

Location of East Africa

East Africa is located on the Eastern side of the African continent. The region extends from approximately 23° North, to 12° South latitude and from 22° East to 51° East longitude. The region is crossed by Equator. East Africa is bordered by the Indian Ocean to the East and the Red Sea to the Northeast. To the West, it borders Central Africa and the Democratic Republic of Congo.

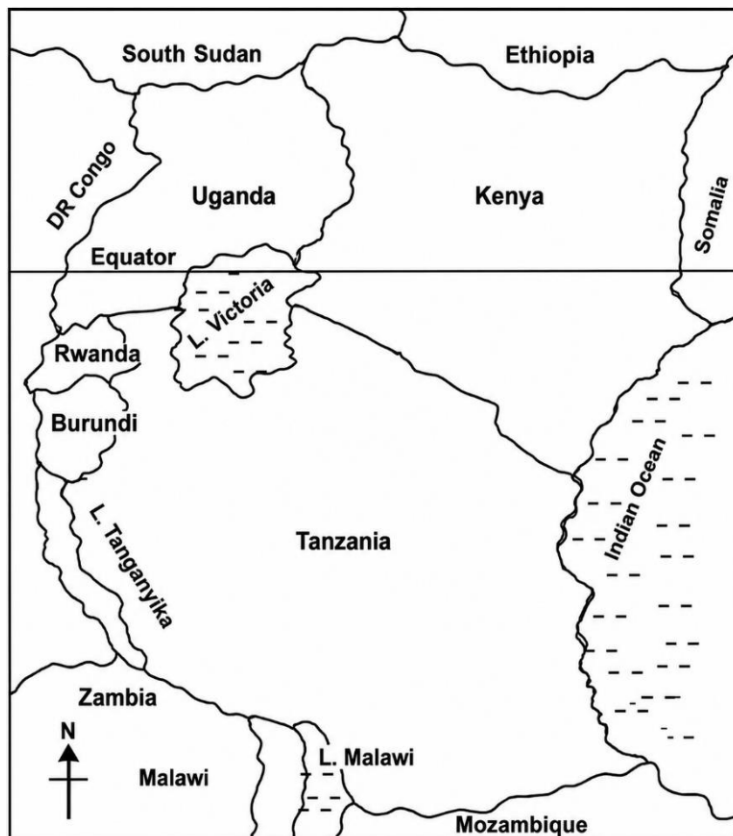
Size of East Africa

Geographically East Africa is made up of three countries (Uganda, Kenya and Tanzania). The region of East Africa covers a total land area of 1,768,313 KM² with Tanzania occupying the biggest land area (945,087 KM²), followed by Kenya (581,677 KM²) and Uganda (241,548 KM²).

It is important not to confuse the Geographical size of East Africa with the economic union or political community (East African Community). On the other hand, the East African Community is bigger in terms of size and the partner states include Burundi, Kenya, Rwanda, Somalia, South Sudan, Tanzania, Uganda, and the Democratic Republic of the Congo.

In this topic however, we are referring to the traditional idea of East Africa as Uganda, Kenya and Tanzania.

Sketch Map Showing the Location of East Africa



Country	Size	Population
Uganda	241,548 KM2	52.8 million people
Kenya	581,677 KM2	58.6 million people
Tanzania	945,087 KM2	72.6 million people

Combined, these three hold a total population of over 183.9 million residents, making up a massive share of the consumer market and workforce within the East African Community (EAC).

RELIEF REGIONS OF EAST AFRICA

Relief refers to the appearance of land in a particular area of the Earth's surface. The relief regions of East Africa include the Coastal Plains, Rift Valleys, Highlands, the Eastern Plateau as well as the Central and Lake Plateau. These regions are defined by their varied altitudes

1. Coastal Plains: These are low-lying, gently sloping areas that lie along the Indian Ocean, with altitudes generally between 0 and 250 meters above sea level. Primarily formed by river and wave deposition of sedimentary rocks from the Indian Ocean. Examples includes areas around major rivers like the Tana in Kenya and Rufiji in Tanzania.

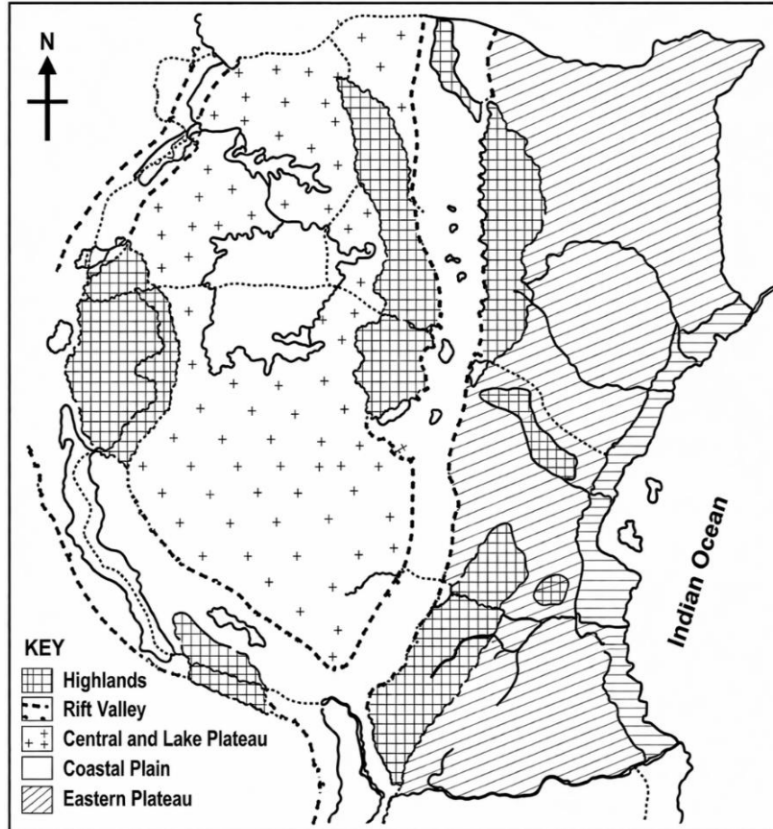
2. Rift Valleys: A rift valley is a long, deep depressions on the Earth's surface, bounded by steep slopes on either side. Rift valley is formed by significant tectonic faulting within the Earth's crust. The East African Rift valley has two arms (the Eastern and the Western arm). The western arm cover Uganda, Burundi, Rwanda and Tanzania and the eastern arm covers Kenya and Tanzania. Both arms consist of lakes which provide rich base of fishing activities. Examples of lakes in the western arm include (L. Albert, Tanganyika (the deepest lake in Africa (and one of the deepest in the world), Malawi, George and Edward). Examples of lakes in the Eastern Arm of the Rift Valley include Lake Turkana (the largest lake in Kenya and largest desert lake in the world), Lake Baringo (freshwater), Lake Naivasha (freshwater), Lake Nakuru (alkaline), and Lake Magadi (a soda lake).

3. Highlands: These are areas of high altitude extending between 1500 and 6000 meter above sea level. Often highlands are characterized by volcanic mountains and ranges. Formed by volcanic activity, where magma erupts, solidifies, and creates layered structures. Examples of highlands in East Africa include Mount Kenya (the highest mountain in Kenya), Mount Kilimanjaro (the highest mountain in Africa), and Mount Elgon (an extinct volcanic mountain shared by Uganda and Kenya).

4. Eastern Plateau: This is an upland area with a relatively uniform surface, typically situated between 250 and 1100 meters above sea level. The surface gradually rises towards the west and is sometimes interrupted by isolated hills and inselbergs. Often called the Nyika Plateau, covers parts of southeastern Kenya and Tanzania. Key features include the Taita Hills in Kenya and inselbergs in the Morogoro and Iringa regions of Tanzania.

5. Central and Lake Plateau: This region encompasses the interior of East Africa, lying between the Eastern and Western branches of the East African Rift Valley. This region is a high-altitude, gently sloping, and largely flat area, known for its scattered hills and the presence of shallow, irregular-shaped lakes. The Central and Lake Plateau in East Africa primarily covers Uganda and parts of Western and Northern Tanzania, encompassing the lakes of Victoria, Kyoga, and their associated basins. Associated basins are the surrounding lowlands and drainage areas connected to a lake e.g River Kagera and Katonga flow into Lake Victoria, River Sezibwa flows into Lake Kyoga, River Katonga (via wetlands) also contributes to the Lake Kyoga Basin.

Sketch Map of East Africa Showing Relief Regions



Note on Geological Formation: The varied relief of East Africa is primarily the result of massive tectonic forces that occurred during the Miocene epoch. Vertical uplift created a vast central plateau, while subsequent tensional forces caused sections of the earth's crust to crack and subside, forming the Great Rift Valley. Volcanic activity along the Rift Valley margins and the wider plateau gave rise to the region's towering mountains and fertile volcanic soils.

Influence of Relief on Weather and Climate

1. When moist air meets a mountain or highland, it is forced to rise, cools and condenses, forming clouds and causing heavy rainfall on the windward side (side facing the wind). On the leeward side (sheltered side), the air descends and dries causing a rain shadow with little or no rainfall.
2. For every 1,000 meters increase in altitude, the temperature drops by about 6.5°C (known as the environmental lapse rate). Higher altitudes are generally cooler. For example, Kabale, located in the highlands of southwestern Uganda, is cooler than Kampala because it is on higher altitude compared to Kampala.
3. High elevations are more likely to experience fog and low-level clouds due to cooling and condensation of moisture at those altitudes.
4. Relief creates microclimates in form of small areas with distinct weather/climate conditions compared to surrounding regions. For example, a valley might be warmer during the day but colder at night.
5. Mountains can act as barriers to larger air movements to reduce the risk of storm and create calm zones.

Relationship Between Relief Features and Natural Hazards in East Africa

The East African Rift Valley: The Rift Valley is a deep tectonic depression bounded by steep cliffs (escarpments). Its unique relief creates active seismic, volcanic, and mass-wasting hazards.

Volcanic Eruptions (Present): Ol Doinyo Lengai (the "Mountain of God") is an active volcano located on the floor of the Eastern Rift Valley depression in northern Tanzania. It continues to erupt a rare, low-temperature natrocarbonatite lava.

Volcanic Hazards (Past): Dormant volcanic cones such as Mount Longonot and Mount Suswa in Kenya present a history of violent ash explosions.

Earthquakes (Past & Present): Deep fault lines across the entire western arm (bordering western Uganda around Lakes Albert and Edward) and the eastern arm (Kenya/Tanzania) frequently trigger minor to moderate tectonic tremors.

Escarpment Landslides (Present): Severe rains on the steep walls of the North Rift Escarpments in Kenya (such as Elgeyo Marakwet) frequently trigger destructive mudflows and slumping down onto the valley floor.

The East African Highlands (High Mountains): Landslides **(Past & Present):** The foothills of Mount Elgon in the Bududa District of eastern Uganda suffer from frequent, fatal landslides. Massive cataclysms occurred here in 2010 and 2012, where entire mountainsides collapsed due to heavy saturation of weak volcanic soils.

Rockfalls and Mass Wasting: Hilly highland relief zones along the Kabale-Katuna ridge and the slopes of the Ruwenzori block mountains (Bundibugyo) in Uganda frequently experience rockfalls and soil creep that cut off transport networks.

Central and Lake Plateaus: Flooding **(Present):** Because this relief region is a low depression compared to the surrounding highlands, water empties rapidly into it. The flat areas surrounding Lake Victoria, Lake Kyoga (Uganda), and major river basins like the Tana River (Kenya) face regular swamp overflows and seasonal flash floods during intense rainy seasons.

The Coastal Plains: Flooding & Cyclones **(Past & Present):** Low-lying coastal cities like Dar es Salaam and Tanga in Tanzania, alongside Mombasa in Kenya, face high exposure to sea-level rises, coastal erosion, and seasonal flooding caused by tropical storms moving over the Indian Ocean.

Formation of Major Landform in East Africa

Rocks are naturally occurring, solid, non-living materials composed of one or more minerals that have been cemented together by geological processes.

Classification of Rocks: Rocks are classified into three main types based on how they form these types include; Igneous Rocks, Sedimentary Rocks and Metamorphic Rocks

Igneous Rocks: Igneous Rocks form from the cooling and solidification of magma (molten rocks) either in the interior or on the surface of the earth. Igneous rock exists in two types i.e

1. Intrusive Igneous Rocks
2. Extrusive Igneous Rocks.

Intrusive Igneous Rocks: Also called Plutonic rocks originate from the cooling of magma beneath the Earth's surface.

Characteristics of Intrusive Igneous Rocks

1. Large crystal size due to the slow cooling rate of magma.
2. Have a coarse-grained texture due to the slow cooling of magma.
3. They are crystalline in structure because slow cooling allows large crystals to grow and interlock.
4. They are usually very hard, making them highly resistant to weathering and erosion.
5. Form beneath the Earth's surface, so they are not exposed immediately after formation.
6. They often form visible plutonic landforms such as batholiths, laccoliths, dykes, and sills when exposed by long-term erosion.
7. Usually have no air spaces (non-porous) because gases escape slowly during the deep cooling process.

Examples:

Rock	Description
Granite	Light-colored rock with large crystals; commonly used in building.
Diorite	Black and white speckled rock with coarse grains.
Gabbro	Dark-colored, coarse-grained rock; similar composition to basalt.
Pegmatite	Very coarse rock with extremely large crystals.

Extrusive Igneous Rocks: Also called volcanic rocks, these form when lava cools and solidifies on the Earth's surface.

Characteristics of Extrusive Igneous Rocks

1. Small crystal size due to rapid cooling, which prevents large crystals from growing.
2. Have a fine-grained (aphanitic) or glassy texture because cooling happens quickly.
3. They form on the Earth's surface where temperatures drop fast.
4. They can be vesicular (porous) due to gas bubbles getting trapped during rapid cooling (e.g., pumice).
5. They are formed from lava that erupts from volcanoes or fissures and solidifies.
6. They can have a smooth, ropery, or blocky appearance depending on the lava flow type and cooling conditions.
7. They are commonly found in volcanic regions and along active tectonic plate boundaries.

Rock	Description
Basalt	Dark, fine-grained rock formed from lava; common in oceanic crust.
Obsidian	Black volcanic glass with no crystals.
Pumice	Light, porous rock that can float on water.
Basalt	Dark, fine-grained rock formed from lava; common in oceanic crust.

Sedimentary Rocks: (Definition and Formation)

Sedimentary rocks develop from the accumulation of plant and animal remains, as well as fragments of pre-existing rock materials.

Formation process stages

Weathering: Physical and chemical forces break down rocks and organic matter into small fragments called sediments.

Erosion: Natural forces loosen and detach these sediments from their original source.

Transportation: Moving agents like rivers, wind, or glaciers carry the sediments away.

Deposition: Sediments settle and drop in a new location, such as a lake bed, ocean floor, or valley floor.

Lithification: The intense weight of newer, overlying layers compresses the lower sediments (compaction) while dissolved minerals glue the particles together (cementation) to transform loose sediment into solid rock.

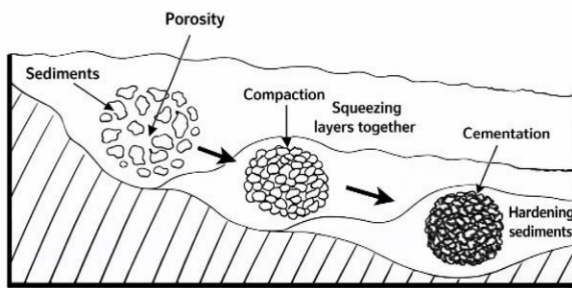
Mechanically: Form when fragments of pre-existing rocks are physically broken down, transported, and then deposited. These loose sediments undergo compaction under the pressure of overlying layers, to form a solid rock.

Examples depend on the size of the grains. For example, sandstone is made of sand grains, while mudstone and siltstone are composed of silt and mud, respectively. The finest of all is clay.

Chemically: Form when dissolved minerals separate from a water solution to become solid rock. This process, known as precipitation, occurs when the water evaporates, leaving the minerals behind. Common examples include evaporite rocks like rock salt, as well as limestone formed when dissolved calcium carbonate precipitates from seawater.

Organically: Form when the remains of plants and animals accumulate and are then buried under layers of sediment. Over vast periods, the immense pressure and heat from the overlying layers transform this organic matter, compacting and cementing it into rocks. Examples include coal, which forms from compressed plant material and Limestone, made from cemented marine shells and skeletal remains.

Process of sedimentary rock formation



Characteristic of sedimentary rocks

1. Layered Structure (Stratification): They occur in distinct horizontal layers called strata or beds.
2. Fossil Containment: They are the only rock type that can contain fossils (the preserved remains of dead plants and animals).
3. Their textures range widely from fine-grained (like clay in shale) to coarse-grained (like pebbles in conglomerate).

4. They are generally softer and more easily weathered than igneous or metamorphic rocks.
5. Many sedimentary rocks are porous, meaning they have open spaces or holes that can store groundwater, oil, or natural gas.
6. They are typically non-crystalline because they form from the compaction of fragments rather than the cooling of molten crystal minerals

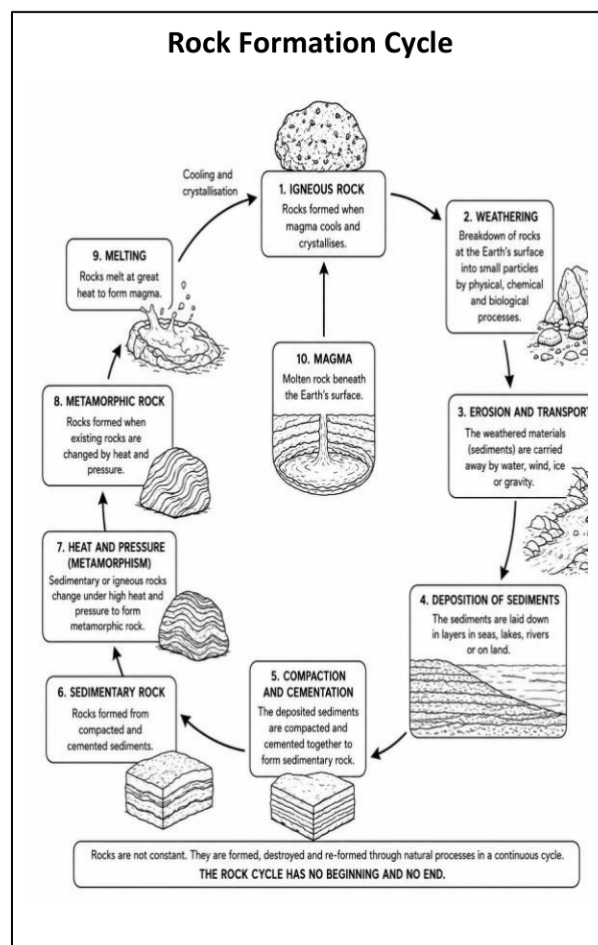
Metamorphic Rock: Form when existing igneous, sedimentary, or other metamorphic rocks are subjected to intense heat and pressure hence changing the texture, colour and mineralogical content of the original rock. These conditions occur deep within the Earth, often where tectonic plates meet. Examples include:

Original Rock	Heat and Pressure	Metamorphic Rock
Limestone(sedimentary)		Marble
Clay (sedimentary)		Slate
Coal (sedimentary)		Graphite
Sandstone (sedimentary)		Quartzite
Granite (igneous)		Gneiss

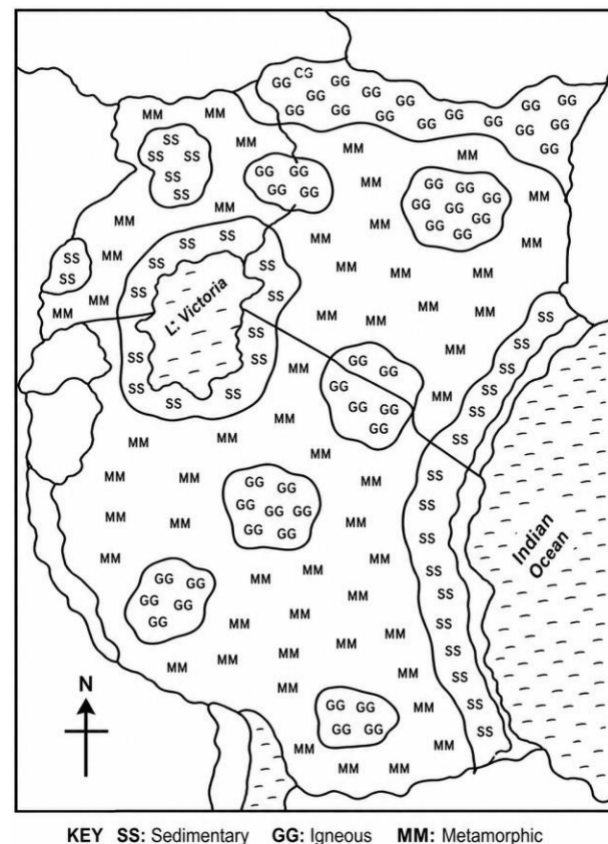
Characteristics of Metamorphic Rocks

1. Formed from pre-existing rocks that are changed by heat, pressure, or both.
2. They often show foliation (layering or banding) due to alignment of minerals under pressure.
3. They may have a shiny or crystalline appearance because of recrystallization of minerals.
4. Fossils are usually absent because original rock structures are destroyed during metamorphism.
5. They have interlocking mineral crystals, making them very compact and strong.
6. They do not melt during formation but change in solid state under intense conditions.
7. They may have different textures depending on the degree of heat and pressure applied (e.g., slate is fine-grained while marble is coarse-grained).

Rock Formation Cycle: The formation of rocks is a cycle which describes the continuous process of transformation between the three main types of rocks (igneous, sedimentary, and metamorphic) over geologic time, driven by Earth's internal forces like heat and external forces like weathering and erosion.



Sketch Map of East Africa Showing the Distribution of Rocks



Note: Soil formation takes anywhere from 200 to 1,000 years to produce just 1 centimeter of topsoil under natural conditions deep enough and fertile enough for stable agriculture

Economic Importance of Rocks to the People

- Rocks are the primary source of vital minerals like gold used in manufacturing of jewelleryes.
- Materials like granite and sandstone are quarried for building homes, roads and bridges.
- Sedimentary rocks contain fossil fuels such as coal and oil which provide energy industries.
- Rocks like limestone are used to make cement, while other types produce ceramics, glass, and bricks.
- Gradual breaking and weathering of rocks is the origin of all soil which support agriculture.
- The porous nature of certain rocks, such as sandstone, allows them to be used in water filtration systems.
- Beautiful stones like marble are carved into sculptures, used as decorative floors.
- Rocks act as natural reservoirs for underground water (aquifers), storing and supplying water through wells and springs for domestic and agricultural use.

Problems Associated with Rocks in East Africa

- Rocky outcrops break expensive ploughs and mining equipment, resulting in steep maintenance and replacement costs.
- Soluble rocks like limestone dissolve underground, creating unstable foundations that can lead to building collapses.
- Certain formations contain toxic minerals like asbestos, which cause severe lung diseases and cancer during quarrying.
- Unstable rock masses along steep tectonic escarpments often trigger destructive rockfalls, endangering nearby communities.
- The chemical weathering of specific mineral-heavy rocks releases excess salts, reducing agricultural soil fertility.
- Molten rocks break through the crust as lava, completely destroying infrastructure, farmlands, and human lives.
- Large expanses of exposed hard rock surfaces prevent root penetration and make mechanical digging impossible.

Influence of Rocks and landforms Formation in East Africa

- Very hard igneous rocks resist heavy weathering to form rugged, prominent landforms like steep cliffs and high ridges.
- Softer, layered sedimentary rocks easily wear down to form expansive, flat plateaus and low-lying plains via erosion.
- When hard and soft rocks sit adjacent, erosion selectively carves the weaker rock to create deep river valleys.
- Natural rock joints guide river channels, creating dramatic waterfalls where hard rock layers overlap softer beds.
- Rising magma erupting through the crust constructs massive volcanic cones, mountain peaks, and wide basaltic plateaus. Soluble calcium carbonate in limestone dissolves rapidly in acidic rainwater, creating underground caves and deep sinkholes.
- Resistant metamorphic rocks form the stable basement protruding as isolated, rounded hills (inselbergs) and undulating plateaus after millions of years of prolonged denudation.

Weathering: Weathering is the breaking down of rocks into smaller particles with the particles remaining in the same place (unlike erosion, which involves movement). Types include;

1. Physical (Mechanical) Weathering: Breaking of rocks into smaller pieces without changing their chemical composition. Temperature changes cause expansion in rocks when hot and contract when cold and eventually break. Processes of Physical (Mechanical) Weathering include:

Freeze–thaw action/Frost Wedging/Frost shuttering: Water enters cracks, freezes and cause expansion in rock, repeated freezing and thawing eventually breaks the rock into smaller pieces.



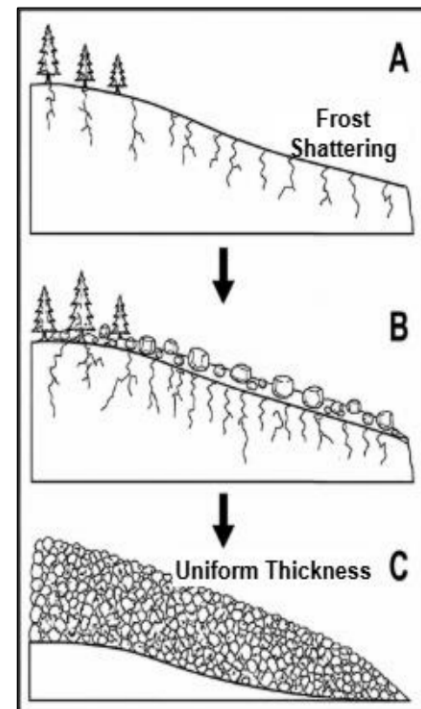
Feature Associated with Freeze–Thaw/Frost Wedging/Frost Shuttering

Block field (felsenmeer): Gently sloping alpine plains become covered in a blanket of rocks. Found in high-altitude zones such as Mount Kenya, Mount Kilimanjaro, and the Rwenzori Mountains.

Step A (Frost Shattering): Intense freeze-thaw cycles strike a relatively flat or low-angle bedrock surface. Water enters the extensive network of intersecting horizontal and vertical joints.

Step B (Deepening Cracks): Continual freezing and thawing shatter the bedrock in situ (in its original place). The cracks spread evenly across the surface rather than falling down a cliff.

Step C (Uniform Thickness): Over time, the entire bedrock surface breaks apart into a chaotic, continuous layer of angular stone blocks. Because there is no steep slope for gravity to pull them down, they stay in place as a flat field of stones with a uniform thickness.

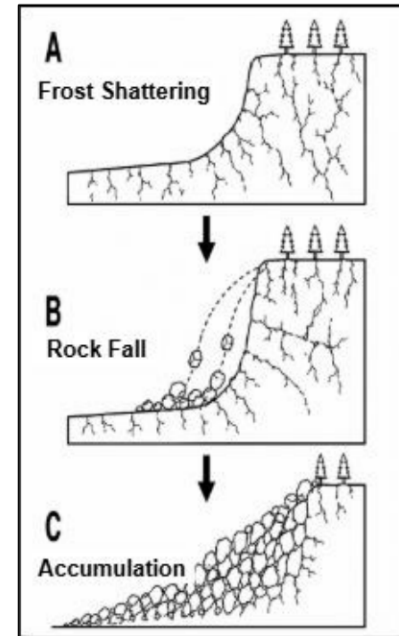


Talus (Scree) slope: Accumulations of loose, sharp rock fragments sitting at the base of steep mountain cliffs. These are highly prominent along the steep escarpments of the East African Rift Valley and on the upper slopes of East Africa's volcanic peaks such as Elgon and Kilimanjaro.

Step A (Frost Shattering): Water seeps into vertical joints and cracks at the top of a steep cliff face. As the temperature drops below freezing, the water expands into ice, widening the cracks and shattering the rock.

Step B (Rock Falls): The shattered, loose blocks lose their structural support and detach from the cliff face. Gravity pulls them down, causing them to bounce and roll down the slope.

Step C (Accumulation): The fallen rock fragments pile up at the bottom of the cliff. They form a distinctive, inclined fan-shaped slope of loose debris known as a talus slope.



Exfoliation/Pressure release (onion skin peeling): Rocks that form deep underground are under very high pressure from the weight of overlying rocks. When erosion removes the rocks above, the pressure is released. The rock below expands unevenly, outer layer cracks and forms a curved sheet and peels off eventually. Associated landforms include;

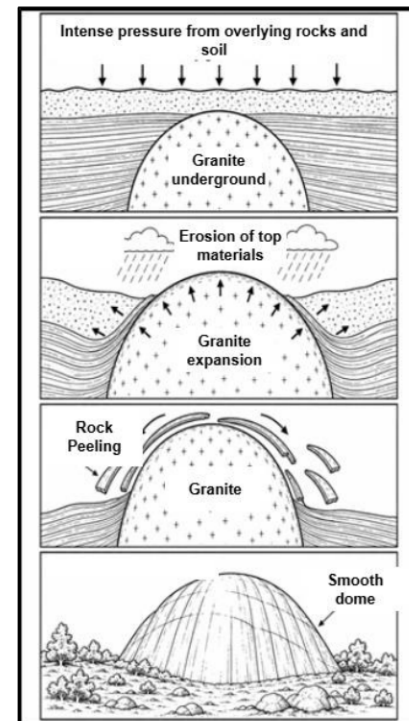
Exfoliation Dome: A massive, smooth, rounded mountain made of solid rock (usually granite) that peels away in curved sheets. Prominent examples include Mubende rocks in Uganda or the rocky hills of central Tanzania.

1. The Deep Squeeze: Millions of years ago, molten granite cooled deep underground under immense pressure from miles of heavy rock and soil sitting on top of it.

2. Popping Out: Over ages, heavy tropical rains and rivers eroded away all the heavy soil and surface rock. With the crushing weight finally gone, the buried granite compressed expands upward and outward, stretching toward the surface.

3. Peeling: As the rock expands into the open air, the immense internal pressure release causes the outer layer to crack parallel to the ground. The rock layers snap and peel off in giant, curved sheets, just like an onion skin.

4. The Smooth Dome Left Behind: The peeled sheets eventually fall away due to gravity, leaving behind a steep, smooth, bald mountain standing tall against the landscape.



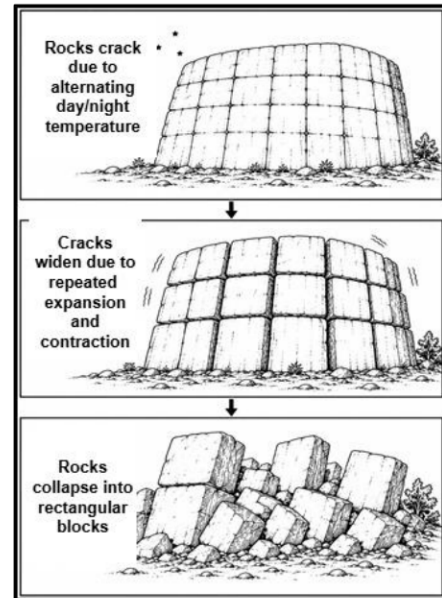
Thermal Expansion and Contraction: Rocks break due to repeated heating and cooling. During the day, rocks are heated by the sun and expand. At night, temperatures fall and the rocks contract. Continuous expansion and contraction create stress within the rock, causing it to break into pieces. Associated landforms include;

Block Disintegration: Refer to massive rocks split cleanly along their natural joints and bedding planes into large, rectangular blocks.

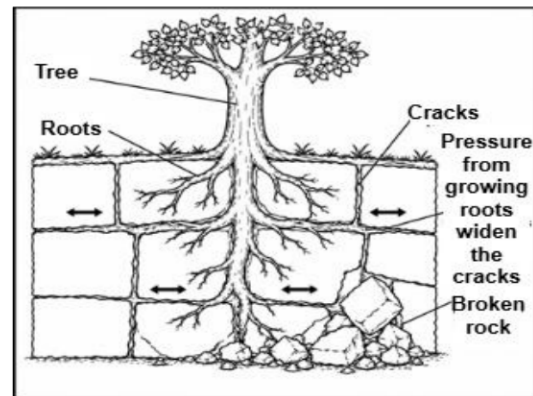
During daytime: In hot, arid regions (like parts of Northern and Eastern Kenya or Karamoja in Uganda), rocks bake under intense solar heat during the day. The outer layers expand.

During nighttime: At night, desert temperatures plummet. The rock cools rapidly and shrinks.

Over time: This constant expanding and shrinking puts immense stress on the rock. Because the rock already has natural vertical and horizontal joint lines, the stress cracks it right along those lines. Eventually, the rock cleanly drops apart into a pile of massive, square-shaped blocks, looking like a ruined stone wall.



Biological Weathering: Weathering caused by living organisms (plants and animals). Plants extend roots into rocks causing expansion and breaking. Likewise, burrowing animals (rodents) such as mice, squirrels drill holes in the ground and expose rocks making them vulnerable to weathering. **Burrowing Pits** are the main feature, where loose, crumbled rock beds are created when tunneling animals dig into underground rock joints, widening them mechanically.



Human Activities: Mining and Quarrying involves the extraction of stone from the Earth using heavy machinery and explosives. The process includes blasting which cracks open solid bedrock, while heavy equipment crushes and grinds large rocks into smaller pieces. This activity immediately breaks the rock apart and exposes a large surface area of fresh rock to Physical Weathering.

P r o c e s s e s o f C h e m i c a l W e a t h e r i n g :

Oxidation: Dissolved oxygen reacts with iron minerals inside rocks to form brittle rust, which structurally weakens the rock mass.

Carbonation: Atmospheric carbon dioxide mixes with rainwater to create weak carbonic acid, which completely dissolves alkaline rocks like limestone.

Hydrolysis: Hydrogen ions in water react chemically with silicate minerals in granite, altering them into soft, crumbly clay.

Solution: Pure water acts as a solvent, directly dissolving highly soluble rock minerals like rock salt and carrying them away. Over time, this continuous chemical leaching widens microscopic rock fractures into expansive underground networks and deep surface hollows.

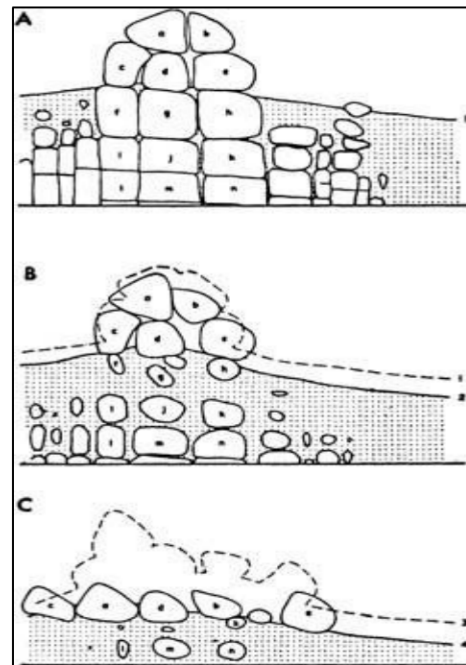
Landforms Resulting from Chemical Weathering

Tors (castle koppies): Free-standing, jointed piles of weathered rock blocks that project abruptly from flat plains. They are famous across the Serengeti Plains of Tanzania (locally called kopjes or koppies), as well as Kit Mikayi in Kenya and Kachumbala Rock in Kumi, Uganda.

A: Underground Chemical Weathering: Water seeps into underground joints. Chemicals rot rock into soft mud. Sharp stone corners begin to round.

B: Partial Exposure: Surface erosion washes away topsoil layers. Underground blocks turn into core stones. Topmost rocks peak above the ground.

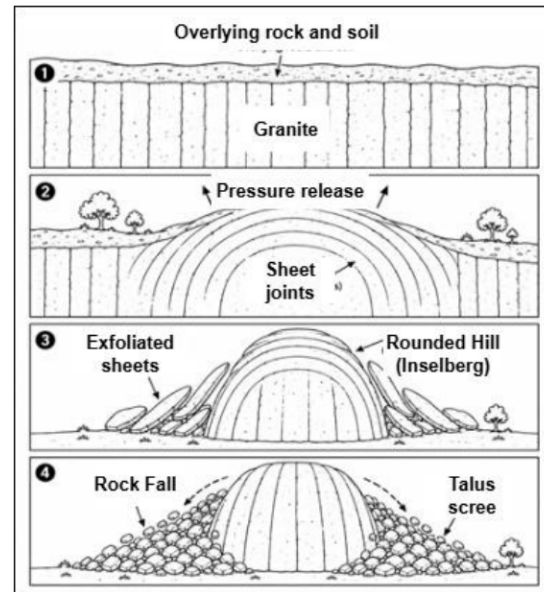
C: Final Exposure and Collapse: Soft mud washes away completely. Massive rocky towers are fully exposed. Unsupported top stones collapse and fall.



A Tor belongs under both Chemical Weathering (Hydrolysis) and Physical Weathering (Frost Wedging).

Inselberg: An inselberg is an isolated, steep-sided rock hill or small mountain that rises abruptly out of a flat, level plain.

Stage 1: A massive underground body of rock (usually granite) has areas with many cracks (joints) and areas that are completely solid. Rainwater mixed with organic acids from plants seeps deep into the ground. It aggressively attacks and rots the fractured rock sections, turning them into soft mud and clay (called regolith). The solid, unjointed rock centers completely resist this rotting. They remain perfectly hard and solid underground, forming a hidden dome shape.



Stage 2: Over millions of years, the earth's crust undergoes tectonic uplift, or the climate shifts, causing heavy wind, rain, and rivers to vigorously erode the surface. These erosional forces wash away the soft, rotted mud and clay layers, carrying them away down rivers. The surrounding landscape is stripped down to a flat floor called an etch plain.

Stage 3: As the surrounding landscape is stripped down to a flat floor called an etchplain, the massive, unjointed granite core is left behind. Because it is completely solid, it resists surface erosion. It is fully exposed to the open air, standing tall as a magnificent, isolated, steep-sided rock mountain rising abruptly out of the flat plain.

Limestone Cave: A limestone cave is a natural underground chamber or network of tunnels formed entirely within limestone rock. These are the most common types of caves on Earth, making up over 70% of all cave systems. They are part of a unique topography called a karst landscape. The Amboni Caves near Tanga, Tanzania are the most extensive limestone caves in East Africa.

Stalagmite (Down): A stalagmite is a cone-shaped rock formation that grows upward from the floor of a cave.

The drop finally loses its grip and plunges all the way down to the hard cave floor.

When the drop hits the floor, it splashes aggressively. This violent impact forces the remaining carbon dioxide gas out of the water instantly.

The splash spreads the calcium carbonate outward over a wider area. Because of this messy splashing, stalagmites grow upward as thick, broad, solid mounds rather than thin needles.

Stalactite (up): A stalactite is a cone-shaped rock formation that grows downward from the floor of a cave.

Water seeps through the cave ceiling and clings there for a moment as a hanging drop.

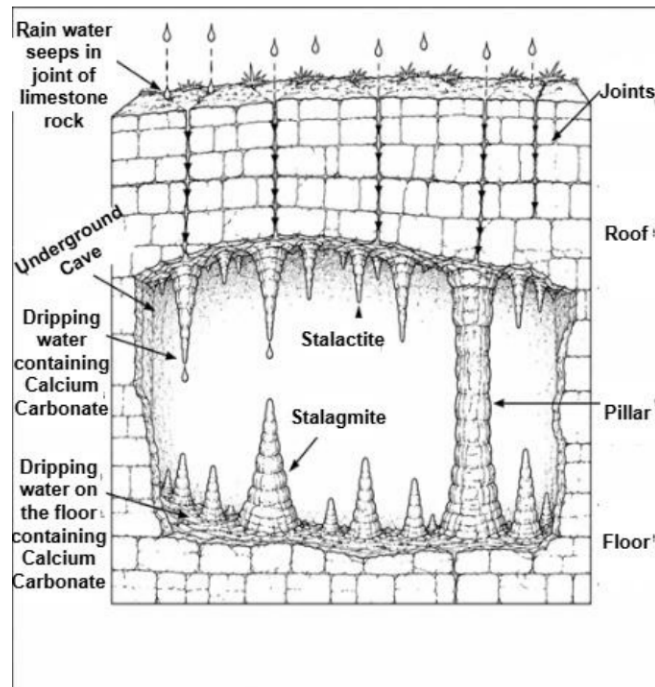
Before the drop even falls, it loses carbon dioxide gas to the cave air. This causes a tiny ring of calcium carbonate to crystallize directly onto the ceiling around the rim of the drop.

Because the water is calmly hanging, it forms a thin, hollow, very neat tube (like a drinking straw) pointing straight down. It does not splash here.

Limestone Pillar: A limestone pillar (also called a limestone column) is a solid vertical post of rock created when a hanging stalactite from the ceiling and a rising stalagmite from the floor grow toward each other over thousands of years and finally fuse together in the middle.

Example: Tooro hanging stalactites produce dripping calcium carbonate water that looks white and milky. Because they look exactly like breasts dripping milk, the local Tooro people named them "Amabere ga Nyina Mwiru" (The breasts of Nyina Mwiru) based on an ancient cultural. In cave/chamber of Amabere, Stalagmites and Limestone Pillar also exist.

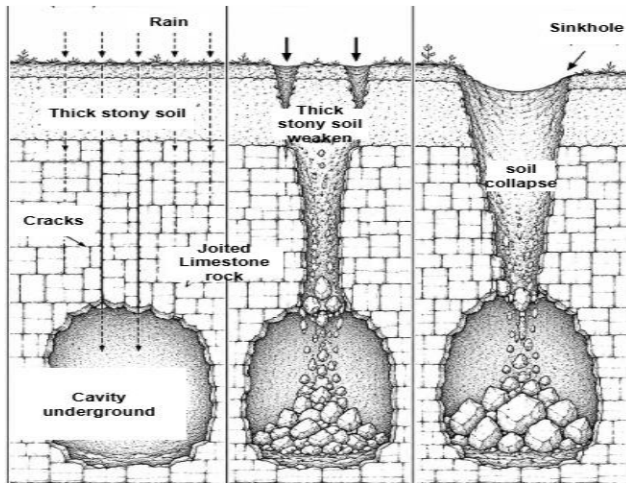
Activity 8.0 Scenario: Kaseka Hill is a rocky hill located near a village in eastern Uganda. Over many years, people have noticed different changes to the rocks. Some large rocks have cracked into smaller pieces after very hot days and cold nights. In other places, tree roots have grown into cracks and widened them. Farmers have also observed that rainwater has dissolved some limestone rocks, forming small holes and caves. Near the foot of the hill, mosses and lichens are growing on rock surfaces, causing the rocks to become weak and crumble. During a Geography field study, learners are asked to identify the different weathering processes taking place at Kaseka Hill.



Tasks:

- Identify the different types of weathering with evidence from the scenario that supports your answer.
- Explain how each of the identified weathering process in the scenario breaks down the rocks.

Sinkhole: (also widely known in geography textbooks as a doline) is a classic karst landform consisting of a closed, bowl-shaped depression or hole in the ground surface formed by the dissolution of underlying limestone bedrock.



Formation from Water droplets:

Solution Dolines: Acidic rainwater puddles in a small surface joint. As the water slowly seeps down, it dissolves the limestone walls, widening the crack into a broad, shallow, saucer-shaped depression over thousands of years.

Collapse Dolines: An underground cave stream dissolves a massive cavern beneath the surface. As the cavern grows, its ceiling weakens until the heavy overlying soil suddenly collapses completely into the underground void, leaving a steep, deep, dramatic pit. Example: the famous Amboni Caves network in Tanga, Tanzania.

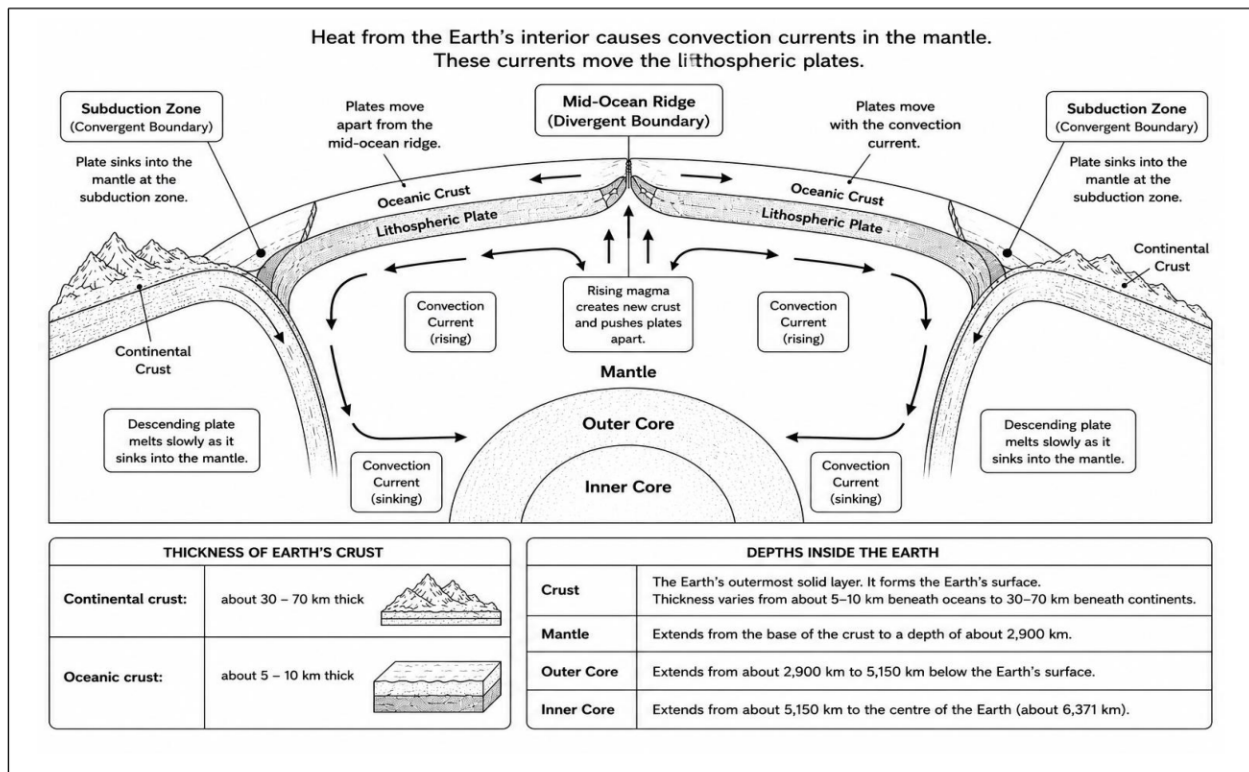
NB: Karst features are the unique surface and underground landforms created when slightly acidic water dissolves soluble bedrock, most commonly limestone, dolomite, or marble.

Activity 8.0 Scenario: A group of Senior Two Geography learners visited a limestone region in East Africa as part of their field study. During the excursion, they observed a large underground cave with water dripping continuously from the roof. They noticed pointed mineral deposits hanging from the cave roof and cone-shaped deposits growing upward from the cave floor. In some places, the deposits had joined together to form thick rock pillars. Outside the cave, they saw several circular depressions scattered across the landscape and a few large isolated rocky hills rising above the surrounding plain. Their guide also pointed out several rounded rock boulders with smooth surfaces that had been exposed after the surrounding weathered material had been removed.

Tasks: a) Identify seven landforms observed by the learners.

- a) State the main process responsible for the formation of these landforms.
- b) Explain how the process lead to the formation of each identified landform.
- c) Explain the economic value attached to the identified landforms.
- d) Explain the challenge of living near the identified landforms.

Plate Tectonics: Plate tectonics is the movement of large plates (oceanic and continental) of the Earth's crust. Radioactive decay of elements produces extremely high temperature in the mantle resulting into a force known as convection current force. This force causes horizontal plate movements such as compression, tension, and shearing, and vertical movements such as uplift, subsidence and eruption activities. These movements lead to endogenic (internal geological) processes which form various landforms. These processes include; Faulting, Folding, Warping, Volcanicity, and Earthquakes

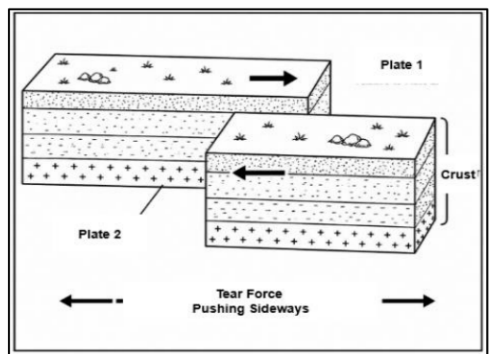
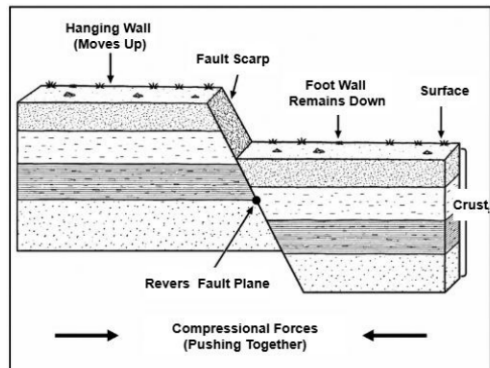
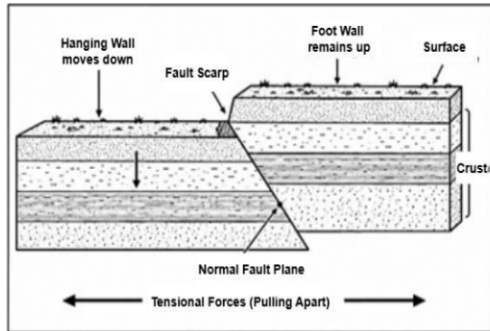


Influence of Plate Tectonics on Landforms

Types of Movement	Process	Landforms	Examples
Compression	Folding	Fold Mountains	Atlas Mountains
Tension	Faulting	Rift Valleys	East Africa Rift Valley
Tear	Transform Faulting (Earthquake)	Depression and raised landforms	1928 Sabukia Earthquake in Kenya
Vertical	Volcanicity	Volcanic mountains	Mount Elgon and Kilimanjaro
Uplift and Subsidence	Warping	Basin Lakes	Lake Victoria and Kyoga

Faulting: Is the process by which rocks in the Earth's crust crack and move along a fracture called a fault due to tectonic forces such as tension, compression, or tear force.

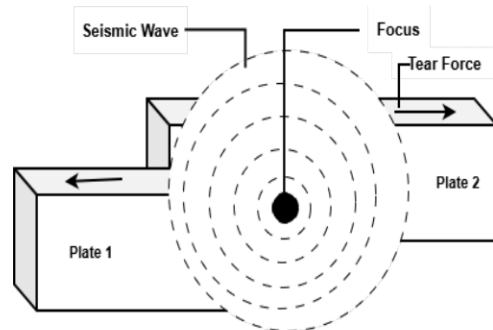
Normal Fault: Occurs when tectonic tension forces stretch and pull the Earth's crust apart. Along the resulting fracture line, the rock blocks slide vertically. The block of rock sitting directly above the inclined fault plane is called the hanging wall, while the block beneath it is the footwall. In a normal fault, the tensional pulling force causes the hanging wall to drop downward relative to the footwall.



Reverse Fault: Occurs when tectonic compressional forces squeeze and push the Earth's crust together. Along the resulting fracture line, the rock blocks are forced vertically past one another due to horizontal shortening. The block of rock sitting directly above the inclined fault plane is the hanging wall, while the block beneath it is the footwall. Under intense compressional stress, the hanging wall is pushed upward relative to the footwall.

Tear/Wrench/Transform Fault: A occurs when tectonic forces cause blocks of the Earth's crust to slide horizontally past one another. Unlike normal and reverse faults, which feature vertical movement up or down a fault plane, the movement along a tear fault is entirely lateral (sideways). These faults develop under shearing stress, where lateral forces push different parts of a rock mass in opposite horizontal directions. Because the displacement is horizontal, the fault plane itself is typically vertical or nearly vertical.

Earthquakes: An earthquake is the sudden shaking of the Earth's crust caused by the abrupt release of accumulated energy along fault lines when friction is overcome. This "stick-slip" mechanism occurs when tectonic forces cause rocks to break or slip after becoming locked, releasing energy as seismic waves from the focus causing the ground shaking experienced on the surface.



Landforms Resulting from Faulting

Landforms resulting from faulting include Block Mountains/Horst, Rift Valleys, Fault Scarps/Escarpment, Rift Valley Lakes/Grabens, and Tilted Blocks.

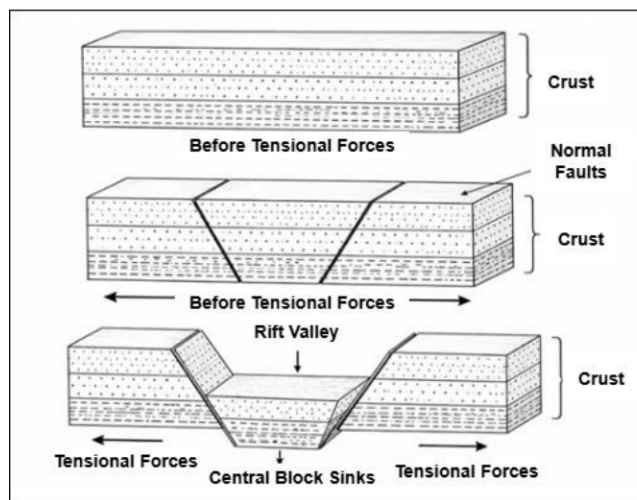
Rift Valley/Graben: A rift valley is a long, narrow, steep-sided depression on the Earth's surface, formed as a result of tensional or compressional forces acting on the earth's crust. Rift Valleys have the following Characteristics:

- Elongated (they extend over great distances).
- Narrow shape at floor.
- They are bordered by steep slopes (fault scarps/ escarpments) on both sides.
- Deep (the valley floor lies much lower than the surrounding land).
- Presence of Rift valley/Graben lakes.
- They are often associated with horsts (block mountains) on the sides.

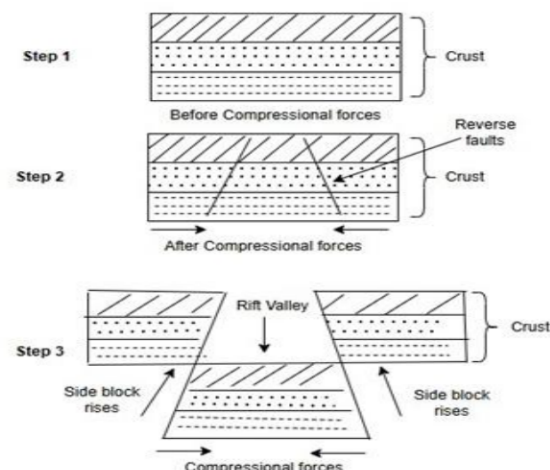
Formation of a Rift Valley by Tensional Forces: Tensional forces pull apart the Earth's crust, causing it to crack and create a normal fault line. The block of crust in the middle sinks between these faults forming a depression called Rift Valley. The blocks on either side remain standing higher, forming Escarpments.

Formation of a Rift Valley by Compressional Forces: Compressional forces push the earth's crust towards each other, causing it to crack and create a reverse fault line. The central block of land is squeezed downwards relative to the sides, forming a depression called a Rift Valley. The blocks on either side remain standing higher, forming Escarpments.

Tensional Forces



Compressional Force



IMPORTANT: A Lake formed in the sunken part of Rift Valley is called a Rift Valley Lake or Graben Lake. These lakes are typically long, narrow, and very deep because they fill the steep, steep-sided troughs created by faulting. Examples in East Africa include Lake Tanganyika, Lake Malawi (Nyasa), Lake Albert, and Lake Edward.

Sketch Map of East Africa Showing the Rift Valley and Rift Valley Lakes



Importance of the rift valley to the people of East Africa

1. The Rift Valley has spectacular landscapes e.g Lakes and Escarpments that attract tourists, earning foreign exchange and creating jobs.

2. Rift Valley contain minerals such as soda ash in Lake

5. The Rift Valley provides suitable conditions for geothermal energy production, for example in Olkaria Geothermal Field, helping to generate electricity.

6. Some Rift Valley lakes such as Lake Nakuru support fishing activities, providing food and employment to local communities.

. The Rift Valley lakes acts as a natural route for transport and communication, making movement of people and goods easier in some regions.

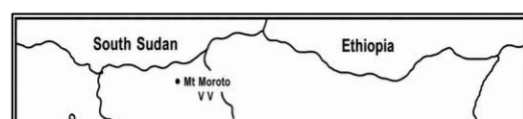
Problems Faced by People Living in Rift Valley Region of East Africa

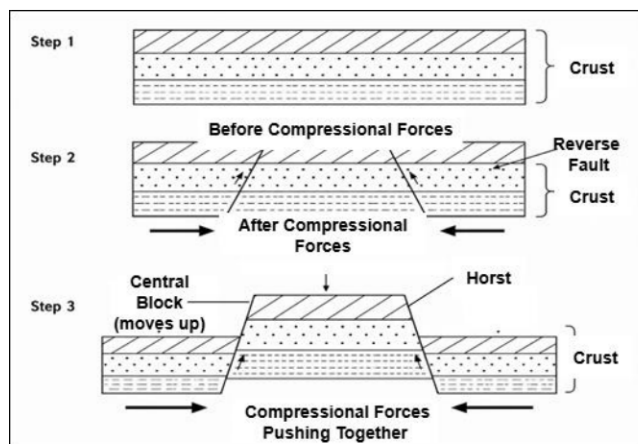
1. The steep escarpments have rugged terrain making construction of roads, railways, and airports very expensive.
2. Landslides in form of rock falls on steep escarpments threaten life and property
3. Rift Valley lakes sometimes flood hence displacing people and destroying crops.
4. Swamps in the rift valley can harbor disease vectors like mosquitoes and snails which cause for malaria and bilharzia respectively.
5. Some parts of the Rift Valley have saline soils e.g near lake Magadi with soda ash limiting farming and food supply.
6. Rift valley areas may experience earthquakes due to tectonic activity, destroying infrastructure such as schools, hospitals and roads.

Formation of a Block Mountain/Horst by Compressional Forces

Intense horizontal compressional forces push the Earth's crust inward from opposite sides. This extreme pressure causes the crust to fracture, developing parallel, inward-sloping reverse fault lines. As the compressional squeezing continues,

Sketch map of East Africa Showing Block Mountains





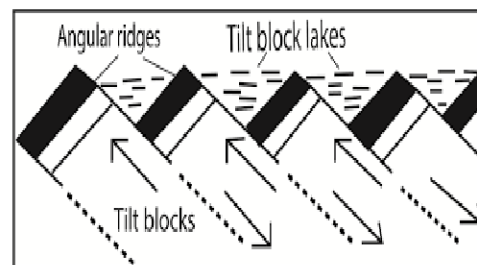
Importance of Mountains to the People of East Africa

1. Rivers which generated HEP often originate from mountains e.g, river Mubuku and Bujuku enabling Bugoye Power station all originate from Rwenzori.
2. Crater and caldera lakes on volcanic mountain tops are sources of fish used for food and income
3. Lower slopes of mountains are good for grazing livestock due to abundant pastures. This activity supplements food supply and earn income to the community
4. Mountains generate orographic rain when air rises, cools, and condenses to form clouds. This rain support crop growing and reduces hunger
5. Mountains like Rwenzori attract tourists for their beauty, wildlife, glaciers, and adventure. This creates job and income for tour guides enabling them to pay bill like for water.
6. Mountain forests provide timber used in house construction, fire wood for cooking and medicinal plants which heals illness and promote health.
7. Mountains contain valuable minerals such as gold, copper, and tin which support mining activities which in end create jobs for locals.
8. Some mountains have cool temperatures that are suitable for growing temperate crops like wheat, barley, and Irish potatoes which can be eaten or sold for money.

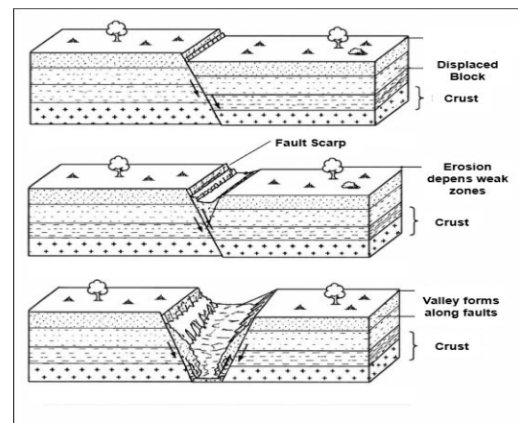
Problems Faced by People Living in Mountain Regions of East Africa

1. Landslides are common on steep slopes e.g. Mt. Elgon threatening life and property.
2. Volcanic eruptions occur in some mountain regions, destroying property and threatening lives.
3. Avalanches (rapid flow of snow from a mountains) steep slopes can also be deadly
4. Very cold temperatures at high altitudes limit human settlement and farming.
5. Thin air at high altitudes causes breathing problems for people and animals.
6. Soils on steep mountain slopes are often shallow and easily eroded.
7. Farming on slopes leads to soil erosion and landslides if not managed properly.
8. Steep and rugged terrain makes it difficult and expensive to construct roads, railways, and communication lines.
9. Mountain communities often have limited access to schools, hospitals, and markets due to remoteness.
10. People living near mountain forests may face threats from wild animals that destroy crops or attack livestock.

Tilt Blocks: is formed when the Earth's crust is subjected to tensional forces that cause it to crack and break along faults. Instead of both sides moving vertically in opposite directions equally, one side of the crust is uplifted while the other side subsidise, causing the block between the faults to tilt.



Fault Guided Valleys: These are valleys formed along lines of weakness (faults) where erosion is easier. Over time, the continuous erosion deepens and widens these weak zones, leading to the formation of valleys that follow the direction of the fault lines.



Activity 8.1: Scenario:

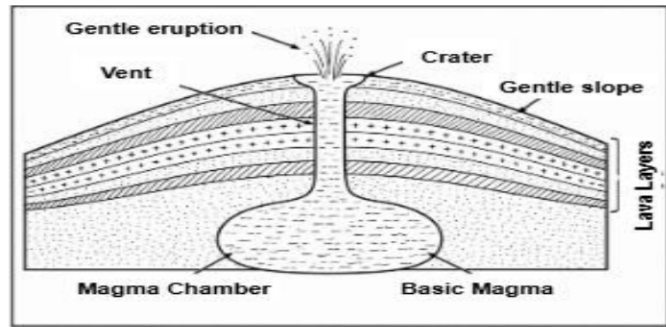
A team of Geography learners visited Kikorongo Valley in western Uganda. During the field study, they observed a long, narrow depression occupied by a lake. On either side of the depression were steep slopes rising sharply above the surrounding land. Nearby, they also saw an isolated block of high land standing above the lower surrounding area, while another area had sunk to form a broad plain used for farming. Along the foot of one steep slope, warm water was emerging naturally from the ground.

Task: Identify five features formed by faulting described in the scenario.

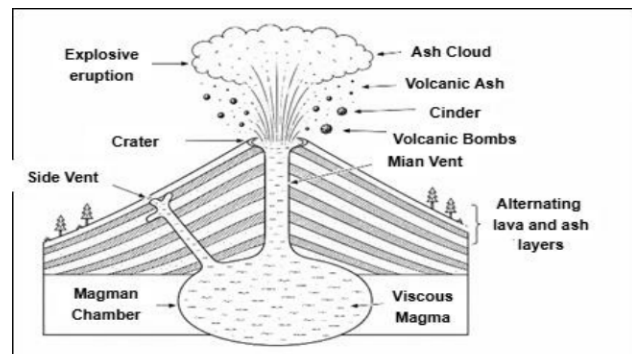
specifically to extrusive processes where magma erupts onto the Earth's surface to form volcanoes and related features. Landforms due to Volcanicity include the following;

Volcano: A volcano is a vent or opening in the Earth's crust through which magma, ash, and gases erupt. Over time, the accumulated lava and ash build up around this opening, creating a mountain-like structure. Volcanoes are primarily classified according to their activity, shape, and the materials that form them.

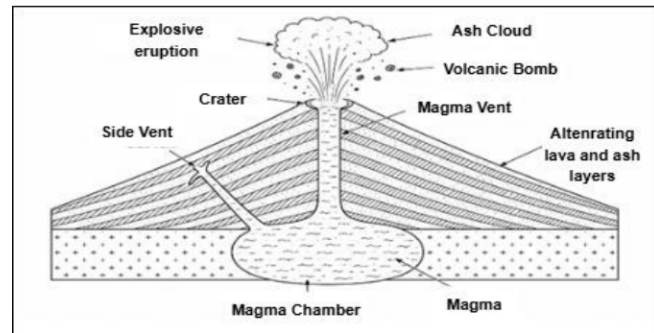
Shield Volcano: A broad volcano with gently sloping sides, formed by successive layers of fluid, basic lava that flows great distances before cooling and solidifying. Examples include Mt. Elgon (Uganda/Kenya)



Ash and Cinder (Cinder Cone) Volcano: A small, steep-sided volcano made of ash, cinders (scoria/small lava fragments), and volcanic bombs ejected violently during explosive eruptions. Examples in Uganda include the Busoke and Bitale cones, or the numerous scoria cones lying between Muhavura and Lake Mutanda in Southwestern Uganda.



Composite (Strato) Volcano: A tall, symmetrical, cone-shaped mountain built of alternating layers of lava, volcanic ash, and pyroclastic debris. They are formed by thick, viscous magma and are often highly explosive. Examples include Mt. Muhavura (Uganda/Rwanda), Mt. Kilimanjaro (Tanzania), or Mt. Kenya.

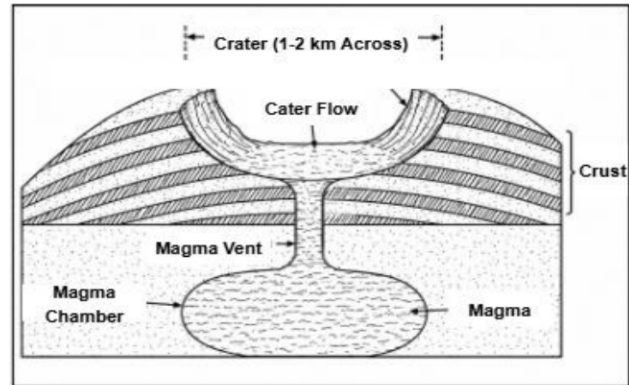


A volcanic mountain: A mountain formed when lava, ash, and volcanic materials erupt from the Earth's interior and build up around a central vent over time. Simply put, it is a mountain constructed entirely from materials ejected during volcanic eruptions.

Classification of Volcanic Mountain: **Active Volcanic Mountain:** Currently erupting or has erupted recently e.g. Mt. Nyiragongo in DRC. **Dormant Volcanic Mountain:** Not erupting

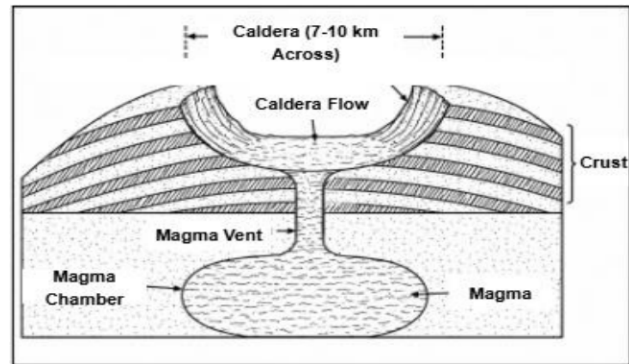
currently but shows signs that may e.g. Mt. Kilimanjaro in Tanzania. **Extinct Volcanic Mountain:** Has not erupted and is not expected to erupt e.g. Mt Elgon in Uganda.

Crater: sometime called summit crater is a relatively small, bowl-shaped or funnel-shaped depression found at the summit of a volcano, formed by the violent, explosive ejection of magma, gases, and pyroclastic materials through a central vent. Examples include the crater at the peak of Mt. Muhavura.



Crater Lake: During an eruption, magma and gases explode out of the vent. The force of the eruption blows away the surrounding rocks. This leaves a circular hole at the summit of the volcano. When this depression fills with water it forms a crater lake. Example of a Summit Crater Lake: Lake Bisoke (on the Uganda/Rwanda border) or the crater at the top of Mt. Muhavura. Sometimes crater lake is called summit crater lake.

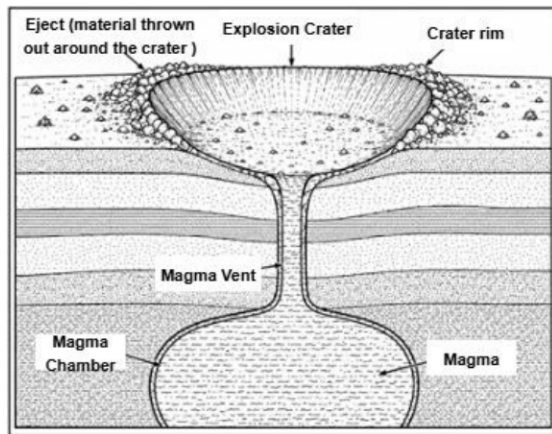
Caldera: A caldera is a very large, wide depression at the top of a volcano, much bigger than a normal crater. When magma comes out, it leaves an empty space underground, so the land above falls in and forms a large hollow. Examples of Calderas in East Africa: Ngorongoro (Tanzania), Menengai (Kenya), and Mt. Longonot (Kenya).



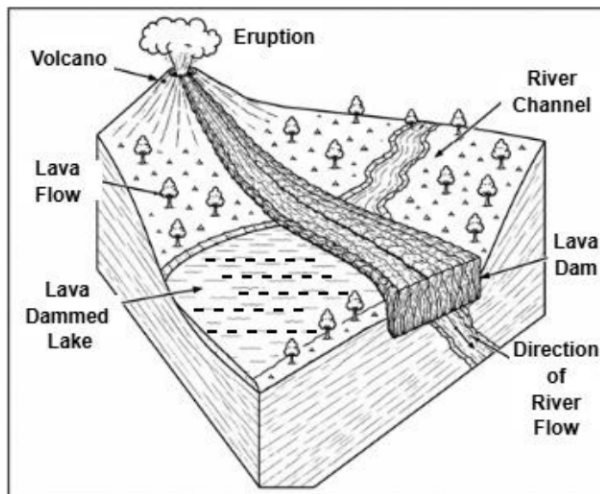
Caldera Lake: A large body of water formed when a highly violent eruption rapidly empties an underlying magma chamber. Deprived of structural support, the volcano's summit collapses inward to form a massive depression called a caldera. Over time, this basin fills with rainwater or groundwater to form a lake. Examples of Caldera Lakes in East Africa: Lake Ngozi (Tanzania).

Explosion Crater

Explosion Crater: Explosion Crater: A shallow, flat-floored circular depression formed when high-pressure underground gases and magma violently blast away the Earth's surface rocks and soil. Because the eruption consists mostly of escaping gases and ash thrown over a wide area, no steep volcanic mountain cone is built

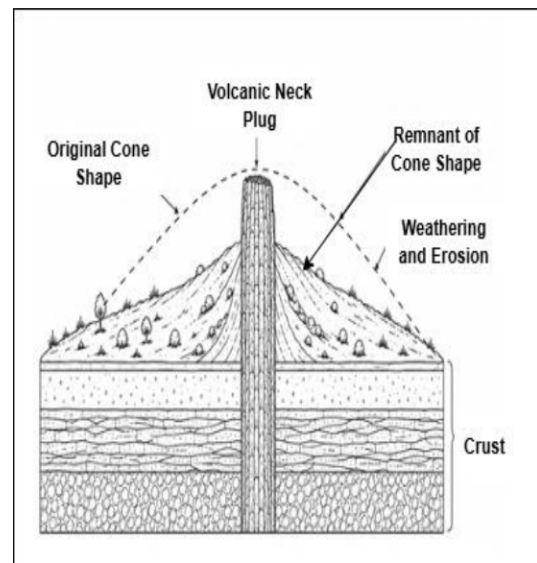


Lava-Dammed Lake

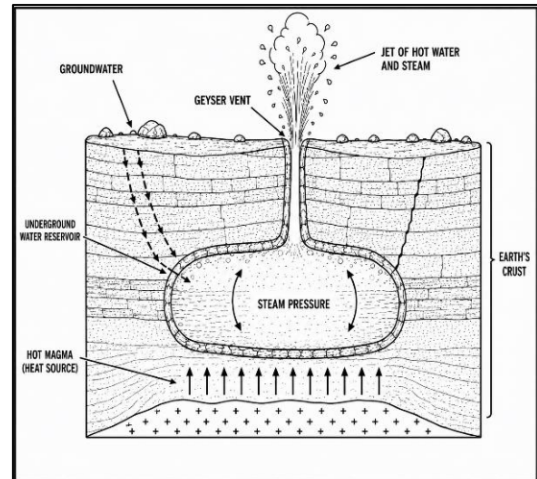


Lava-Dammed Lake: Lava-dammed lakes form when lava from a volcanic eruption flows into and blocks a river valley, creating a natural dam. Back-ponding of water behind the newly formed lava dam creates a lake. Most lava dammed lakes in East Africa are found in Southwestern Uganda. They include Lake Bunyonyi in Kabale. Lake Mutanda near the border with the Democratic Republic of Congo and Rwanda. Lake Mulehe and Lake Kayumbu in Kisoro.

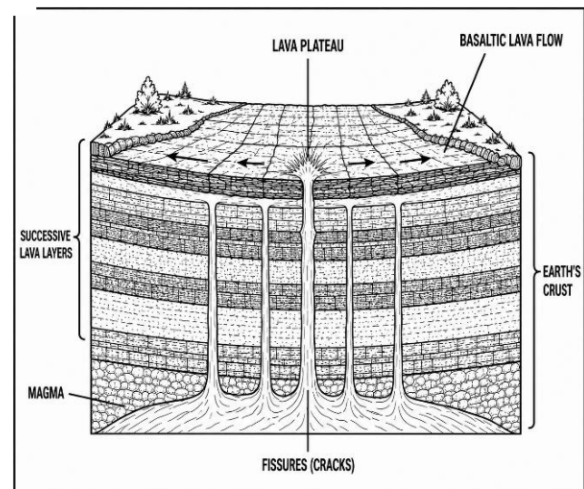
Volcanic Plug: Volcanic Plug (Volcanic Neck): A distinctive, vertical landform that forms when magma cools and hardens inside the active vent of a volcano, sealing it shut. Over millions of years, weathering and erosion completely wear away the softer, outer volcanic cone, leaving the harder, solidified magma column standing alone as a prominent pillar. Examples: The Mawenzi Peak of Mount Kilimanjaro. Bati and Nelion Peaks of Mount Kenya (the central plugs left after the mountain eroded). The peaks of the Jinja-Iganga highway (small basaltic plugs like those around Magamaga). Chogoria plug in Kenya.



Hot Spring: A thermal spring where heated water rises through open fissures and flows out onto the surface quietly and continuously because there are no obstructions to block its path. Examples: Sempaya Hot Springs (Semuliki National Park, Bundibugyo District) and Kitagata Hot Springs (Sheema District, Western Uganda). **Geyser:** A specialized hot spring characterised by the intermittent (periodic) and violent ejection of a column of boiling water and steam. This happens because the underground crack/joint system is narrow and twisted, trapping steam and building up massive pressure until it explodes. The Mwananyila geysers inside Semuliki National Park.



Lava plateaus: Form from successive flooding of highly fluid lava. During these extensive and long-duration eruptions, basic lava flows from numerous cracks or weak points in the Earth's crust, spreading over vast areas. As the lava cools and solidifies in thick, successive layers, it builds up to create a wide, flat, elevated landform (Lava plateaus). Examples: The Aberdare and Laikipia Plateaus in Kenya. The Kisoro/Bufumbira Lava Plains in Southwestern Uganda (small scale).



However, when magma solidifies within the crust the following features intrusive Volcanicity are formed named by their shape, size, and how they cut through the surrounding rock layers. We can only see them and name them today because of a process called denudation (a combination of weathering and prolonged erosion).

Dyke: a wall-like sheet of rock formed when magma forces its way upward through vertical or near-vertical existing horizontal rock layers. Example: The dykes visible along the Sukulu Hills in Tororo.

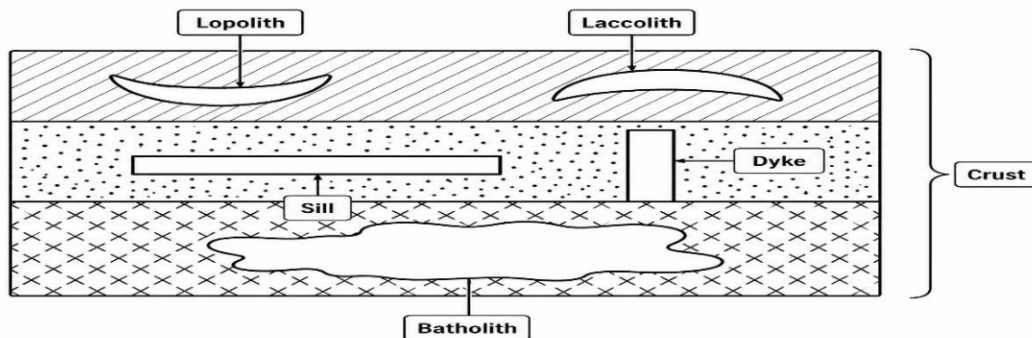
Sill: a flat, horizontal sheet that lies parallel to the surrounding rock layers formed when magma squeezes horizontally between existing parallel layers of bedding rock. Example: Thika Falls sill in Kenya.

Laccolith: a dome-shaped or mushroom-shaped mass with a flat base formed when high-viscosity (thick) magma forces its way between horizontal rock layers but cannot spread out easily. Instead, it pushes the overlying rock layers upward.

Lopolith: a large, saucer-shaped or bowl-shaped depression formed when a massive amount of magma intrudes between horizontal rock layers. The immense weight of this magma causes the underlying crust to sag downward.

Batholith: an irregular rock mass that forms when Enormous plumes of magma rise deep within the Earth's crust over millions of years, melting and displacing huge areas of surrounding rock. Example: The Mubende-Mityana batholith, the Singo batholith in Uganda, or the Iringa batholith in Tanzania.

Summary of Intrusive Volcanic Features



Advantages of Living in Volcanic Areas

1. Weathered volcanic rocks and ash break down to produce fertile volcanic soils (Andosols) rich in essential minerals like potassium, calcium, and magnesium. These soils heavily support intensive cash crop farming like on slopes of Elgon and Kigezi highland.
2. Mining: Volcanic processes and hydrothermal activity concentrate valuable industrial minerals and ores near the surface, providing raw materials and creating jobs in the mining sector. Salt: Mined at the Lake Katwe Explosion Crater in Western Uganda.
3. Hot rocks beneath heat water into steam used for geothermal power e.g., Olkaria power station, Kenya which provides cheap, renewable electricity. For homes and industries.
4. Volcanoes, Crater lakes, Hot springs and Geysers attract tourists e.g Sempaya hot spring in Semuliki National park. Tourism brings foreign exchange and jobs.
5. Volcanic areas provide natural habitats for wildlife and support national parks, for example Mount Kilimanjaro National Park, promoting conservation and tourism.
6. Volcanic regions often have cool and favorable climates, especially at higher altitudes, making them suitable for human settlement and some types of farming.
7. Volcanic rocks such as tuff and basalt are widely used as building materials for roads, houses, and other infrastructure, reducing construction costs.
8. The scenic landscapes of volcanic areas encourage the development of recreation and eco-tourism activities such as hiking, mountaineering, and camping, which generate income for local communities.

Problems of Living in Volcanic Areas

1. Magma flows, ash, gases, and volcanic bombs can destroy lives, homes, and farmland e.g Mt. Nyiragongo in DRC erupted in 2021 and destroyed parts of Goma.
 2. Volcanic areas often experience tremors and landslides e.g mountain Elgon landslides in Bududa, Eastern Uganda.
 3. Volcanoes release gases like sulfur dioxide and carbon dioxide, which are dangerous to people and animals. Sulfur dioxide irritates the eyes, nose, and lungs, causing breathing difficulties, coughing, and chest pain.
 4. Fresh lava and volcanic rocks may cover land, making it unproductive for farming until weathered which may lead to food shortage and hunger.
- Steep volcanic slopes and rugged terrain make roads, railways, and buildings expensive to construct.
5. Volcanic eruptions can force people to relocate, leading to loss of homes and disruption of social services like schools and hospitals.
 6. Volcanic ash can reduce air quality and cause respiratory diseases such as asthma and coughing.
 7. Volcanic landscapes are often isolated and difficult to access, limiting trade and communication with other regions.
 8. Volcanic ash can damage crops by covering leaves and reducing photosynthesis, leading to poor harvests.
 9. Ash clouds from eruptions can disrupt air transport by reducing visibility and damaging aircraft engines.
 10. Heavy ash fall can accumulate on rooftops, causing buildings to collapse under the weight.
 11. Water sources may become contaminated by volcanic ash, acidic gases, and other volcanic materials, making water unsafe for drinking and domestic use. This can lead to outbreaks of water-borne diseases.

W a r p i n g i n E a s t A f r i c a

Warping is the vertical movement upward or downward of large parts of the Earth's crust due to internal forces/endogenic forces. Warping produces gentle, broad uplifts or depressions.

Landforms Resulting from Warping in East Africa

In East Africa, Lake Victoria Basin and Lake Kyoga Basin are believed to have formed through crustal warping.

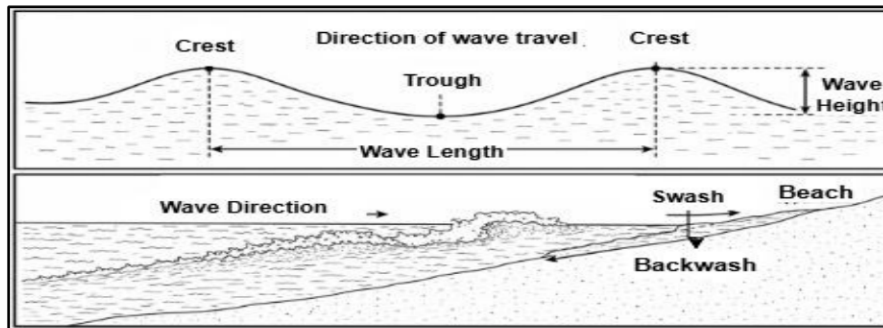
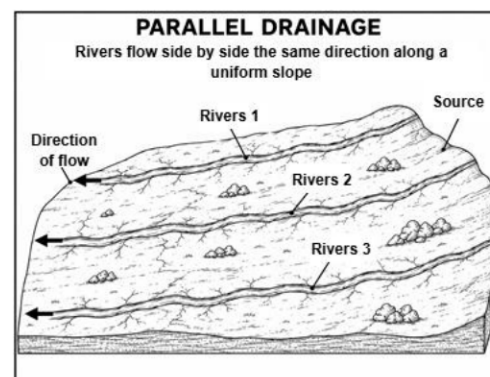
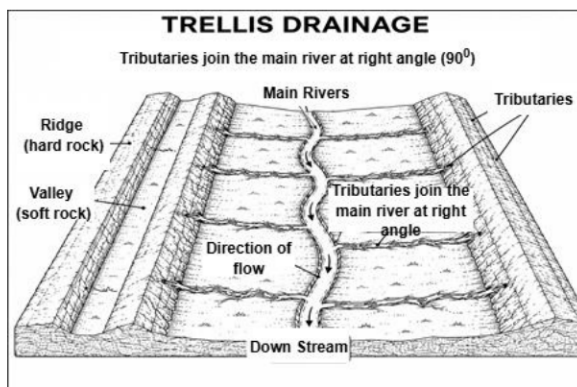
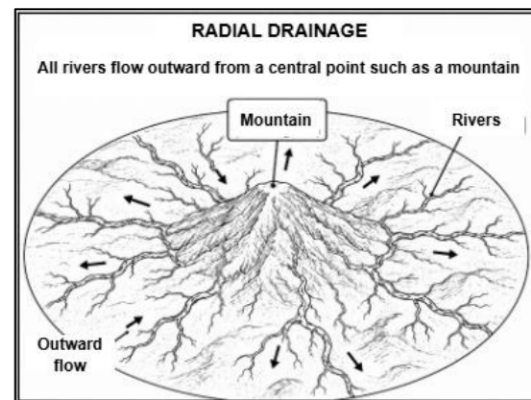
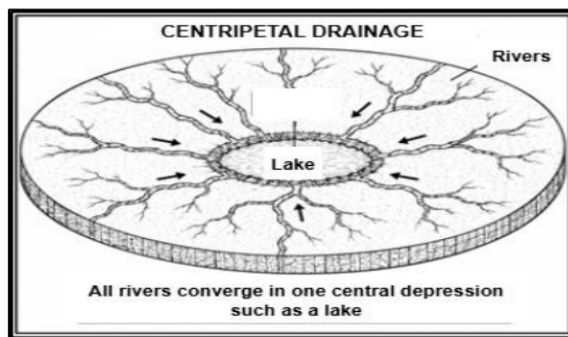
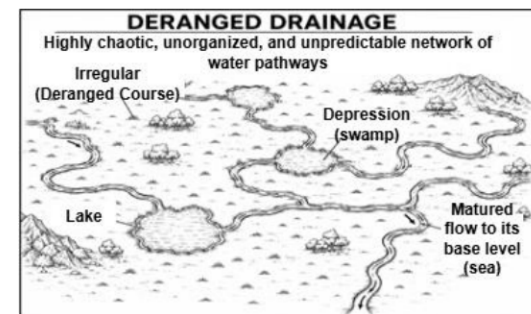
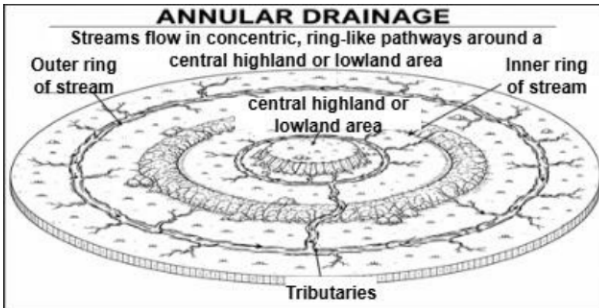
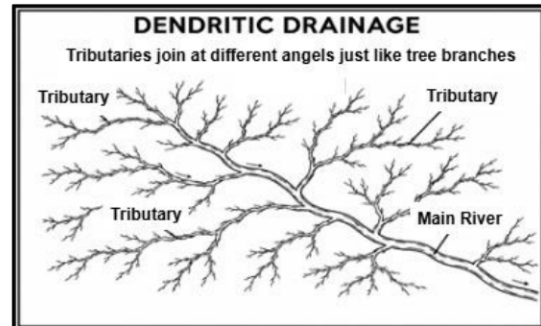
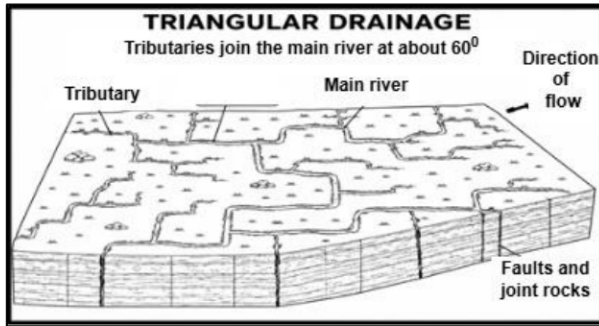


Diagram illustrates the Formation of basin sometimes called crustal Lake such as Victoria and Kyoga.

Drainage: Refers to the collection and discharge of water from a natural water sources like glaciers, streams and rivers. **Drainage Pattern:** is the arrangement or layout of rivers and its tributaries on the land. This pattern is strictly determined by the rock type, structural layout (faults, folds, warping), and the slope of the land.





River: A river is a natural, flowing body of water that moves under the force of gravity. Rivers start from a source like a spring or mountain and eventually emptying into a larger body of water such as an ocean, lake, or another river.

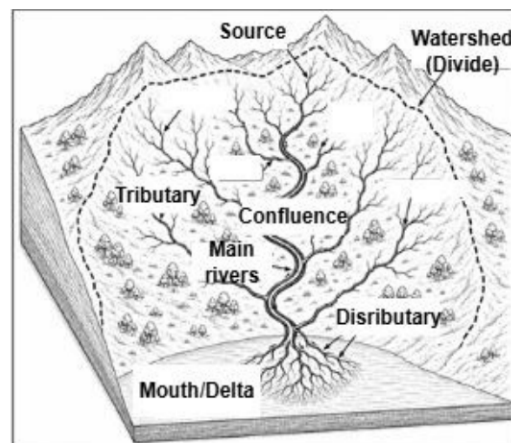
Tributary: A small river that feeds or joins the main river.

Distributary: A small river that leaves the main river.

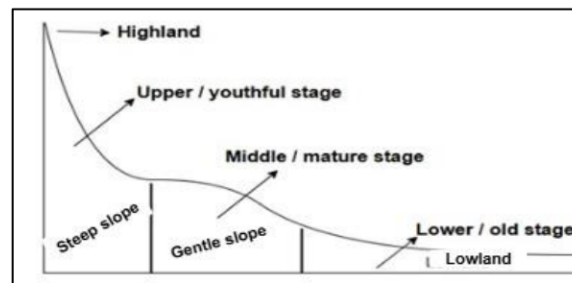
Deferred tributary: A tributary that flows parallel to the main river before joining it.

River confluence: A point at which the tributary joins the main river.

A water catchment area: Is an area of land where all the rainwater and surface runoff drain into the same river, lake, or ocean.



River Profile: The profile describes the shape, slope, and gradient of a river as it flows from its source to its mouth.



Upper Stage River Characteristics

- Very steep gradient (the land slopes sharply).
- The river flows due to high gravity.
- Channel is narrow, shallow, and V-shaped.
- Water volume is small (because tributaries have not yet joined).
- Vertical erosion dominates (river cuts downward into the bed).
- Carries mostly large rocks (boulders).
- Transportation is by traction (rolling) and saltation (bouncing).

Middle Stage River Characteristics

- The gradient is gentle than in the upper course.
- The river flows more smoothly, though still fairly fast.
- The river channel becomes wider and deeper as tributaries add more water.
- The valley becomes more open and less steep-sided than in the upper course.
- Lateral erosion (sideways) becomes more dominant than vertical erosion.
- The load carried is smaller than in the upper course (mostly pebbles, sand).

Lower Stage River Characteristics

- Very gentle gradient (almost flat land).
- River flows slowly and sluggishly.
- Channel is widest and deepest here.
- River carries a large volume of water (collected from tributaries).
- Deposition dominates over erosion (little energy left for erosion).
- Load carried is mostly fine material (silt, sand, and clay), transported mainly in suspension (fine material floating in water) and solution.

Summary of River Action: Upper Stage = Erosion Middle Stage = Erosion and Deposition Lower Stage = Deposition and All stages = Transportation.

River Erosion Processes

Hydraulic Action: This is the direct force of the running water against the banks and bed. The water's pressure forces air into cracks in the rock, weakening and breaking it apart.

Abrasion: The water carries sediment, which acts like sandpaper, rubbing against the bed and banks. This constant scraping and grinding wears away the rock.

Corrosion (Solution): If the river flows over rocks that are soluble (like limestone), the running water can chemically dissolve them. This is a slow but continuous process that breaks down the rock material.

Attrition: The load of rock and sediment that water carries is constantly knocking against itself. This collision causes the particles to break down into smaller, forming more rounded smooth rock pieces over time.

NOTE: Do not confuse **abrasion** with **attrition**. In **abrasion**, the river's load wears away the **river bed and banks** by scraping and grinding. In **attrition**, the river's load **wears itself down** as rock fragments collide with one another, becoming smaller, smoother, and more rounded.

River Transport Processes

Traction: Large, heavy materials (boulders, pebbles) are rolled or pushed along the river bed.

Saltation: Smaller stones and pebbles are bounced or hopped along the river bed by the force of moving water. It looks like a “jumping” movement.

Suspension: Very fine particles like silt and clay are carried within the water itself, making the river look muddy or brown.

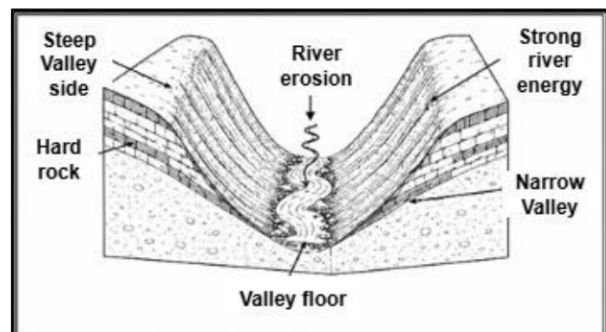
Solution (Dissolved load): Some minerals (like salts and limestone) are dissolved in water and carried invisibly in liquid form.

Summary of River Action Processes from Source to mouth

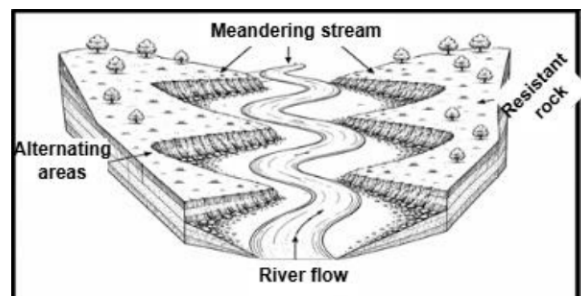
Stage	Action	Processes
Youth/Upper	Erosion	Hydraulic action: water force breaks rocks
		Abrasion: River load scrapes rocks like sandpaper
		Attrition: Rocks knock and break each other
		Solution: Rocks dissolve in water
Mature/Middle	Transport	Traction: Rolling big stones
		Saltation: Hopping (jumping up/down) small stones
		Suspension: Floating fine particles
		Solution: Dissolved materials
Old/ Lower	Deposition	Happens naturally

Features Formed in Upper River Stage (River Erosion Landforms)

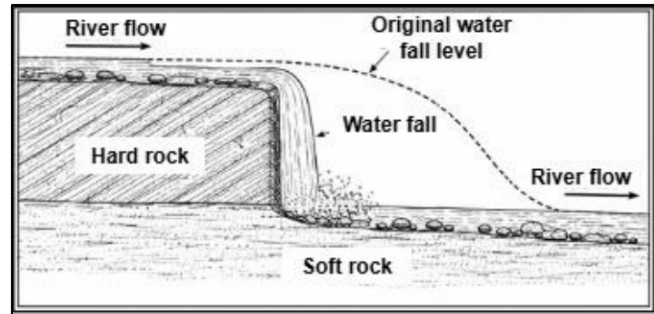
V-Shaped Valleys: These are formed by vertical erosion, which carves the river channel deeper, giving the valley its characteristic V-shape. Examples V-Shaped Valleys: These are formed by vertical erosion, which carves the river channel deeper, giving the valley its characteristic V-shape.



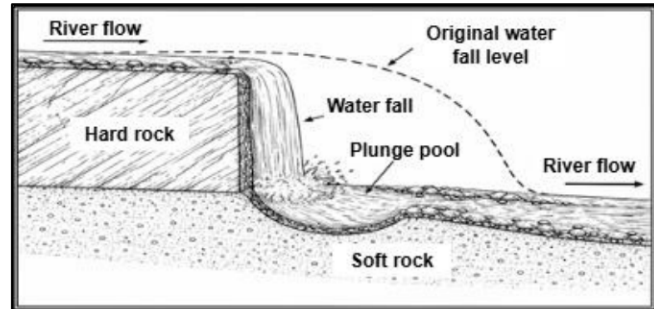
Interlocking Spurs: As the river erodes the valley, it winds around obstacles of hard rock that project from alternate sides of the valley. This process by the river result into a feature called Interlocking Spur. Examples: River Mubuku and River Nyamwamba (Rwenzori Foothills)



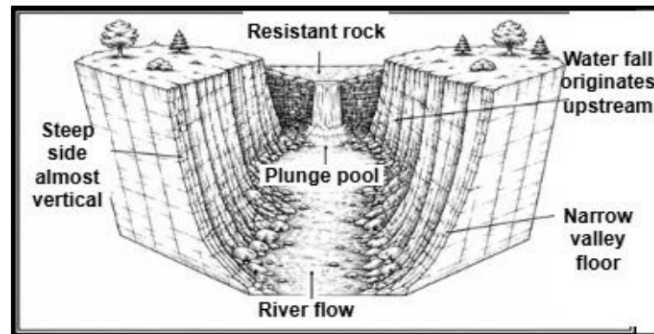
Waterfalls: These occur when the river flows over a band of hard, resistant rock underlined by the softer rock. The softer rock erodes faster, causing the river to steepen and drop over the hard rock. Examples: Sipi Falls in Kapchorwa, Mount Elgon, Murchison Falls (Kabalega Falls) and Kisizi falls.



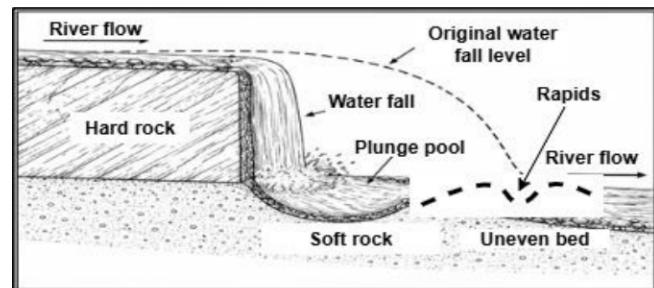
Plunge Pool: The force of the water at the base of a waterfall erodes the rock, creating a deep hollow called a plunge pool. Examples: around Sipi Falls in Kapchorwa, Mount Elgon, Murchison Falls



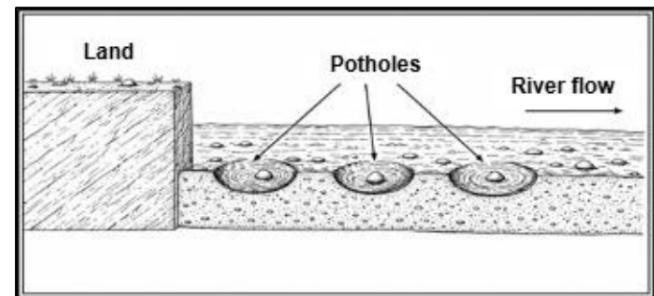
Gorges: These are narrow, steep-sided valleys that can form as a result of vertical erosion, often developing at the site of a waterfall as it retreats. Examples: Birira (Bwindi) and Kyambura river Queen Elizabeth. When a Gorge is extremely deepened due to prolonged undercut then it forms a Canyon e.g river Kalambo Canyon in Tanzania.



Rapids: These form from fast-flowing water over an uneven riverbed, caused by differential erosion where softer rocks erode faster than harder rocks, creating a staircase-like drop. Examples: Bujagali dam and Itanda falls in Jinja.

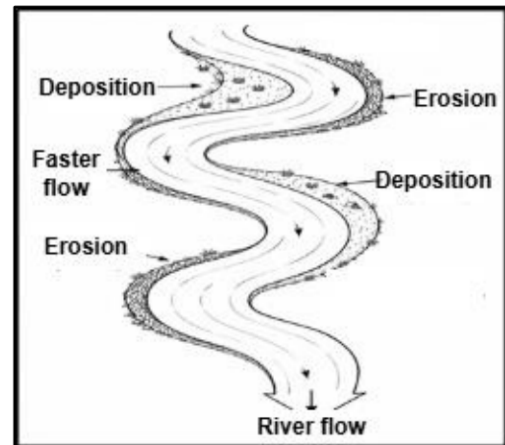


Potholes: These are round shaped holes on the bedrock created due to saltation and traction movement of large boulder that hit against the river bed. Examples of Potholes are found on River Athi in Kenya. The Victoria Nile / Karuma Falls (Uganda) In areas where the Nile rushes over hard metamorphic rocks.

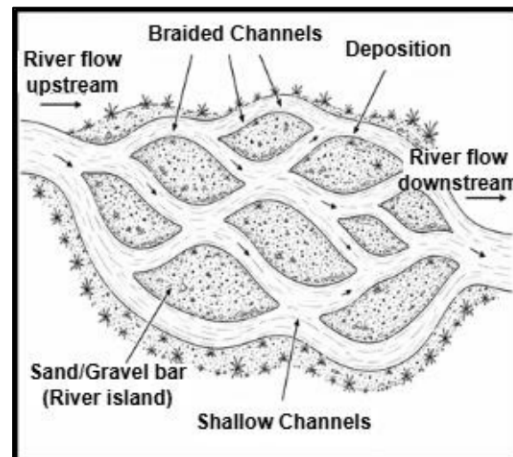


Middle Stage landform (River Transport): Because the river begins to erode sideways (lateral erosion) and starts depositing some load, specific features emerge:

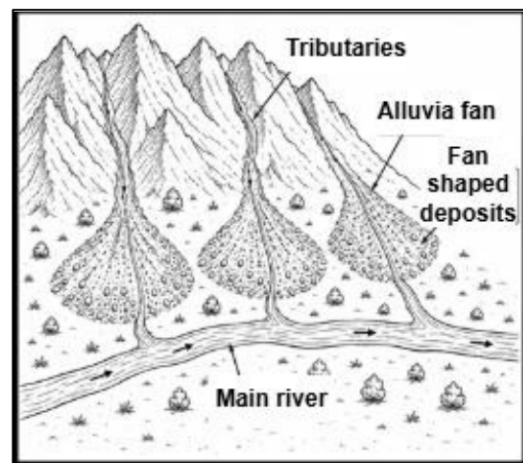
Meanders: These are winding bends in the river formed by the natural variation in water speed and a corkscrew flow pattern (flowing around a bend) within the channel. River Cliffs and Slip-Off Slopes are features of a meander. Fast water cuts away the outer bank into a steep river cliff through lateral erosion, while slow water builds a gentle beach or slip-off slope on the inner bank through deposition. Outer bend erosion forms a river cliff, and inner bend deposition forms a slip-off slope. Together, these continuous processes of erosion, transport, and deposition create a meander.



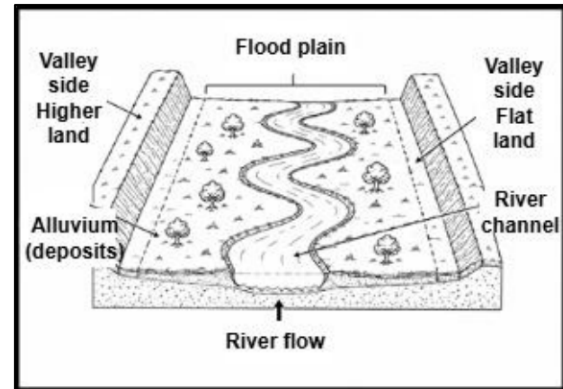
Braided Channels: when a river carries an exceptionally high load of coarse sediment, causing the channel to split into multiple, smaller, interconnected streams separated by shifting sediment bars. This occurs when a river rapidly loses energy often due to a sudden decrease in gradient, a drop-in water volume, or a reduction in velocity. The resulting loss of competence forces the river to deposit its heavy bedload, forming temporary sand and gravel bars. These bars block the main path, forcing the water to divide, flow around them, and continuously carve out new, braided pathways.



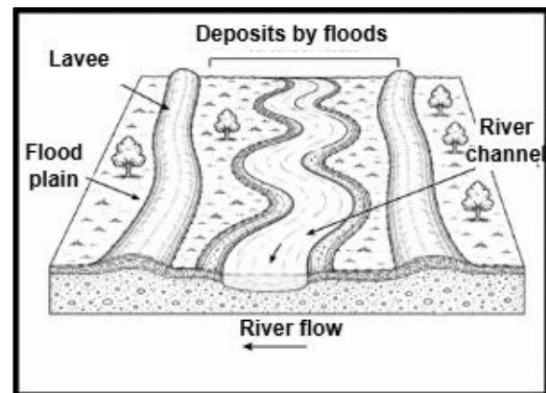
Alluvial Fans: These form when a fast-moving, sediment-laden stream emerges from a steep, narrow mountain canyon onto a flat, open plain, causing the water to abruptly slow down and lose its energy. This sudden loss of velocity reduces the stream's capacity to carry sediment, leading to the rapid deposition of boulders, gravel, sand, and silt. The material radiates outward from a single point at the mountain base (the apex), creating a distinctive, fan- or cone-shaped landform.



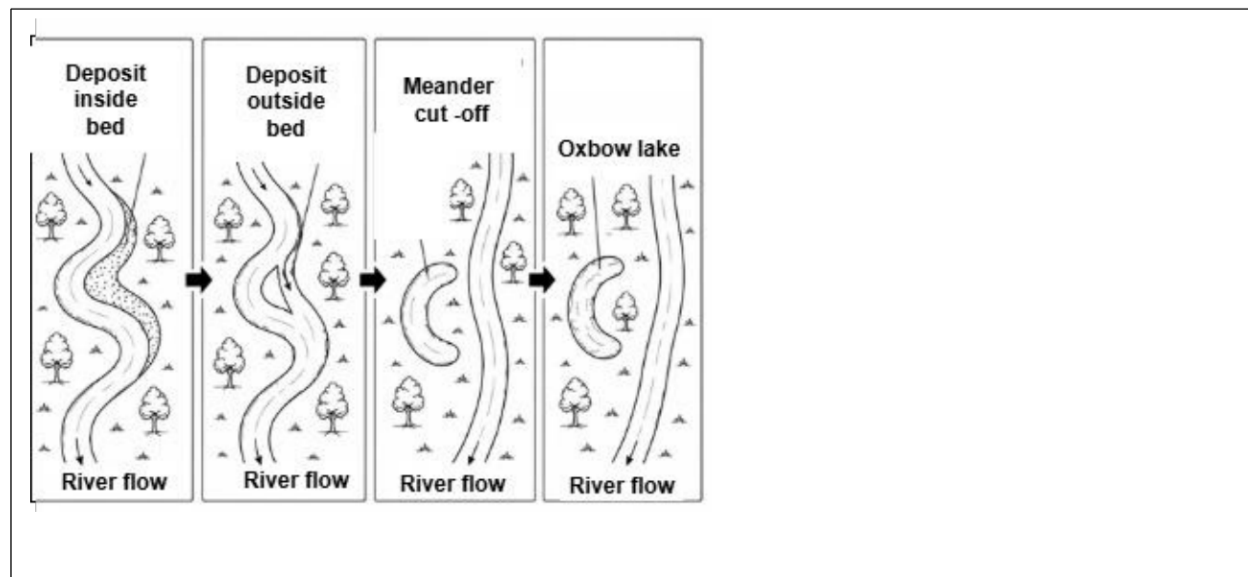
Floodplains: These are relatively flat areas of land adjacent to a river or stream. In the lower course, a river flows over flat land and often floods its banks. During floods, the river water spreads out and deposits fine silt and clay across the valley floor. Over many floods, these layers build up into a wide, flat fertile plain (Floodplain).



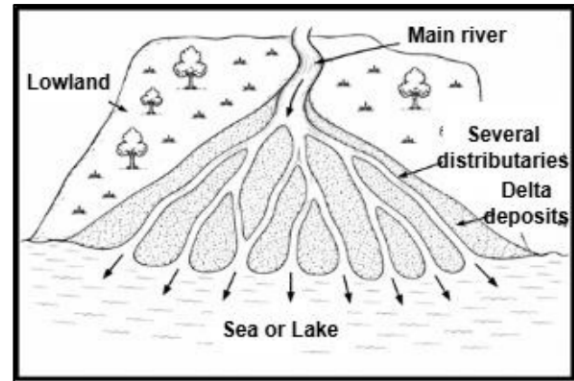
Levees: Is an elevated ridge of sediment that runs parallel to a river's banks, increasing the channel's capacity to contain minor floods. It forms when the river overflows its banks and rapidly loses energy. Because velocity drops sharpest immediately after leaving the channel, the heaviest materials (gravel) are deposited first, right next to the river banks, while finer silts travel further onto the floodplain. Repeated flooding over time builds up these raised ridges into prominent natural barriers.



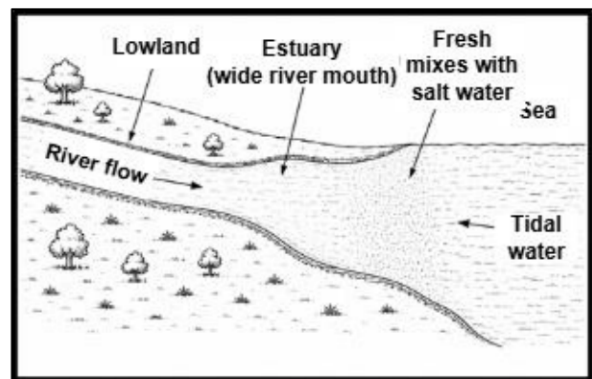
Oxbow Lakes: These form when continuous lateral erosion narrows the neck of a highly pronounced meander. During a period of high discharge or flooding, the river takes the shortest path of resistance, cutting directly through the narrow neck to establish a straighter channel. As water velocity slows down at the entrances of the abandoned loop, the river deposits sediment, eventually sealing off the old bend entirely and leaving behind an Oxbow shaped, free-standing body of water.



Deltas: When a river enters a standing body of water, such as a lake or sea. The river loses its energy and deposits its remaining load at its mouth. If marine waves are weak enough, these deposits accumulate outward into the water. As the sediment blocks the main river mouth, the river is forced to split into multiple smaller channels, called distributaries, which fan out across the emerging delta plain.



Estuaries: Instead of forming a delta, some rivers terminate in a broad, funnel-shaped mouth where the river's freshwater mixes with the sea's saltwater to create salty water. This occurs in coastal areas with high tidal ranges, where strong tidal currents and waves continuously wash away river sediment, preventing a delta from building outward.

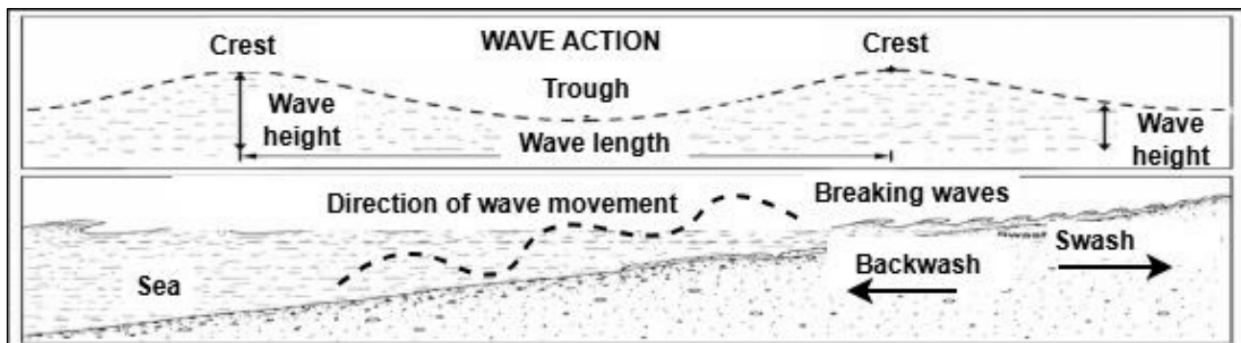


SEA AND LAKE WAVE ACTION (Wave Erosion and Deposition)

Waves: These are oscillations of water on a sea or lake surface, primarily generated by wind blowing across the open water. Upon reaching the shoreline, waves transport water and sediment. The forward movement of water rushing up the beach is known as the swash, while the gravity-driven retreat of water back to the sea is called the backwash.

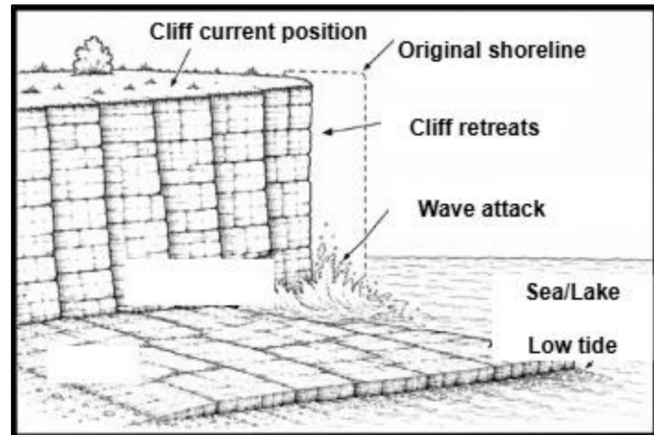
Destructive Waves: These drive coastal erosion by removing sediment from the shore. They have high energy, a steep gradient, and a high frequency. Because their backwash is more powerful than their swash, they drag sand and pebbles away from the beach and deposit them offshore.

Constructive Waves: These drive coastal deposition by building up the shoreline. They have lower energy, a flat gradient, and a low frequency. Because their swash is more powerful than their backwash, they carry sediment up the beach and leave it behind, widening the shore.

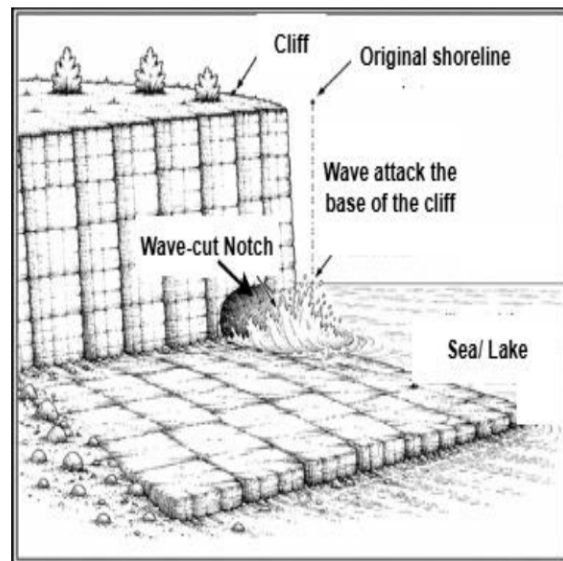


Features Formed by Destructive Waves (Lake and Sea Erosion Features)

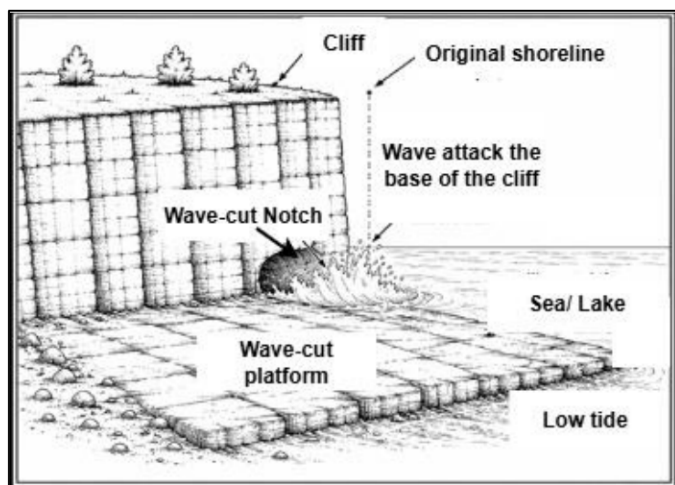
Cliff: Is a steep, vertical rock face formed along the coastline due to marine erosion and weathering. High-energy waves launch an assault at the base of the coastline, carving out a hollow known as a wave-cut notch. As this notch deepens over time, the overhanging rock above weakens and eventually collapses under gravity. This continuous undercutting and collapse cause the cliff face to steadily retreat inland while remaining steep



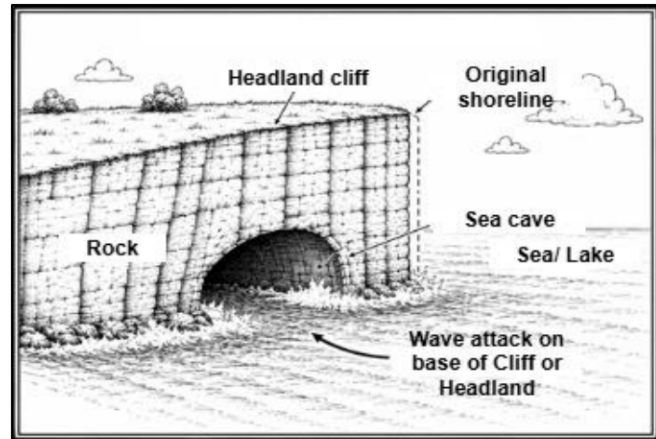
Wave-Cut Notch: Is a deep cut into the base of a coastal cliff at the high-tide mark, formed when constant breaking waves wears away the rock. This feature develops primarily through hydraulic action, where crashing waves compress air inside rock fractures to shatter the cliff base, and abrasion, which occurs as the ocean pounds sand and stones against the coast like sandpaper. Over time, this localized, daily pounding hollows out a shallow groove along the waterline, undermining the cliff face above it until the weight of the overhang causes the rock to collapse into the sea.



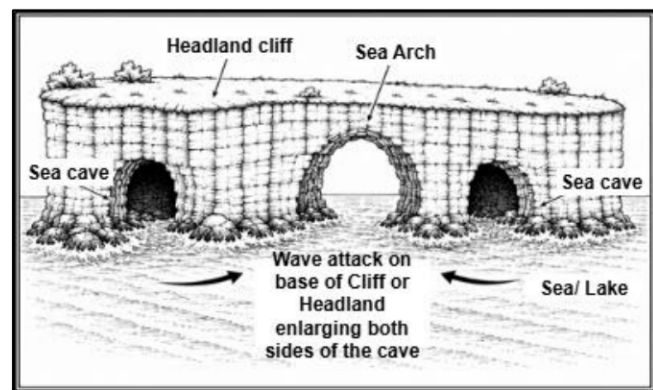
Wave-Cut Platform: Is a gently sloping, rocky surface located at the base of a cliff, which is submerged at high tide and exposed at low tide. It is formed as a cliff steadily retreats inland due to wave undercutting and collapse. The solid bedrock left behind at the old base of the cliff is continuously smoothed and flattened by the abrasive action of waves dragging sand and pebbles across it.



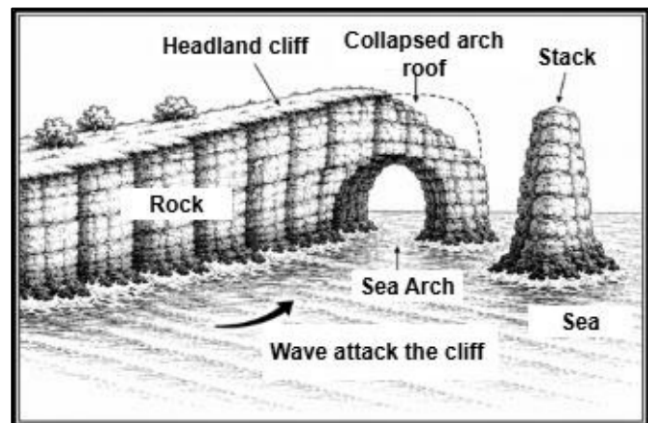
Cave: Is a natural hollow formed at the base of a cliff or headland. It develops when waves exploit natural cracks or lines of weakness in the rock through hydraulic action and abrasion. Over time, continuous wave impact deepens these fractures into hollow chambers. In other words, the cave develops from an enlarged wave-cut notch. Example Kasenyi landing site along the shoreline of Lake Victoria.



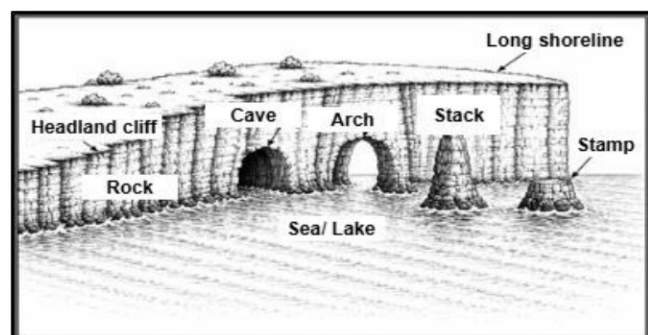
Arch: Is a tunnel-like passage that cuts completely through a headland. It forms when wave erosion attacking from both sides of a narrow headland fully breaks the rock wall. Over time, two back-to-back caves meet in the middle to create this open coastal pathway.



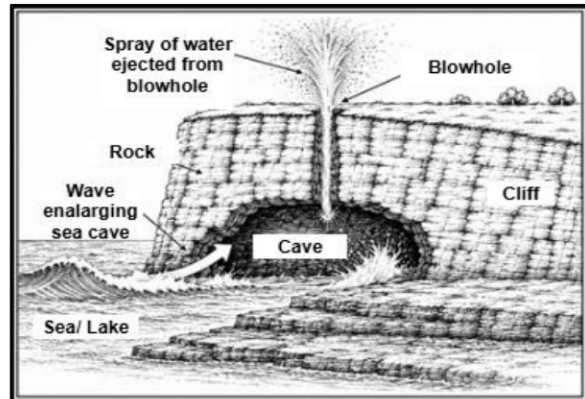
Stack: Is an isolated pillar of rock standing detached from the main coastline. It forms when the roof of a sea arch becomes too heavy and unsupported. Weakened by sub-aerial weathering from above and wave undercutting from below, the arch roof collapses into the sea, leaving the vertical stone pillar standing alone.



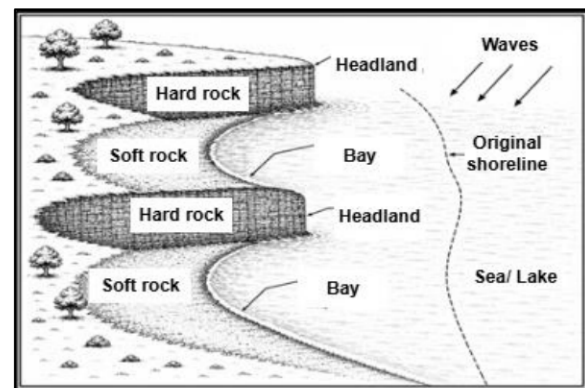
Stump: Is the low-lying rocky remnant of eroded stack. It forms when waves continuously attack the base of a stack, causing it to collapse. The remaining base is completely submerged at high tide and only becomes visible during low tide.



Blowhole/Gloup: Is a vertical shaft connecting the roof of a sea cave to the top of a cliff face. It forms when wave action hydraulic-presses air and water into a cave's roof, eroding upward along a vertical fault or weakness. During high tides or stormy weather, water is forced upward and spectacularly blasts out of the top of the cliff opening.

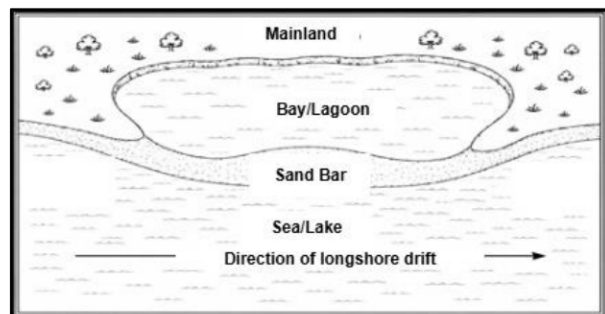


Headlands and Bays: These form along discordant coastlines where alternating bands of hard and soft rock run perpendicular to the sea. By differential erosion, waves erode the softer rock rapidly inland to form sheltered bays. The harder rock erodes much slower, protruding out into the sea to form prominent headlands.

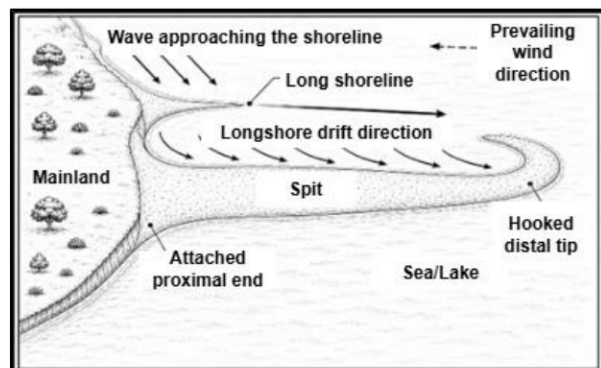


Features Formed by Constructive Waves (Lake and Sea Deposition Features)

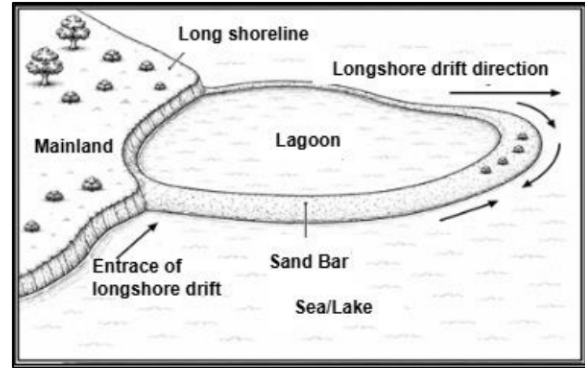
Sand Bar: Is a submerged or low-lying ridge of sand and shingle deposited within the coastal zone. It forms when waves or longshore drift drop sediment in shallow water, creating a barrier that seals off the bay mouth



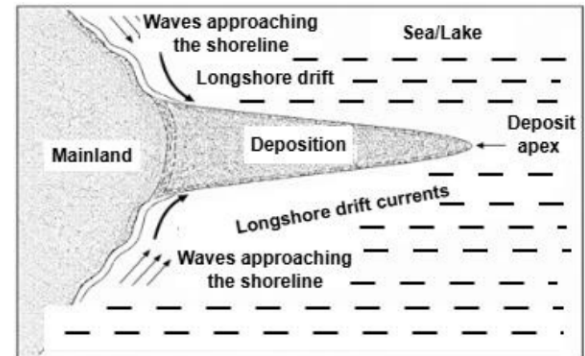
Spit: A narrow, linear coastal landform made of sand or shingle that is attached to the mainland at one end and extends out into open water, formed primarily by the process of longshore drift; in contrast, a sand bar forms when a spit extends entirely across a bay to connect two headlands, or builds up completely offshore.



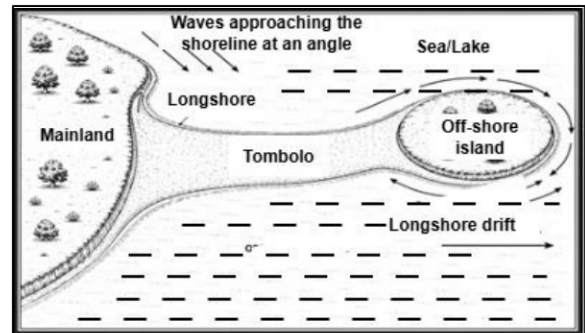
Lagoon: A lagoon is a shallow body of calm water separated from a larger sea or lake by a low-lying sediment barrier. It forms when longshore drift creates a spit or baymouth bar that grows completely across a bay, trapping a pocket of water behind it. example: Lake Nabugabo.



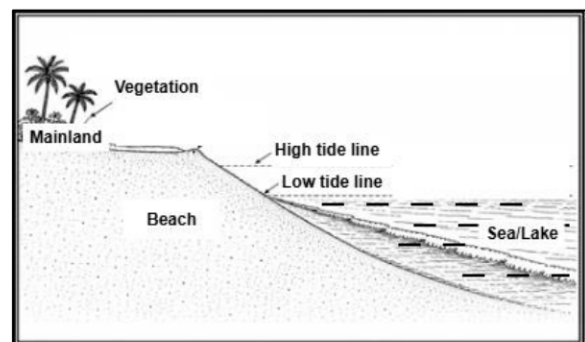
Cuspate Foreland: A cuspate foreland is a large, triangular headland of sand and shingle that projects outward from the shoreline. It forms when two opposing longshore drift currents converge, causing them to lose energy and deposit sediment together at a central point (the apex).



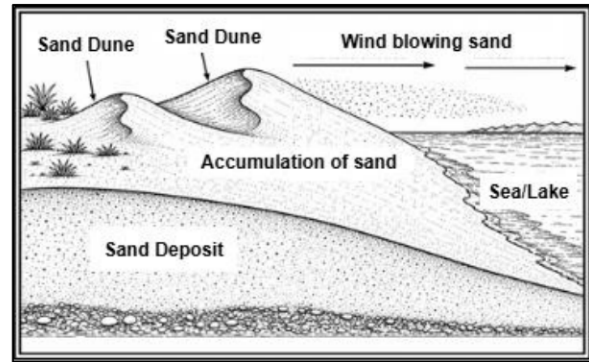
Tombolo: A tombolo is a depositional landform created when a spit expands outward from the mainland and connects to an offshore island. This occurs via longshore drift, which continually deposits sand and shingle until a permanent ridge of sediment bridges the gap between the island and the coast.



Beach: A beach is a gently sloping shoreline landform composed of sand, shingles, pebbles, or mud deposited by constructive waves. It spans the coastal zone from the low-tide mark up to the highest point reached by high-energy storm waves.



Sand Dunes: A sand dune is a ridge or mound of loose sand built up in deserts or along coastlines. It forms through wind deposition when wind carrying sand grains encounters an obstacle—such as vegetation or rocks—causing it to lose velocity and drop its sediment load.



GLACIATION: This is the process by which large masses of ice (glaciers) form, move, and shape the landscape through erosion, transportation, and deposition.

Plucking: Is a glacial erosion process where the glacier freezes on the rocks at the valley floor or sides. As the glacier moves, it pulls pieces of rock away.

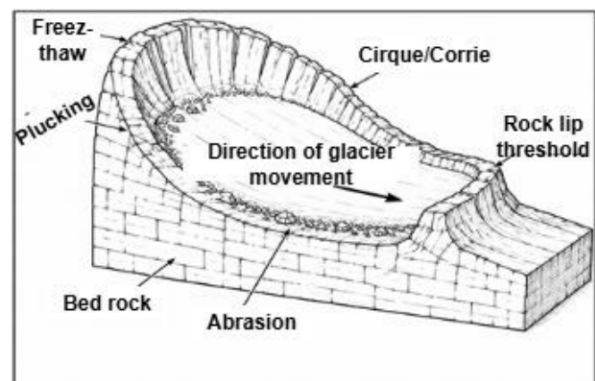
Abrasion: Here glacial erosion occurs when rocks and debris frozen into the glacier act like sandpaper. As the glacier slides over the bedrock it scratches and damages it.

Freeze-thaw/Frost shattering: Water enters cracks in rocks and when temperature drops at night, it freezes, expands and widens the cracks. Repeated freezing and thawing causes rocks to break apart, which are then picked up by the glacier.



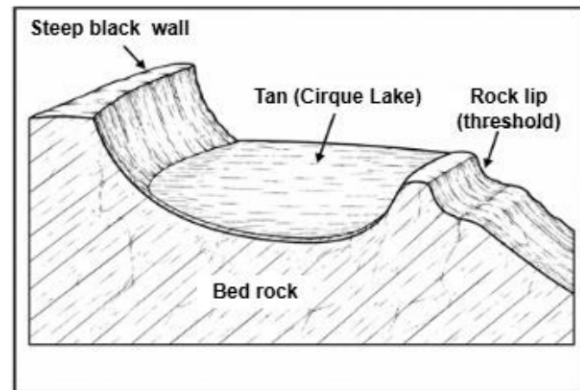
L a n d f o r m s f r o m G l a c i a l E r o s i o n

Cirque/Corrie: A cirque is a steep-walled, armchair-shaped hollow carved into mountain sides by glacial erosion. Freeze-thaw weathering above the glacier shatters the rock face, supplying debris. Plucking takes place at the base and backwall as meltwater refreezes onto the bedrock, tearing away rock fragments and steepening the walls as the glacier moves.

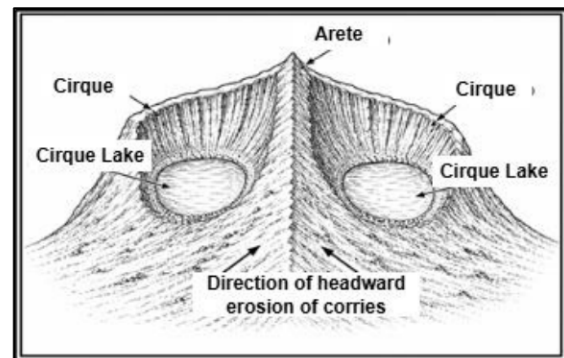


Simultaneously, abrasion occurs as these embedded rocks grind against the valley floor, deepening the hollow into a polished, bowl-shaped depression. When the glacier melts, this depression often fills with water to form a circular mountain lake called a Tarn.

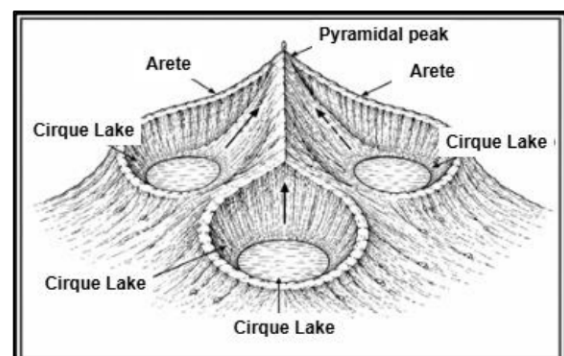
Cirque Lake (Tarns): A tarn is a small, circular mountain lake that forms inside an abandoned cirque. After the glacier melts, the over deepened, bowl-shaped depression left behind on the mountainside collects water from rainwater, snowmelt, and groundwater. Such as Lake Bujuku and Lake Catherine on mountain Rwenzori.



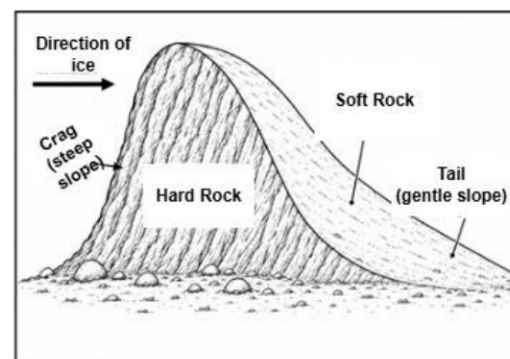
Arete: Is a narrow, steep-sided, and knife-edged ridge of rock. It forms when two neighboring cirques erode backward toward each other from opposite sides of a mountain ridge. As plucking and freeze-thaw weathering systematically steepen the backwalls of both hollows, the rock wall dividing them is narrowed into a sharp, jagged spine.



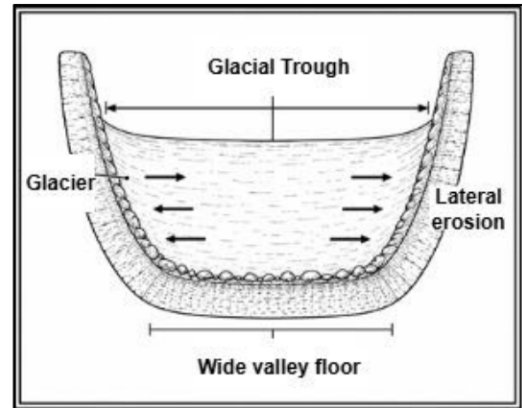
Pyramidal Peak: Is a sharp, pointed mountain summit with steep, triangular rock faces. It forms when three or more cirques erode backward into the same central mountain mass. As processes like plucking and freeze-thaw weathering systematically steepen the walls of each hollow, they leave behind a radial network of aretes splitting downwards like Margherita Peak, the highest point on Ruwenzori.



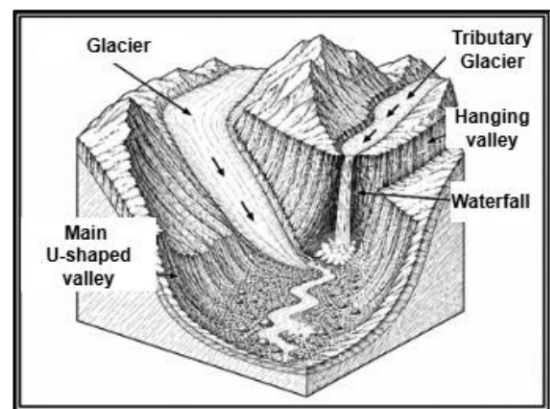
Crag and Tail: Is a linear, streamlined landform formed by a combination of glacial erosion and deposition. The crag is a steep, highly resistant plug of rock (often an ancient volcanic neck) that faces into the oncoming glacier, blocking its path. As the ice overrides this obstacle, the crag shelters the weaker bedrock and loose sediment on its downstream (lee) side. This protection results in a gently tapering ridge of softer rock and glacial debris, known as the tail.



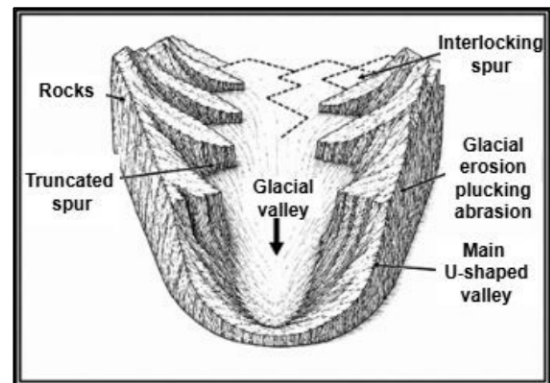
Glacial Trough (U-Shaped Valley): A glacial trough is a steep-sided, flat-floored valley carved by a glacier. It forms when a massive ice sheet advances through a pre-existing riverine V-shaped valley. Through powerful plucking and abrasion, the glacier simultaneously deepens the valley floor and widens its sides, bulldozing and cutting off the tips of interlocking mountain ridges to leave behind truncated spurs.



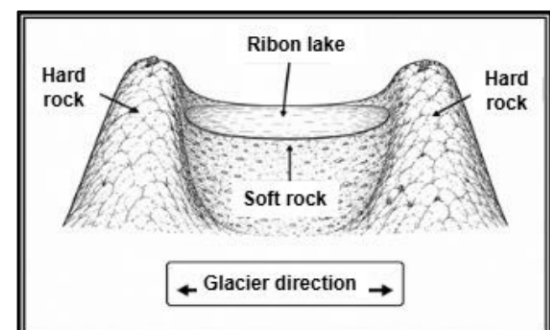
Hanging Valley: This is a smaller valley that enters a main glacial valley from the side but is left hanging above the main valley floor after glacial erosion. A smaller tributary glacier flows into a larger main glacier. The main glacier is thicker and more powerful, so it erodes its valley deeper than the tributary glacier. When the glaciers melt, the tributary valley is left high above the main valley floor.



Truncated Spur is a ridge of land that has been cut off sharply from an interlocking spur by glacial erosion. When a glacier moves through the valley, its large, powerful ice mass cannot wind around the spurs like a river. Instead, it plucks and abrades the ends of the spurs, cutting them off sharply.



Ribbon Lake: Is a long, narrow lake that forms in a glacial trough (U-shaped valley) due to glacial erosion. Glaciers erode the valley floor unevenly because some rocks are softer (more easily eroded) and some are harder. The glacier erodes soft sections more deeply, creating depressions in the valley floor. When the glacier melts, water fills these depressions, forming a long, narrow lake.



Glacial Deposition: Glacial deposition creates large accumulation of rocks, sand, and debris among other materials. The accumulation of unsorted glacial materials named above is called moraine. Types of moraine include;

Lateral Moraine: Deposition of glacial material occurs along the sides of a glacier

Medial Moraine: Deposition of glacial material occurs in the middle of a glacier, where two lateral moraines meet

Terminal Moraine: Deposition of glacial material occurs at the end of a glacier, marking its furthest point reached.

Recessional Moraine: Forms during temporary pauses in glacier movement due to loss of ice.

Glacial Deposition Landforms

Erratics: An erratic is a large boulder that has been transported and deposited by a moving glacier. It is uniquely characterized by having a rock composition completely different from the native bedrock on which it rests. These 'wandering rocks' help scientists trace the historical path of ancient ice movement. Prominent local examples can be traced along the glaciated valleys of Mount Rwenzori.

