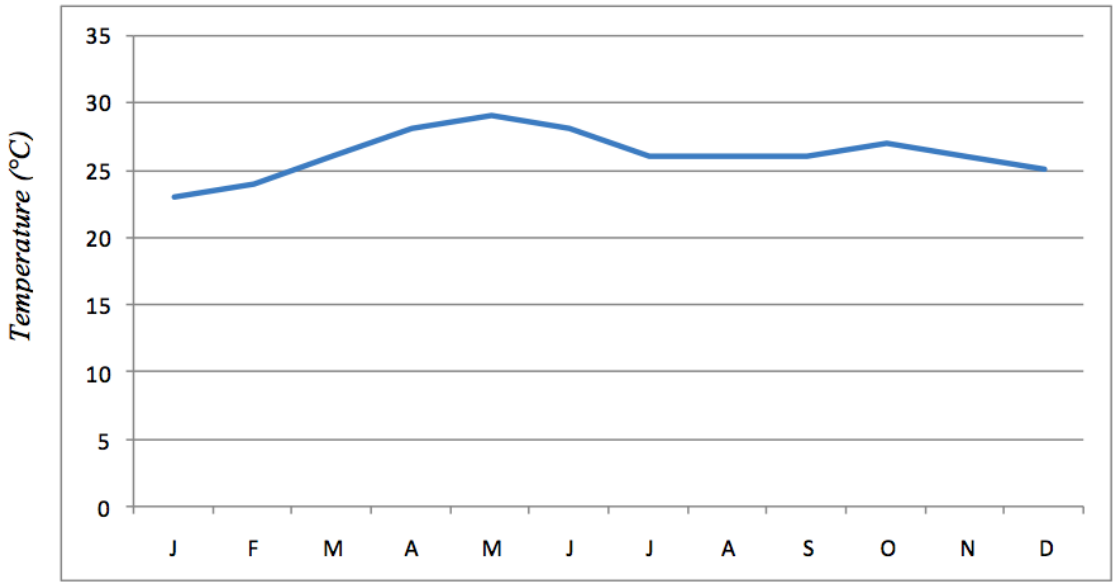
3. Determine the horizontal scale (y-axis) depending on the available space. Let, for instance, 1 cm represent one month.

4. Draw both axes and label them: y-axis for temperature and x-axis for months.

5. Plot the points and join them by a smooth line to make a curve.

6. Insert the title and scale.

The following is a simple line graph showing monthly temperature for station X.



Average monthly temperature for Station X

Source: Hypothetical data

Scale

- Vertical – 1 cm:3°C

- Horizontal – 1 cm:1 month

Advantages of simple line graphs

1. They are easy to draw, read and interpret.
2. They show specific values of data, so if you are given one variable the other can easily be determined.
3. They show patterns in data clearly, meaning that they visibly show how one variable is affected by the other as it increases of decreases.
4. They enable the viewer to make predictions about the results of data. So they allow for determination of intermediate or continuing values.
5. It is easy to read the exact values against plotted points on straight line graphs.
6. A broken scale can be used when the value starts at a large number.

Disadvantages of simple line graphs

1. They can only be used to show the data of one item over time.
2. One can change the data of a line graph by not using consistent scales on the axis.
3. They can give a wrong impression on the continuity of data even when there are periods when data is not available.
4. They do not give a clear visual impression of the actual quantities.

Group (comparative) line graph

A group line graph is also known by the following terms:

- Comparative line graph
- Composite line graph
- Multiple line graph
- Polygraph

A group line graph involves drawing more than one line on the same statistical graph. It shows the relationship between sets of similar statistics for two or more items.

Usefulness of a group line graph

- Comparing different values or trends in two or more data variables.
- Examining the possibility of a relationship existing between the distributions of a number of variables over time.
- Comparing the distribution of the same variable at different places.

Construction:

The method of drawing a group line graph is the same as for a simple line graph. Therefore, to draw each single line in a group line graph, follow similar steps used for construction of the simple line graph.

The following things should be considered before drawing the graph:

1. The lines drawn should not be uniform in colour, thickness, general appearance, etc (See the graph below in which each line has a different colour).
2. The number of lines that a graph can accommodate should not exceed 5, meaning that not more than 5 items should be compared in a single graph.

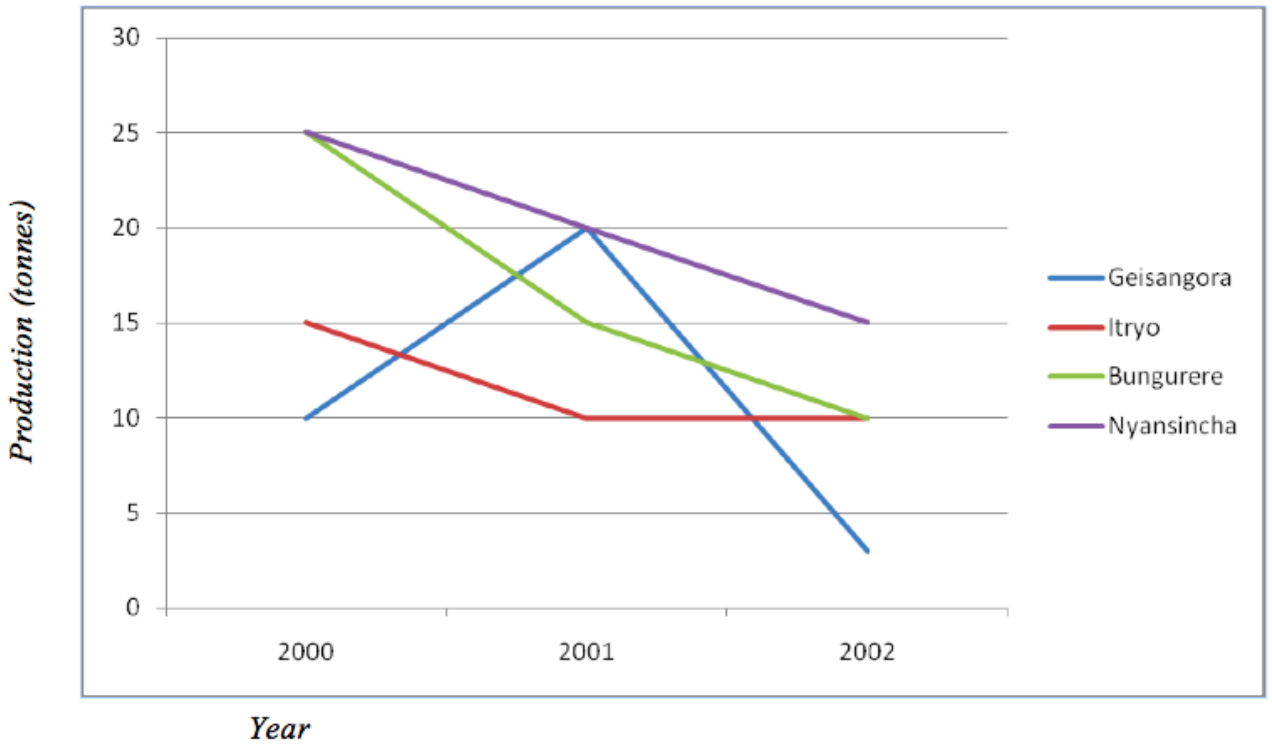
The following table shows banana production (in tonnes) by three villages in Ingwe Division, Tarime district. These data have been used to plot the group (comparative) line graph as shown below:

Banana production by three villages

Village/Year	**Geisangora**	**Itiryo**	**Bungurere**	**Nyansincha**
2000	10	15	25	25
2001	20	10	15	20

2002	3	10	10	15

Source: Hypothetical data



Maize production by three villages between 2000 and 2002

Advantages of group line graph

1. The quantity of each component is shown clearly by different line shadings.
2. Time and space are saved since all the line graphs are drawn at ago as a group.

Disadvantages of group line graph

1. The lines can be overcrowded and hence become difficult to read and interpret if many data are involved.
2. It does not give a clear visual impression of actual quantities.

Compound line graph

A compound line graph is used to analyse the total and the individual inputs of the specific commodities or economic sectors. The graph involves drawing two or more lines, each line

corresponding to one item in a different year or region. The items are differentiated from each other or one another by shading differently.

Construction:

The table below is used for construction of the graph. The table contains hypothetical figures for mineral exports between 2010 and 2012.

Year/Mineral	**Diamond**	**Gold**	**Tanzanite**
2010	10,000	16,000	20,000
2011	20,000	25,000	32,000
2012	25,000	35,000	40,000

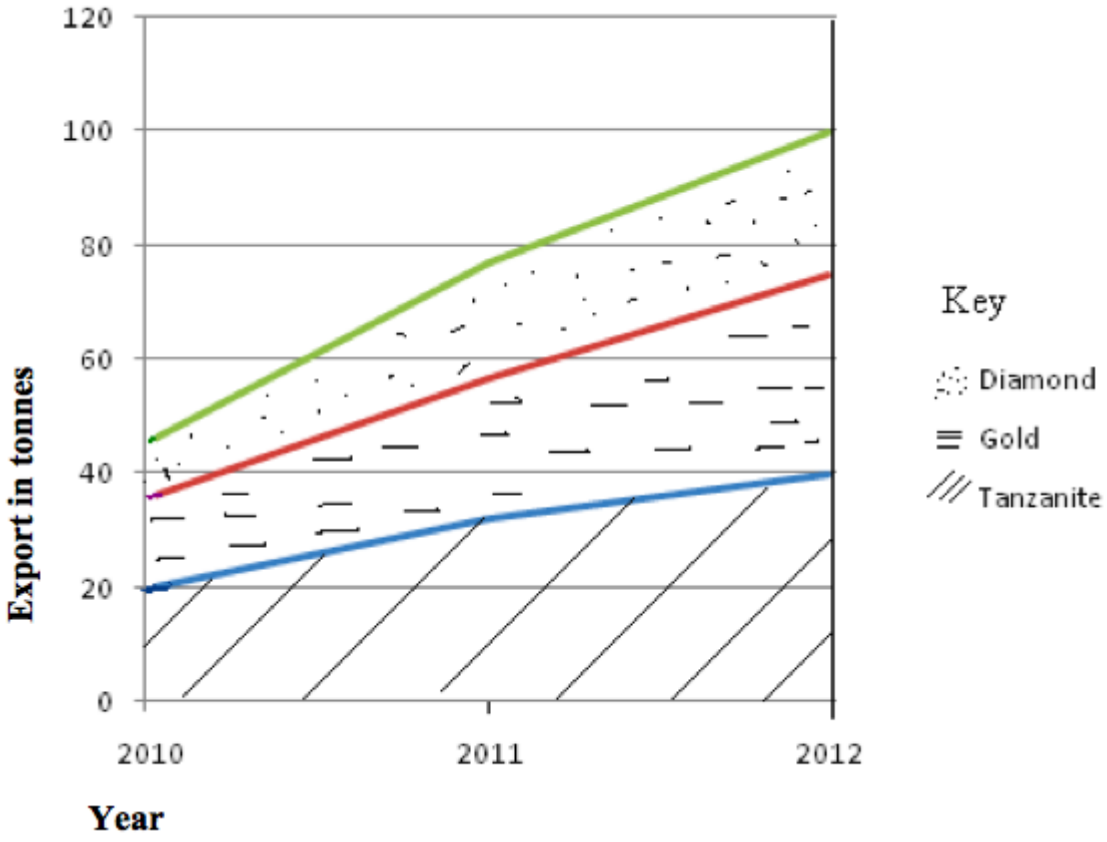
Procedure:

- Simplify the data to make the presentation work easy by dividing each value by 1000.

Year /Mineral	**Diamond**	**Gold**	**Tanzanite**
2010	10	16	20
2011	20	25	32
2012	25	35	40

- Add the values for each year to get the cumulative export: 2010 = 10+16+20 = 46; 2011 = 20+25+32 = 77; 20112 = 25+35+40 =100; These values will be used to determine the uppermost height of the graph. They will also help estimate the scale to be used. In case of the above data, the highest value is 100. So if we want to use the scale of 1 cm to 1 tonne (1000 tonnes in reality), the uppermost height of our graph will be 100 cm (see the graph drawn
- Plot the values for mineral exports against years on a graph. Usually the line graph for data with the highest values is drawn first. Thus, first draw the line graph for tanzanite since it has the highest values, followed by that of gold and finally diamond.

- Draw the second line graph above the first one to show the next component. To get the values for plotting the second line graph, add the values of the first item (in this case, tanzanite) to that of the second item (gold) for each year, thus: 2010 = 20+6 =36; 2011 = 32+25 =57; 2012 = 40+35 =75
- Draw the line graph for the last item (diamond) above that of the second item. To get the values for plotting this graph, add the values for the second item to those of the last item, thus: 2010 = 36+10 =46; 2011 = 57+20 =67; 2012 = 75+25 =100
- Shade the component parts between the line graphs using different shadings as shown.
- Label the axes, show the key and indicate the scale used to construct the graph.



Advantages of compound line graph

1. Total values are shown clearly and easily.
2. It gives good visual impression.

3. Combining all graphs in one saves time and space.

Disadvantages of compound line graph

1. Graph construction is difficult and time-consuming.
2. It involves a lot of calculations which are difficult and time-consuming.
3. It is difficult to read and interpret the value for any one commodity for any particular year.

Divergent line graph

A divergent line graph is a line graph which shows how variables deviate from the mean. The mean is represented by zero axis drawn horizontally across the graph paper.

Year	**Yield (tonnes)**
2012	1000
2013	1500
2014	500
2015	3000

Construction

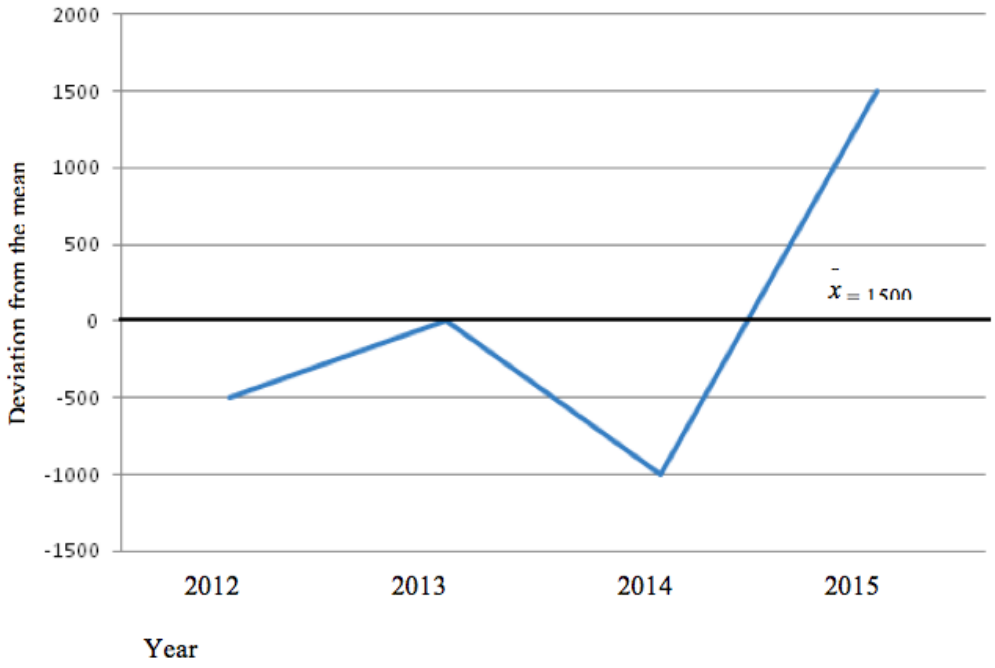
- Sum up the values of all items or commodities. 1000 + 1500 + 500 + 3000 = 6000
- Calculate the arithmetic mean (average) of the values. 6000/4 = 1500 Thus the arithmetic mean () = 1500
- Calculate the deviation from the mean of each value as shown in the table below.

Deviation from the mean value

Year	X	X –
2012	1000	-500

2013	1500	0
2014	500	-1000
2015	3000	+1500

- Plot the graph using the values of deviation from the mean; and remember to include the title and scale of the graph.



Advantages of divergent line graph

1. It clearly shows how items fluctuate from the mean.
2. It compares the values of the items and hence facilitates a sound conclusion.
3. It shows both the positive (profit) and negative (loss) phenomena.
4. It is easy to construct, read and interpret.

Disadvantages of divergent line graph

1. It involves many calculations and hence time-consuming.
2. It might be difficult to interpret if one lacks statistical skills.

3. It is applicable for only one item per graph.

Bar graphs

A bar graph is also called bar chart or columnar graph. This method is used to present data which are not continuous. This means that in a bar graph there is no relationship between or among data.

Bar graphs emphasize individual amounts and their relative variations. When drawing such graphs, bar width in a graph is kept constant while bar lengths change in size as per the amount of the independent variable in question.

Though the bars can also be drawn horizontally, they are usually drawn vertically. The bars should be separated from one another by a space.

Types of bar graphs:

a. Simple bar graphs

b. Group or comparative bar graphs

c. Compound bar graphs

d. Divergent bar graphs

Simple bar graph

A simple bar graph is drawn to show a single item per bar. It mainly represents simple data.Consider the data in the table below which shows the value of sisal exported by Tanzania between 1900 and 1993:

Year	Sisal export (Tsh ‘000)
1990	106126
1991	107430
1992	142601

1993	161180
1994	202425

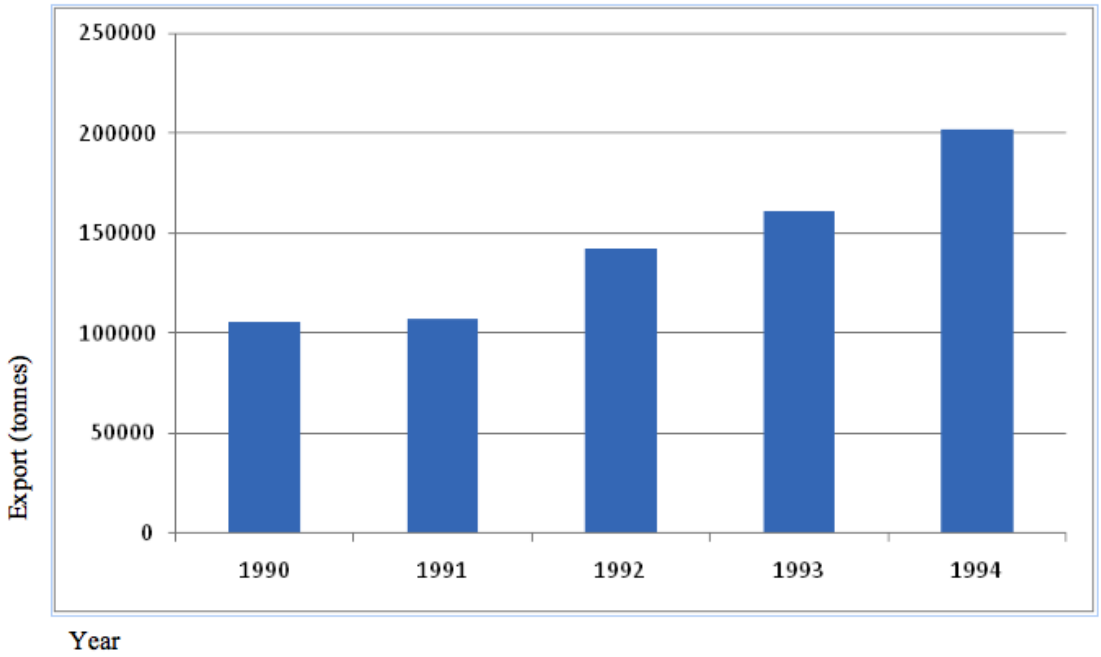
Construction:-

1. Choose the appropriate scale. However, note that the table below is not drawn to scale – it was drawn using the computer. All hand-drawn graphs must indicate the scale used. For, example, in our graph below, we might have chosen 1 cm to represent 10,000 tones, in which case we could obtain the values 5, 10, 15, 20 and 25 that we could have used to plot the graph.

2. Draw the axes and insert the bars. Note that all the bars must have the same width and spacing.

3. Shade the bars uniformly by using shade, lines, crosses, dots, etc.

4. Insert vertical and horizontal scales and the title.



Tanzania sisal export

Scale: 1 cm to 50,000 tonnes

Advantages of a simple bar graph

1. It is simple to construct, read and interpret.
2. It has a good visual impression.
3. It can be used to compare how the amount of an item varies from time to time.

Disadvantages of a simple bar graph

1. It is limited to only one item or commodity and hence not suitable for massive data.
2. Not suitable for continuous data such as temperature.

Group (comparative) bar graph

A comparative bar graph consists of several bars drawn side by side on the same chart for the purpose of comparison. The technique involves grouping of bars in a chart. The graph can be used to show how production of certain commodities varies each year.

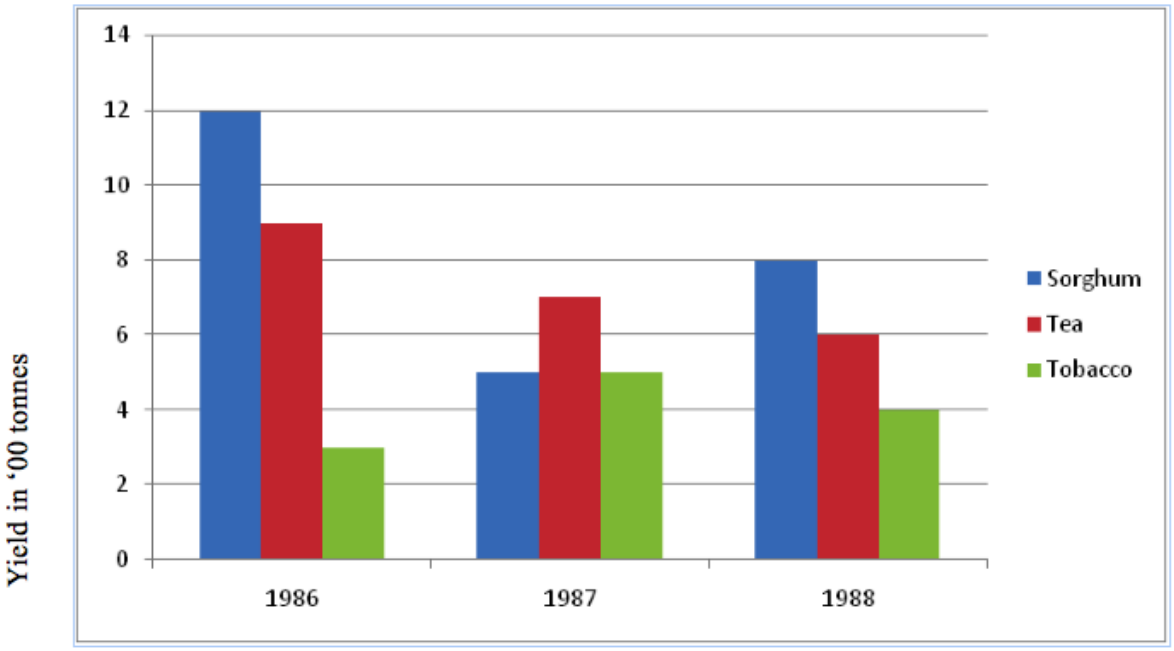
Construction:

The procedure for construction of the comparative bar graph is similar to that of drawing the simple bar graph except that the simple bar graph contains a single bar while the comparative bar graph comprises of multiple bars.

Consider the data in the table below, showing agricultural production in metric tonnes.

Year/Commodity	**1986**	**1987**	**1988**
Sorghum	1200	5000	8000
Tea	9000	7000	6000
Tobacco	3000	5000	4000

The graph for the data is as shown below.



Group (comparative) bar graph showing crop yields in '000 kg (1986-1988)

Advantages of a group bar graph

1. The total values are expressed well for illustration of points.
2. It is easy to construct, read and interpret.
3. The importance of each component is shown clearly.

Disadvantages of a group bar graph

1. It is difficult to compare the totals of each item/component.
2. Trends such as fall and rise cannot be shown easily.

Compound (divided) bar graph

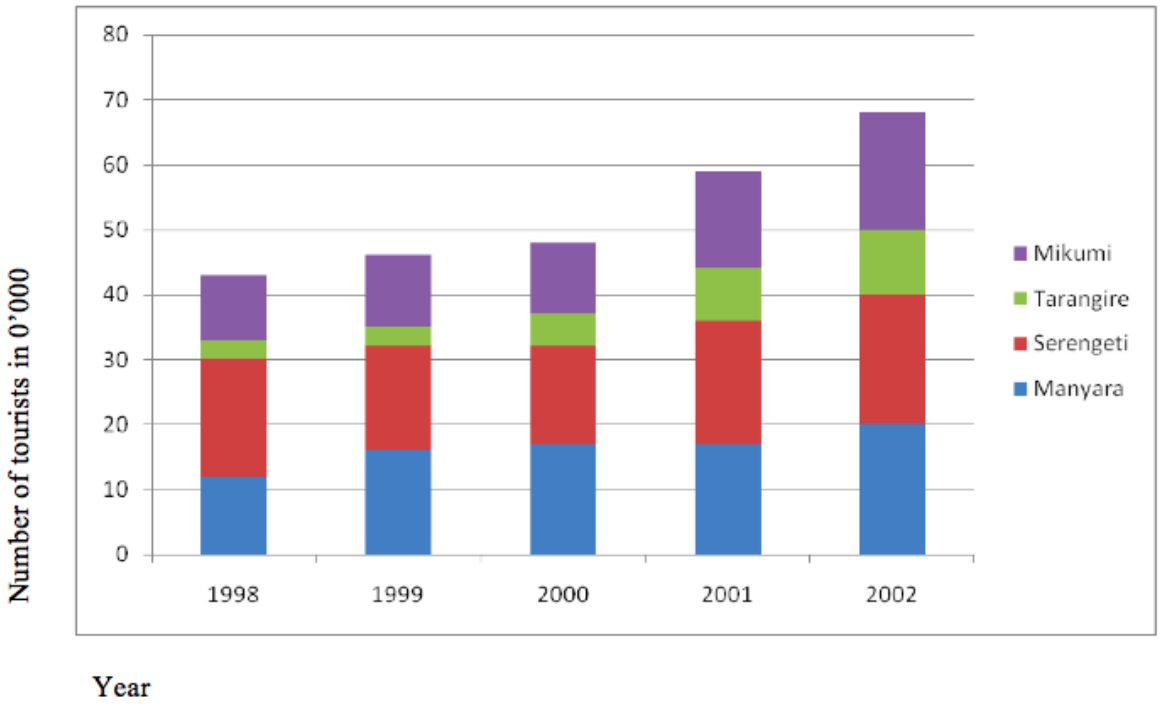
This is a method of data presentation that involves construction of bars which are divided into segments to show both the individual and cumulative values of items. The length of each segment represents the contribution of an individual item in the total length while that of the whole bar represents the total (cumulative) value of the different items in each group.

Construction

- Get the data needed for presentation. For example, consider the table below, which shows the number of tourists who visited the named Tanzania National Parks from 1998 to 2002.

Year /park	**1998**	**1999**	**2000**	**2002**	**2003**
Manyara	120,000	160,000	172,000	170,000	203,000
Serengeti	175,000	160,000	148,000	185,010	201,000
Tarangire	29,000	30,000	54,100	79,000	102,000
Mikumi	100,000	110,000	111,000	150,000	183,400

- Simplify the data (to make the presentation work easy) by dividing each value by 10,000. Then add the values to get the total for each year. The simplified data are as shown in the table below.
- Determine the scale of the bar length based on the highest total value. In this case, the highest total value is 68 (20 + 20 + 10 + 18). Recall the construction of the compound line graph! If we choose 1 cm to represent 1 tourist (10,000 tourists in reality), then the length of the tallest bar will be 68 cm. Note that the maximum height of a graph for each year equals the cumulative total values for each year (i.e. **43**, **46**, **48**, **59**, **68**).
- Decide on the bar spacing, for example, 1 cm apart.
- Draw the axes and label them.
- Start by drawing bars that represent the highest values.
- The first sets of bars to be drawn are those that represent the highest values. On top of these, the second highest segments are drawn. The last segments to be drawn are those with the lowest values in general.
- To make it easy to follow the rise and fall of individual values, a soft line could be drawn across bars to separate individual segments.
- Colour or shade the segments to improve the appearance and simplify interpretation.
- Inset the scales, key and title.



Compound (divided) bar graphs showing tourist visits in 0'000 (1998-2002)

Advantages of compound (divided) bar graph

1. It is easy to read and interpret as the totals are clearly shown.
2. It gives a clear visual impression of the total values.
3. It clearly shows the rise and fall in the grand total values.

Disadvantages of compound (divided) bar graph

1. The values of individual segments above the first set are difficult to establish because they don't start at zero. To get the correct values of the top segments, you have to add the figures, which is difficult for someone not well equipped with statistical skills.
2. The graph is very difficult to construct and interpret.
3. It is not easy to represent a large number of components as this would involve very long bars with many segments.

Divergent bar graph

A divergent bar graph is a graph which shows the fluctuation of individual items from the mean.

Construction:

1. Calculate the arithmetic mean (average) of the items.
2. Subtract the mean from each item.
3. Draw the graph using the resulting values.
4. Insert the scale and title of the graph.

The data below show the enrolment of Form One students at Mara Secondary School from 1980–1985. Study the table and present the data by a divergent bar graph.

Year	**Number of students**
1980	100
1981	150
1982	175
1983	200
1984	225
1985	300

Procedure:

- Find the arithmetic mean:

$$\bar{x} = \frac{\sum x}{n}$$

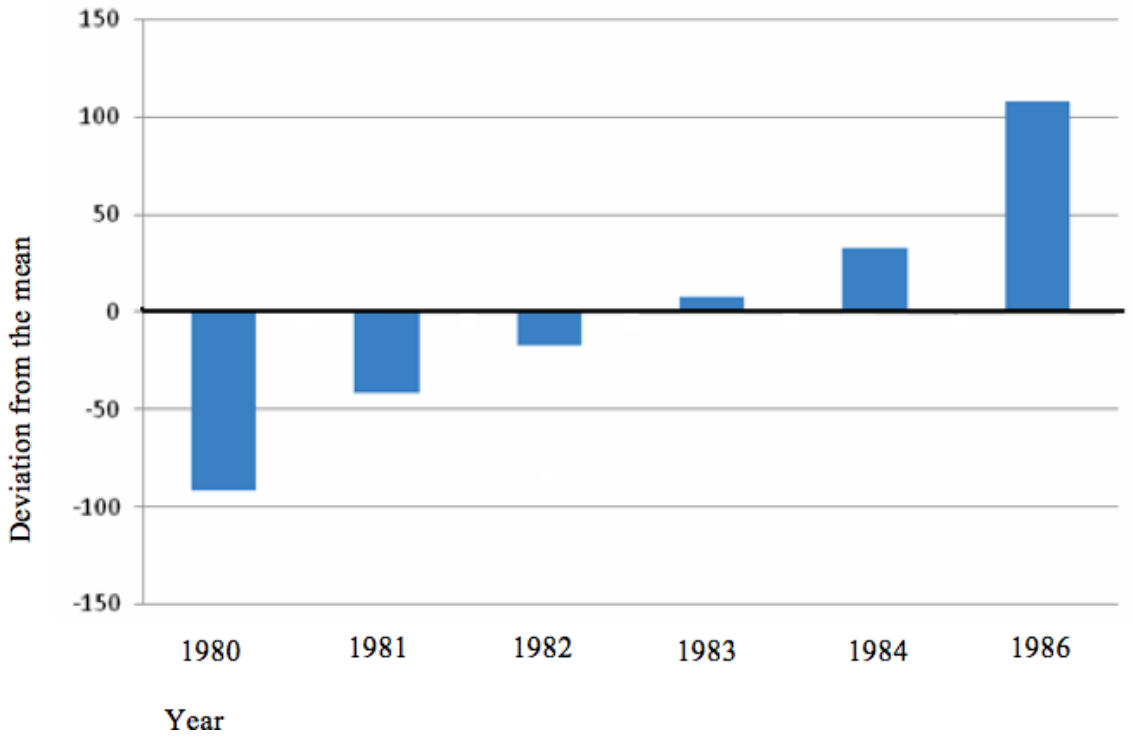
Where:
$\bar{x}$ = mean
$\sum x$ = sum of individual items
n = the total number of items

Therefore, $\frac{\sum x}{n} = \frac{1150}{6} = 192$

- Subtract the mean from each item:

Year	**Number of students**	X –
1980	100	-92
1981	150	-42
1982	175	-17
1983	200	8
1984	225	33
1985	300	108

- Choose a suitable scale and construct the graph using the obtained values (X –).



A divergent bar graph showing student enrolment (1980-1985)

Advantages of divergent bar graph

1. Fluctuation in values, which helps to detect the problem in general terms, is shown.
2. It is important for comparison of positives and negatives.
3. Profit (success) or loss (failure) can easily be deduced.
4. They are simple to construct, read and interpret.

Disadvantages of divergent bar graph

1. Graph construction is time-consuming since it involves many steps.
2. The calculations involved may be difficult to someone who is poor at mathematics.
3. It is limited to analysis of only one variable.

Divided circles (pie charts)

A divided circle is also known as pie chart, circle chart or pie graph. The chart involves dividing the circle into “pie slices” to represent and show relative sizes of data. The size of each slice or

segment is always proportional to the value it represents. Divided circles can appear in two forms:

a. Simple divided circles.

b. Proportional divided circles.

A simple divided circle involves a single set of data whereas the proportional divided circle involves more than one set of data such that the circles will be proportional to the total quantity that each circle represents.

Simple divided circle

Construction:

- Obtain the data to work on. Study this hypothetical record showing enrolment of Form One students in selected Secondary Schools in Tarime District:

A table showing student enrolment in selected schools in Tarime District

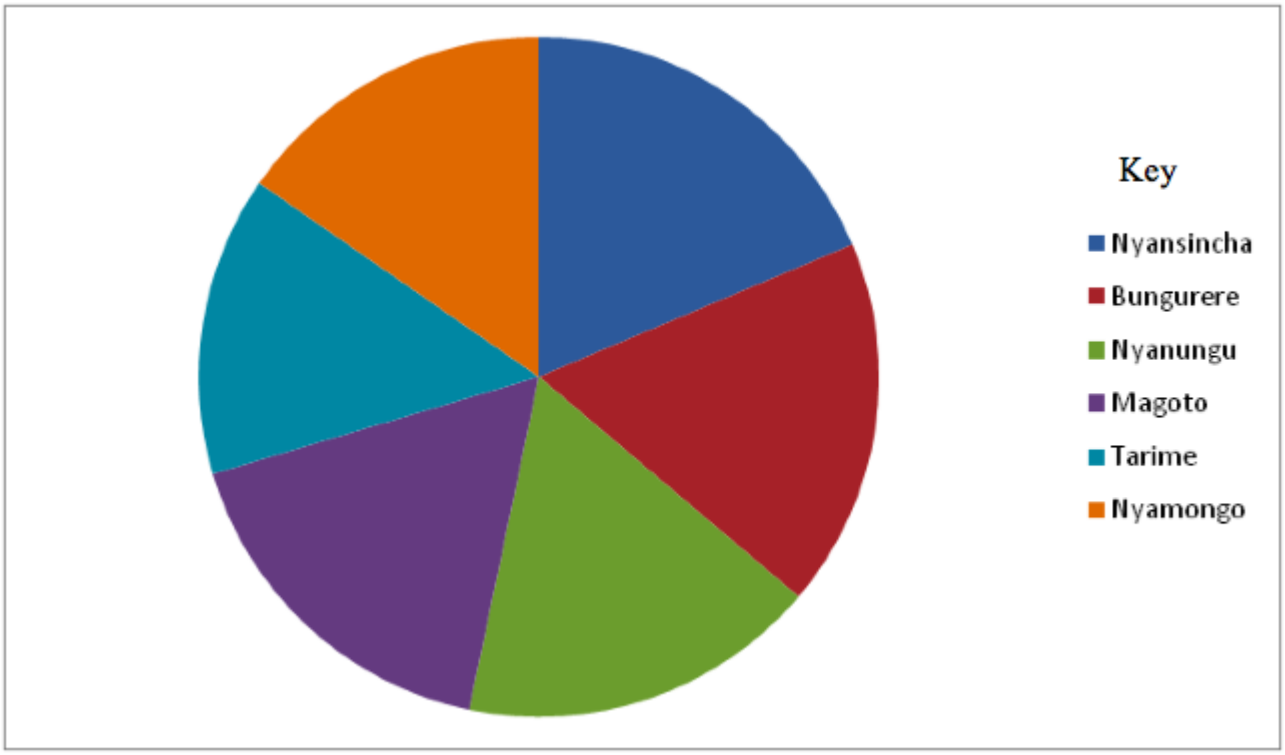
Name of school	**Number of students**
Nyansincha	85
Bungurere	80
Nyanungu	78
Magoto	78
Tarime	65
Nyamongo	70
Total	**456**

- Calculate the total number of students as shown in the table.
- Calculate the angle in a circle that would represent the number of students enrolled in each school. For example, 85 out of 456 students enrolled in Nyansincha Secondary School will

be represented in the circle by a segment with an angle of 85/456 ×630 = 67 degrees.This will give the following results:

Name of school	**Number of students**	**Degrees**
Nyansincha	85	67°
Bungurere	80	63°
Nyanungu	78	62°
Magoto	78	62°
Tarime	65	51°
Nyamongo	70	55°
Total	**456**	**360°**

- Draw a circle of a reasonable size.
- Using a protractor, draw a radius from the 6 o'clock mark to the centre of the circle.
- Starting with the largest segment representing a specific component, measure and draw its angle from the centre of the circle.
- Do the same for other components in ascending order.
- Divide a circle into segments according to the sizes of the angles.
- Shade the segments and write the title and key of the drawn graph.



Student enrolment in selected Secondary Schools in Tarime District

Advantages of divided circles

1. It is easy to compare components as they are represented by angles.
2. Analysis and interpretation of data is easy.
3. It is easy to assess the proportion of individual components against the total.
4. Construction of this graphical representation is relatively simple.
5. It is easy to determine the value of each component since it is indicated on each segment.
6. Visual impression of the individual components is clear and facilitates the understanding of the information in the data.

Disadvantages of divided circles

1. It is time-consuming because it involves a lot of calculations.
2. The represented actual values remain hidden as the values shown on the faces of the segments may be in percentages.

3. Where the range of data is large and involves small and big values, accurate construction of the chart is difficult.

4. When the values of data set vary slightly, it is difficult to visualize the proportional differences between values (as it is the case in the pie chart above).

The Importance of Statistics to the User

Explain the importance of statistics to the user

Statistics is important in geography because of the following reasons:

1. It enables the geographers to handle large sets of data and summarize them in a way that can be easily understood.

2. It can also enable the geographers to make comparisons between geographical phenomena, e.g. to compare the amount of rainfall and agriculture production or population distribution in different regions, etc.

3. Statistics translates data into mathematical ways which make the application of quantitative techniques possible.

4. It enables the geographers to store the information in forms of numbers, graphs, tables, charts, etc.

5. Statistics give precise rather than generalized information. This offers a lot of satisfaction to the user.

6. Statistics is very useful for planning at local and national levels. For example, statistics on census can be used to plan for social services.

How Massive Data can be Summarised

Describe how massive data can be summarised

The massive data collected from the field have to be summarized so as to make it easy to read, interpret and apply. The massive data can be summarized by the following ways:

Frequency distribution

A frequency distribution shows a summarized grouping of data divided into mutually exclusive classes and the number of occurrences in a class. It is a way of showing unorganized data e.g. to show results of an election, income of people for a certain region, sales of a product within a certain period, student loan amounts, etc. Some of the graphs that can be used with frequency distributions are histograms, line charts, bar charts and pie charts. Frequency distributions are used for both qualitative and quantitative data.

Frequency distribution helps to determine how many times a certain score occurs in a sample. In statistics, a frequency distribution is a table that displays the frequency of various outcomes in a sample. Each entry in the table contains the frequency or count of the occurrences of values within a particular group or interval. In this way, the table summarizes the distribution of values in the sample.

Consider the following table which shows family size of 20 families which were interviewed in a certain village:3, 2, 2, 4, 3, 7, 8, 1, 3, 6, 2, 2, 4, 5, 6, 4, 3, 4, 5, and 2.

The data can be summarized in a frequency table thus:

a. Arrange the scores in a descending order from 8 to 1. It is advised to arrange the scores in ascending order.

b. Distribute each score in the sample to determine the number of times each score occurs (frequency) in the data sample.

Score	Frequency
8	1
7	1
6	2
5	2
4	4
3	4
2	5
1	1

The frequency indicates how many times a score or event appears or occurs in a sample.However, in each case, it is certainly difficult to deal with individual scores separately. In such cases, a grouped frequency is used.

The steps for making a grouped frequency are as follows:

1. Decide about the number of classes. Too many classes or too few classes might not reveal the basic shape of the data set; also it will be difficult to interpret such a frequency distribution. The maximum number of classes may be determined by formula: *Number of classes = C = 1 + 3.3log(n) or C = √n(approximately) where n is the total number of observations in the data.*

2. Calculate the range of the data (Range = Max – Min) by finding minimum and maximum data value. Range will be used to determine the class interval or class width.

3. Decide about the class interval denote by h and obtained by h = Range/Number of classes

4. Decide the individual class limits and select a suitable starting point of the first class which is arbitrary, it may be less than or equal to the minimum value. Usually it is started before the minimum value in such a way that the midpoint (the average of lower and upper class limits of the first class) is properly placed.

5. Take an observation and mark a vertical bar (|l) for a class it belongs. A running tally is kept till the last observation. However, it is not always necessary to show tallies in the Frequency Distribution Table because the frequency column serves the same purpose.

6. Find the frequencies, relative frequency, cumulative frequency etc. as required.

Frequency distribution table

Class interval	**Frequency**	**Cumulative frequency**
0 – 9	4	4
10 – 19	9	13
20 – 29	8	21
30 – 39	3	24
40 – 49	4	28
50 – 59	7	35

60 – 69	5	40
70 – 79	4	44
80 – 89	2	46

Characteristics of the class interval

1. A score appears only once. That means no score should belong to more than one class.

2. The size of the class interval should be the same. No score should fall in more than one class. Arrange the class intervals in order of ranks as shown in the frequency distribution table above.

3. The class intervals should always be continuous.

4. The range of class interval should be between 3 and 20. Thus, the intervals should not be below 3 and not above 20.

From the summarized data in the table above, one can identify two concepts:

a. Apparent upper limit

b. Apparent lower limit

These limits (or boundaries) are seen in each class interval. The apparent lower limit opens the class interval while the apparent upper limit closes the class interval.The table above shows 80, 70, 50, 40, 30, 20 and 10 as apparent lower limits and 89, 79, 69, 59, 49, 39, 29, 19 and 9 as the apparent upper limits.

Apart from the two concepts above, the table has real limits which are not visible. These are 0.5 below or above the apparent limits.

From the above summarized data, other measures of statistics can be deduced. Such measures include the measures of central tendency, measures of dispersion (variability), measures of relationship (correlation) and measures of relative position.

Simple Statistical Measures and Interpretation

Methods of Presenting Simple and Mixed Data

Describe methods of presenting simple and mixed data

Measures of central tendency (averages)

A measure of central tendency is a single value that attempts to describe a set of data by identifying the central position within that set of data. As such, measures of central tendency are sometimes called measures of central location. They are also classed as summary statistics. The mean (often called the average) is most likely the measure of central tendency that you are most familiar with, but there are others, such as the median and the mode.

The mean, median and mode are all valid measures of central tendency, but under different conditions, some measures of central tendency become more appropriate to use than others. In the following sections, we will look at the mean, mode and median, and learn how to calculate them.

The Mean, Mode and Median

Calculate the mean, mode and median

Arithmetic mean

The mean (or average) is the most popular and well known measure of central tendency. It can be used with both discrete and continuous data, although its use is most often with continuous data. The mean is equal to the sum of all the values in the data set divided by the number of values in the data set. So, if we have n values in a data set and they have values x1, x2, ..., xn, the sample mean, usually denoted by (pronounced x bar), is:

$$\bar{x} = \frac{(x_1 + x_2 + \cdots + x_n)}{n}$$

This formula is usually written in a slightly different manner using the Greek capital letter, ∑, pronounced "sigma", which means "sum of...":

$$\bar{x} = \frac{\sum x}{n}$$

Where:

$\bar{x}$ = arithmetic mean

x_1 = individua score

n = number of occurences or events

Example 1

In English exam, students obtained the following percentage scores: 45, 42, 35, 86, 40, 56, 87, 40, 35, 74, 68 and 50

The arithmetic mean of the score is:

$$\frac{45+42+35+86+40+56+87+40+35+74+68+50}{12} = \frac{688}{12} = 54.8$$

The average score was 54.8%

Advantages of the mean

1. It is rigidly defined by a mathematical formula
2. It is easy to understand and calculate
3. It is based on all observations
4. It is determined in all cases
5. It is suitable for further mathematical treatment or manipulation
6. Compared to other averages, arithmetic mean is affected least by fluctuation of sampling

Disadvantages

1. It is greatly affected by extreme values of the data
2. It cannot be obtained if a single observation (item) is missing

3. It is not appropriate in some distributions

Median

The median is the middle score for a set of data that has been arranged in order of magnitude. Suppose we want to find the median from the data below:

65, 55, 89, 56, 35, 14, 56, 55, 87, 45, 92

We first need to rearrange that data in order of magnitude (smallest first):

14, 35, 45, 55, 55, 56, 56, 65, 87, 89, 92

Our median mark is the middle mark - in this case, 56 (highlighted in bold). It is the middle mark because there are 5 scores before it and 5 scores after it. This works fine when you have an odd number of scores, but what happens when you have an even number of scores? What if you had only 10 scores? Well, you simply have to take the middle two scores and average the result. So, if we look at the example below:

65, 55, 89, 56, 35, 14, 56, 55, 87, 45

We again rearrange the data in order of magnitude (smallest first):

14, 35, 45, 55, 55, 56, 56, 65, 87, 89

Only now we have to take the 5th and 6th score in our data set and average them to get a median of 55.5.

Advantages of the median

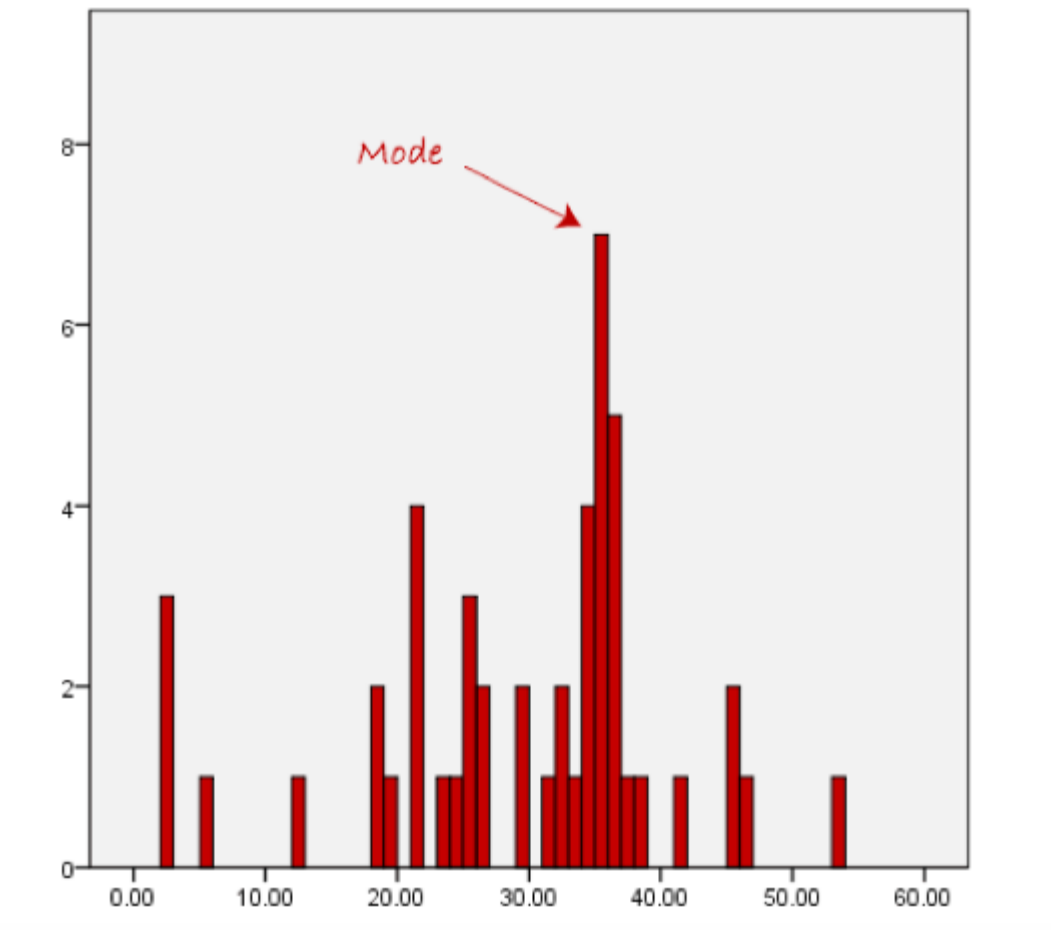
1. It is easy to calculate and understand
2. It can also be calculated in qualitative data
3. It is appropriate for skewed distribution
4. It is not affected by all extreme observations. Hence, it is a better average than the arithmetic mean when extreme observations are present.
5. The values of a median can be obtained graphically.

Disadvantages

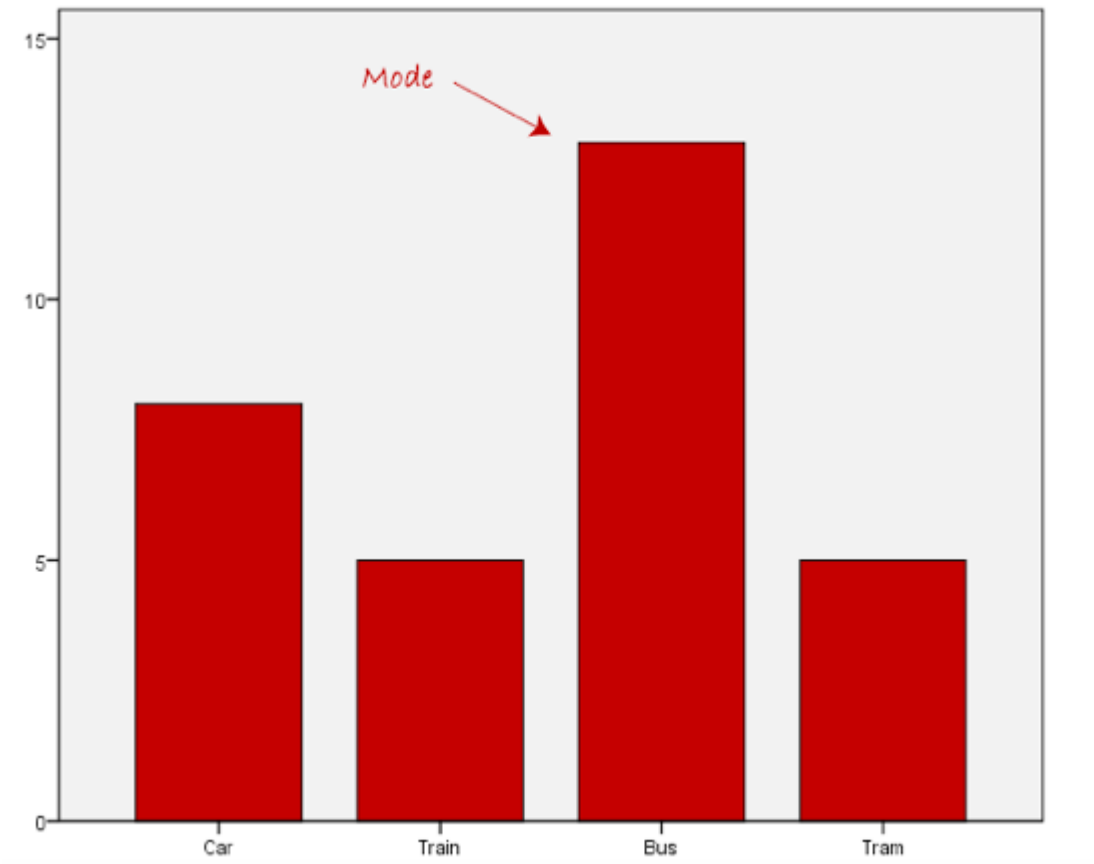
1. It is not suitable for further mathematical treatment.
2. It is not rigidly defined.
3. It is based on all values or observations.
4. Compared to mean, median is more affected by fluctuation of sampling.
5. In case of ungrouped data, rearrangement of values in order of magnitude becomes necessary.

Mode

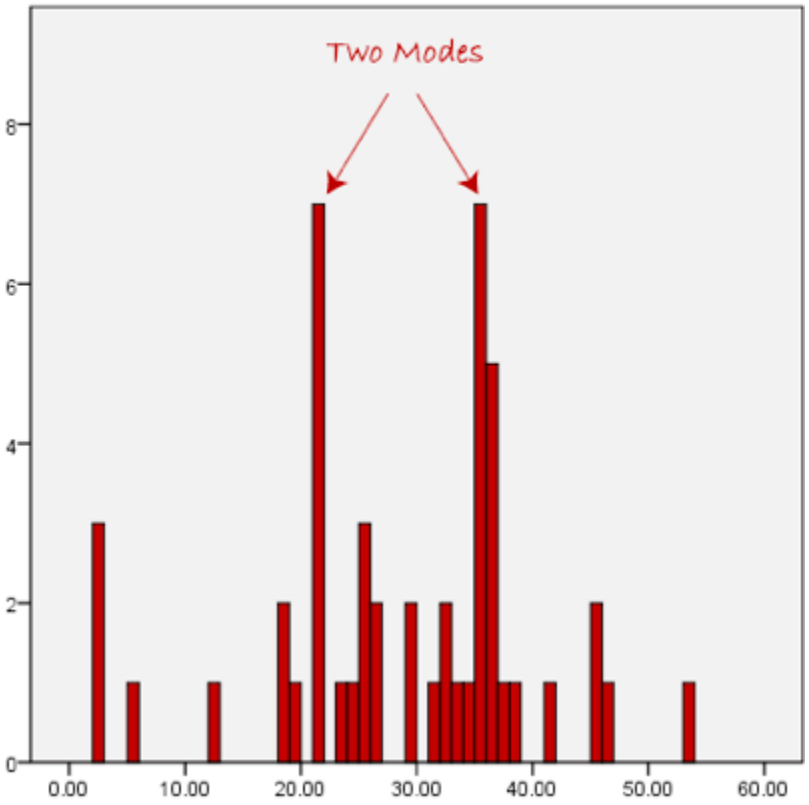
The mode is the most frequent score in a data set. It represents the highest bar in a bar chart or histogram. You can, therefore, sometimes consider the mode as being the most popular option. An example of a mode is presented below:



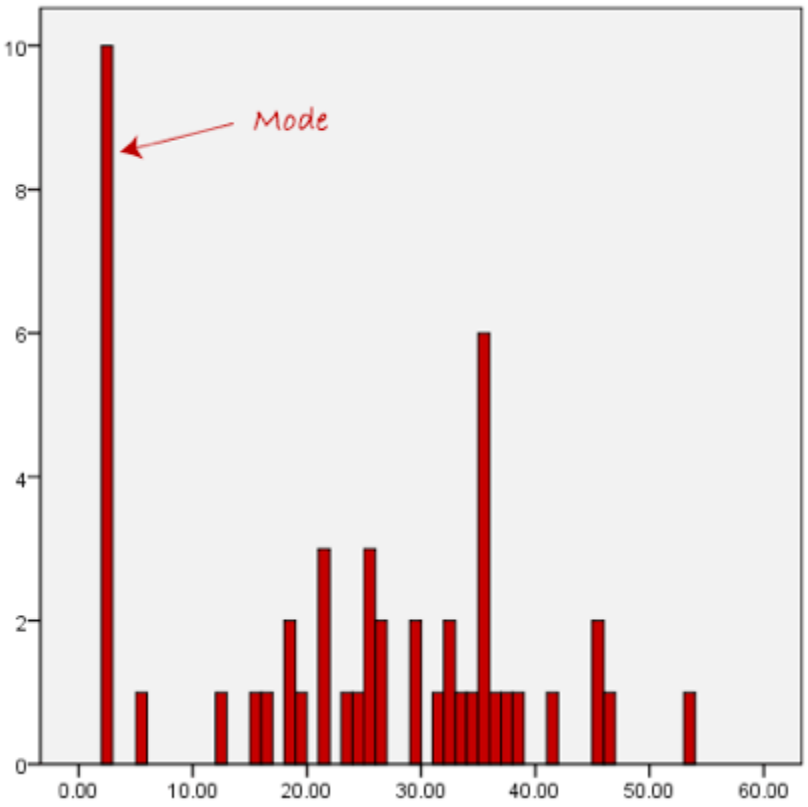
Normally, the mode is used for categorical data where we wish to know the most common category, as illustrated below:



We can see above that the most common form of transport, in this particular data set, is the bus. However, one of the problems with the mode is that it is not unique, so it leaves us with problems when we have two or more values that share the highest frequency, such as below:



Another problem with the mode is that it will not provide us with a very good measure of central tendency when the most common mark is far away from the rest of the data in the data set, as depicted in the diagram below:



In the above diagram the mode has a value of 10. We can clearly see, however, that the mode is not representative of the data, which is mostly concentrated around the 2 to 3 value range. To use the mode to describe the central tendency of this data set would be misleading.

Advantages of the mode

1. It is simple to compute.
2. It is easy to understand and calculate. In some cases it can be located merely by inspection. The value of the mode can be obtained graphically from the histogram.
3. It gives a rough idea of the differences of the data set.
4. It is the only average that can be used when the data is not numerical.

Disadvantages

1. It is not rigidly defined; hence it is unstable for large samples.
2. It is independent of sample size except under special circumstances.

3. It is not based on all the values of the data.

4. Mode is not suitable for further mathematical treatment.

5. As compared to mean, mode is affected to a great extent by the fluctuation of sampling.

6. There may be more than one mode (as is the case in the previous graph).

7. There may be no mode at all if none of the data are the same. 8. It may not accurately represent the data.

The Significance of Mean, Mode and Median

Explain the significance of mean, mode and median

Measures of central tendency are very useful in statistics. Their importance is because of the following reasons:

1. **To find representative value:** Measures of central tendency or averages give us one value for the distribution and this value represents the entire distribution. In this way averages convert a group of figures into one value.
2. **To condense data:** Collected and classified figures are vast. To condense these figures we use average. Average converts the whole set of figures into just one figure and thus helps in condensation.
3. **To make comparisons:**To make comparisons of two or more than two distributions, we have to find the representative values of these distributions. These representative values are found with the help of measures of the central tendency.
4. **Helpful in further statistical analysis:** Many techniques of statistical analysis like Measures of Dispersion, Measures of Skewness, Measures of Correlation, and Index Numbers are based on measures of central tendency. That is why measures of central tendency are also called measures of the first order.

Interpretation of Data using Simple Statistical Measure

Interpret data using simple statistical measures

In the section about averages (mean, mode and median), we learned how to calculate the mean for a given set of data. The data we looked at were ungrouped and the total number of elements

in the data set was not that large. The method is not always a realistic approach especially if you are dealing with grouped data.

Assumed mean (A), like the name suggests, is a guess or an assumption of the mean. It doesn't need to be correct or even close to the actual mean and choice of the assumed mean is at your discretion except for where the question explicitly asks you to use a certain assumed mean value.

Assumed mean is used to calculate the actual mean as well as the variance and standard deviation.

Measures of central tendency can be calculated from grouped data, for example:

1. Mean $(\bar{x}) = A + \frac{\sum fd}{N}$

Where:
A = assumed mean
$\sum fd$ = sum of the product of frequency and deviation
N = total frequency

2. Mode = $L + \left(\frac{t_1}{t_1 + t_2}\right) i$

Where:
L = the lower limit of the modal class
t_1 = the excess of the modal frequency over the frequency of the next lower class
t_2 = the excess of the modal frequency over the frequency of the next higher class
i = the modal class interval

3. Median = $L + \left(\frac{\frac{N}{2} - n_b}{n_w}\right) i$

Where:
L = the lower boundary of the median class
N = the total number of frequency
n_b = the total number of items in classes below the median class
n_w = the total number of items within the median class
i = the class interval

Calculation of measures of central tendency for grouped data

Study the frequency distribution table below:

Class	*Real limits*	*Mid point (x)*	*f*	*d =*
0 – 4	0.5 – 4.5	2	2	
5 – 9	4.5 – 9.5	7	6	
10 – 14	9.5 – 14.5	12	10	
15 – 19	14.5 – 19.5	17	8	
20 – 24	19.5 – 24.5	22	4	
			N = 30	

Calculation from the table:

$$\text{Mean } (\bar{x}) = A + \frac{\sum fd}{N}$$

Where:
A = 12
$\sum fd = 30$
N = 30

$$\text{Mean} = 12 + \frac{30}{30}$$

$$\therefore \text{Mean} = 13$$

$$2.\ \text{Mode} = L + \left(\frac{t_1}{t_1 + t_2}\right) i$$

Where:
$L = 9.5$
$t_1 = 10 - 6 = 4$
$t_2 = 10 - 8 = 2$
$i = 5$

Assumed mean (A) = 12

Note: we find the class interval by using the class limits as follows: *i* = upper class limit – lower class limit + 1