OCEANS, SEAS AND THEIR COASTS

Definitions

- **Ocean**: - vast bodies of saline/salty water on the eath's surface that surrounds the land or continent
- Examples are Pacific, Atlantic, Indian and Arctic oceans
- **Seas** are defined as follows:
  - Large salty water bodies surrounded by land/saline but lack connection with the oceans e.g. Caspian Sea, Aral Sea, Dead Sea. They lack an outlet to the ocean
  - Large salty water bodies joined to/separated from the oceans through a submerged rock sill/strait e.g. Mediterranean Sea (connected to the Atlantic Ocean through a strait – Gilbatar). Others are Red, Black and Baltic seas
  - Smaller divisions of oceans aka marginal seas i.e. are at the margins of the four oceans e.g. Caribbean Sea, Arabian Sea, North China Sea, etc

Distinctions between seas and oceans

Similarities

1. Both contain saline water
2. Their waters are in constant motion due to waves

Differences

1. Oceans are affected by tides whereas seas are not affected by tides other than marginal seas
2. Oceans have strong ocean currents whereas seas have well developed land and sea breezes
3. Oceans surround continents/vast lands while seas are surrounded by vast lands/continents other than marginal seas
4. Sunlit eastern coasts of oceans lead to corals formation whereas seas experience/lack coral formation whether sunlit or not

Nature of Ocean Water

- The nature of ocean water has the following aspects: -
  (i) Saline Water
  (ii) Temperature of Ocean water
  (iii) Ocean topography
  (iv) Ocean life
  (v) Ocean pollution

(i) Saline water

- Source of ocean water mineral salts are mainly;
  - The ocean water dissolves soluble mineral salts from the rocks forming the ocean bed.
  - A lot of salt is added to the oceans from rivers, springs which flow over soluble rocks

- Volcanic eruptions in the ocean bed also generate huge amounts of soluble minerals salts.

N/B: ***Isohalines*** – are lines drawn on a map to show places with the same salinity in the ocean.

Factors influencing salinity of oceans water

1. **Latitude**
   - This affects the salinity of the surface water. The salinity is lower at the Equator than at the poles. The greatest salinity is around 30^0N because of higher temperature causing evaporation.
   - Salinity is low in temperate oceans due to low evaporation rates and melting ice being added.
   - It decreases towards the equator because of heavier rainfall and less evaporation due to high humidity and more cloud cover.
2. **Depth** – The surface water is generally more saline compared to the bottom water.
3. The amount of fresh water added into the ocean
4. The position of the inland water: - Seas located in regions of high temperatures have higher evaporation rates hence the water is more saline.
5. Mixing of surface water and water below the surface makes the level of salt in the water to be fairly constant.

(ii) Ocean Temperature

- Ocean water temperature is not uniform i.e. it varies depending on the following factors;
  - Latitudinal position of the oceans.(oceans found in higher latitudes experience lower temperature|)
  - Depth – temperature decreases from surface to bottom.
  - Mixing/ upwelling of surface and deep waters
- Generally ocean water temperature increases with depth except in the poles

(iii) Ocean Topography

- Ocean topography is composed of various features such as continental shelf, continental slope, abyssal/deep sea plain, oceanic island, mid ocean ridges and sea scarps

(a) <u>Continental Shelf</u>

- This is the relatively flat part of the continent which is covered by ocean water.
- It's characterized by the following;
  - It is shallow (about 180m deep) and gently sloping
  - Width varies between 120 – 160 km between places
  - Some have islands formed by marine erosion and coral reefs
  - Contains depositional materials brought in by rivers and spread out by currents

(b) <u>Continental Slope</u>

- This is the steeply dipping surface between the outer edge of the continental shelf and the ocean basin

(c) *Abyssal/deep sea plain*

- This is the flat and almost level area of the ocean where mud/sediments from the continental shelf and continental slope are deposited
- These plains, which generally extend from the continental slope rise to the mid-oceanic ridges.
- They are the deepest parts of the ocean, with the exception of deep-sea trenches

(d) *Mid Ocean ridges and Sea scarps*

- These are found within the ocean waters where they are submerged with various heights formed through volcanic and seismic activities.
- Those formed through faulting are called sea scarps

(e) *Oceanic islands*

- Island, any comparatively small body of land completely surrounded by water
- There are three types of oceanic islands.

(i) **Continental island**: - these rise from the continental shelf and are structurally similar to the neighboring continental land mass. They form as a result of submergence of upland coasts due to isostatic or climatic changes. Examples; Pemba, Lamu, Zanzibar, Malagasy, Sri Lanka, Indonesian and Philippine islands, Newfoundland and British Isles

(ii) **Volcanic islands**: - These rise from the deep sea floor. Volcanic eruption within the sea builds up islands where the materials pile up above sea level e.g. the Canary Islands, Cape Verde, Seychelles.

(iii) **Coral islands**: May be found both on the continental shelf and in the deep seas. Accumulation of coral into reefs becomes coral islands e.g. Bermudas (Atlantic), Aldabra and Maldives (Indian Ocean)

N/B

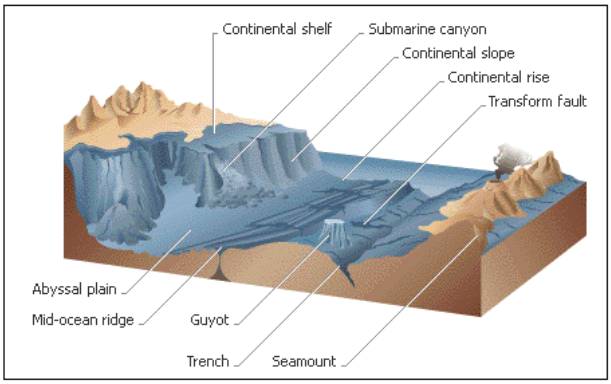
Islands may also from in the following.

(i) As the coastline retreats due to marine erosion resistant rocks are isolated as islands

(ii) Deposition of materials across bays, river mouths and lagoons build up barriers/ islands which project above the water level.

(f) *Deep Sea Trenches*

- These are narrow deep sided sub marine valleys on the ocean floor.
- They occur when the ocean crust is destroyed and where the ocean plate melts by sliding under the adjacent mantle
- They are associated with guyots and seamounts
- Guyots are submerged atolls forming an underwater mountain with a flat top within the ocean water
- Seamounts are volcanoes that do not rise above the sea level



Movement of Water in the Oceans

- Ocean water is not static i.e. moves vertically and horizontally covering many kilometres and great depths
- Only a portion of ocean water is involved in these movements (not the whole mass)

Vertical movements

- This is the rising of water from the ocean bottom to replace the sinking water from the ocean surface.
- It's caused by,
  - **(i) Difference in the density of ocean water.**
    - Density of ocean water depends mainly on temperature and salinity. Density is lower within the tropics where water is heated and is denser in the temperate and polar lands.
    - In the poles the cold denser surface water tends to sink after which it moves horizontally towards the equator at low depths. While the less dense water of the tropics tends to move to the poles through the action of winds. The cooler water below rises to take its place.
    - When a mass of ocean water with a high salinity meets another mass of low salinity, the more saline water sinks below the less saline water because it is denser.

  - **(ii) Convergence of oceans currents.**
    - Upwelling water can also form at a meeting point of two converging masses of surface water. Upon converging sinking occurs. At the lower depths the sinking water diverges after which it moves horizontally.

Horizontal movements

These are movements of water across the ocean waters. It occurs in three ways namely Ocean currents, Waves and Tides.

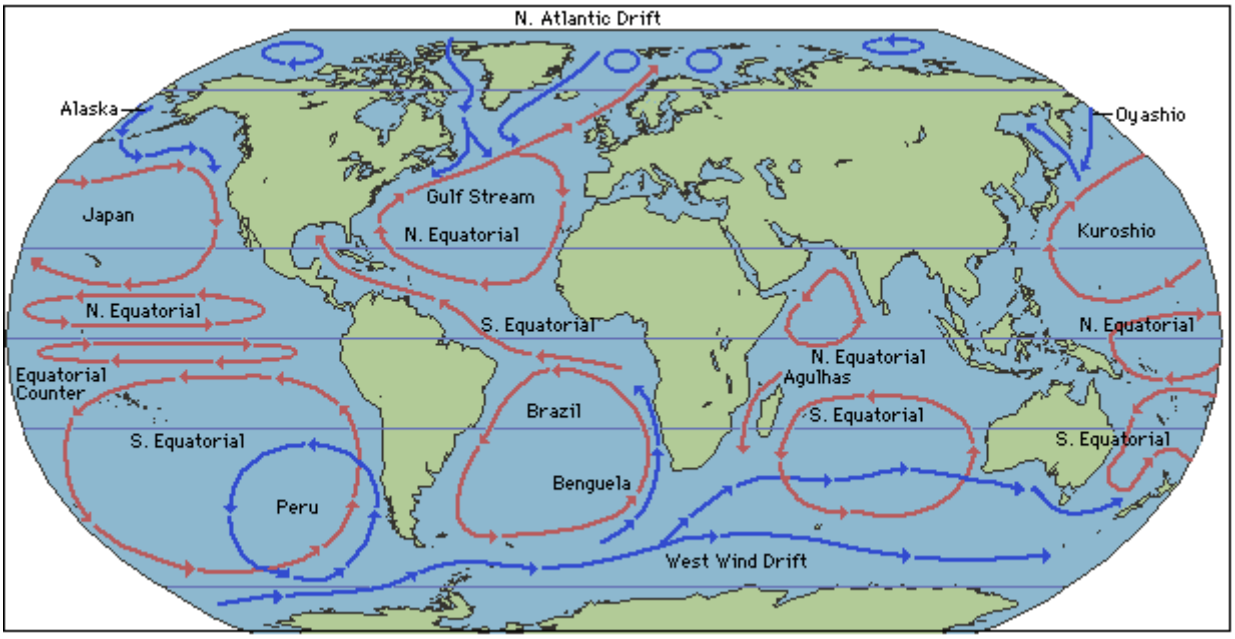
<u>Ocean Currents</u>

- An ocean current is a mass of surface ocean water which covers a considerable distance and depth and which is moving in a distinct direction.
- Ocean currents are caused by: -
  - **(a) Winds**: - as the prevailing winds blow, they encounter friction with the surface ocean water causing the water to move in the direction of the wind. Ocean currents resulting from movement of winds are called drift currents e.g. the North Atlantic drift current caused by the westerlies
  - **(b) Rotation of the earth**: - affects the direction of winds and that of ocean currents. In the northern and southern hemispheres, winds and ocean currents are deflected to the right and left respectively. This phenomenon is called ***coriolis effect*** which causes a body in motion to be deflected from its initial path due to earth's rotation
  - **(c) Shape of the landmass**: - When an ocean current flows from the ocean towards a land mass, it changes its direction and follows the outline of the coastline. In some cases a current may be split into two when it meets a land mass e.g. South equatorial current split by Madagascar Island. Where an ocean current flows through a constriction between land masses, its velocity increases on leaving the area of constriction. Such a current is referred to as a ***stream current*** e.g. the Gulf stream
  - **(d) Differences in water temperature and density**: - the warm less dense water in the tropics tends to move pole wards while the polar cold and denser water sinks and moves equator wards where it rises to replace the tropical water

Characteristics of major ocean currents

1. Generally the ocean currents flowing from the equator/low latitude areas towards the poles are warmer.
2. Ocean currents which flow from the poles/high latitude areas towards the equator are cooler/cold.
3. Ocean currents which flow in the Northern hemisphere generally move in a clockwise direction while the ones flowing in the Southern hemisphere move anticlockwise.
4. The warm ocean currents are found on the eastern coasts of continents, while the cold ocean currents are found on the western coasts of continents.
5. Convergence of ocean currents tends to occur on the eastern coasts while divergence tends to occur on the western coasts of continents.
6. Ocean currents are less developed in the northern part of Indian Ocean because the monsoon winds interfere with the smooth flow.

Distribution of ocean currents in the world



360^0 Atlas page 139

Tides

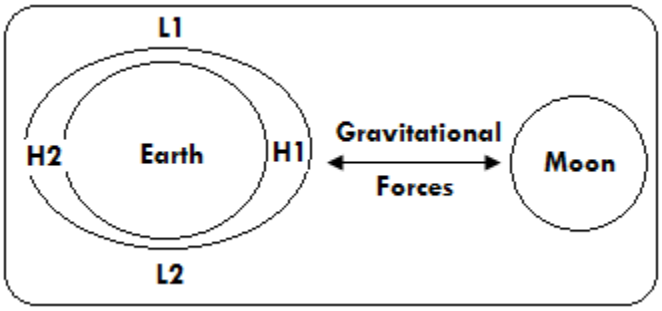
- Tides are the periodic rise and fall in the level of the sea and other large water bodies.
- All water bodies are held onto the earth by the force of gravity.
- The moon and to some extent the sun, also exert their gravitational pull on the earth including its water bodies. This results in the bulging of water.

Causes of tides

1. ***<u>Rotation of the earth</u>***
   - Rotation of the earth brings any point on the earth's water surface under the influence of two high and two low tides during the lunar day i.e. time taken by the earth in revolve once in respect to the moon.
   - At high tide the level of water rises and covers most of the beach while at low tide the level of water falls and waves can be seen breaking a distance away on the sea ward end.
   - The difference in height between the high water level and the low water level is called ***tidal range***.

2. **<u>The influence of the moon and the sun</u>**

- The moon has a strong gravitational pull on the earth. As it does so, the water on the earth's surface which faces the moon bulges resulting in a high tide on that side of the earth.
- At the same time the earth is also pulled towards the moon, the water on the opposite of the earth also piles to form a high tide.
- While this is happening the water on the sides around the earth is drawn away resulting in low tides



Types of tides

(a) *<u>Spring tides</u>*

- Occur when the sun, moon and the earth are in a straight line- a position called **syzygy.**
- The tide producing forces are very strong resulting in the highest high tide and the lowest low tides
- This happens twice a month when the moon lies between the earth of the sun and at full moon when the earth is lying between the moon and the sun.
- The forces causing the tides to occur are strongest when the moon and the sun are pulling in the same direction

(b) *<u>Neap tides</u>*

- Occur when the moon, sun and earth are at **quadrature** i.e. such that they form a right angle with the earth at the right angle apex
- This position is reached twice in a lunar month (the time between one new moon and the next, a period of about 29.5days/the time the moon takes to make one complete orbit of the earth) and at half moon
- At this position, the moon and the sun exert their gravitational pull on the earth in opposition to each other.
- This results in the high tide being lower than normal and the low tide not as low as expected

(c) *<u>Perigean tides</u>*

- Occur when the moon is at its nearest point to the earth, a point known as **perigee**.
- At this position the moon's tide producing effect is greatest and results in high tide which are 20% higher than normal of so is the tidal range

(d) *<u>Apogean tides</u>*

- Occur when the moon is at its farthest point from the earth, a point known as **apogee**.
- Its influence is weakest resulting in high tides which are lower than normal and so is the tidal range.

Waves

- A wave is a ridge of moving water which is caused by oscillation of water particles.
- As the wind blows over the water, there is frictional drag between the bottom layer of wind and the surface water.
- The frictional drag is transmitted into layers above and surface water begins to oscillate as waves.
- Waves form over open water bodies

- The distance of open water over which the wind blows is called a fetch
- The size of a wave is determined by: -
  - The strength/speed of wind
  - Wind regularity and duration
  - The fetch over which the wind blows

Breaking of a wave

- As the wave nears the shore, the depth of water decreases causing the wave to break
- After a wave has broken some water moves forward to the beach, this movement is termed as the ***swash.***
- The water then moves backwards to the sea due to gravity. This movement is known as the ***backwash***.
- Some of the water may be pushed back to the shore by the next breaking wave while the rest flow at the bottom back into the sea in water current called the ***undertow***

Types of waves

(a) <u>*Constructive waves*</u>: - have a stronger swash than the backwash hence responsible for building features such as beaches, sandbars through deposition.

(b) <u>*Destructive waves*</u>: - these have a weaker swash and a stronger backwash hence responsible for destruction or modification of the existing coastal features through erosion

Wave action and resultant features

- Involves erosion, transportation and deposition

Wave Erosion

- Erosion by waves occurs through the processes of hydraulic action, solution, corrasion and attrition

(a) Hydraulic action

- This is the action caused by the force of moving water. The force causes the water to remove loose materials from the coastline
- It takes place through the following ways
  - ***(i) Compressed air action***: - The force of breaking waves compress air in the cracks/joints on the cliff face thus increases its pressure. Due to the increased pressure the cracks widen. As the wave retreats, the pressure is suddenly released causing the trapped air to suddenly expand. This causes the rocks to fracture further and the cracks to enlarge. The process of alternate compression and expansion of air is repeated over a period of time causing the cliff face to shatter. The backwash then carries away the broken rock particles towards to sea.
  - ***(ii) Direct wave action***: - In a breaking wave, large amounts of water crush against the rock face shattering the rocks

(b) Solution

- This occurs when the rocks that make the cliff-face and the bed of the shore is soluble in sea/ocean water e.g. limestone, it is dissolved by the chemical reaction of water

(c) Corrasion

- The rock fragments carried by the waves are used as erosive tools as the waves break against the cliff face. These materials are hurled against the foot and face of a cliff causing the rock to break up/undercut.
- As the waves retreat, the fragments are dragged back into the water by the back wash. The materials scratch the ocean floor.

(d) Attrition

- As the pebbles, boulders and rock fragments are dragged up and down the shore by the swash, they continuously hit against each other and against the cliff.
- In this way they gradually break up and become smaller in size.
- This process does not contribute to the wearing away of the coast but provides erosive tools to be used to abrade the cliff and sea floor

Factors influencing wave erosion

- Availability and nature of marine load.
- Nature of the rock bordering the sea: - if resistant, less wave erosion
- The strength of the wave: - stronger waves lead to more erosion
- The gradient of the shore: - erosion is more dominant on steeply sloping shores

Features resulting from wave erosion

- These include cliffs, wave cut platforms, caves, blowholes, geos, arches, stumps, stack

1. Cliff

- This is a steep rock face which borders the sea. It may be vertical or nearly vertical
- The breaking waves attack the steep coast through hydraulic action and abrasion creating a notch at the position where they break at high tide.
- Continued wave attack makes the notch to be more pronounced and wider. Meanwhile the upper part of the rock face where waves do not reach is attacked by agents of weathering forming an *overhanging cliff.*
- Continued undercutting by breaking waves may cause the overhanging cliff to collapse leaving a steep rock face bordering the sea called a ***cliff*****.**

Figure 5.12 (a) – (c) – Certificate Geog Bk Three page 114

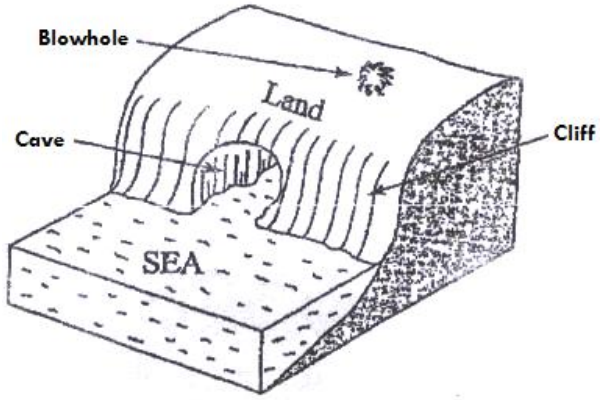
2. Wave Cut Platform

- This is a flat part of the shore which is formed by wave erosion as the cliff line retreats inland.
- The process of cliff formation may continue and the cliff line retreated inland forming a fairly flat part of the shore
- The initial stage is a smooth sloping land surface. Undercutting begins at the base of the cliff at about high tide level forming a notch.
- The notch is enlarged by wave erosion which produces undercutting. The overhanging cliff is formed and eventually collapses due to gravity. A new cliff face results and provides a fresh starting point for undercutting.
- The process is repeated over a period of time, the cliff line retreats leaving behind a rock surface floor known as a ***wave cut plat form*****.**

Figure 5.13 – Certificate Geog Bk Three page 115

3. ***Cave***
   - This is a natural cylindrical tunnel-like chamber extending inland into a cliff or into the side of a headland.
   - It mainly forms at the base of a cliff. Abrasion and hydraulic force enlarge initial hollow/ line of weakness in the coastal rock especially along joints and bedding planes
   - Corrosion/direct dissolving act on the base of the cliff enlarges the hollow which extends inwards into the cliff. This process continues until the hollow is transformed into a cylindrical chamber called a ***cave***
   - They are common along the Kenyan coast at Watamu, Shimoni and Funzi Bay

4. ***Blowhole***
   - On the leeward side of a cliff, a near vertical hole may form with its bottom open to the roof of the cave
   - Wave erosion acts on a line of weakness at the back part of the roof of a sea cave. At the same time weathering especially by solution acts on the line of weakness from the surface downwards
   - Eventually a vertical shaft/hole which connects the surface to the cave below is formed called a ***blowhole***



5. ***Geo***
   - During the high tide as the breaking wave splash against cliff face, a spray of water emerges through the blowhole
   - When the roof of the cave collapses, a narrow inlet is formed called a ***geo***

6. ***Arch***
   - Caves may develop on both sides of a head land or a single case may extend right through the headland to the other side forming an opening called an ***arch***
7. ***Stack***
   - Continued erosion may enlarge the arch until its roof collapses leaving a pillar of rock standing on the seaward side of the cliff line called a ***stack***
8. ***Stump***
   - Continued erosion of the stack gradually reduces its height to a point where it becomes submerged during high tide and becomes visible as a remnant of a stack only during low tide such a feature is called a ***stump***.

Figure 8.20 KLB Geography Bk 3 pp 107

Wave Transportation

- The load transported by waves is acquired from the following sources,
  - Materials brought in by rivers and wind.
  - Materials that are products of mass wasting along the coast
  - Products of erosion and weathering along the coast
  - Volcanic debris resulting from volcanic eruption in the sea or on the coast

The Longshore Drift

- If waves break obliquely to the shore, the swash will push the materials up the shore obliquely while the backwash will drag them back at right angle to the shore.
- These two actions are responsible for the progressive dragging of materials along the shore.
- Some of the materials are moved into the deeper waters by the undertow

Figure 5.14 – Certificate Geog Bk Three page 116

Factors influencing transport of materials along the coast.

1. **Strength of a wave** – Strong waves can carry large quantities and varieties of load over a long distance. Weak waves can only move materials over short distances along the shore.
2. **Tides** – When a tide occurs it extends the area under the influence of waves further up the beach. As the tide rises, the tidal current brings materials from the water to the land. These materials are also deposited further up on the beach.
3. **Ocean currents** – the movement of ocean currents is responsible for the movement of materials from one part of the ocean to another and eventually onto the beach.
4. **Gradient of the shore** - On gentle coasts, transportation of materials by longshore drift is favored especially where waves approach the coast at an oblique angle. When the waves break, the swash and the backwash drag materials along the beach. Conversely, as waves break on the cliffs along steep coasts, the materials they carry bounce off the cliff and remain floating in the water.
5. **Orientation of the coastline**. Where the coastline is aligned obliquely to the direction of breaking waves, transportation of materials by longshore drift is favored. Where the coastline lies transversely to the path of the waves, the waves move the materials back and forth on the beach along the same line.
6. **Nature of the load.** Very heavy materials boulders are not transported by waves. After breaking from the cliff, they drop directly below on to the seabed while lighter load such as sand are carried over long distances.

Wave Deposition

- Waves sort out their load during deposition i.e. boulders are deposited at the furthest end on the land side followed by pebbles then sand and finally mud which is dropped nearest to the water.
- Boulders are swept towards the land by powerful swash during high tide. The weak back wash brings back the lighter load towards the sea.

Factors influencing wave deposition.

1. **The nature of the waves –** for deposition to take place, the breaking waves must have a strong swash and a weak backwash. Waves should also break at a low frequency to allow materials to settle.
2. **Gradient of the shore**- a shore with a gentle gradient reduces the velocity of the backwash thus causing the waves to start depositing their load.
3. **Configuration of the coastline**: - this is in relation to the path of prevailing winds and the direction of advancing waves. Where the coastline changes direction abruptly, the longshore drift is halted and the transported material is deposited there
4. **Depth of the water**- deposition is great where the water is shallow since cyclic motion of waves is broken as the waves come into contact with the floor of the sea.

Features resulting from wave deposition

1. *Beach*

- A beach is a gently sloping mass of accumulated materials such as sand, shingle, pebbles and boulders along the coast
- They are formed by constructive waves especially during calm weather when the backwash is at its weakest
- This results in the accumulation of materials at the shore
- Conditions for formation of beaches include:
  - They form where the land slopes gently into the sea at the head of bays.
  - The waves must be constructive
  - Requires relatively calm weather
  - The waves should carry large quantities of load (sand, shingle)
  - Occurrence of low and high tides
  - Presence of boulders, sand and coral fragments
- Examples of beaches along the Kenyan coast are Diani, Nyali, Bamburi, Shanzu, Silver Sands, Watamu and Malindi
- Several smaller features may develop on the beaches. These include beach ridges, berms, beach cusps and beach rock shells

  (a) ***<u>Beach Ridges</u>***: - are low ridges of coarse sand, boulders and shingle deposited along a regular coast and are roughly parallel to the shore line. They are constructed by breaking waves. They develop on the foreshore of a beach and are only visible during the low tide

  (b) ***<u>Berms</u>***: - is a ridge or bench/terrace of shingle that has been thrown up to the beach by storm waves. They appear like a platform with a steep front facing the sea

  (c) ***<u>Beach Cusps</u>***: - are projections of sand and shingle alternating with rounded depressions along the beach

  Fig 5.15 Certificate Geography Bk 3 pg 118

  (d) ***<u>Beach Rock Shells</u>***: - comprises of sand, shells and pebbles that have been cemented together by calcium carbonate forming projections above the sand on the beach

2. *Spit*

- This is a low lying ridge of sand, shingles and pebbles with one end attached to the coast and the other end projecting into the sea
- It forms at a point where the coastline changes its direction towards the land e.g. across a river estuary or at the entrance to a bay
- They develop when the movement of materials by the longshore drift is halted and the material piled up/deposited in the sea/ocean water.
- This continues until they bulge out with the accumulation growing towards the sea

Fig 5.17 Certificate Geography Bk 3 pg 119

Conditions necessary for formation of a sand spit.

- Presence of ample materials to be deposited.
- A weak longshore drift.
- An indented coastline/presence of a headland.
- A shallow continental shelf
- A relatively weak backwash.

3. *Tombolo*

- This is a bar that links the mainland to an offshore island
- It starts as a spit then grows out into the sea until it joins and island into the sea
- An e.g. in Kenya is at Ngomeni (north of Malindi)

Fig 8.26 KLB Geography Bk 3 pg 110

4. ***Bars***

- A ridge of sand, mud, shingle or a mixture of these materials deposited by waves in the shallow water at the coast
- There are two types of bars namely bay bars and offshore bars

(a) ***<u>Bay Bars</u>***: - forms when a spit grows completely across a bay or sea inlet. It encloses a section of water on the landward side to form a lagoon

Fig 5.19 Certificate Geography Bk 3 pg 120

(b) ***<u>Offshore Bars</u>***: - Along very shallow coastline, waves are forced to break off-shore hence deposit its load at the point of breaking. The materials accumulate and form a ridge of sand running parallel to the shore. The bar may enclose a shallow lagoon with the main land.

Fig 5.20 Certificate Geography Bk 3 pg 120

5. Cuspate Foreland

- This is a broad triangular shaped deposit of sand or shingle projecting from the main land into the sea
- It is formed by two spits converging towards each other at an angle. This is due seasonal changes in the direction of winds that cause a change in the way the waves approach the shore
- Continued deposition makes it wider as more materials are added to form beach ridges.
- Eventually the lows are filled with water to form shallow lagoons

Fig 5.23 Certificate Geography Bk 3 pg 121

6. Mudflats & Salt marshes

- Mudflats are formed when fine silt is deposited on the sheltered part of the foreland.
- Their development is assisted by alluvium carried seawards by rivers.
- When vegetation grows and spreads on the mudflats, a salt marsh is formed

7. Dune belts

- These comprises of fine sand that is carried further and deposited above the high tide level forming coastal sand dunes

Types of Coasts

Definitions

Coast: - this is the zone of contact between the land and the sea or ocean

Shore – The land along the edge of the sea. Such land lies between the lowest point and the highest point reached by the waves.

Coastline – This is the line where the highest wave reaches the land. On rocky/highland coasts it's called the *cliff-line*.

Shore line – This is the line where the shore and the water meet.

- The various types of coasts form as a result of certain factors responsible for coastal evolution. These factors influence the shape and character of coastlines as well as coastal land forms.
- Coasts can be concordant or discordant.
- Concordant (regular/longitudinal) coasts lie parallel to the great trend line of the land e.g. the coast of Kenya between Malindi and Lamu. They lie parallel to the prevailing winds hence are dry
- Discordant (irregular/traverse) coasts lie at right angle to the prevailing winds e.g. the coast of Mombasa

Factors influencing the type of coast existing in a given area

1. **Action of waves and tidal currents.**
   - Waves are agents of erosion, transportation and deposition by the sea. Where erosion is dominant the coast is characterized by features of wave erosion. On the other hand, where deposition takes place, the coast will have accumulation of deposited materials.
   - Tides influence the area of the shore exposed to wave action. Coasts with large tidal ranges haves more surface area over which waves can operate.
2. **Nature of the coastal rocks.**
   - Along a coast made of resistant rocks, wave erosion is minimal forming a highland coast characterized by steep resistant cliffs.
   - If the coastal rocks offer little resistance to erosion then wave erosion will be intense resulting in the formation of sea inlets such as bays.
   - Where rocks are soluble (e.g. limestone) they are easily eroded through solution process forming caves.
3. **Orientation of the coastline to the path of prevailing winds.**
   - When the coast lies across the path of prevailing winds, the waves will be breaking transversely as well. Marine erosion is therefore very intense on such a coast.
   - Where waves break almost parallel to the coastline, transportation and eventual deposition of materials will be more pronounced than erosion.
4. **Climate**
   - Coral coasts develop in the tropical regions along the warm seas.
   - Fiord coasts exist in coastal uplands that experienced glacial erosion.
   - Climate also influences the weathering of coastal rocks; weakening them hence wave erosion is more effective
5. **Changes in sea level**
   - A rise in the level of the sea results in coast submergence forming features such as fiords, rias, and straits. Submergence of lowland coasts may result in estuaries and broader continental shelf.
   - Alternatively a fall in sea level exposes the coastal feature such as coral reefs.
6. **Human activities**
   - For example as construction of canals and harbours influence the shape and character of a coastline.

- ***Coasts are divided into submerged, emerged and coral coasts***

Submerged Coasts

- Form when part of the coastal land is drowned by sea water due to changes in base level or relative rise in the sea level.
- Submergence can be due to
  - Subsidence of the coastal region as a result of local faulting or folding along the coast
  - Subsidence of the coastal land could also be due to the ocean bed rising due to isostatic movements
  - A positive change in the sea level due to increased rainfall or melting of ice sheets and glaciers may cause a rise in the sea level which eventually drowns the adjacent coastal land.
- They are further divided into submerged lowland and submerged upland coasts

(a) <u>Submerged lowland coasts</u>

- These are characterized by gentle slopes. Upon submergence water covers extensive areas of land. River mouths and sizeable section of their upstream valleys are drowned to form *estuaries* which are much wider and shallower
- Submergence of lowlands results in the broadening of the continental shelf***.***
- Along glaciated rocky lowland coasts, *fjards* form. These are sea inlets resulting from the submergence of glaciated coasts. They are deeper then rias but have lower shores and broader profiles than fiords.

-

(b) <u>Submerged upland coasts</u>

- These are places where land slopes steeply into the sea. When such an upland area is submerged a number of features are formed
- They are classified into rias, fiords and dalmatian coasts

(i) ***Rias***: - form from the submergence of a river mouth in the upland coast. It's funnel shaped and deeper on the sea ward end but becomes shallower and narrower further inland. The drowned river mouth is called an estuary while the interlocking spurs project into the sea as headlands/promontories e.g. Kilindini. They are suitable sites for harbours because they are deep and well sheltered

Fig 5.24 Certificate Geography Bk 3 pg 124

(ii) ***Fiords/fjords***: - are submerged glacial troughs found in the upland areas lying adjacent to the coastline. They form inlets which are shallower at the sea ward end but deeper inland. The shallowness is caused by the deposition of terminal moraine. They are common on the coasts of Scandinavian countries

Fig 5.25 Certificate Geography Bk 3 pg 125

(iii) ***Dalmatian/Longitudinal coasts***: - form when mountains lie parallel to the coast. They form during submergence of these mountains to form long sounds (a passage, channel of water in between an island and mainland) with parallel islands. They are straight and regular

Emerged Coasts

- A coast may emerge from the sea when part of the land which was formerly under water becomes permanently exposed.
- Emergence could also be due a change in the level of the sea in relation to the land caused by;
  - Negative change in the sea level due to a reduction in sea water as a result of incomplete hydrological cycle when glaciers hold up water instead of releasing it to the sea.
  - Uplift in the coastal land due to upward displacement by faulting. Tectonic movements may cause up warping.
  - Isostatic adjustment can also cause the coastal land to rise
- Emerged coasts can either be upland or lowland coasts
- **Emerged upland Coast** – result from high lands adjacent to coasts. They are characterized by;
  - Raised beaches – found on land that is far away from the present edge of the water and standing above the present shoreline
  - Raised wave cut platforms
  - Exposed notches on the raised cliffs: - these are V shaped cuts formed due to undercutting of a cliff during high tides on an emerged coast
- **Emerged lowland coast –** These are constructed from emergence of gently sloping/low lying coasts. They are characterized by;
  - Fall line is a point where rivers flowing into the ocean descend through waterfalls and rapids from the edge of the plateau into the emerged lowland coast.
  - Gentle coastal plains: - the original coast is raised to form a gentle or almost flat plain

Diagram

Coral Coasts

- Coral is a limestone rock called coralline limestone. It comprises of remains of tiny marine organisms called polyps
- Coral polyps (tiny marine organisms) extract calcium from the sea water to form exoskeleton. These organisms live in colonies and attach themselves onto rocks and to one another. When they die, their shells are cemented by algae to form a ridge – like rock which is parallel to the shore.
- Coral coasts are majorly found in the tropical lands and can extend as far as 30^0 north and south of the equator

Conditions favouring the growth of polyps

- Optimum temperature 25^0C -29^0C and should never fall below 20^0C for proper growth. This explains why coral coasts are generally found on the eastern side of land masses in the tropical regions.
- The polyps must be submerged but may be exposed during low tide only for a short period of time.
- The water must be clear and salty hence corals are not found at river mouths due to presence of silt and mud. The saltiness is also diluted. Clear water allows sunlight to penetrate.
- The waters must be shallow. Most polyps thrive at a depth of less than 10m and others up to 60m
- The absence of moving wave and tidal load. Sand is destructive to growing polyps because; it smoothens young coral and provides a loose base for the coral to grow.

N/B: Corals do not grow in polar areas due to the following reasons

- ***Low water temperatures***
- ***Sea water of low salinity***
- ***Presence of cold ocean currents***
- ***Presence of deep submerged upland coasts***

Coral Reefs

- A mass of coral is called a reef.
- Coral reefs are narrow ridges of coral rocks found at or near the surface of the sea/ocean. They are nearly parallel to the shoreline
- Coral reefs are divided into fringing reefs, barrier reefs and atolls

(a) Fringing Reefs

- This is a platform of coral which forms when coral polyps start building a reef near the shore.
- The reef extends seawards where the building is faster because there is more food and the water is clearer.
- As the reef builds seawards, it encloses a shallow lagoon with the coast.

Fig 8.32 KLB Geography Bk 3 pg 114

(b) Barrier Reefs

- This resembles a fringing reef except that it is formed a long distance away from the shore.
- It is separated from the shore by a wide and deep lagoon.
- A barrier reef may form parallel to the mainland or as a ring around an island.

Fig 8.33 KLB Geography Bk 3 pg 115

(c) Atolls

- These are coral reefs which are roughly circular in shape enclosing a fairly deep lagoon. They form islands
- They are found in mid oceans especially in the west and central Pacific
- They are thought to have formed due to sinking and rising of the sea level
- The rings of corals that grew around the islands were subjected to slow and gradual submergence

- As the island sunk as a result of rising sea level, the polyps continued to deposit their skeletons, the reef sustained itself through upward growth

Fig 8.34 KLB Geography Bk 3 pg 115

- Because of the fact that they are found in deep oceans where their base is too deep for polyps to survive, a number of theories have been advanced to explain their origin

(i) <u>*Darwin' s Theory*</u>

- Suggests that both barrier reefs and atolls form from fringing reef which develops around an oceanic island
- The oceanic island begins to subside; the fringing reef becomes larger and grows upwards to keep pace with the rising level of the sea.
- The seawards growth is more vigorous as there is more food and the water is clearer. The fringing reef transforms into a barrier reef that extends a great distance away from the island enclosing a deep lagoon.
- If the island continues to subside, it may reach a stage when the whole of it is completely submerged. The barrier reef then forms a ring of coral reefs called. *Atolls.*

Fig 5.35 Certificate Geography Bk 3 pg 132

(ii) <u>*Daly's Theory*</u>

- This suggests that formation of atolls is a based on the positive changes in the sea level and not subsidence of the sea floor
- During the pre-glacial period, prevailing warm conditions favored the growth of polyps around an island.
- In the glacial period, temperatures were so low that growth of all pre- existing corals ceased. Water was held up in form of glaciers and ice sheets, the sea level experienced global fall.
- Consequently, coral islands were planed down by marine erosion to the sea level at that time.
- After the ice age, as temperatures begun to rise again, volumes of melt water was released in the oceans resulting in a global rise in the sea level.
- The higher temperature allowed the growth of coral reefs which grew faster upwards and sea wards to keep pace with the rising sea level. The reefs enclosed a deep lagoon

Fig 5.37 Certificate Geography Bk 3 pg 134

(iii) <u>*Murray' s Theory*</u>

- The formation of the barrier reef doesn't involve subsidence; it starts as a fringing reef that gradually grows outwards.
- Breaking waves then disintegrate the fringing reef , the debris of which accumulate on its seaward side
- The deposited material eventually forms the base for the growth of polyps
- On the seaward side, the corals grow more vigorously due to more exposure to food, on inner side; the corals are deprived of food and die.
- Dissolved dead corals on the inner side deepens the lagoon

Fig 5.36 Certificate Geography Bk 3 pg 133

Significance of oceans, coasts and coastal features

Oceans

- Presence of oceans modifies climatic conditions of an area through land and sea breezes.
- Oceans provide rich grounds for subsistence and commercial fishing.
- Ocean tides and waves can be harnessed to produce tidal power.
- Oceans are natural habit for marine life/ Biodiversity conservation.
- Provides cheap free water ways to transport goods and services across continents.
- Oceans provide sites for a variety of recreational activities e.g. water skiing, cruising sport fishing and tourism.
- Oceans provide grounds for navy/ military activities
- Valuable minerals such as oil, natural gas are sometimes extracted from rocks that lie beneath the oceans.
- Sea water can be distilled to provide fresh water
- Provide grounds for scientific/ educational research

Coastal landforms

- Coral rocks are mined and used to manufacture cement
- Emerged coastal plains provide land for settlement
- Many coastal features- sandy beaches, coral reefs, caves, and cliffs attract tourists.
- Coral rocks are used as building materials
- Port development – submerged coasts (fiords, Rias) favour the development of deep and well sheltered natural harbors.