Geography Fact Sheet

Oceanography

Ocean bottom relief

- The ocean floors can be divided into four major divisions: (i) the Continental Shelf; (ii)the Continental Slope; (iii) the Deep-Sea Plain;(iv) the Oceanic Deeps
- **The continental shelf-→ the extended margin of each continent** occupied by relatively shallow seas and gulfs. It is the shallowest part of the ocean
- Shelves are almost **absent or very narrow along some of the margins like the coasts of Chile, the west coast of Sumatra,** etc. The Siberian shelf in the Arctic Ocean is the largest in the world.
- **The continental slope** connects the continental shelf and the ocean basins. Canyons and trenches are observed in this region.
- **Deep sea plains** are gently sloping areas of the ocean basins.
- **Oceanic Deeps or Trenches** are relatively steep sided, narrow basins. They occur at the bases of continental slopes and along island arcs and are associated with active volcanoes and strong earthquakes.
- **A mid-oceanic ridge** is composed of two chains of mountains separated by a large depression. Iceland, a part of the mid- Atlantic Ridge, is an example.
- **Seamount** is a mountain with pointed summits, rising from the seafloor that does not reach the surface of the ocean. Seamounts are **volcanic in origin.** The emperor seamount, an extension of the Hawaiian Islands
- **Submarine Canyons** are deep valleys, sometimes found cutting across the continental shelves and slopes, often extending from the mouths of large rivers. The Hudson Canyon is the best-known submarine canyon.
- **Guyots** is a flat-topped seamount
- **Atoll** are low islands found in the tropical oceans consisting of coral reefs surrounding a central depression

TEMPERATURE OF OCEAN WATERS

- Ocean waters get heated up by the solar energy but heating and cooling of the oceanic water is slower than land.
- The average temperature of surface water of the oceans is about 27°C
- the temperature of surface water **decreases from the equator towards the poles** because the amount of insolation decreases poleward.
- the oceans in **the northern hemisphere receive more heat** due to their contact with larger extent of land than the oceans in the southern hemisphere.
- **the winds blowing from the land towards the oceans drive warm surface water away from the coast** resulting in the upwelling of cold water from below. the onshore winds pile up warm water near the coast and this raises the temperature.
- warm ocean currents raise the temperature in cold areas while the cold currents decrease the temperature in warm ocean areas.
- **The enclosed seas in the low latitudes** record **relatively higher temperat**ure than the open seas; whereas **the enclosed seas in the high latitudes have lower** temperature than the open seas.

- **the temperature decreases with the increasing depth.** The boundary region, from where there is a **rapid decrease of temperature, is called the thermocline**. In this zone, temperatures approach 0° C.

SALINITY OF OCEAN WATERS

- Salinity is calculated as the amount of salt (in gm) dissolved in 1,000 gm (1 kg) of seawater. It is usually expressed as parts. Salinity **of 24.7 o/oo has been considered as the upper li**mit to demarcate 'brackish water'.
- The salinity of water in the surface layer of oceans depend mainly on evaporation and precipitation.
- Surface salinity is greatly **influenced in coastal regions by the fresh water flow** from rivers, and in polar regions by the processes of freezing and thawing of ice.
- Wind and ocean current also influences salinity of an area by transferring water to other areas.
- **Highest salinity in water bodies →Lake Van in Turkey (330 o/oo), Dead Sea (238 o/oo), Great Salt Lake (220 o/oo)**
- In the land locked Red Sea, it is as high as 41o/oo, while in the estuaries and the Arctic, the salinity fluctuates from 0 - 35 o/oo, seasonally.
- In hot and dry regions, where evaporation is high.
- Salinity **decreases from 35 o/oo - 31 o/oo on the western parts of the northern hemisphere because of the influx of melted water f**rom the Arctic region.
- **The North Sea, in** spite of its location in higher latitudes, records higher salinity due to more saline water brought by the North Atlantic Drift. **Baltic Sea** records low salinity due to influx of river waters in large quantity.
- The **Mediterranean Sea records higher** salinity due to high evaporation.
- Salinity is, however, very low in Black Sea due to enormous fresh water influx by rivers.
- **The low salinity trend is observed in the Bay of Bengal due** to influx of river water. On the contrary, the Arabian Sea shows higher salinity due to high evaporation and low influx of fresh water.
- Salinity, generally, **increases with depth and there is a distinct zone called the halocline,** where salinity increases sharply.
- Other factors being constant**, increasing salinity of seawater causes its density to increase**. High salinity seawater, generally, sinks below the lower salinity water. This leads to stratification by salinity.

WAVES

- Waves are actually the energy, which moves across the ocean surface. Water particles only travel in a small circle as a wave passes.
- Wind provides energy to the waves.
- As a wave approaches the beach, it slows down due to the friction occurring between the dynamic water and the sea floor.
- When the depth of water is less than half the wavelength of the wave, the wave breaks. The largest waves are found in the open oceans.
- Waves travel because wind pushes the water body in its course while gravity pulls the crests of the waves downward. The falling water pushes the former troughs upward, and the wave moves to a new position.

TIDES

- Movement of water caused by meteorological effects (winds and atmospheric pressure changes) are called surges.
- **The periodical rise and fall of the sea level, once or twice a day, mainly due to the gravitational attraction** of the sun and the moon, is called a tide.
- Another factor is **centrifugal force,** which is the force that acts to counter balance the gravity. Together, the gravitational pull and the centrifugal force are responsible for creating the two major tidal bulges on the earth.
- On the side of the earth facing the moon a tidal bulge occurs while on the opposite side though the gravitational attraction of the moon is less as it is farther away, the centrifugal force causes tidal bulge on the other side
- The tidal bulges on wide continental shelves, have greater height. When tidal bulges hit the mid-oceanic islands, they become low.
- The **shape of bays and estuaries along a coastline can also magnify the intensity of tides**. When the tide is channeled between islands or into bays and estuaries, they are called tidal currents.
- **Semi-diurnal tide**: The most common tidal pattern, featuring two high tides and two low tides of approximately same height each day.
- **Diurnal tide:** There is only one high tide and one low tide of approximately same height during each day.
- **Mixed tide**: Tides having variations in height are known as mixed tides. These tides generally occur along the west coast of North America and on many islands of the Pacific Ocean.
- **Spring tides:** When the sun, the moon and the earth are in a straight line, the height of the tide will be higher. These are called spring tides and they occur twice a month on full moon period and new moon
- **Neap tides:** At this time the sun and moon are at right angles to each other and the forces of the sun and moon tend to counteract one another. Normally, there is a seven-day interval between the spring tides and neap tides.
- Once in a month, when the **moon's orbit is closest to the earth (perigee)**, unusually high and low tides occur.
- when **the moon is farthest from earth (apogee), the moon's** gravitational force is limited and the tidal ranges are less than their average heights.
- When **the earth is closest to the sun (perihelion), around 3rd January each year,** tidal ranges are also much greater, with unusually high and unusually low tides.
- **When the earth is farthest from the sun (aphelion), around 4th July each year**, tidal ranges are much less than average.

Ocean currents

- The primary forces that influence the currents are**: (i) heating by solar energy; (ii) wind; (iii) gravity; (iv) Coriolis force**.
- near the equator the ocean water is about 8 cm higher in level than in the middle latitudes. This causes a very slight gradient and water tends to flow down the slope.
- Friction between the wind and the water surface affects the movement of the water. Gravity tends to pull the water down the pile and create gradient variation.
- The Coriolis force intervenes and causes the water to move to the right in the northern hemisphere and to the left in the southern hemisphere.

- These large accumulations of water and the flow around them are called Gyres. These produce large circular currents in all the ocean basins.
- Water with high salinity is denser than water with low salinity and in the same way cold water is denser than warm water. Denser water tends to sink, while relatively lighter water tends to rise.
- Cold-water ocean currents occur when the cold water at the poles sinks and slowly moves towards the equator.
- Warm-water currents travel out from the equator along the surface, flowing towards the poles to replace the sinking cold water.
- **Surface currents** constitute about 10 per cent of all the water in the ocean and deep-water currents make up the other 90 per cent of the ocean water.
- Deep waters sink into the deep ocean basins at high latitudes, where the temperatures are cold enough to cause the density to increase.
- **Cold currents** are usually found on the west coast of the continents in the low and middle latitudes (true in both hemispheres) and on the east coast in the higher latitudes in the Northern Hemisphere
- **warm currents** are usually observed on the east coast of continents in the low and middle latitudes (true in both hemispheres). In the northern hemisphere they are found on the west coasts of continents in high latitudes.

Pacific Ocean Currents

- **Equatorial Pacific Ocean Currents -** Under the influence of prevailing trade winds [tropical easterlies], the north equatorial current and the south equatorial current start from the eastern pacific (west coast of Central America) and move from east to west.
- **Counter equatorial current -** This raises the level of western pacific (near Indonesia and Australia) ocean by few centimeters. And this creates a counter-equatorial current which flows between the north equatorial current and the south equatorial current in west-east direction.
    - **the formation of Counter-Equatorial current** -→Piling up of water in the western pacific due to trade winds and earth rotation; The presence of doldrums aids the backward movement of piled up western pacific waters.
    - **Kuroshio current →**The north equatorial current turns northward off the Philippines to form the Kuroshio current
    - **Oyashio Current and Okhotsk current →** are two cold currents in the northern Pacific, Oyashio flows across the east coast of Kamchatka Peninsula to merge with the warmer waters of Kuroshio, and the Okhotsk current flows past Sakhlain Islands to merge with the Oyashio current off Hokkaido (Northern Japanese Island).
    - **North-Pacific current→**From the south-east coast of Japan, under the influence of prevailing westerlies, the Kuroshio current turns eastwards and moves as the North-Pacific current, reaches the west coast of North America, and bifurcates into two.
    - **Alaska currents→**The northern branch flows anti-clockwise along the coast of British Columbia and Alaska and is known as the Alaska current. The water of this current is relatively warm as compared to the surrounding waters in this zone.
    - **Californian current →**The southern branch of the current moves as a cold current along the west coast of USA and is known as the Californian current. The Californian current joins the north equatorial current to complete the circuit.
    - **East Australian current-→**Following the pattern in the northern hemisphere, the south equatorial current flows from east to west and turns southwards as the East Australian current. It then meets the South pacific current near Tasmania which flows from west to east.

- **Peru current or Humboldt Current→**Reaching the south-western coast of South America, it turns northward as the Peru current. It is a cold current, which finally feeds the south equatorial current, thus completing the great circuit.

Atlantic Ocean Currents

- **Equatorial and counter-equatorial current Atlantic Ocean Currents→same as pacific**
- **Antilles current→** The equatorial current bifurcates into two branches near Cape de Sao Roque (Brazil)
- A part of this combined current enters the Caribbean Sea and the Gulf of Mexico, while the remaining current passes along the eastern side of the West Indies as the Antilles Current.
- **Gulf Stream and North Atlantic Drift**. The part of the current which enters the Gulf of Mexico comes out from the Florida Strait and joins the Antilles current. This combined current moves along the south-eastern coast of the U.S.A and is known as the Florida Current up to Cape Hatteras. Beyond Cape Hatteras, it is known as the Gulf Stream.
- A cold current from the Arctic Ocean called **Labrador Current**, which flows along the eastern coast of Canada, meets the warm Gulf Stream near the northeast corner of the U.S.A.
- The confluence of these two currents, one cold and the other warm, produce fog around the region and makes it the most important fishing ground in the world.
- The Gulf Stream then deflected eastward under the combined influence of the westerlies and the rotation of the earth.
- It then crosses the Atlantic Ocean as the **warm North Atlantic Drift.**
- In this journey, another cold current from the Arctic called the **East Greenland Current** joins with the North Atlantic Drift.
- The North Atlantic Drift bifurcates into two branches on reaching the eastern part of the ocean.
- The northern branch continues **as North Atlantic Drift**; reaches the British Isles from where it flows along the coast of Norway **as the warm Norwegian Current** and enters the Arctic Ocean.
- The southern branch flows between Spain and Azores Island as the **cold Canaries Current.**
- The Canaries Current finally joins the North Equatorial Current and completes the circuit.
- **The South Equatorial Current** turns south and flows along the eastern coast of South America as Brazil Current.
- At about 350 south latitudes, due to the influence of westerlies and the rotation of the earth, the current moves eastward.
- A **cold current called the Falkland Current** which flows along the south-eastern coast of South America from south to north joins with the current at this time.
- **The Brazil Current** moves eastward and crosses the Atlantic Ocean as South Atlantic Current.
- A part of the west wind drift or the **Antarctic Circumpolar Current** merges with the South Atlantic Current while crossing the Atlantic.
- Near the Cape of Good Hope, the South Atlantic Current is diverted northward as the **Cold Benguela Current.**
- Benguela Current finally joins with the South Equatorial Current and completes the circuit.

Currents of the Indian Ocean

- the Indian Ocean is blocked by the continental masses in the north. In the northern hemisphere, there is a clear reversal of currents in the winter and summer seasons, which are completely under the influence of the seasonal changes of monsoon winds.

INDIAN OCEAN: NORTHERN HEMISPHERE DURING WINTER

- During winter, Sri Lanka divides the currents of the Arabian Sea from those of the Bay of Bengal.
- The **North-East Monsoon Drift** flows westward just south of Sri Lanka with a counter current flow between it and the South Equatorial Current.
- During the winter season, in the northern section, the Bay of Bengal and the Arabian Sea are under the influence of North East Monsoon Winds.
- These North East Monsoon winds drive the waters of the Bay of Bengal and the Arabian Sea westward to circulate in an anti-clockwise direction.

INDIAN OCEAN: NORTHERN HEMISPHERE DURING SUMMER

- In summer, the northern part comes under the influence of the South West Monsoon.
- It results in an easterly movement of water in the Bay of Bengal and the Arabian Sea in a clockwise direction.
- This current is called the **South West Monsoon Drift**.
- In the Indian Ocean, the summer currents are more regular than those of the winter.

INDIAN OCEAN: SOUTHERN HEMISPHERE

- In the southern part, the South Equatorial Current which flows from east to west is strengthened by its corresponding current of the Pacific Ocean.
- It then turns southward along the coast of Mozambique in Africa.
- A part of this current moving in between the African mainland and Mozambique is called the warm **Mozambique Current**.
- After the confluence of these two parts, the current is called **Agulhas Current**.
- Agulhas Current merges with the West Wind Drift when it crosses the Indian Ocean.
- A branch of this merged current flows along the western coast of Australia as cold **West Australian Current**.
- It later joins with the South Equatorial Current to complete the circuit.