VULCANICITY

This refers to the total process by which gases and molten rocks from the earth's interior are intruded into the earth's surface or extruded onto the earth's surface hence forming intrusive igneous and extrusive igneous features.

When the molten material (magma) is intruded into the earth's surface, it solidifies giving rise to intrusive features. When the materials reach on top of the earth's surface (lava), it solidifies to form extrusive features.

Origin of vulcanicity.

The rocks beneath the earth's surface are at a very high/hot temperature e.g. 1500°C-5000°C and pressure is also great as a result of geochemical activities and radioactive decay. This intense heat melts the rocks into a semi solid state, magma. The molten magma then begins moving upwards through the mantle.

Heat also can be generated by friction between moving rocks or plate boundaries. The molten rocks give rise to development of convective currents. its these currents that drive the plates and rocks in the mantle leading to development of heat, pressure and fissures along which magma is extruded or intruded on the earth's surface or into and beneath the earth surface respectively.

Pressure and Heat is also generated by the weight of the overlying rocks on to the mantle. Volcanicty is influenced by enormous pressure which the overlying rocks exert onto the asthenosphere in the interior of the earth.

Convectional currents are set up within the earth and cause the magma to move upwards into the mantle. The pressure is high in the interior compared to the surface. When there is a fault/crack in the crust, the magma finds its way to the surface where it is now referred to as lava. The lava cools and solidifies to form extrusive land forms e.g. composite volcanoes and if it does not reach outside, it forms intrusive land forms e.g. batholiths.

The molten material that originated from the upper plastic layer of the earth's mantle is

kept in a semi molten or plastic state due to the high temperatures and additional heat sufficient enough to take the material to melting point.

Through the natural process of radioactivity, heat is generated and this makes the rocks to be plastic and fluid. Any additional increase in heat can trigger off upward movement of molten rock. The lighter elements of the material begin to rise upwards to the surface. The rising is made possible along lines of weakness like cracks or faulting.

The magma then forces its way out to the surface along fault lines and forms various landforms on reaching the surface.

It should be noted that when magma erupts on the surface and loses its gases, it is then known as lava. It's the escaping gases and steam which expand rapidly and its due to high pressure that makes the eruptions to be explosive.

Lava varies considerably in its composition particularly in its silica content. The nature of lava partially affects the nature of landforms.

Nature of materials.

1. **solids**

When an eruption takes place, various materials are ejected. These include the following:

(i) **Acidic lava.**

This flows for a short distance from the point of eruption. The lava is highly viscous (thick and sticky) and solidifies even at hot temperatures.

Acidic lava is so viscous and largely immobile and consequently solidifies quickly to form steep sided landforms like volcanic plugs. Sometimes acid lava solidifies so quickly and blocks the fissures resulting into explosive eruptions.

(ii) **Intermediate lava.**

This flows at an intermediate distance from the point of eruption(vent) simply because this lava its compostion is between basic and acidic. It is fairly viscous.

(iii) **Basic lava.**

This flows for a long distance from the point of eruption. It has low silica content and highly mobile. Basic lava is very fluid and mobile and therefore forms extensive lava plains.

2. **Gaseous materials:**

It produces very violent eruptions and appears dark during eruption because these gases consist of water vapor (steam) , with carbon dioxide and sulfur dioxide and forms features and land forms such as explosion craters like lake Katwe, some geysers etc.

3. **Liquid**.

This is usually the most important product of an eruption when magma reaches the earth surface. The material cools and solidifies at the surface. The nature of volcanic materials formed largely depends on the degree of silica present in that material.

When an eruption takes place explosively, the magma is often ejected inform of ash, cinder, stones, blocks and gases and the finest is ash. The fragmental materials are referred to as pyroclasts.

Lava varies considerably in chemical composition particularly in its silica content. The silica content determines the degree of mobility.

Because of this, there are three types of lava and these include acidic lava, intermediate lava and basic lava.

Type of lava	**% of silica content**	**Degree of mobility**	**Example of rock type**
Acidic	Above 66 %	Extremely viscous and immobile and solidifies quickly.	Rhyolite, granites

Intermediate lava	Between 52-65%	Fairly viscous and able to flow for a far distance	Andesite.
Basic	Between 42-51%	Very fluid and mobile able to flow for long distance before solidifying.	Basic

The process results into formation of volcanic landforms namely;

Extrusive volcanic landforms & Intrusive volcanic landforms.

EXTRUSIVE VOLCANIC LANDFORMS

When magma is ejected to the surface, extrusive volcanic features/ land forms are formed. However, these will depend on:

i***) Nature of the eruption (quiet or violent)***

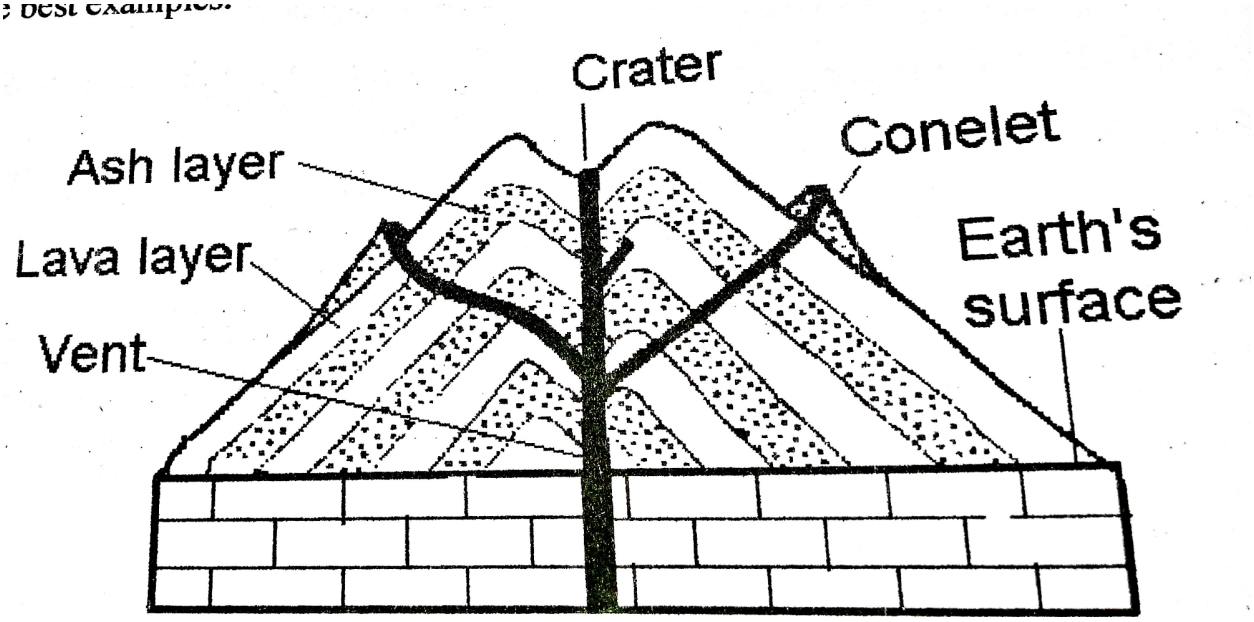
ii) Type of lava(whether acidic, basic or gaseous) ejected and because of these, the landforms and features formed vary from tiny craters to high volcanic mountains like Kilimanjaro.

These are formed when magma is extruded onto the earth's surface. They take various forms depending on the type of lava which forms them. They include the following;

A volcano. A volcano is a hill or mountain formed by eruption of molten lava from the central opening known as a vent onto the earth's surface. The material erupted builds around the vent and generally forms a dome or cone with a funnel like structure or depression on top called a crater.

As long as there is continued supply of magma, the volcano will continue to grow to a height to which the difference in pressure can still force the erupted materials onto the earth's surface. If the pressure becomes insufficient for magma to reach the main crater, the mountain rock may then force its way on the earth's surface through other vents and may build up parasitic or secondary cones on the slopes of the main volcano.

Illustration.



Volcanoes vary in size from small ones to few meters high to large mountains like Kilimanjaro and Elgon among others.

They can also be classified according to the present state of activity i.e. active volcanoes, dormant volcanoes and distinct volcanoes.

Active volcanoes. An active volcano is one that has erupted its thought to have erupted within the last 500 years. Examples include Longnot, Meru, Oldoinyo-Lengai all in the eastern arm of the rift valley.

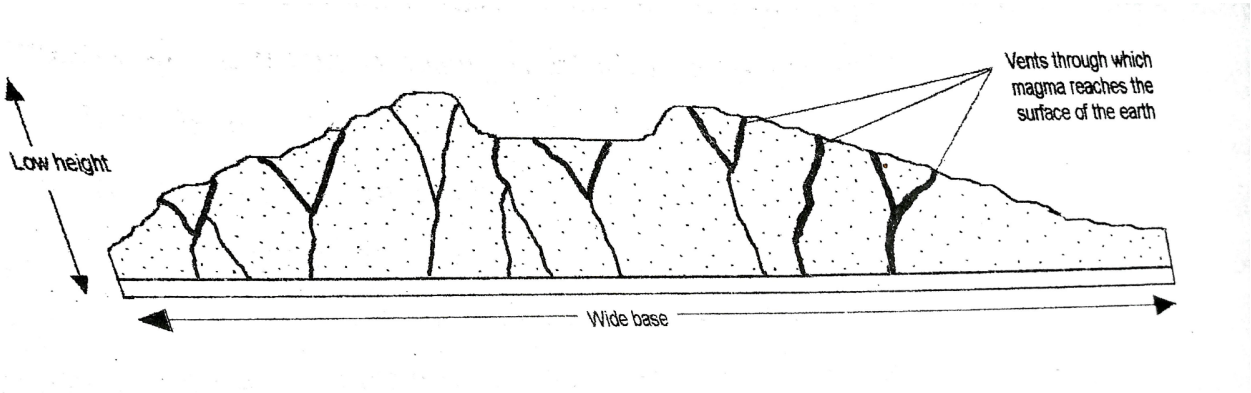
Dormant volcanoes. This is one which has not been known to have erupted andyet it is not extinct. Some dormant volcanoes show limited activity in form of fumaroles like Kilimanjaro.

Extinct volcanoes. These refer to the volcanoes which show no further signs of eruptions and much of their original structure may have been destroyed by denudation processes of erosion and weathering for example mountain Elgon.

Basalt dome or shield volcano. A basalt dome is a large flat topped or convective dome

which is formed from basic lava with gently sloping sides. It's usually low in height relative to its large base. Its flat topped shape is caused by very fluid lava which is able to flow for some time before solidifying. Usually a shallow steep sided sunken crater is found located on the basalt top. A good example is found near Muhavura ranges in south western Uganda. In this case, lava flows through numerous fissures other than a single vent.

Illustration



Volcanic plug / neck. A volcanic neck is formed as a result of magma which is so viscous that is forced out as a rigid cylindrical feature formed from acidic lava which is very thick and immobile and hence solidifying in the vent of the cone and thus hardened to form a plug. The outer soft rocks are removed by the denudational processes like erosion. The base of the plug is surrounded by exploited debris. For example Tororo rock and Alekitek near Napak caldera in Uganda, Mwadui plug and Mawenzi plug in Tanzania, Loldiani, Tinderet and Timboro in the Kano plains of Kenya.

Illustration.

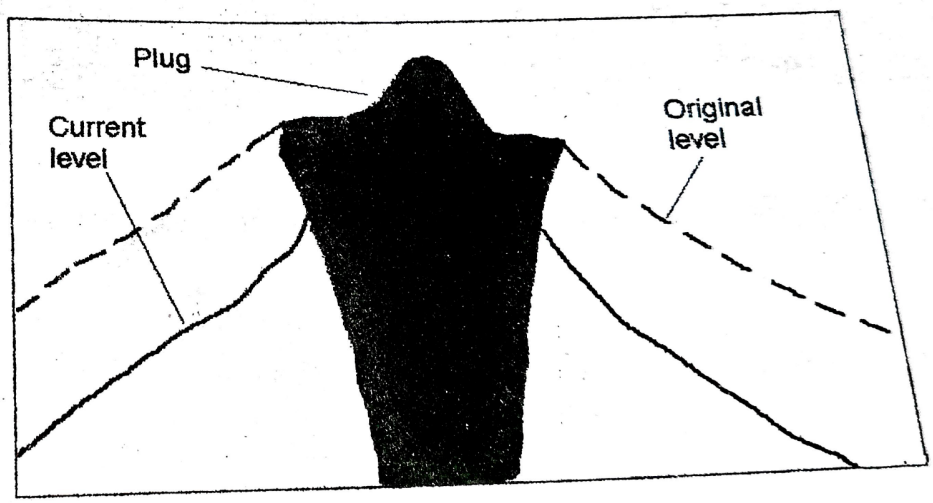


Fig 9,016 Formation of a volcanic plug

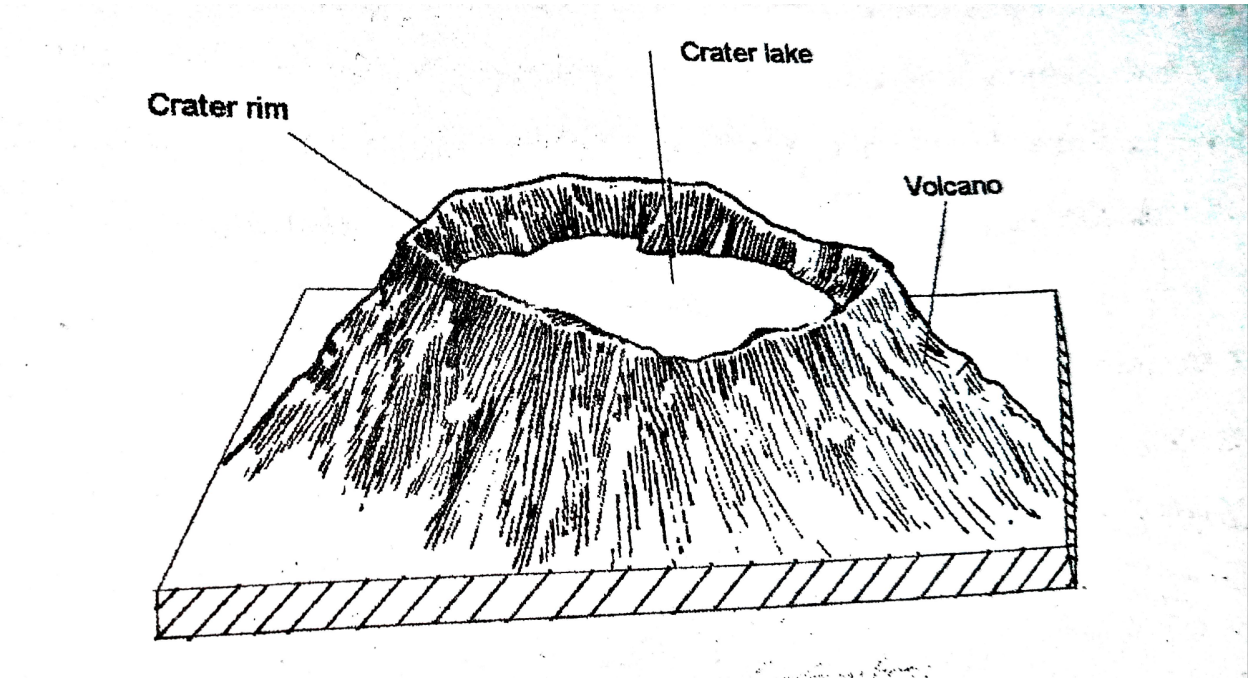
Explosion crater. An explosion crater is a shallow flat floored depression which is surrounded by a low rim of pyroclasts and local rock. Craters are usually less than 50m in depth and 500m in diameter. Explosion craters may appear in singly or in groups. Their formation is based on two theories i.e.

The first theory states that a crater is formed as a result of explosive eruption which blows off the upper part of a volcano creating a small depression called a crater.

The second theory states that as magma is poured on the earth's surface from the earth's interior, a chasm (empty space) is created and with the weight of the material, the volcanic plug sinks in creating a depression called a crater. This process of sinking is called cauldron subsidence. Examples are found in western Uganda. Some of these craters are dry while others remain swampy and marshy. When these craters are filled with water, they now form the crater lakes like Katwe, nyamunuka, nyamusingwe among others.

Lake Katwe is the largest crater lake and it's a source of salt.

Illustration



A caldera. A caldera is another landform resulting from volcanicity. A caldera is a wide depression or big crater. It can be formed in two ways i.e.

The first theory states that a caldera is formed as a result of explosive eruption which blows off the upper part of a volcano leaving behind a big depression called a caldera.

It can also be formed through the process of cauldron subsidence. Major eruption may reduce magma supply and leaves a big space (chasm) beneath a volcano. Consequently, the weight of the overlying solidified magma becomes too great; a fault develop and collapses into the chasm leaving behind a big depression known as a caldera.

Calderas can also develop from a combination of both explosion and subsidence. Prominent calderas in East Africa include menengai near the Nakuru valley in Kenya, Suswa in Kenya, Napak in south western Karamoja, Ngorongoro in Tanzania among others. When a caldera is filled with water, it forms a caldera lake for example lake Ngonzi in Tanzania.

It should be noted that a caldera extends for about 1km in diameter.

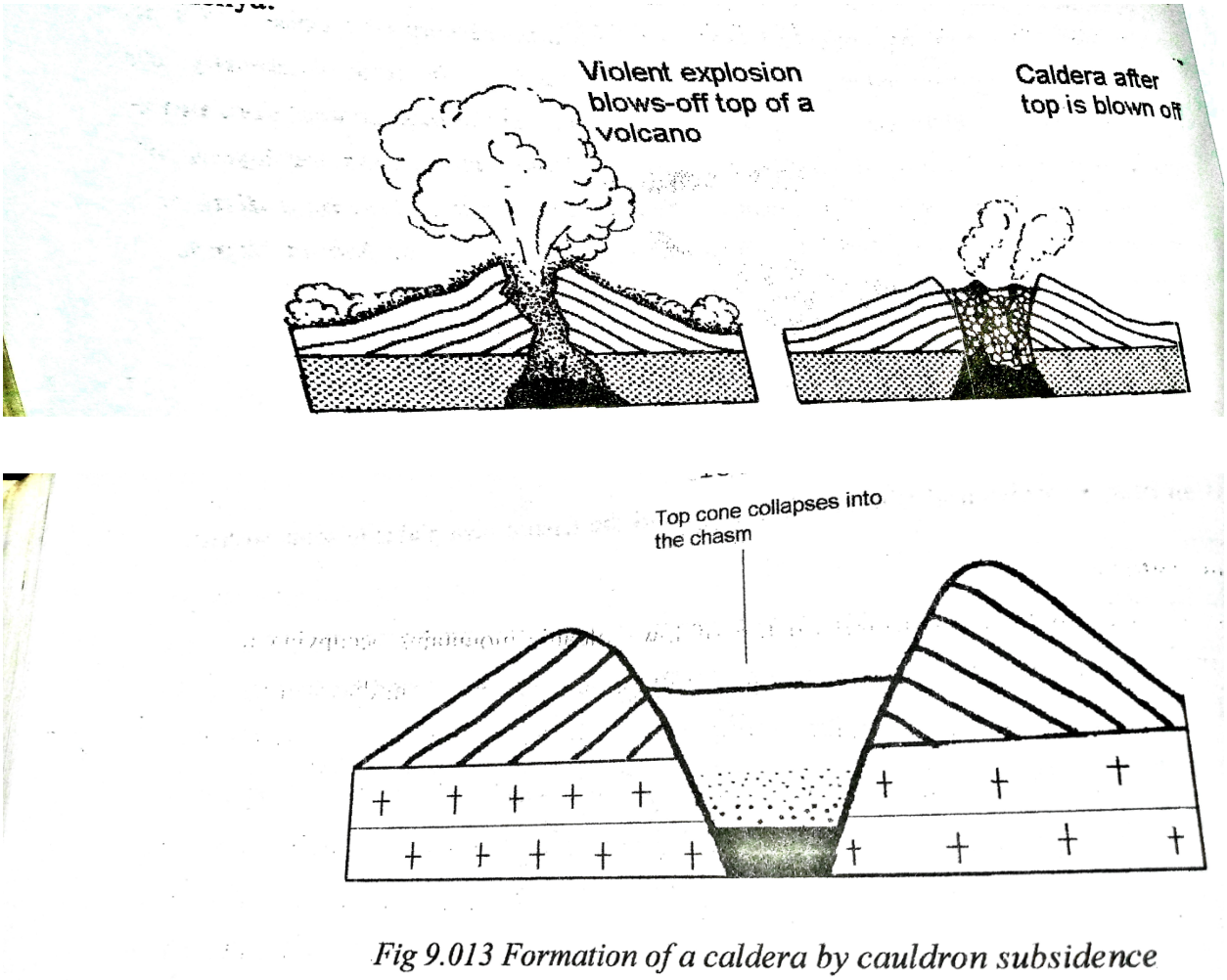
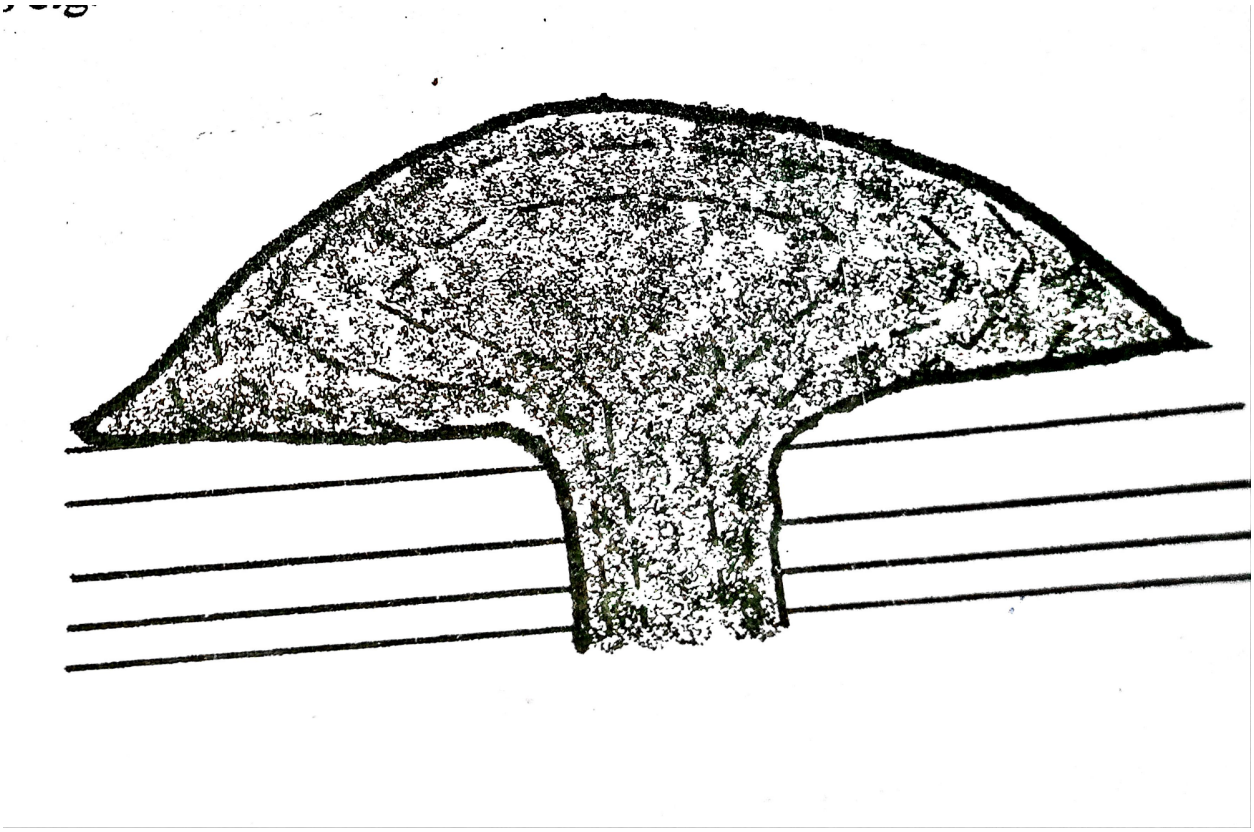


Fig 9.013 Formation of a caldera by cauldron subsidence

A cumulo-dome. A cumulo dome is a steep sided convex feature of acidic lava. It is formed from very viscous lava which doesn't flow for far but instead it piles around the vent where it hardens quickly. Where the extrusions are unable to reach the earth's surface, the overlying layers will be curved outwards. When a cumulo dome develops in a crater, it's called a thalloid. An example can be seen at the Ntumbi cumulo dome in Tanzania. It can be illustrated as below.



Lava plateau or plain. A lava plateau is a highland with more or less a monotonous relief and is formed of successive layers of lava. It is formed by the eruption of very fluid or mobile or basic lava that upwells the surface through various fissures.

The lava reaches the surface and then spreads out for long distances. Eventually, the depth of lava may be hundreds of meters thick completely covering the original hills and valleys. Vertical jointing may cause the plateau edges to be abrupt and where a plateau has been dissected by rivers, a valley tends to be steep sided and gorges are formed. Examples of lava plateaus include Laikipia lava plateau and Kisorro lava plateau in south western Uganda.

Illustration.

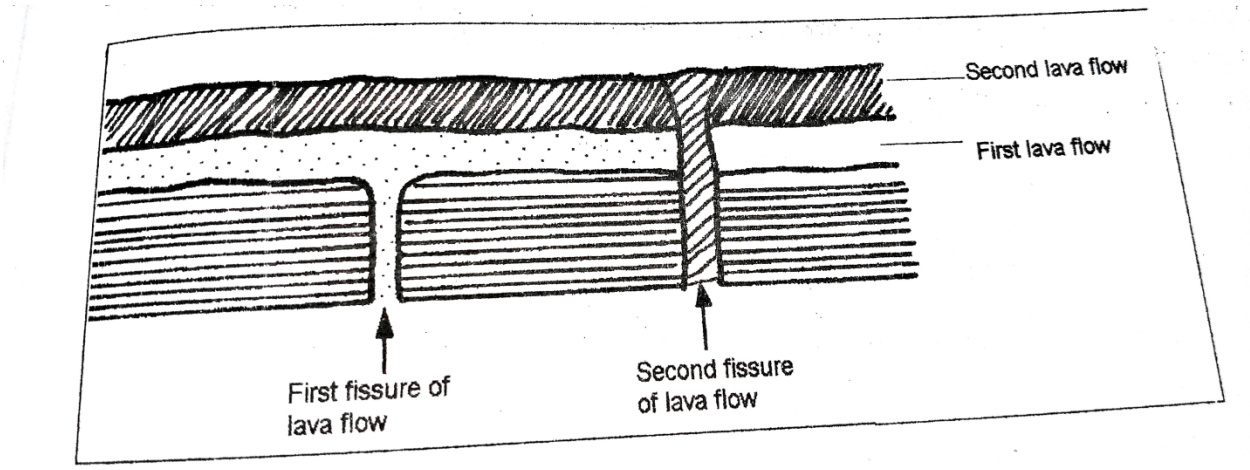
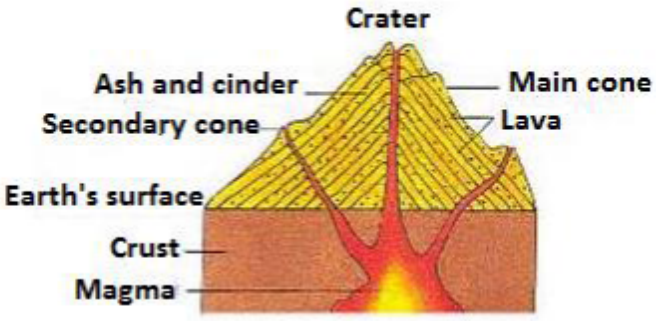


Fig 9.015 Formation of a lava plateau or lava plain

Ash and cinder cone. These are steep sided hills formed by volcanicity. Pyroclasts of all sizes are ejected and accumulate around the fissures to build up a volcanic hill or an ash and cinder cone. Such cones are steep sided and approximately 150m high above its base. Examples are in Kisoro district and Lakaiyu cinder cones in the south of lake Turkana.

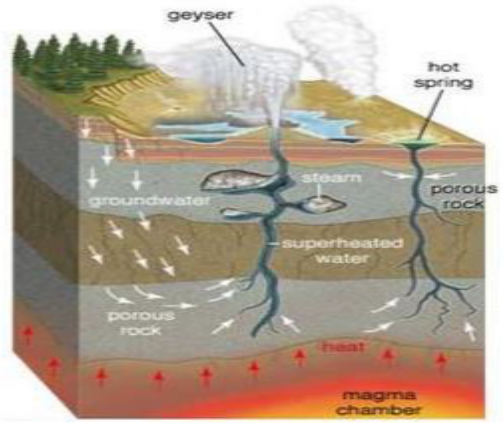
Illustration



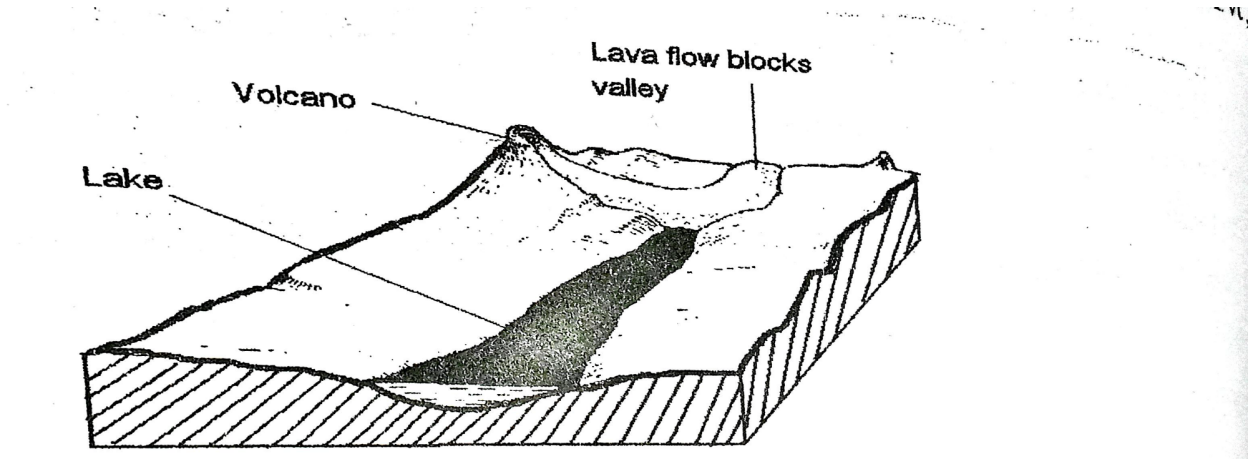
Geysers and hot springs. A geyser refers to hot water accompanied by steam. A hot spring is natural hot water issuing out of the ground. It is also hot or warm. Both features owe their origin from the existence of hot rocks associated with volcanicity

beneath the surface of the earth. They are formed when rain water sinks into the ground and comes into contact with rocks associated with volcanicity (hot rocks). The water is therefore heated and due to the pressure differences, the water upwells the earth's surface inform of geysers and hot springs.

They differ in a way that a hot spring is super-heated water which flows quickly whereas a geyser; water is thrown with a great force and accompanied by steam (geysers are ejected explosively / as jets). Examples include the Sempaya hot spring in Bundibugyo, Kitagata hot springs in Bushenyi and Kisiizi in Rukungiri.



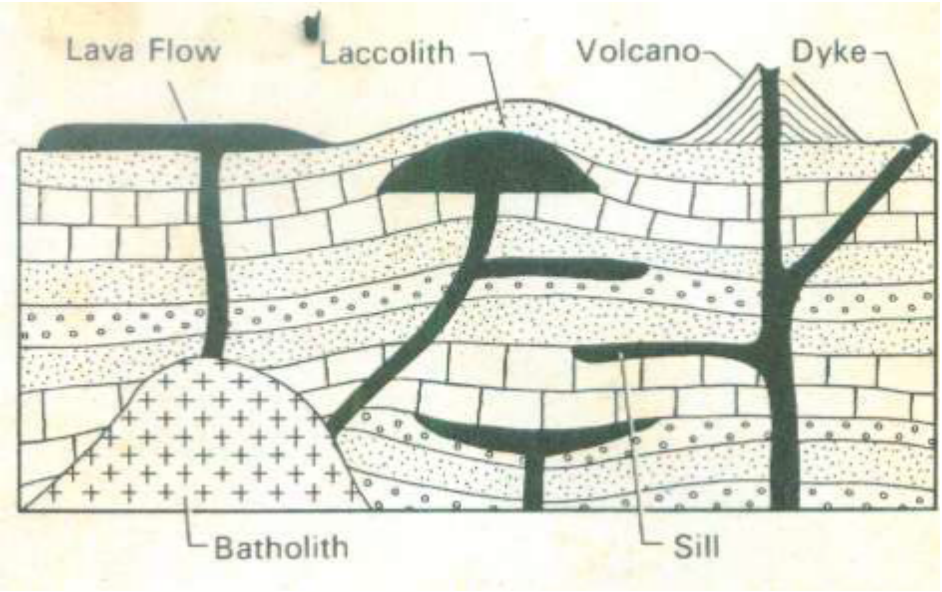
Lava dammed lakes. They are formed when basic lava comes out from a volcanic mountain and may block a flowing river leading to back ponding of river valley hence creating a lava dammed lake. Examples include lake Bunyonyi, Mutanda, Mulehe among others.



INTRUSIVE VOLCANIC LANDFORMS.

In general, intrusive volcanic landforms affect relief only after they have been exposed by denudation processes. Intrusions of various forms depend on the relative hardness or may depend on resistance of the surrounding rocks.

The various forms of intrusions can be seen as below



A batholith (s). This is a very large intrusion formed at a great depth. They are usually bottomless and are usually from granitic rocks. Batholiths are the largest forms of

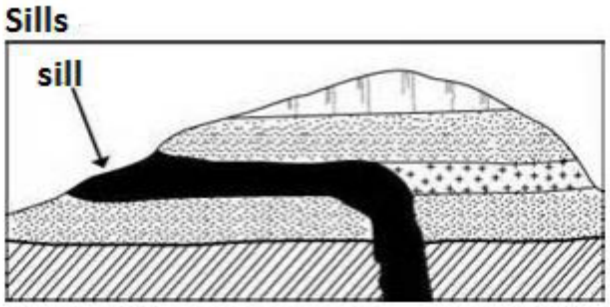
intrusions and they result from large scale intrusion of magma which cools slowly beneath the surface of the earth. Examples include the Tanganyika batholith which out crops between mwanza and Iringa, batholiths are also found in Mubende district particularly the singo batholiths. In Kenya, they are found in Maragoli.

When they are exposed by denudation forces, batholiths form uplands when their rocks are more resistant than the adjacent rocks. However, if the rocks making up the batholiths are softer than the surrounding rocks, they then are then eroded away forming depressions called arenas.

A dyke. A dyke is a vertical or steeply inclined igneous intrusion. It's said to be discordant with the rock layers. Dykes are formed when molten magma up wells across the layers and solidifies within the earth's crust before reaching the earth's surface. Sometimes they occur in groups and they are referred to as ring dykes. Examples are found in south and west of lake Turkana in Kenya.

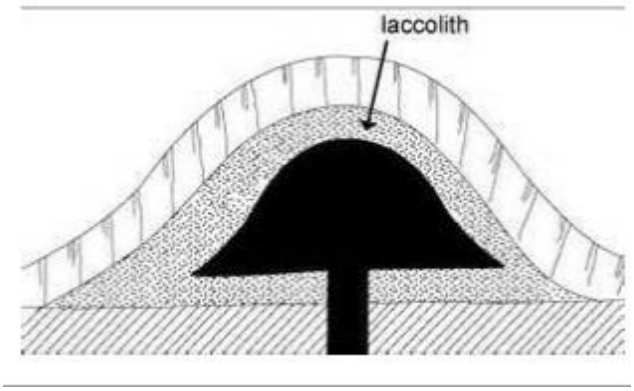
After denudation, if the dyke is more resistant than the surrounding rocks, it may form an upland with steep slopes. If on the other hand, its less resistant than the adjacent rocks, it may form a trench.

A sill. Sills are horizontal intrusive features which lie between rock layers. They are therefore concordant with the rock layers. Magma rises from the earth's interior and spreads horizontally along the bedding planes. After denudation, a resistant sill may form escarpments of flat topped hills. In a river valley, resistant sills may form waterfalls and rapids for example the Thika falls in Kenya are as a result of this. Sills may appear singly or in groups and examples of sills are found in Thika district in Kenya. *It can be illustrated as below.*

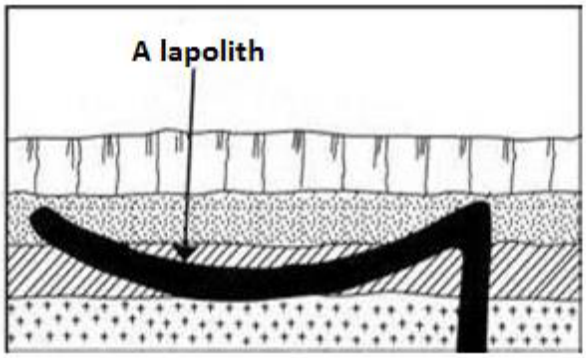


Laccolith. This is a dome shaped intrusion with more or less a flat base. Its formed when magma rises and solidifies within the crust before reaching the earth's surface. Its formed from viscous magma which is unable to move and spread for long distances. Magma accumulates in large mass forcing the over lying rocks to arch upwards. Laccoliths are found in Madagascar and Algerian coast. If the formed laccolith is more resistant than the adjacent rocks, it may form an upland.

Illustration



Lapolith. It's a very large saucer shaped intrusion formed when magma forces its way out of the earth's surface but cools very quickly before reaching the earth's surface. Its saucer shape is due to the increased weight of the crust which may cause sinking. If the lapolith is exposed by denudation processes, then then up turn edges may sometimes form out facing scarps. Examples are in Zimbabwe north of Harare. *It can be illustrated as below*.



Economic importance of volcanicity to man.

Volcanism leads to the formation of volcanic soils which are fertile and useful for agriculture for example in Mbale on the slopes of mountain Elgon.

Some water falls formed on the slopes of volcanic mountains provide and are suitable sites for construction of hydro Electric power plants for example the Siipi falls in Kapchwora.

Volcanic mountains moderate climate i.e. relief or orogenic rainfall.

Water from hot springs and geysers are used for medicinal values i.e. in Kitagata hot springs in Bushenyi.

The peculiar landforms promote tourism like volcanic plugs, the highest mountain in East Africa is Kilimanjaro with 5895 meters above sea level and snowcapped in the equatorial region. This attracts many tourists throughout the year. Others include hot springs and geysers.

Some volcanic mountains help in the demarcation of country boundaries in East Africa for example mountain Kilimanjaro which demarcates Kenya and Tanzania, Elgon which demarcates Uganda and Kenya.

Volcanic activity resultsinto the formation of valuableminerals like salt in Katwe in Uganda, limestone in Tororo and Toro region.

Plutonic igneous rocks are potential and actual resources as far as quarrying is concerned. These rocks can be excavated and crushed to get materialswhich are used in building and construction purposes.

Volcanic mountains are associated with heavy rainfall and luxuriant vegetation on their slopes. The vegetation can be used for forestry and lumbering.

Negative.

Volcanic eruptions can be destructive to both life and property for example of the most destructive volcanic natural disaster was mountain Nyivagingo in Zaire which erupted in 1977 and 2002 which destroyed many coffee plantations, many people died and many people were left homeless.

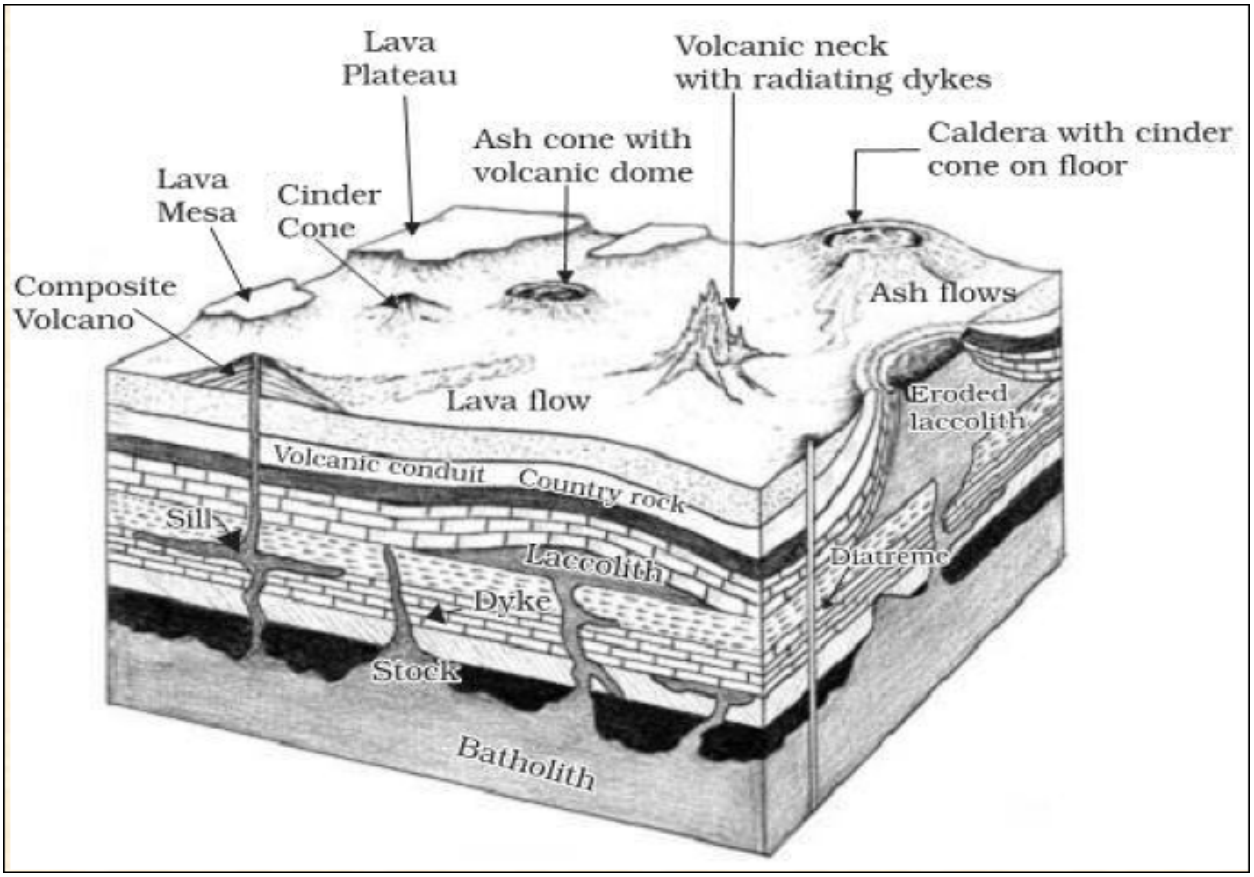
Volcanic mountains create rainfall on the windward side but influence aridity on the lee ward side. The lee ward side is located is located in the rain shadow and therefore largely dry for example the water parts of Kenya are in the rain shadow of mountain Elgon.

The steep slopes of volcanic mountainshave rendered volcanic highlands inaccessible. The regions have remained remote because of difficulty and high costs involved in construction of transport and communication infrastructures for example some of the highlands in kigezi are not well served with transport infrastructures.

Steep slopes of volcanic mountains are prone to soil erosion and land slide and rock falls. This is common in kigezi, Kenya and kipengere ranges in southern Tanzania.

Revision questions

1. Examine the influence of volcanicity on drainage.
2. Examine the relationship between the nature of material ejected and extrusive volcanic landforms in East Africa.
3. Examine the impact of volcanicity on landform evolution in East Africa.


Lava Plateau
Volcanic neck with radiating dykes
Ash cone with volcanic dome
Caldera with cinder cone on floor
Lava Mesa
Cinder Cone
Composite Volcano
Ash flows
Lava flow
Eroded laccolith
Volcanic conduit
Country rock
Sill
Laccolith
Diatreme
Dyke
Stock
Batholith