STANDARD HIGH SCHOOL ZZANA

S.5 GEOGRAPHY PAPER 1 NOTES

FAULTING IN EAST AFRICA

EFFECTS OF FAULTING ON LANDFORM DEVELOPMENT IN EAST AFRICA

QN. Examine the influence of faulting on the development of relief/ land forms in East Africa.

QN. Examine the effect of faulting on the development of relief land forms in East Africa.

Approach

- Define faulting
- Explain the origin/ causes of faulting
- Describe the land forms produced by faulting
- Draw diagrams and give examples.

Answer guide

Faulting is an endogenetic process involving the fracturing and relative dislocation and displacement of hard rocks of the earth crust due to strain and stress caused by tension and compression forces operating in the earth crust.

Origin of faulting

Faulting is originates from Radio-activity and Geo-chemical reactions within the interior of the earth (mantle and core); generating intense heat that keeps the weak rock in the upper mantle (Asthenoshere) in molten state/ form.

Molten rock is light therefore tends to rise in form of convective currents which flow horizontally underneath the crust; creating tension, compression and vertical forces responsible for fracturing, dislocation and displacement of hard rocks

Regions affected by faulting in East Africa

Faulting affected areas of western Uganda, western and central Kenya, central and southern Tanzania.

Faulting formed a wide range of relief features in East Africa like rift valley, Block Mountains, fault scarps, grabens, tilt block landscape and fault guided valleys.

The Rift valley

A rift valley is an elongated trough or depression between more or less parallel faults or in-facing fault scarps. The formation of the rift valley is not clear thus various theories have been put forward by different Geographers to explain its formation. Namely: tensional theory, compression, differential up-lift theory e.t.c

Use at least two theories stated above to explain the formation of the rift valley

Tension theory

This theory was advanced by J.W Gregory to explain the formation of the Eastern section of the rift valley.

According to Gregory, radio-activity and Geo-chemical reactions generated intense heat that produced convective currents in the mantle.

When convective currents reached the earth crust, diverged leading to development of tensional forces within the crust of East Africa.

Tensional forces pulled the crust in opposite direction from the central point within the earth crust forming **normal faults** and displacement of the rock strata.

Consequently, the Side blocks were pulled apart or away from each other while the middle/ central block sunk down under its own weight; displacing the rocks below to form **a rift valley with gentle slopes**.

Denudation forces such as weathering, erosion and mass wasting modified the side slopes.

Clear Diagram

Compression theory

This theory was advanced by E.J Wayland to explain the formation of the western section of the East African rift valley. (Lake Albert region).

According to wayland, intense heating in the interior of the earth by radioactivity and geo-chemical reactions resulted into convective currents

When convective currents reached the earth crust, tended to converge; creating compressional forces that pushed the crust of East Africa in the same direction, resulted into **reversed faulting**.

Continued compression forced sideway fault blocks to override the central/ middle block that remained stable at a relatively lower level, formed a rift valley with steep slopes or sharp edges.

After a long period of time, the sharp edges of up-thrusted fault blocks, hanging above the middle block were modified denudation forces such as weathering, erosion and mass wasting to produce smooth escarpments of today.

Clear Diagram

Differential uplift theory or subsidence theory

The theory was advanced by Dixey and Troup to explain the step faulted part of the rift valley near Nairobi.

The theory assumes that there was a period of general uplift/ up warping of East Africa probably due rising convective currents generated from intense heat produced by radio activity and geo-chemical reactions in the interior of the earth.

The general uplift of the region resulted into normal faulting; creating numerous parallel faults in the crust, raised at different rates.

The theory assumes that side way fault blocks were raised faster than the central / middle fault block that rose slowly hence lagged behind in stages to form the rift valley.

Alternatively, compressional forces produced several fault lines in the crust. Compression was accompanied by sinking convective currents (back into the mantle) pulled the faulted crust downwards in stages or different rates.

The theory assumes that the middle/ central fault block sunk faster than the side way fault blocks which sunk slowly hence lagged behind in stages to form a rift valley.

At each stage of either uplift or subsidence, the mass of land formed a terrace hence formation of kedong fault scarp near Nairobi, appearing as a series of terrace rising from the rift valley floor up to the escarpments.

The gaps in the middle of the terraces formed the rift valley.

Clear Diagram

Up-arching theory by Lester .C. King

According to this theory, rising convective currents in the mantle caused a general up-bending or up- arching of the East African region. According to Lester King, tension forces caused the crest or summit of the up-bent area to crack and opened to form a rift valley. This theory is justified by the fact that the rift valley is on a raised plateau.

Sea floor spreading and plate tectonic theory by Harris Hess

The theory assumes that diverging convective currents underneath the African plate are creating deep faults in the plate causing the faulted region to sink slowly into the mantle hence a rift valley on the surface.

The continuous flow of convective currents underneath the African plate is increasing tensional forces causing the rift valley to widen at an estimated rate of 1.2cm each year.

In conclusion, the formation of the Great Rift Valley is a product of convective currents in the interior of the earth generating tension, compression and vertical endogenetic responsible for fracturing the earth crust to form a rift valley as explained above.

Emphasis should be on major theories of tension and compression

Block Mountains or Horsts

A block mountain is a **raised fault block** bordered by faults on one or more sides and stands above the surrounding land, for example mountain Rwenzori in south western Uganda, Uluguru, Usambara, Mahange, Pare in Tanzania, Nyiru and Ndoto in Kenya.

The formation of the horsts is not clear, leading to different theories to try explaining its formation. Namely; differential up-lift theory, relative subsidence theory e.t.c

Use the two theories stated above to explain the development of the block mountain.

The differential up-lift theory

According to this theory, compression forces produced by convective currents moving in opposite direction below the crust, produced numerous fault lines in the crust. Compression was followed by vertical moving forces created by raising convective current, which raised/ up-lifted the faulted crust.

The middle/ central fault block was however up-lifted faster and higher than the side-way blocks to form a horst.

Diagram

Relative Sinking /Subsidence Theory

According to this theory, compressional forces produced several fault lines in the crust.

Sinking convective currents (back into the mantle), pulled the faulted crust downwards to the mantle at different rate/ speed.

Side-way fault blocks sunk faster than the middle fault block which lagged behind and remained standing above the surrounding land formed a horst/ block mountain.

Diagram

Fault scarps \fault escarpments

A fault scarp is a steep slope **along a single fault line**. A fault scarp is formed when vertical forces produced by rising convective currents in the interior of the earth; acted on a single fault and caused one block **to slide down** relative to another to form a steep slope. For example Butiaba fault scarp near Lake Albert and Kicwamba in fort portal, western Uganda. Mau and Elgeyo fault scarp in Kenya and Manyara fault scarps in Tanzania.

Diagram

Grabens or hollows

A graben is a narrow trough between parallel faults formed within the rift valley due to secondary faulting on the floor of the rift valley. Later the grabens were filled with

rain water, streams and rivers to form rift valley lakes for example grabens occupied by Lake Albert, Edward in Uganda, Turkana, Baringo, Nakuru and Magadi in Kenya, Tanganyika and Eyasi in Tanzania.

Graben lakes are deep, have steep banks, elongated with regular shore line.

Diagram

Tilted block landscape

This is a landscape of made of angular ridges and narrow depressions formed when tensional and compressional forces were accompanied/ followed by vertical operating forces which raised/ up-lifted and tilted the faulted blocks on one side, for example Aberdare region in Kenya.

Diagram

Fault guided river valley

A fault guided river valley formed where a single fault developed in the crust. Faulting created a single fault line where rocks were displaced and shattered, therefore easily deepened by running water and widened by denudation forces such as weathering and wasting to form a fault guided valley.

Later, the river abandoned its original course and started flowing following the fault line hence the name fault guided river valley, For example river Aswa valley in Northern Uganda, Kerio valley between Elgeyo escarpment and Kamasiya ridge in Kenya.

Diagram

QN. With the aid of specific examples, examine the influence of faulting on the development of landforms in any one country of East Africa.

Approach

- Define faulting
- Explain the origin/ causes of faulting
- Describe the land forms produced by faulting
- Draw diagrams and give examples strictly from the country selected /chosen

THEORIES FOR THE FORMATION OF THE GREAT RIFT VALLEY

QN.Account for the formation of the East African rift valley.

QN.Justify the validity of the theories put forward to explain the formation of the Great Rift Valley in East Africa.

QN Examine the theories put forward to explain the formation of the Great Rift Valley in East Africa.

Approach

- Define a rift valley.
- Locate the Great Rift Valley descriptively or by drawing a sketch map.
- Explain the origin of the rift valley and describe the theories advanced to explain its formation.
- Point out the evidences where possible to justify the theories and with clear diagrams

VULCANISM IN EAST AFRICA

Vulcanicity is the total process by which gases and molten rock/ magma are injected into the crust and or ejected onto the surface of the earth crust through vent/ fissures/ fault lines to form intrusive and extrusive volcanic features respectively.

Vulcanicity therefore combines both intrusive and extrusive volcanic activities.

INTRUSIVE VOLCANIC LAND FORMS IN EAST AFRICA

QN. Examine the effect of intrusive volcanicity on land form development in East Africa.

QN. Examine the influence of intrusive volcanicity on the development of relief landforms in East Africa.

Approach

- Define intrusive volcanicity
- Explain the process or origin/causes of intrusive volcanity
- Describe the land forms produced by intrusive volcanicity
- Draw diagrams and give examples.

Answer guide

Intrusive volcanicity is the process by which molten rock/ magma is injected or pushed into the earth crust from the interior of the earth to form intrusive volcanic landforms.

Origin

•Intrusive Volcanicity is brought about by radio activity and geo-chemical reactions in the interior of the earth generating intense/ great heat and pressure; melting mantle rock into molten rock/ magma.

•Some times magma forms as a result of Friction between moving rocks during plate movement and faulting.

•High pressure pushes out the molten rock/ magma into the crust; rising towards the surface through lines of weakness such as faults created by tectonic forces/ movements such as faulting.

•The injected materials solidify within the earth's crust at different levels due to;

– reduction in pressure,

–the chemical composition of magma,

– the nature of the surrounding rocks in terms of jointing and hardness.

•The conditions stated above also determine significantly the size and shape of the resulting landforms such as sills, dykes, laccoliths, lapolith and batholiths and are associated with various reliefs in East Africa.

•Intrusive volcanic landforms remain invisible until they are exposed on the surface by denudation processes like weathering, wasting and erosion that remove the overlying less resistant rocks or strata.

LAND FORMS CREATED BY INTRUSIVE VOLCANICITY

Sills- these are horizontal sheets of igneous rock structure lying between the bedding planes of sedimentary rocks.

They are formed when a sheet of basic magma rises and solidifies horizontally in the bedding planes of sedimentary rocks near the surface.

Sills vary in thickness and may extend for a wide area for example in Mubende, Tororo and Thika in Kenya.

Where sills are harder than the soft surrounding rocks, they were exposed and formed flat-topped hills, escarpments or cliffs as relief landforms after prolonged weathering and erosion for example Sukuru hills in Tororo and Kakinzi in Luwero

In addition, the escarpments and impermeable rocks associated with sills along river course created waterfalls for example Sipi falls in Kapchorwa, Kisiizi falls in Rukungiri and Thika falls in Kenya.

Dykes - are vertical or steeply inclined sheet of igneous rock structures cutting across rock strata.

They were formed when magma solidified vertically in fissures before reaching the surface to form a wall like feature in the crust.

Dykes vary from few centimeters to hundreds of meters and are always discordant to the bedding planes of the rock strata for example Sukuru hills and dykes in southern parts of Lake Turkana.

In areas where dykes are harder than the surrounding rocks, they formed elongated hills or ridges and volcanic plugs as the surrounding rocks were destroyed by weathering and erosion for example ridges in Busia, Sukuru, Isingiro, Rungwe complex in Kenya and Tororo rock.

In areas where soft dykes alternate with hard country rocks , they were worn away to form long narrow ditch like depressions on the surface called trenches for example linear trenches near lake Turkana in Kenya

Batholiths- are very large dome-shaped intrusions made of large crystalline granite rock. They are formed when acidic magma cools down very deep in the crust, usually at the root of major volcanic mountains.

These hard batholiths were later exposed by prolonged denudation force of weathering and erosion, forming uplands/ highlands/ hill rock out crops which stand out as inselburgs or residual hills surrounded by soft low laying relief / plain for example Singo hills in Mubende, Sukuru hills in Tororo, Labwor and Parabong batholiths in Northern Uganda. Maragoli and Sangalo hills in western Kenya

In areas where soft batholiths alternate with hard country rocks, they were worn away to form arenas or wide depressions on the surface for example Rubarola arena in Kabale.

Laccoliths- are mash room or dome shaped intrusive igneous rock structures with a flat base.

They are formed from injection of viscous /acidic magma into the layers, unable to spread far; accumulated in large mass.

The viscous magma forced the overlying rock strata to bend upwards hence dome shaped as it solidified.

When exposed by denudational forces, laccoliths have formed uplands when harder than the surrounding rocks for example Kitui and Voi areas in Kenya.

EXTRUSIVE VOLCANICITY

QN. Examine the influence of volcanicity on the development of relief land forms in East Africa.

QN. Examine the effect of extrusive volcanicity on the development of relief land forms in East Africa.

Approach

- Define volcanicity
- Explain the origin/ causes
- Describe the land forms produced by volcanicity
- Draw diagrams and give examples.

Answer guide

Volcanicity is the process through which gases and molten rock are extruded onto the earth's surface through the vent or fissures to form various volcanic landforms.

Origin of extrusive volcanic landforms

Volcanicity is brought about by radio activity and geo-chemical reactions in the interior of the earth generating intense/ great heat and pressure; melting mantle rock into molten rock/ magma.

Some times molten magma forms as a result of Friction between moving rocks during plate movement and faulting.

High pressure pushes out the magma into the crust; rising to the surface through vent and lines of weakness such as faults created by tectonic forces/ movements such as faulting.

The shape and the size of the volcanic landforms are determined by the chemical composition/viscosity of magma and the nature of volcanic eruption. That is acidic (high silica content), intermediate and basic magma(less silica)

LANDFORMS PRODUCED BY VOLCANICITY

Ash and cinder cones, composite cones, shield and lava plateaus, explosion craters, caldera, Cumulo domes, volcanic plugs and neck e.t.c

Ash and cinder cones- are cones formed when acidic lava is ejected in violent eruption; breaking down into volcanic dust **(ash)** and small rock fragments **(cinder**).

These materials/ rock fragments fall back and build up a concave shaped cone around the vent due to the spreading out of materials near the base.

Ash is laid first followed by cinder and each layer represents a phase of eruption.

Characteristics of ash and cinder cones

- have steep slopes,
- small in size, not exceeding 300 meters (1000 ft) and
- often form parasitic cones on or near larger volcanoes.
- occur frequently in groups for example Sarabwe and Sabiniyo in Kisoro district, Teleki in Kenya and on the Eastern side of mountain Elgon.

Composite cones / strato volcanoes-these are larger cones made of alternate layers of ash and lava ejected through the vent over a long period of time.

The first eruption is violent and breaks down into volcanic dust called ash laid down around the vent to form the first layer. As pressure reduces, lava pours out on top of the ash to form the second layer.

Successive eruptions build up a composite cone which can rise thousand of meters high above the surrounding surface.

Characteristics of ash and lava cones

- they are usually larger cones with steep slopes and broad bases,

- have smaller parasitic cones on the sides as exists for lava when the vent is sealed during the gentle eruption,
- have large craters at the top; created by secondary eruption which blows off the top of the cone,
- take long to erupt because lava hardens and seals the vent.

Examples include mountain Kilimanjaro, Kenya, Oldoinyo Lengai in Tanzania and Muhavura in south western Uganda.

Both ash and cinder cones and composite volcanoes are associated with high relief in East Africa

Shield volcanoes / Basalt volcanoes. They are elongated volcanoes formed when basic lava flows for a long distance and over a wide area before cooling and solidifying on the surface. The consequent solidification leads to formation of a much stretched lava cone.

▪The magma forming such a volcano comes out through several fissures or openings in the crust.

▪Rapid loss of gases occurs and because lava is less viscous, it flows for a while before solidifying.

Characteristic of shield volcanoes

- Shield volcanoes are of low height but with broad bases and extensive gently sloping sides,
- Some basalt volcanoes have large shallow and steep-sided small craters formed due to the subsidence of the summit of the volcano,

Example is Nyamlangira in Eastern Congo within the Virunga/ mufumbira ranges.

Lava plateaus. They are stretched / elongated uplands with generally leveled summit made of successive layers of basaltic lava.

▪Lava plateaus are formed when basic lava slowly pushes to the surface from several fissures in the earth crust and spreads out over the surrounding country side before solidifying as a sheet of basalt.

▪Repeated fissure eruptions build a thick and high plateau which may reach 6000 ft. high

▪Examples include laikipian on the eastern slopes of Aberdare range and Yatta plateau in Kenya, lava plateaus in Kisoro and Ntungamo.

Characteristic of Lava plateaus

- Have stretched/ elongated tops
- Have gentle to steep slopes

Lava plateaus and shield volcanoes are usually associated with areas of moderate relief

Explosion craters. These are Shallow and wide circular depressions on the surface of the earth crust formed by violent gaseous explosion that removes the over lying crystalline rocks. Rock fragments fall back and pile up to form a low rim round of the crater.

Characteristic of Explosion craters

- They are normally flat floored and may be as wide as 500 meters in diameter but usually less than 50 meters high
- Since the depression extends toward the water table; they are filled with water to form explosive crater lakes which usually
- occur in groups for Example Lake Katwe, Nyungu, Nyamunuka in south western Uganda and Lake Basoti North East of Singida in Tanzania.

Volcanic craters (Mountain Craters)- these are funnel shaped or circular low depressions in the tops of volcanic mountain /cones. They are usually less than a kilometer in diameter

▪Mountain Craters are formed when the top of a volcano is blown off during second violent eruption.

▪Most Mountain craters are filled with rain and glacier water to form crater lakes found in the top/ summit of dormant and extinct volcanoes.

▪example of Mountain crater lakes include Menengai crater in Kenya's rift valley, Lake Simbi in south- Nyanza district (Kenya), Lake Katungi in Bushenyi, Gisozi in Kisoro, crater lakes on Mount Elgon, Kenya, Kilimanjaro and Muhavura and Paradise on the summit of mount Marsabit.

Calderas. A caldera is a large circular depression in top of a volcanic mountain, usually 1km in diameter.

Most calderas are formed when the summit/ top of a volcano either;

- collapses/ subsides into the magma chamber below under its own weight because of the movement of supporting magma. The caldera formed by this

process is called Cauldron or subsidence caldera, for example Napak in Karamoja Uganda, Menengai and Suswa calderas in the Eastern Rift valley in Kenya

Or

- when the upper part of the dormant volcano is blown off in a violent explosive secondary eruption, for example Longonot caldera on mount Longonot in Kenya and Ngorongoro crater in Tanzania.

Diagram

Cumulo dome- A Cumulo dome is a steep sided convex dome formed when acidic lava is pushed slowly out of the crust under low pressure and swells on the surface. Lava being acidic, piles up around the vent where the outer layers solidify quickly on exposure to air while the magma inside remains in semi liquid state. As more lava pushes out, the outer layers bulge/ swell into dome shape or a ball like structure with steep slopes, for example the Cumulo dome at Ntumbi near Mbeya in southern Tanzania

Tholoid- this is a Cumulo dome formed inside a crater or caldera of a larger volcanic mountain, for example the tholoid in the caldera on mount Rungwe in Tanzania.

Volcanic plug. A volcanic plug is a mass of hard rock/lava standing out vertically on the surface of the earth.

It is formed due to a sudden reduction in pressure during volcanicity; causing acidic lava to solidify in the vent and becomes resistant to denudation forces such as weathering and erosion that remove the surrounding weak/ soft rock layers. For example Tororo rock, in Eastern Uganda and Alekitek near Napak caldera in southern Karamoja

.QN**. Examine the relationship between the nature of material ejected and the resultant extrusive land forms in East Africa.**

Approach

- Define volcanicity
- Explain the origin/ causes
- Identify the types of magma/lava and
- Describe the land forms associated with each type
- Draw diagrams and give examples.

INFLUENCE OF VOLCANICITY ON DRAINAGE IN EAST AFRICA

QN. Examine the influence of vulcanicity on drainage in East Africa.

Approach

- Define vulcanicity
- Explain the origin/ causes
- Identify forms of drainage
- Identify land forms resulting from vulcanicity associated with drainage with specific examples from East Africa.

Answer Guide

Volcanicity is the process through which gases and molten rocks are extruded onto the earth's surface through a central vent or fissures.

Volcanicity is brought about by radio activity and geo-chemical reactions in the interior generating intense/ great heat and pressure; melting mantle rock into molten rock/ magma.

Some times molten magma forms as a result of Friction between moving rocks during plate movement and faulting.

High pressure pushes out the magma into the crust; rising towards the surface through vent and lines of weakness such as faults created by tectonic forces/ movements such as faulting.

The shape and the size of the volcanic landforms are determined by the chemical composition/viscosity of magma and the nature of volcanic eruption. That is acidic (high silica content), basic magma(less silica) and intermediate

The effects of extrusive volcanicity on drainage features depend on the nature of eruption and the magma ejected. That is;

Violent gaseous explosion removes overlying crystalline rocks to form wide circular depressions that are filled with water to form **explosion crater lakes** for example Lake Katwe, Nyamunuka, Kasenyi, Kikorongo, e.t.c in south western Uganda.

Violent eruption may blow off the top / summit of a volcano or the summit of a volcanic mountain may collapse into the chasm to form a smaller circular depression filled with water to form mountain crater lake for example Lake Katungi in Bushenyi, Gisozi in Kisoro, crater lakes on Mount Elgon, Kenya, Kilimanjaro and

Muhavura, Menengai crater in Kenya's rift valley and Lake Simbi in south- Nyanza district (Kenya) and Lake Paradise on the summit of mount Marsabit. Crater lakes are usually very small.

Some times violent eruption or subsidence of the summit forms a large, wide and circular depression on the volcanic mountain filled with water to form **caldera lakes** for example Lake Ngozi, Embagai and Ngorongoro in Tanzania.

Lava dammed lakes are formed as a result of deposition of basic lava across the existing river valleys causing damming and back ponding of the river for example lake Bunyonyi, Mutanda, Kyahifi, Kayumbo and Murehe in Kigezi south western Uganda, Lake Saka in Fort Portal.

Violent eruption of acidic lava builds Volcanic cones or mountains which form **divides/water shed** for numerous rivers forming **radial drainage** whose subsequent streams develop dendritic pattern for example Manafwa, Sironko, Malaba and Nzoia on mount Elgon and those on mountain Kenya, Kilimanjaro and Muhavura.

Volcanic materials that are porous in nature do **limit surface drainage** for example the basalts in Kisoro area and Bunyaruguru lack flowing rivers/surface drainage.

Intrusive volcanicity influences drainage especially where formerly existing dykes and seals are exposed by continuous erosion for example

Waterfalls and rapids develop where rivers cross resistant intrusive land forms such as dykes and sills. For example Sipi falls in Kapchorwa and Kisiizi falls in Rukungiri.

Presence of waterfalls and rapids lead to formation of other related features for example **gorges, plunge pools** e.t.c formed by falling water on soft rocks. Murchison gorge

Hot springs- mass of hot underground water flowing to the surface of the earth through fissures

Geysers- mass of underground steam and hot water gushing out to the surface through fissures.

Hot springs and geysers partly owe their origin to vulcanicity. Due to the existence of hot rocks or molten rock beneath the surface of the earth, when it rains

water sinks into the ground and comes in to contact with super heated rocks and is therefore heated. Pressure builds up and steam and hot water expand in the fissures, rising to the surface. Hot springs are evident in Bundyibugyo district like Sempaya, Kitagata in Bushenyi and Kisiizi in Rukungiri.