VULCANICITY OR VULCANICISM

Vulcanicity is the total process through which gases and molten rock (magma) from the earth's interior are intruded into the earth crust or extruded onto the earth surface. The magma originates from the upper plastic mantle called **asthenosphere** in the interior of the earth. This magma is kept in a semi-solid or semi-plastic or semi-molten state by the hot temperatures (over 4500^0 C) in the mantle. This heat is **generated by geochemical and geophysical** reactions as well as **radioactivity** due to decomposition of uranium in the earth's interior which releases a lot of heat that keeps the rocks in a molten state. Additional heat is generated by **friction along plate boundaries** due to faulting and other crustal movements. The heat results in the formation of **convective currents** which drive molten rock towards the crust.

The molten rock rises to the surface through **cracks/faults/lines of weakness** created in the crust by **faulting**. The molten rock rises due to the lower pressure at the surface along fissures in the crust. When magma is poured onto the earth surface it loses its gases and is turned into **lava**. Lava varies considerably in its chemical composition, particularly in its silica content. The silica content determines the degree of mobility and this also party explains the different types or shapes of volcanoes and nature of eruption whether explosive or quiet.

Basic lava is very fluid and mobile with a poor silica content, thus it is able to flow long distances before solidifying. It forms gently sloping cones, lava plateaus and plains.

Acidic lava is very viscous and immobile with high or rich silica content. It solidifies quickly and eruptions are violent or explosive. It forms steep landforms such as volcanic neck and plug.

Intermediate lava is fairly viscous with moderate silica content, thus it is unable to flow far before solidifying. Intermediate and acidic lavas are usually associated with explosive eruptions due their viscosity.

Type	**% of silica**	**Degree of mobility**	**Rock type**
Acidic (Felsic)	Greater than 66%	Very viscous and immobile. Solidifies rapidly at high temperatures	Rhyolite, Granite
Intermediate	52 - 66%	Fairly viscous, unable to flow far before solidifying	Trachyte, Gabbro
Basic (Mafic)	45 - 52%	Very fluid and mobile, able	Basalt,

This is the ***process by which molten magma from the earth's interior is ejected and deposited onto the earth surface through a central vent or fissure***. When eruption occurs, magma is ejected in form of ash, stones and blocks as well as gases. These fragmental materials are known as ***pyroclasts***. The features formed take various shapes depending on the type of lava which forms them.

LANDFORMS RESULTING FROM EXTRUSIVE VOLCANCITY

1. **Composite Cone or Strato Volcano –** This is usually ***a large cone with fairly steep sides consisting of alternate layers of ash and lava ejected through a central vent over a long period of time***. It is formed by alternate **violent and non-violent eruptions** releasing a lot of ash and lava which pile up around the vent. The violent cycle creates a layer of ash while the non-violent cycle creates a layer of lava. When the cycle of ash and lava is

repeated over and over in alternating layers, a composite volcano is formed. The **acidic lava** released is very viscous hence cools and hardens before spreading. A later violent explosion may blow off the top of the volcanic cone forming a large crater. Secondary or parasitic cones may develop on the sides when the main vent is blocked by solidified magma. Examples include ***Mt. Muhavura, Mgahinga, Meru, Kenya, Kilimanjaro, Ol Doinyo Lengai and Nyiragongo (DRC); Mt. Cameroon***.

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2. **Ash and Cinder Cones (Scoria Cone) –** This is a ***small steep sided volcano composed of ash and cinder layers***. It is formed when **acidic magma** is **violently or explosively ejected** creating many fragments (pyroclasts) of varying sizes, the smallest being ash. The fragments are later laid down in alternate layers of ash and cinder which accumulate and gradually build a conical hill with steep sides and a bowl-shaped crater at the top. They frequently occur in groups and are usually small, less than 200m in height. Examples include ***Suswa, Menegai; Nabuyatom, Abili Agituk, Murniau, Likaiyu and Teleki hills south of Lake Turkana; Mathanioni and Sambu in Kibwezi area of Kenya; Longonot, Sarabwe and Fileko, in Tanzania; Muganza, Sagitwe, Busoka, Bitale and Bisalo in Kisoro, SW Uganda and Chuyulu hills in Uganda***; Kitsimbanyi, north of Nyamlagira in DRC.

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3. **Shield Dome or Basalt Dome or Volcano (Basic Lava Cone) –** This is a ***large, flat topped gently sloping convex dome***. It's usually low in height relative to its large base. It is formed during a **quiet or non-violent eruption** when **very fluid** basaltic or **basic lava** flowing from one vent or several fissures spreads out over a large area before solidifying to form a very large lava cone or dome with gentle slopes. They are named for their large size and low profile, resembling a *warrior's shield.* Usually a large shallow steep sided crater is found on the basalt top. Examples include ***Nyamlagira (DRC); Mt. Marsabit in northern Kenya, Tukuyu in southern Tanzania; Erta Ale, Mat 'Ala & Alayta in the Afar Triangle, Ethiopia***.

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4. **Volcanic Plug or Neck –** This is a ***cylindrical mass of solidified lava in the vent of a volcano exposed by erosion of the surrounding cone***. It is formed when **very viscous acid magma** solidifies within the vent or pipe of an extinct volcano. After prolonged denudation of the volcano cone a distinctive upstanding landform is exposed. Examples include ***Tororo rock in Eastern Uganda,***

Alekileki on Mt. Napak, in Uganda; Batian and Nelion peaks on Mt. Kenya; Mawenzi, Mt. Kilimanjaro*; Wase Rock, south Jos in Nigeria.*

Tororo Rock, Eastern Uganda Volcanic Plug on Mt. Napak

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5. **Explosion Crater or Ring Crater –** This is ***a circular, shallow, flat-floored depression surrounded by a low rim of pyroclasts and local rock***. The craters are usually less than 50 meters high and often found in groups. Their formation is mainly based on **two** theories;

The **1st theory** notes that they are formed when a vent is blown through the local rock by a series of violent gas explosions. Fragments are deposited around the rim or edge of the crater created.

The **2nd theory** notes that as magma is poured onto the earth surface, a chasm or empty space is left beneath the volcano. Due to the weight of the overlying material (volcanic neck), the neck collapses into the chasm creating a depression.

When the depression extends to the water table it may be filled with water to form a **crater lake**. Examples include ***Lakes Katwe, Nyungu, Kyamwiga, Nyamusingire, and Nyamunuka in western Uganda around Lakes George and Edward; Lake Nkugute in Queen Elizabeth National Park; Ndali - Kasenda craters near Fort Portal and Kibale Forest****; Lake Kyaninga crater lake in Fort Portal; Ghama & Ndobot craters, Tanzania;* *Bishoftu & Hora craters, Ethiopia*.

Crater Lake in Western Uganda

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6. **Caldera –** This is a ***large, circular depression found on top of a volcano***. They usually exceed 1km in diameter. Their formation is based on two theories.
The **1st theory** noted that they are formed when a **violent eruption** blows off the volcano top and disintegrates into a mass of rocks and ashes, leaving behind a large circular depression.
The **2nd theory** notes that the caldera is formed by a process known as ***cauldron subsidence***. After a major eruption, the supply of magma is depleted or exhausted creating a large empty space (chasm) beneath the volcano. Due to the massive weight of the volcanic cone above, faults develop and in time the whole cone collapses into the chasm below creating a large depression called a caldera. Examples of calderas include ***Ngorongoro and L. Ngozi calderas in Tanzania; Longonot; on Mt. Menegai, Suswa and Meru in Kenya; on Mt. Elgon, Napak and Kadam in Uganda***. When a caldera is filled with water it forms a caldera lake such as ***Lake Shala, Ethiopia; Lake Bosumtwi, Ghana***.
Panorama View of Ngorongoro Crater

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7. **Cumulo Dome or Acid Lava Dome –** This is a ***steep sided convex dome of acid lava***. It is formed when **viscous acidic lava**, which does not flow far, piles up around the vent and hardens quickly on the outside. Later eruptions are unable to reach the surface may force the overlying layers outwards. The dome usually has no visible crater. Examples include ***Mt. Ntumbi east of Mbeya, Tanzania***.
Cumulo domes which form inside craters or calderas are called ***Tholoids***, for example in the caldera of ***Mt. Rungwe in Tanzania***.

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8. **Lava Plain or Plateau or Field or Bed –** This is an ***upland with a generally level summit made of successive layers of lava***. It is formed when **basic lava** which is very fluid or mobile, flows out from several fissures or cracks in the crust and spreads out over a wide area before solidifying. Repeated non-violent eruptions lead to the building of a thick and high plateau, completely covering the original landscape. Examples include ***Laikipia, Yata, Kapiti and Simbara plateaus in Kenya; Kisoro plains in south west Uganda***.

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9. **Hot springs and Geysers –** A ***geyser is a spring of hot water and steam ejected into the atmosphere with great force or explosively at irregular intervals***. A ***hot spring is a spring or stream of hot water coming out of the ground with water temperatures above its surroundings***. Both features are caused by surface water gradually seeping down through the ground until it meets rocks super-heated by magma. The geothermally heated water then rises back toward the surface by convection through porous and fractured rocks. If the water becomes so hot that it builds steam pressure and erupts in a jet above the surface of the earth, it is called a ***geyser***. If the ***water only reaches the surface in the form of steam and other gases***, it is called a ***fumarole*** e.g. on *Mt. Kilimanjaro around Kibo's crater*. If its water only flowing out then it forms a ***hot spring***. If the water is mixed with mud and clay, it is called a ***mud pot***. Examples of hot springs include ***Kitagata in Sheema, Sempaya and Buranga in Bundibugyo, Kisizi in Rukungiri, Ihimba south of Kabale, at Panyimur, Nebbi District; Maji ya Moto near Nakuru in Kenya***.

INTRUSIVE VULCANICITY

This is the process by ***which molten magma from the earth's interior is intruded into the earth crust and cools or solidifies before reaching the surface***. Landforms resulting from intrusive vulcanicity lie below the earth surface but may later be exposed to the surface by denudational processes such as erosion, weathering and mass wasting to form important features in the landscape. The major intrusive features include;

1. **Dyke –** This is a ***vertical or steeply inclined rock sheet intruded into or cut across rock layers or strata***. It is formed when magma solidifies within a vertical fissure or fault or crack in the earth crust before reaching the surface. Its thickness varies from a few centimeters to hundreds of metres. Dykes are said to be discordant with the surrounding rock layers or strata. They can occur singly or in large groups (swarms). Examples occur in ***south Nyanza, Thika district (Kenya) and Rungwa, east of Kisumu***.
When the dyke is eroded it may form a wall-like **ridge** if it's more **resistant** than the adjacent or surrounding rocks, such as ***Isingiro ridges in western Uganda; in Busia & Rungwa complex***, **BUT** if it's **less resistant** than the adjacent rocks it will form a shallow **trench** such as those in ***west of Lake Turkana, Kenya***. Sometimes dykes give rise to waterfalls or rapids.

ILLUSTRATION

2. **Sill –** This is a ***horizontal or tabular sheet of magma intruded along a bedding plane***. Its thickness varies from a few centimeters to thousands of meters. A sill is formed when magma rises from the interior and spreads horizontally along the bedding plane before solidifying. Sills form from ***basic magma*** which is very fluid and mobile thus it's able to flow far before solidifying. They are concordant (consistent) with the adjacent rocks. They may occur singly or in groups. When sills are **hard** compared to the surrounding rock they may be exposed by erosion to form **escarpments** or **cliffs** & flat topped hills called buttes, e.g. ***Three Sisters in Cape Province of South Africa*** while if they occur across a river bed they may form **waterfalls** and **rapids**. Examples are ***Thika and Thompson falls in Kenya, Ssezibwa falls and Bujagali in Uganda***

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3. **Laccolith –** This is a ***dome-shaped intrusion with a more or less flat base***. It is formed when viscous magma which is unable to flow far rises and solidifies within the crust and accumulates in a large mass, pushing up the overlying rock layers to form a dome or mushroom-like feature with a generally flat base. When exposed a resistant laccolith may form an **upland**. Examples are at ***Kitui Hills, Voi in Kenya***.

Laccolith exposed by erosion of overlying strata in Montana

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4. **Lopolith –** This is a very large saucer-shaped intrusion of viscous magma. It is formed when viscous magma is intruded into the crust and spreads horizontally. The increased weight of the overlying crust may cause sinking of magma giving it a saucer shape. When exposed by denudational forces the upturned edges of the lopolith may form **steep out-facing scarps** while the depression may form a **shallow basin**. Examples include the ***Rubanda arenas in Ankole*** while other lopoliths are found *north of Harare in Zimbabwe*.

   ILLUSTRATION

5. **Batholith –** This is a ***very large dome shaped body or mass of igneous rock (generally granite) formed at great depth by the intrusion and solidification of viscous magma***. This is the largest intrusive volcanic landform. It is formed by large-scale intrusion of viscous magma deep in the earth crust which cools and solidifies slowly. When exposed at the surface by prolonged denudation resistant batholiths may form massive rock **uplands**. These resistant hill outcrops stand out as inselbergs or residual hills surrounded by soft low lying plain. Examples include the ***Tanganyika batholith which outcrops between Mwanza and Iringa, Mubende (Ssingo) batholiths and Parabong hills (Acholi) in Uganda***. Others include *Chaillu Massif in Gabon; Sinda batholith, east Zambia; Cape Coast batholith, Ghana*.