5

HYDROLOGICAL CYCLE AND OCEAN

Water is the most important life supporting element of planet earth. Without water, survival in the entire earth is not possible. Almost 72% of the earth's surface is covered with water. The water on earth is present as solid form (ice), liquid and gas (water vapor). In the present scenario across the globe, the consumption of freshwater and underground water has increased to the greater extent due to the large population. Water is the crucial element of our domestic, agricultural and industrial economy.

In previous lesson we came across the significance of running water, moving ice wind and sea waves for humans. In this lesson we will discuss hydrological cycle, water budget, ocean relief, temperature and salinity, waves, tides and currents.

OUTCOMES

After studying this lesson, learner:

- explains the importance of oceans, the hydrological cycle and water budget on the earth;
- differentiates various relief features;
- analyses the vertical and horizontal distribution of temperature and salinity and its determining factors and
- describes the three types of ocean movements-waves, tides and ocean currents;

5.1 IMPORTANCE OF OCEAN IN LIFE

Oceans are responsible for producing half of the world's oxygen. It also absorb more than 50 percent of carbon dioxide of our atmosphere. Oceans regulate climate. It covers 70 percent of the Earth's surface thus transporting heat from equator to the poles. It provides home to number of species

5.2. HYDROLOGICAL CYCLE

Hydrology is the scientific study that deals with the movement of water on earth surface and its beginning can be traced at any of the processes i.e. evaporation, condensation, precipitation, interception, infiltration, percolation, transpiration, runoff, and storage.

It is well evident that there is a cyclical process of different physical formations on Earth surface. Water also undergoes such cyclical processes. The water cycle is the journey that water makes in its life. Water changes from one state to the other that is from solid to liquid, liquid to gaseous state and vice versa. Water is the cyclical resource of earth surface. It not only changes its form but also from one place to another that is ocean to land or land to ocean etc. There is no starting point as the word 'cycle' suggests. This means that there is no beginning and no end and no fixed path.

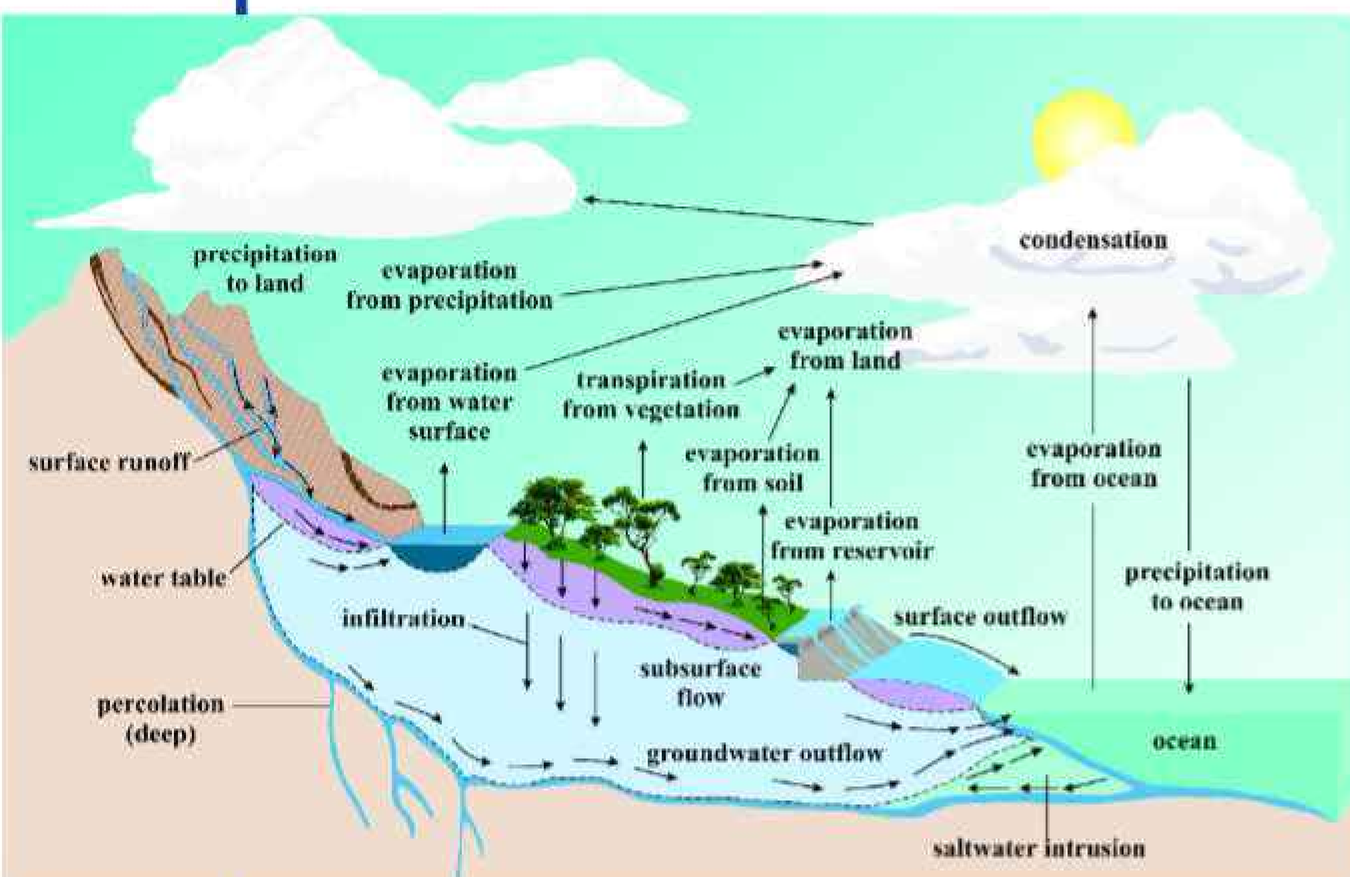

Fig. 5.1: Hydrological Cycle

Notes

Let's know some of the important processes of hydrological cycle:

a. **Evaporation:** Evaporation is the process through which water changes from liquid state to the gaseous state due to increase in temperature and pressure. It is one of the fundamental processes of water cycle. Water stored in ocean moves to the atmosphere through evaporation or evapotranspiration.

b. **Condensation:** Condensation is the process by which water from gaseous state changes into its liquid state i.e. cloud .It is the opposite of evaporation. This state is also known as cloud formation state. Low temperature is required for condensation to happen. Water in the gaseous state is condensed to form cloud.

c. **Precipitation:** Water that got condensed to form cloud gets accumulated in atmosphere in different forms and that accumulated water comes back to land surface in form of snow, rain, sleet, fog and hail due to the increased velocity and force of gravity.

d. **Evapotranspiration:** Evapotranspiration is the process by which water is transferred from the land to the atmosphere by evaporation from the soil and by transpiration from plants. Evapotranspiration accounts for about 10 percent of vapor in the atmosphere.

e. **Transpiration:** Transpiration is the process by which water from the plant surface gets evaporated and gets changed into gaseous form due to change in temperature, humidity and pressure.

f. **Runoff:** Runoff is the form of precipitation that does not get infiltrated or absorbed by soil and it gets collected to form ponds, seas and oceans. Runoff is one of the major causes of soil erosion and it also carries lot of chemicals thus causing water pollution.

g. **Infiltration:** The process of the absorption of the precipitated water is known as infiltration. Water gets absorbed by soil and also runs through pores and spaces in the land surface. Water can be absorbed by the soil and stay in the soil for a long time and gradually gets evaporated. In the area with a lot of green plants the infiltrated water gets absorbed by plant roots and later gets transpired. Infiltration occurs in the upper layers of the ground but may also continue further downwards into the water table.

h. **Groundwater Hydrology:** Water below the surface of Earth, occupying all or part of the void spaces in soils or geologic strata is Groundwater. Both surface and groundwater are related through the hydrologic cycle a cyclical process in the Earth-atmosphere system. Flow of ground water depends upon porosity of the soil and its permeability.

i. **Porosity and Permeability: Porosity** is the measurement of the open space within the rocks. This space can be between grains or within cracks or cavities of the rock. It depends on size of sediments, shape of sediments and sorting of sediments. **Permeability** is the measurement of the ease through which fluid (water) can move through a **porous** rock.

j. **Aquifer:** The underground layer of permeable rock, rock fractures or unconsolidated materials which bear the water is known as an aquifer. We can extract groundwater by using water well. The study of the flow of aquifers is known as hydrogeology.

Importance of hydrological cycle

- Precipitation is essential for the growth of plants.
- Infiltration is essential for cleaning water and also helps in filtration.
- Glaciers, ice, and snow can act as stores of freshwater for both humans and other organisms.
- Runoff contributes to rivers, other freshwater bodies, and eventually the ocean, sustaining freshwater and marine life.

All of these processes sustain life and create the ecosystems around us.

Water Budget

A water budget provides a ground for evaluating availability and sustainability of a water supply. A water budget simply states that the rate of change in water stored in an area, such as a watershed, is balanced by the rate at which water flows into and out of the area.

INTEXT QUESTIONS 5.1

1. What is Porosity?
2. Define water budget?
3. Name any two the processes involved in the hydrological cycle?
4. What are Aquifers?

5.3 OCEAN RELIEF: MAJOR OCEAN RELIEF FEATURES

Ocean relief is an outcome of tectonic, volcanic, erosional and depositional processes and their interactions. The ocean basins have features similar to the topography of the land surface.

The two broad categories of ocean relief are **major relief features** and **minor relief features.**

Notes

a. Major relief features

The major relief features of the oceans are divided into four.

i. The Continental Shelf

ii. The Continental Slope

iii. The Continental Rise

iv. The Deep Sea Plain or the Abyssal Plain

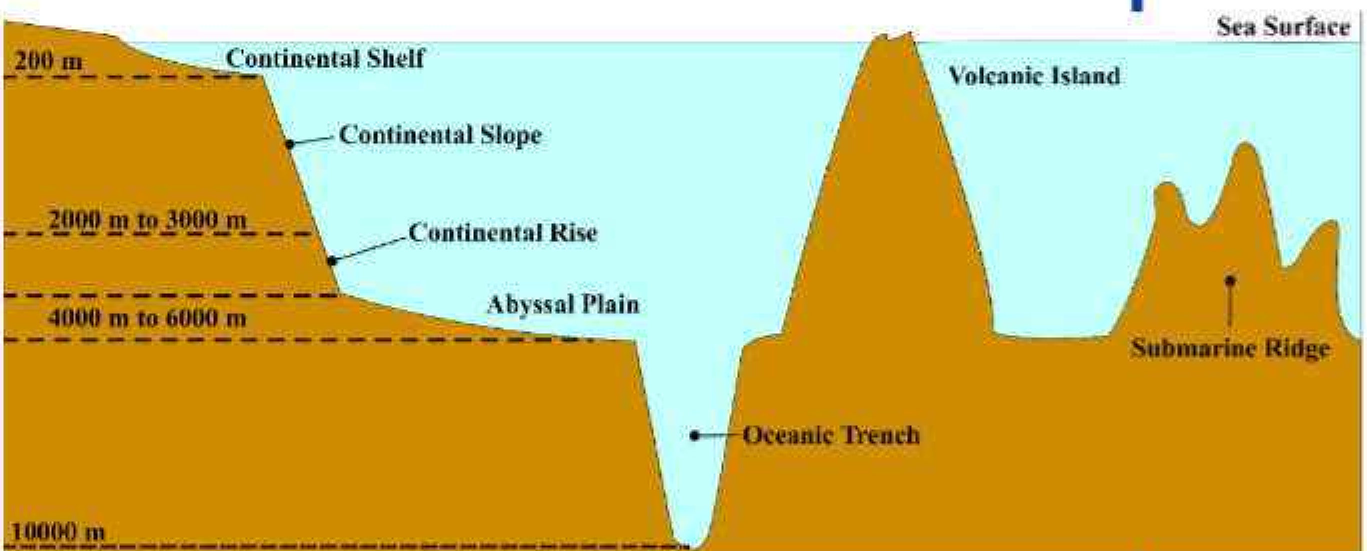

Fig. 5.2 Major Ocean Relief

i. **The Continental Shelf**- The Continental Shelf is the continental margin which starts from the shoreline and extended upto the continental edge. The reasons for the formation of shelves are:

- Submergence of a part of a continent,
- the relative rise in sea level,
- sedimentary deposits, smaller continental shelves could have been caused by wave erosion where the land is eroded by the sea. Continental shelves covers an area of 7.5% of the total area of the oceans and 18% of earth's dry land area. The average width of the shelf is 70 - 80 kms.

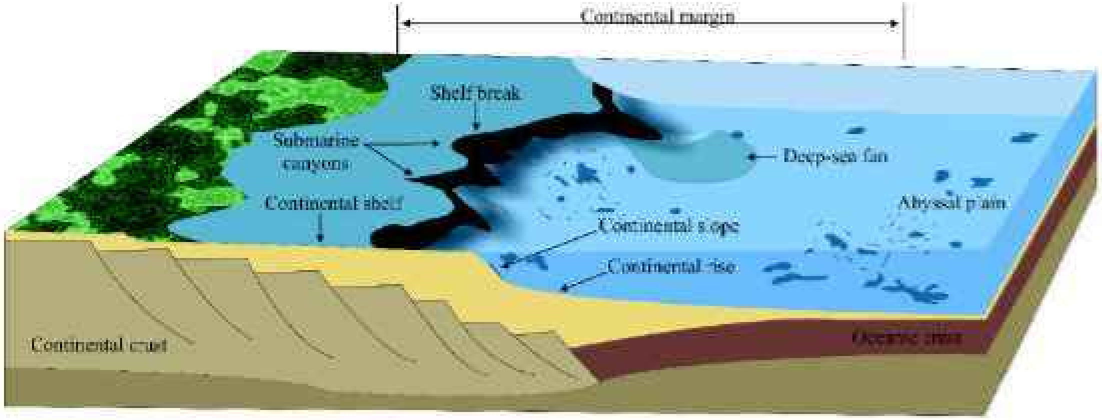

Fig. 5.3 Ocean Relief Features

The significance of Continental Shelves- Continental Shelves are economically and ecologically significant. It is one of the most accessible part of the ocean. Shelves provide conditions for the growth of millions of plankton and microorganisms through penetration of sunlight which makes them excellent breeding ground for fish. Hence continental shelves are the richest fishing grounds in the world. Marine food almost comes entirely from continental shelves. It is also the source of Fossil fuels and leads to the formation of metallic and non metallic ores.

ii. **The Continental Slope**- We can see as the continental slope is the connection between continental shelf and continental rise. The end of the Continental shelf is marked by the sharp increase in the slope. From this point, continental slope starts. There is an abrupt change in the gradient to about 1 in 20. The gradient of the slope is highest off coasts with young mountain ranges and narrow continental shelves and lowest off stable coasts without major rivers. Canyons are also found in this region.

iii. **The Continental Rise**- The Continental Rise is the link between Continental slope and the deep sea or abyssal plain. The steepness of continental rise is lower than that of the continental slope and it gradually merges into the deep sea plain. It is a major depositional regime in oceans made up of thick sequences of continental material that accumulate between the continental slope and the abyssal plain.

iv. **The Deep Sea plain or the Abyssal plain**- Abyssal plain are the sloping areas of the ocean basins. It is considered to be flattest and smoothest regions of the world. These plains are covered with sediments like clay and slit.

Notes

b. Minor Relief features:

i. **Ridges:** The underwater mountain formed by plate tectonics (divergent boundaries) is known as mid-oceanic ridges. These mountains are separated by a large depression

ii. **Seamounts:** It is a mountain with pointed summits, rising from the seafloor that does not reach the surface of the ocean. Seamounts are volcanic in origin. These can be 3,000-4,500 m tall.

iii. **Guyots:** The flat-topped mountains (seamounts) are known as guyots.

iv. **Trenches:** Trenches are relatively long, steep-sided, narrow basins. These areas are the deepest parts of the oceans. They are originated by plate tectonic and are formed during ocean-ocean convergence and ocean-continent convergence. The greatest known ocean deep, the Mariana Trench is nearly 36,000 feet deep and found near Guam Island in the Pacific Ocean.

v. **Coral reefs:** Coral reefs are built by colonies of tiny animals found in marine water that contain few nutrients. They are diverse underwater ecosystems held together by calcium carbonate structures secreted by marine invertebrates called corals.

vi. **Atolls:** The low islands found in the tropical oceans consisting coral reefs surrounding a central depression is known as Atoll. It may be a part of the sea (lagoon), or sometimes part of a body of fresh, brackish, or highly saline water. Example: Lakshadweep is formed on Atolls.

INTEXT QUESTIONS 5.2

1. What is the continental slope?
2. Name the minor relief features of the ocean?
3. What are the major relief features of the ocean?
4. Define trenches?
5. Which Island in India is form of Atolls?

5.4 OCEAN TEMPERATURE AND ITS DISTRIBUTION

Water has the highest capacity of absorbing heat. About 80 percent of heat is absorbed by oceans. The uppermost 10 percent of the oceans contain more heat than the entire atmosphere.

There is a variation in distribution of temperature in oceanic water. It differs from latitude to latitude and from the surface to the bottom.

The major determinants of ocean temperature are:

- **Latitude:** The surface temperature of the oceans declines from the equator towards the poles as the Sun's rays are vertical on the equator.
- **Prevailing Winds:** Direction of the prevailing winds such as the Trade Winds, Westerlies etc., determines the surface temperature of ocean waters at a point.
- **Unequal distribution of Land and Water:** The Northern Hemisphere has more land area than that of the Southern Hemisphere. Hence, the oceans of the Northern are warmer than that of the Southern Oceans.
- **Evaporation Rate:** Highest amount of water is gets evaporated from oceans. However, there is no uniformity in the rate of evaporation. The warmer region experience more evaporation than cooler one.
- **The density of water:** The density of ocean water is governed by the temperature and salinity. There is variation of density of water from latitude to latitude. Areas with high salinity witness the relatively higher temperature of ocean waters and vice versa.
- **Ocean Currents:** The temperature of oceans of surface is also controlled by cold and warm currents. The presence of warm water increases the temperature and thus raising the rate of evaporation. Therefore, the region records more rainfall, while the cold current reduces the temperature of the moisture-laden wind.
- **Local Factors:** Submarine ridges, local weather conditions like storms, cyclones, winds, fogs, cloudiness, the rate of evaporation, lapse rate, condensation, and precipitation are some of the major factor that affect ocean temperature.

a. Horizontal Distribution of Temperature

The usual temperature of the surface water in the lower latitudes is about 26° Celsius which decreases towards poles. The oceans of the Northern Hemisphere record an average temperature of 19.4° Celsius. However, the average temperature recorded at various latitudes also varies with 22° Celsius recorded at 20° latitude, and 14° Celsius recorded at 40° latitude in the Northern Hemisphere. At the poles, the temperature drops to 0° Celsius.

Notes

The maximum and minimum annual temperatures of ocean water in the Northern Hemisphere are in the months of August and February respectively. The average annual range of temperature is about 12 degrees Celsius. The highest annual range of temperature is recorded in the North Atlantic Ocean. Moreover, the annual range of temperature is higher for the inland seas as compared to the open oceans.

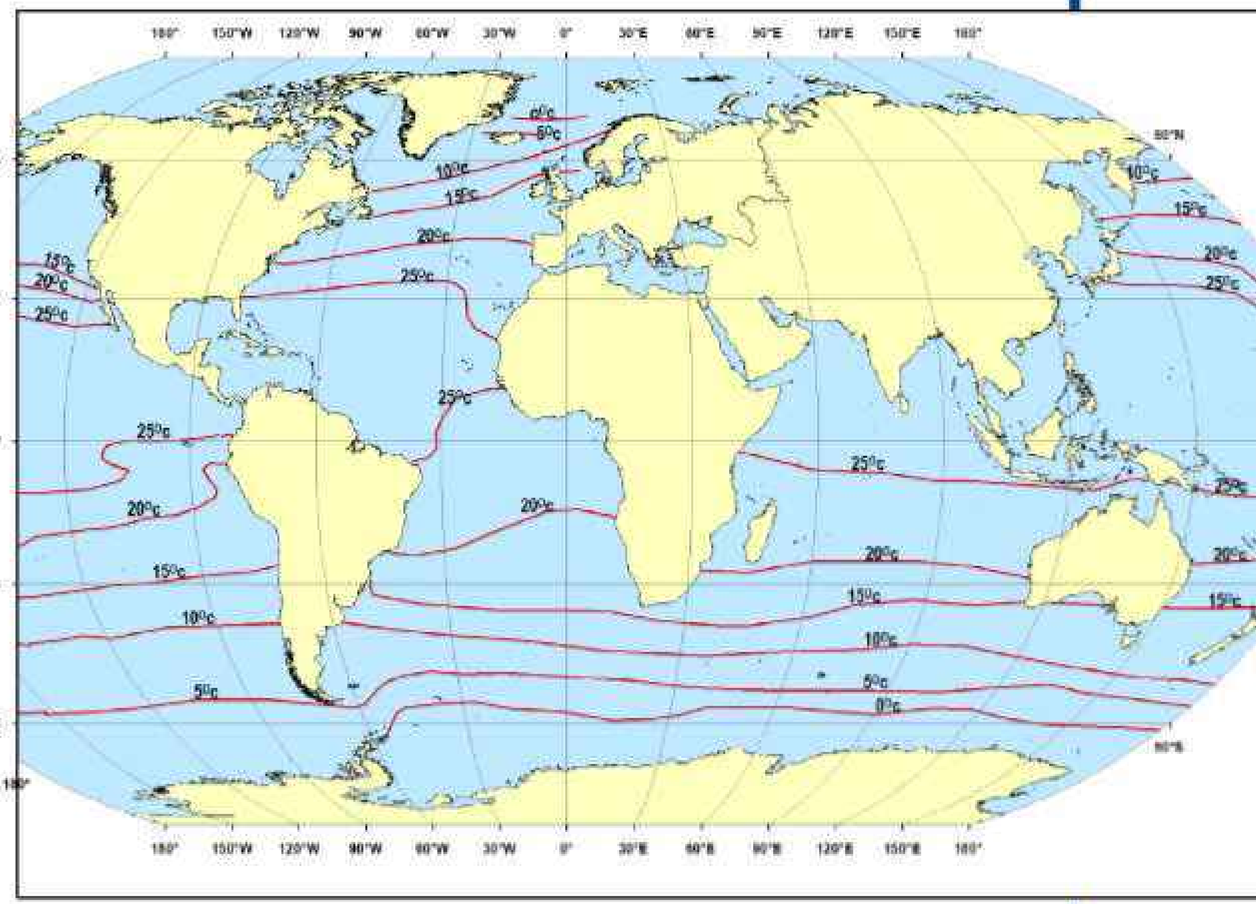

Fig. 5.4: Temperature Distribution in the Oceans

b. Vertical Distribution of Temperature

With the increased depth in the oceans both energy and sunlight decreases. Only about 45 percent of light energy striking the ocean surface reaches a depth of about one meter, and only 16 percent reaches a depth of 10 meters. On the basis of the temperature, the ocean depths may be divided into the following three zones:

- **Surface Zone or Mixed Zone:** This is also known as the Photic zone or Euphoric zone. It is the upper layer of the ocean. In this layer, the temperature and salinity are relatively constant. It contains about 2 percent of the total volume of water in the ocean. It is limited to a depth of about 100 meters.

- **Thermocline:** It lies between 100 metres and 1000 metres. It contains about 18 percent of the total volume of water in the ocean. There is a steep fall in temperature in this zone. The density of water increases with increasing depth.

- **Deep Zone:** This zone lies below 1000 metres in the mid-latitudes. This zone contains about 80 percent of the total volume of water in the ocean. The temperature in this zone remains constant. The ocean bottom always has a temperature which is one or two degrees Celsius above the freezing point.

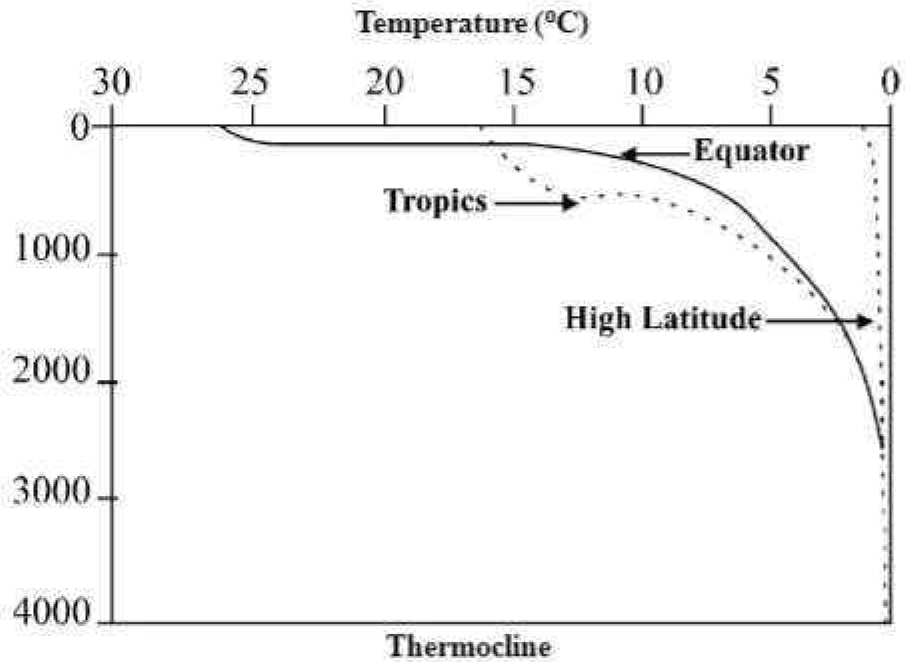

Fig. 5.5 Distribution of Temperature

INTEXT QUESTIONS 5.3

1. What are the major determinants of Ocean temperature?
2. How prevailing winds determines surface temperature of Ocean waters?
3. What is the average annual range of temperature of ocean?
4. Name the three zones in which ocean is divided on the basis of temperature.
5. Define thermocline zone.

5.5 OCEAN'S SALINITY AND SALT BUDGET

The salinity of ocean waters is measured by the amount of dissolved solids present in a unit weight of ocean water, usually expressed in parts per thousand by weight or grams per kilogram.

Salinity of Ocean

The salinity of ocean water is usually around 35 parts per thousand on an average at zero degrees Celsius. This implies that in the total weight of ocean water, dissolved salts amount to 3.5 percent. Sodium chloride or the common salt is the most common among all the dissolved salts in the sea.

Table 5.1: The chemical composition of ocean water

Salt	Percentage
Sodium chloride	2.6
Magnesium chloride	0.3
Magnesium sulphate	0.2
Calcium sulphate	0.1
Potassium chloride	0.1
Potassium bromide	0.01
Other elements	0.01

Sources of salinity

The source of salts dissolved in the ocean waters has their origin on the continental landmasses. They are carried into the oceans by rain, rivers, groundwater table, sea-waves, winds, and glaciers. Some of the dissolved salts are originated from the ocean bottom. The layers of the earth beneath the crust contain minerals in a molten state which can reach the crust either due to volcanic activity or due to their continuous emission in the form of gasses.

Determinants of the salinity of the oceans

Ocean salinity is dependent upon several factors and it keeps varying with the place and time. The major determinants of ocean salinity are-

- **Evaporation:** Salinity is usually higher at places with high rates of evaporation. i.e. the tropical seas such as the Red Sea, Persian Gulf etc.
- **Temperature:** Temperature and ocean salinity are directly proportional to each other. Generally, regions with high temperatures are also the regions with high salinity.
- **Precipitation:** Precipitation and salinity inversely proportional to each other. Hence regions with higher levels of precipitation have lower levels of salinity.

- **Ocean Currents:** Ocean currents plays crucial role in the spatial distribution of dissolved salts in ocean waters. The warm currents near the equatorial region push away the salts from the eastern margins of the oceans and accumulate them near the western margins. Similarly, ocean currents in the temperate regions increase the salinity of ocean waters near the eastern margins.

- **The influx of Fresh Water:** Salinity is relatively lower in areas where major rivers meet the oceans.

a. Horizontal Distribution of Salinity

The surface salinity of oceans decreases on either side of the tropics. For example, the surface salinity along the Tropic of Cancer is around 36 parts per thousand (ppt) while at the equator it's around 35 parts per thousand. On the basis of their salinity levels, seas are categorized as follows:

- **Seas with salinity levels below the normal:** They have a low salinity due to the influx of fresh water. They include the Arctic Ocean, Southern Ocean, Bering Sea, Sea of Japan, Baltic Sea etc. Their surface salinity can be as low as 21 ppt.

- **Seas with normal salinity levels**: They have salinity in the range of 35 to 36 ppt. For example the Caribbean Sea, Gulf of Mexico, Gulf of California, Yellow Sea etc.

- **Seas with salinity levels above the normal:** They have higher levels of salinity because of their location in regions with higher temperatures leading to greater evaporation. For example the Red Sea (39 - 41 ppt), Persian Gulf (38 ppt), Mediterranean Sea (37 - 39 ppt) etc.

b. Vertical Distribution of Salinity

There is no definite trend in the variation of salinity with depth. Instances of increase, as well as a decrease in salinity levels, have been found with increasing depth.

Notes

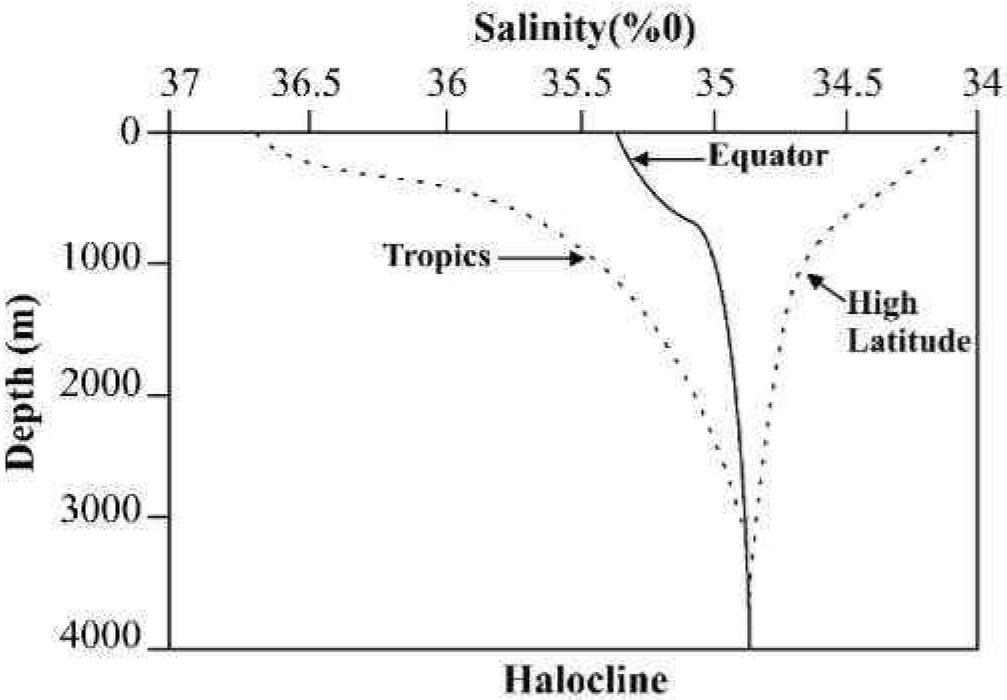

Fig. 5.6 Distribution of Salinity

From the above graph, it can be observed that,

- Salinity decreases with increasing depth at the equator as well as near the tropics.
- At higher latitudes, salinity is found to increase with increasing depth.

Salt Budget

Salt budget is commonly known as the salt cycle. It involves all the processes through which salt moves from the ocean into the lithosphere, to a certain extent into the atmosphere, and back into the oceans.

- The salinity level of ocean water is increased due to the mineral deposition taken from moving water, including groundwater. Minerals leach from the rocks through the process of surface erosion. The water with minerals joins the rivers and streams which finally reach the oceans. These minerals add to the salinity levels of the ocean waters.
- Some of the salts in the ocean waters accumulate at the ocean bottom through the process of sedimentation turning into mineralized rocks. Over a period of millions of years, some of these rocks get raised above the ocean surface due to plate tectonics, or due to volcanic activity. This brings the salt back to the lithosphere in the form of minerals.
- Salt from the oceans also gets sprayed into the atmosphere due to the action of wind. This salt returns to the lithosphere mixed with precipitation.

- Salt cycle operates over a very long period of time.

Every year, around 3 billion tons of salt gets added to the oceans from the land. A tiny fraction of this salt is extracted by humans for daily consumption.

INTEXT QUESTIONS 5.4

1. What are the determinants of salinity of the ocean?
2. How ocean currents determine the salinity of ocean?
3. What is the relationship between salinity and depth at higher altitudes?

5.6 OCEAN MOVEMENT

The ocean water is very dynamic. There is always some sought of movements happening inside the ocean water due to various physical characteristics such as salinity, temperature etc. and also some of the external factors like sun and moon influence those movements. There are three types of ocean movements-ocean waves tides and ocean currents.

a. Ocean Wave

Ocean waves are formed as wind blows across the surface of the ocean, creating small ripples, which eventually become waves with increasing time and distance.

The ocean is never still. Whether observing from the beach or a boat, we expect to see waves on the horizon. Waves are created by energy passing through water, causing it to move in a circular motion. Waves transmit energy, across the ocean and if not obstructed by anything, they have the potential to travel across an entire ocean basin.

The most common cause of waves is wind. Surface waves, are created by the friction between wind and surface water. As wind blows across the surface of the ocean or a lake, the continual disturbance creates a wave crest.

Severe weather condition like hurricane can also develop waves. The strong winds and pressure from this type of severe storm causes storm surge due to which a series of long waves are created far from shore in deeper water and intensify as they move closer to land.

Underwater disturbances also cause hazardous waves. It displaces large amounts of water quickly such as earthquakes, landslides, or volcanic eruptions. These very long waves are called tsunamis. Storm surge and tsunamis are not the types of waves. The gravitational pull of the sun and moon on the earth also causes waves. These waves are tides or, in other words, tidal waves.

Notes

b. Tides

The periodical rise and fall of the water level in oceans and sea, once or twice a day, due to the gravitational pull of the sun and the moon, is called a tide. The study of tides is very complex, spatially and temporally, as it has great variations in frequency, magnitude and height. Three major forces that causes an occurrence of tides are as follows:

1. Moon's gravitational pull
2. Sun's gravitational pull
3. Centrifugal force which acts opposite to gravitational pull of the earth.

Tides occur due to an imbalance between the various forces acting on the ocean water at a point of time. The tide-generating force is the difference between these two forces; i.e. the gravitational attraction due to the mass of the moon and the centrifugal force due to rotation of the earth.

Mechanism of Tides

- When the two forces are not in balance, it gives rise to the tide-generating force. The side of the Earth which is closest to the moon has the strongest gravitational pull towards the moon while water on the other side of the Earth experiences a weaker gravitational pull.
- The moon's gravitational force has a greater effect than the sun's gravitational force due to the relative distance of moon and sun respectively. The tide-generating force is proportional to the product of the mass of the two bodies but also inversely proportional to the square of the distance between them.

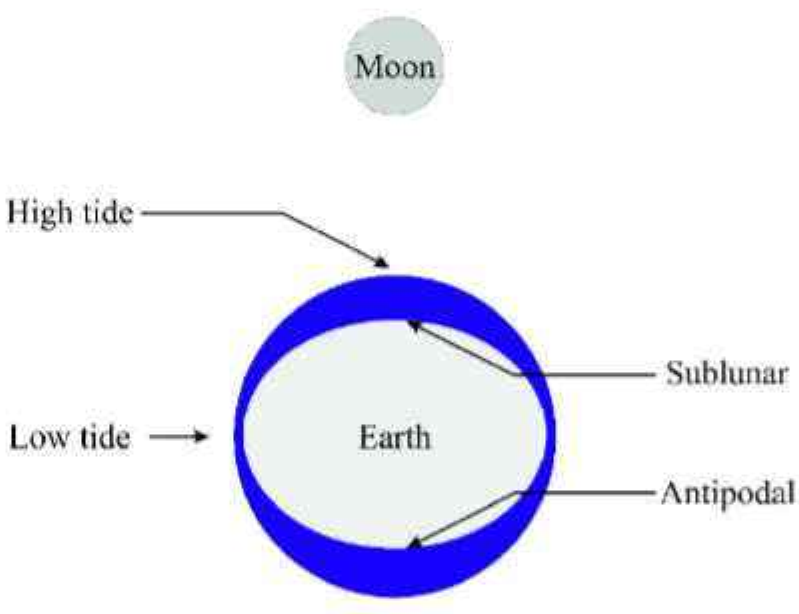

Fig. 5.7 Tide

Other Factors Controlling Tides

- Uneven distribution of water over the globe.
- Irregularities in the configuration of the oceans.
- When the tide is channeled into bays and estuaries they are called tidal currents.

Types of Tides

Types of tides is based on-

- Frequency
- The position of the earth, moon, and sun
- The time period between high tide and low tide
- Magnitude

i. Based on frequency

- **Semi-diurnal Tide**: This is the most common tidal pattern, featuring two high tides and two low tides each day.
- **Diurnal Tides**: Only one high tide and one low tide each day. The successive high and low tides are approximate of the same height.
- **Mixed Tide**: Tides having variations in heights are known as mixed tides. They generally occur along the west coast of North America and also in the Pacific Ocean.

ii. Based on sun, moon and earth's positions

- **Spring Tides**: When the position of the sun, the moon, and the earth are aligned in such a way that it forms a straight line, the height of the tide will be higher than normal. These are called as spring tides. It occurs twice in a month-one on the full moon and the other on the new moon.
- **Neap Tides**: After seven days of spring tides the sun and the moon form a 90 degree angle between each other. The resultant force of gravitation gives rise to a tide of very low magnitude which is termed as the neap tide. It also occurs twice in a month.

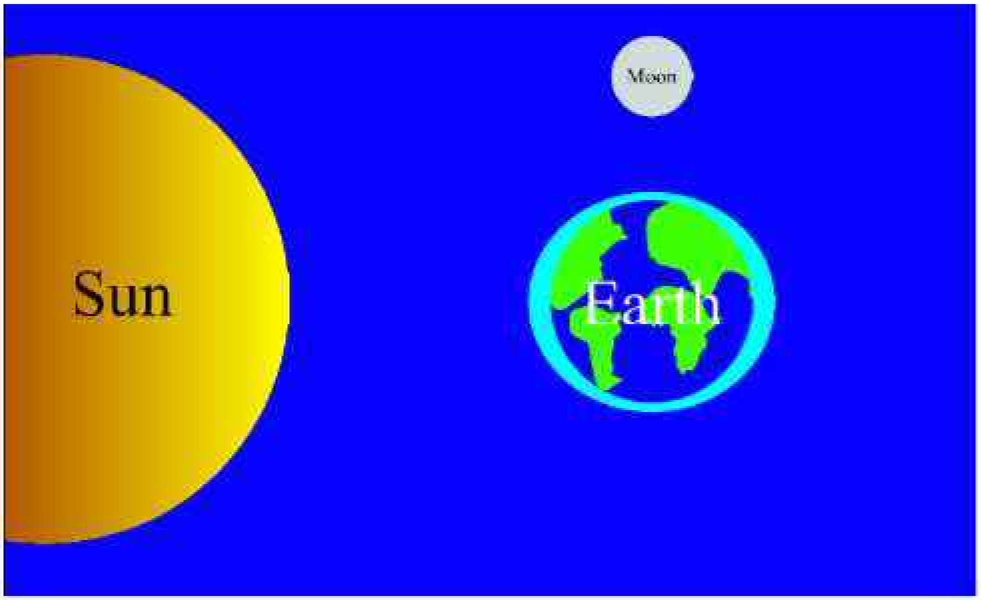

Fig. 5.8 Spring and Neap Tide

iii. Based on magnitude

- **Perigee**: When the moon's orbit is closest to the earth, it is called as perigee. During this period, unusual heights of high and low tide occur.
- **Apogee**: When the moon's orbit is farthest from the earth, it is called as apogee. Tidal ranges will be much less than average height during this period.
- **Perihelion**: It is the position where the earth is closest to the sun (around January 3^{rd}). Unusually high and low tides occur at this time.
- **Aphelion**: It is the position where the earth is farthest from the sun (around July 4^{th}). Tidal ranges will be much less than the average height during this period.

The time period between high tide and low tide

The time between the high tide and low tide, when the water level is falling is called the ebb. The time between the low tide and high tide, when the tide is rising, is called the flow.

Importance of Tides

- Tides help in navigation. Water level rises during high tide. Large ships can enter or leave harbour safely. Diamond Harbour in West Bengal and Kandla port in Gujarat are examples of such ports.
- Tides help the ships to travel up the mouth of the river in case of river ports. High tide increases the volume of water at the river ports to a high volume so that large ships can sail in safely and use a retreating tide to leave the port. Hooghly (Kolkata), London and New York are examples of some of the important river ports of the world.

- Tides help in removal of silt from river mouth. Rivers carry down a lot of soil and sand. Tides wash away these deposits and help to keep the mouth of the river clear.
- Salt water freezes at a temperature that is low than that of fresh water. In cold regions whereas the rivers are frozen in winter, the warmer seawater rushes into the harbours to keep it free from freezing.
- Tides are largely being harnessed to produce electricity as a renewable source of energy (Tidal energy).
- Tides bring in huge volumes of fish and these areas serve as fishing zones for fishermen without venturing too deep into the sea.

C. Ocean Currents

The ocean currents are the large masses of surface water that circulate in regular patterns around the oceans. Ocean currents can be classified into warm currents and cold currents depending upon their temperature.

i. **Warm currents** - Warm currents flow from equatorial regions towards the Polar Regions and hence have a higher surface temperature. These currents flow in the clockwise direction in the northern hemisphere and in the anti-clockwise direction in the southern hemisphere.

ii. **Cold currents** - Cold currents flow from Polar Regions towards the equator and have a lower surface temperature. Cold ocean currents flow in the anti-clockwise direction in the northern hemisphere and in the clockwise direction in the southern hemisphere.

Factors responsible for Ocean Currents

The following factors are responsible for ocean currents:

i. **The Planetary winds**- The Earth's atmosphere is divided into permanent pressure belts - The Equatorial low-pressure belt, The Sub-tropical high-pressure belt, Sub-polar low-pressure belt and Polar high-pressure belts. The planetary winds are permanent winds that blow from one pressure belt to the other.

The Planetary winds influence flow of ocean currents. Evidence of prevailing winds on the flow of ocean currents can be seen in the North Indian Ocean where there is a change in the direction of ocean currents with a change in direction of the monsoon winds. The oceanic circulation pattern corresponds to the earth s atmospheric circulation pattern.

ii. **Temperature**- The energy from Sun reach at the equator more than the poles is the reason behind the difference in the temperature of ocean water. As the temperature gets higher the ocean water gets heated up and expands at the equator. Sun energy makes the warm water lighter and it rises while at the poles, cold water is denser and sinks. Warm water from the equator slowly moves along the surface towards the poles, while the cold water from the poles slowly creeps along the bottom of the sea towards the equator.

iii. **Salinity**-The density of water also depends on its salinity and the salinity of water varies from place to place. Waters of low salinity flow on the surface of waters of high salinity while waters of high salinity flow at the bottom.

iv. **The earth's rotation and Coriolis force**-The earth's rotation deflects moving objects to the right and ocean currents are no exception. Under the action of Coriolis force, the movement of ocean currents in the northern hemisphere is in the clockwise and in the southern hemisphere it is in the anti-clockwise direction. Hence it can be said that ocean currents obey Ferrel's law.

v. **Obstruction due to land**- A land mass obstructs the direction of flow of ocean current and divides the ocean current which in turns flow in a different direction. Example: The south equatorial current in the Atlantic Ocean is obstructed by South American continent and the South equatorial current divides to create the Brazilian current which flows in the south Atlantic Ocean.

Distribution of Ocean Currents

a. **Currents in the Pacific Ocean;**

- **Warm Currents** are; North Equatorial Current, South Equatorial Current, Counter Equatorial Current, Kuroshio System, East Australia Current, and North Pacific Drift.

- **Cold Currents** are; Oyashio Current, California Current, and Peruvian or Humboldt Current.

Currents in the Atlantic Ocean

- **Warm currents** are; North Equatorial Current, South Equatorial Current, Equatorial Counter Current, Gulf Stream, Florida Current, and Brazilian Current.

- **Cold Currents** are; Canaries Current, Labrador Current, Falkland Current, South Atlantic Drift, and Benguela Current.

Notes

Currents in the Indian Ocean

- **Drifts** are; The North East Monsoon Drift, and The South West Monsoon Drift.
- **Warm currents** are; North Equatorial Current, South Equatorial Current, Mozambique Current, Madagascar Current, and Agulhas Current.
- **Cold Currents** are; Somali Current, and West Australian Current.

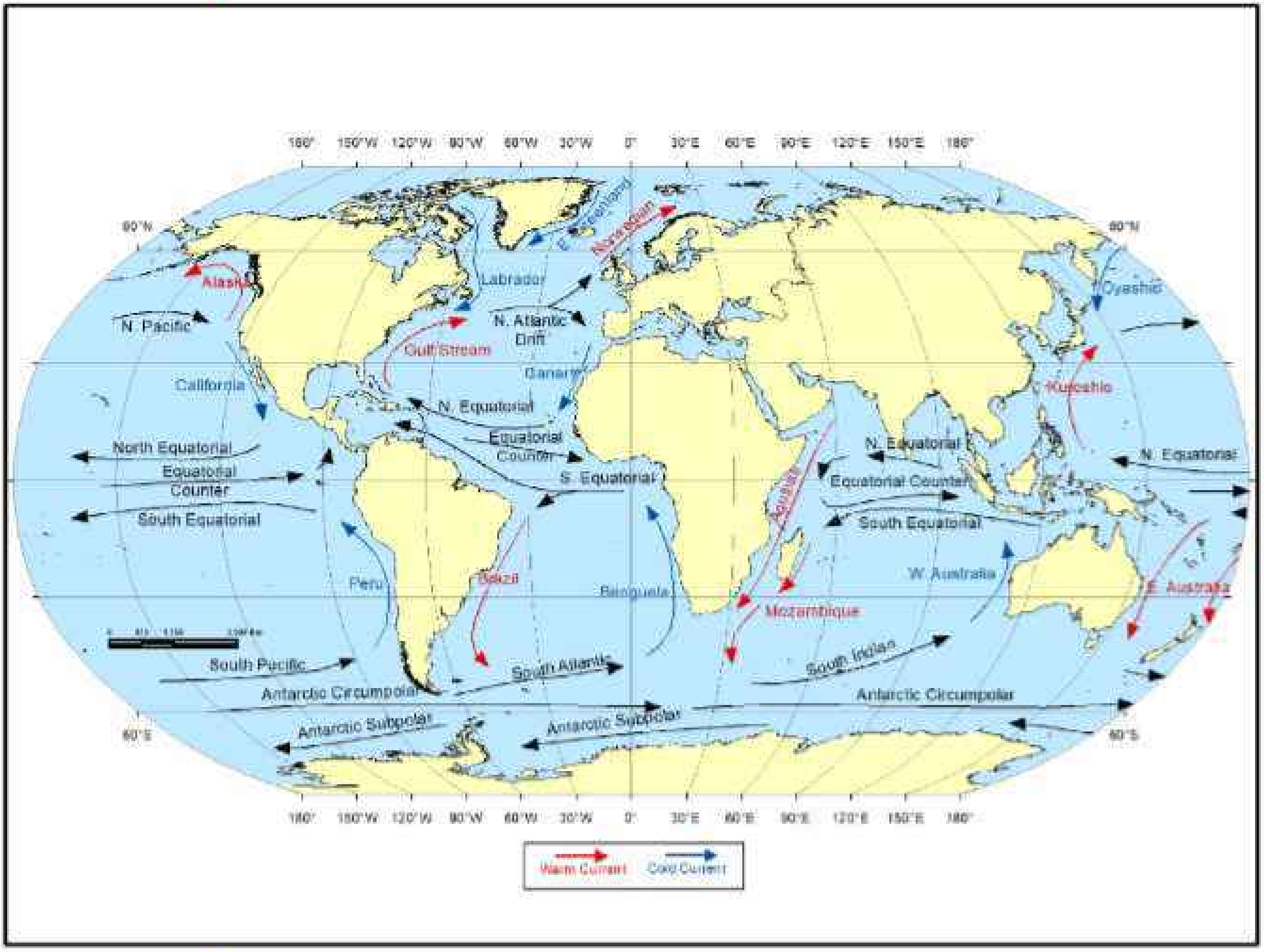

Fig. 5.9: Ocean Currents

INTEXT QUESTIONS 5.5

1. What is a Diurnal tide?
2. Define Aphelion.
3. Name the position when earth is closest to the sun thus causing unusually high and low tide.

4. Name the drifts of Indian Ocean currents.

5. Name the warm currents of Atlantic Ocean.

6. Name the cold currents of Pacific Ocean.

WHAT YOU HAVE LEARNT

- ***Hydrological Cycle***: Elements of Hydrological Cycle are; Evaporation, Condensation, Precipitation, Evapotranspiration, Runoff and Infiltration.
- ***Groundwater Hydrology*:** Groundwater Hydrology is based on the porosity of Soil, Permeability of Soil, and Aquifers.
- ***Ocean Relief:*** Major Relief features are; Continental Shelf, Continental Slope, Continental Rise and Deep Sea Plain or Abyssal Plain.
- ***Ocean Temperature:*** Major determinants of distribution of temperature are; Latitude, Prevailing winds, Unequal distribution of Land and Water, Evaporation Rate, Density of Water and Ocean Currents.
- ***Ocean Salinity***: Major determinants of distribution of Salinity are; Evaporation, Temperature, Precipitation and Ocean Currents.
- ***Ocean Tides:*** Different types of tides based on position of Earth, Moon, and The Sun are; Spring Tides and Neap Tides
- ***Drifts of Indian Ocean currents:*** The North East Monsoon Drift, and The South West Monsoon Drift.
- ***Warm currents of Atlantic Ocean:*** North Equatorial Current, South Equatorial Current, Equatorial Counter Current, Gulf Stream , Florida Current, and Brazilian Current
- ***Cold currents of Pacific Ocean:*** Oyashio Current, California Current, and Peruvian or Humboldt Current.

TERMINAL QUESTIONS

1. What is hydrological cycle? Diagrammatically explain the process of hydrological cycle.

2. Describe the major relief features of ocean floor?

3. What are tides? Describe the mechanism of tide formation.

4. Explain the vertical and horizontal distribution of temperatures.
5. What are the determining factors of salinity?
6. Describe the various types of tides.

ANSWERS TO INTEXT QUESTIONS

5.1

1. Porosity is the measurement of the open space within the rocks. This space can be between grains or within cracks or cavities of the rock.
2. A water budget provides a ground for evaluating availability and sustainability of a water supply.
3. Evaporation, condensation, precipitation, interception, infiltration, percolation, transpiration, runoff, and storage (any two).
4. The underground layer of water-bearing permeable rock, rock fractures or unconsolidated materials is known as an aquifer. Groundwater can be extracted using water well. The study which is concerned with the study of the flow of aquifers is known as hydrogeology.

5.2

1. The continental slope is the connection between continental shelf and continental rise.
2. Ridges, Seamount, Trenches, Guyots, Coral reefs, Atolls.
3. The Continental Shelf , The Continental Slope , The Continental Rise ,The Deep Sea Plain or the Abyssal Plain
4. Trenches are relatively long, steep-sided, narrow basins. These areas are the deepest parts of the oceans.
5. Lakshadweep Islands.

5.3

1. Latitudes, Prevailing winds, Unequal distribution of land and water, Evaporation rule,density of water and ocean currents.
2. Direction of the prevailing winds such as the Trade Winds, Westerly's etc., determines the surface temperature of ocean waters at a point

Notes

3. 12 degrees Celsius.
4. Surface zone or mixed zone, Thermocline and Deep zone.
5. It lies between 100 meters and 1000 meters. It contains about 18 percent of the total volume of water in the ocean.

5.4

1. Evaporation, Temperature, Precipitation, Ocean Currents, The influx of fresh water.
2. Ocean currents plays crucial role in the spatial distribution of dissolved salts in ocean waters.
3. At higher latitudes, salinity is found to increase with increasing depth.

5.5

1. Diurnal tide is tide which takes place 0nly one high tide and one low tide each day. The successive high and low tides are approximate of the same height.
2. It is the position where the earth is farthest from the sun (around July 4th). Tidal ranges will be much less than the average height during this period.
3. Perihelion.
4. The North East Monsoon Drift, and The South West Monsoon Drift.
5. North Equatorial Current, South Equatorial Current, Equatorial Counter Current, Gulf Stream , Florida Current, and Brazilian Current
6. Oyashio Current, California Current, and Peruvian or Humboldt Current.

MODULE - 4

Dynamics of Atmosphere