Lesson - 18

Movements of Ocean Water

Ocean water is never static as it is affected by different factors. It's circulation is a very complex process which is controlled and affected by various factors. The waves on the ocean surface originate due to the friction of the air with water. The effect of the winds is upto 200 m of depth in the oceans. There are three basic movements of oceanic water:-

1. Waves. 2. Tides. 3. Ocean currents

1. Waves of the Ocean

The waves are the regular feature over the surface of the ocean water. According to Richard, "the waves are the disturbance of liquid surface of the ocean." This is the most extensive and universal movement of ocean water. The ocean waves originate due to two causes:-

1. Blowing of winds
2. Vibrating surface of the ocean water due to motions in the earth's surface.

Waves are the oscillatory movements of the oceanic surface. The level of the water in the sea moves up and down, but does not travel from its place. If anything (as a piece of wood), which can float on water, is thrown on surface of water, it will move up and down on its place while wave will appear travelling further.

Structure of the waves

The structure of the wave is divided into following parts:-

1. Wave Crest- the top part of the wave is called crest.
2. Wave trough- the lower part of the wave is called Wave Trough.
3. Wavelength- the distance between two wave crests, is called wavelength.

Speed of the wave

The speed of the wave is related to its wavelength and wave period. It can be calculated by using following formula:-

$$\text{Speed of the wave} = \frac{\text{Wavelength}}{\text{Time period}}$$

Causes of Wave formation

The waves are formed due to pressure and friction of winds. The velocity and shape of the Waves depend on the following factors:-

1. Speed of the wind
2. Duration of the wind
3. The distance over which wind blows uninterrupted.

Therefore, if the speed of the wind continues uninterrupted and it continuously prevails for more than 1600 kilometers for 50 hours ,at the rate of 160 km per hour, then it can create 15 m high waves in the water.

The waves generated due to wind are of three types:-

1. Sea Wave- when the waves of different wavelengths moving from different direction together they form an irregular wave structure which is called sea wave.
2. Swell- when the waves of different wavelengths

move away from the area of winds where they were generated, they begin to move in an uniform pattern of equivalent period and height. They are called swell.

3. Surf- when the waves reach near the sea coast, their slope becomes sleep and height is increased. After reaching the shore, it returns back towards the sea. The waves breaking in coastal areas are called surf or fanil.

Other Waves

Apart from the waves formed by winds, there are many other types of waves. The major ones are Tsunami waves, Stormy waves etc. These waves are formed due to volcanic eruptions, earthquakes or landslides.

Tides

Tides are one of the most significant oceanic movements, because being fomed by gravitational force of the moon and seen these tidal waves regularly rise and fall. The sea level does not remain constant always. The sea water regularly rises and fall, twice a day at a definite interval. The rise of the sea water is called tide and its fall is called Ebb. The Rise and fall of seawater is due to the gravitational force of the earth, moon and sun. The nature and the height of tides differ from place to place.

Origin of tides

The main cause of the origin of tides is reciprocal gravitational forces of the moon, the sun and the earth. The entire earth is attracted towards the sun and the moon, due to their gravitational forces, but it's effect on sea water is more than that landmass. The gravitational force of the moon is two times more than the sun, despite it is much smaller than the sun. This is because the sun is far away from the earth than the moon.

Major Characteristics of Tides

(1) Due to uninterrupted flow of water in open seas and oceans, low tides occur. High tidal waves occurs in shallow seas and Gulfs.
(2) The difference between maximum and minimum fall is called tidal range.
(3) The difference of tides is less in open seas and oceans ,and it is comparatively more in shallow seas and gulfs.
(4) The height of the tide is affected by the coastline.
(5) The time of occurrence of tide is different at different places.

Difference in time of the tide

Every place experiences tides after the interval of 12 hours 26 minutes. The earth completes its rotation in 24 hours. Every place should experience tides after 12 hours but this does not happen. This difference occurs because of rotation and revolution of earth and moon, as the Earth completes its rotation, the moon which is also revolving around the earth, moves ahead. The moon completes its revolution in 28 days. It covers 1\28th part of the circle within 24 hours. As a result the tide centre takes 52 minutes to come in front of the moon. Therefore at every place the next tide occurs 12 hours 26 minutes. It could be understood through the given diagram .

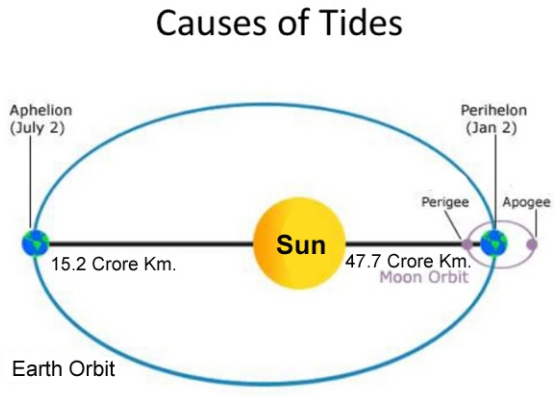

Fig. 18.1 : Interrelationship between Tides and gravitational force

Types of Tides

The height of the tides increases and decreases, according to the respective positions of the Earth, Moon and Sun,. On this basis of this, the tides are of following types:-

(1) High tide
(2) Neap tide

(1) High tide

This situation occurs on full moon and new

moon day. When the sun ,earth and moon are in straight line. This position is called Syzygy. Once a month, the moon is so thin that it appears like a thin thread of silver in the sky. Opposite to this position, the moon completes all its phases and shines as full moon ,once in a month. Thus high tides occur on these two days in every month. When the sun and moon are in one side of the earth, it is called conjuction. When the position of the Earth is between sun and moon it is called as Syzygy. In this way, conjuction occurs on no moon day and Syzygy occurs on full moon day. In this way, the combined gravitational force of sun and moon, affects the Earth,which causes high tides.

(2) Low or Neap Tide

They are 20% less in height than High tides. The earth, sun and moon come in the position of right angle on every 7th or 8th day of fortnight of a month , this results in the formation of low tides. The gravitational force of sun and moon works in opposite direction. This results into the formation of low tides which is called Neap tides.

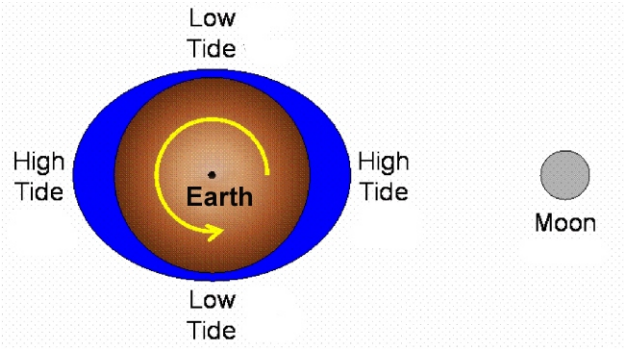

Fig.18.2 : High and Low tides

Advantages of Tides

1. Tides are the sources of energy, because on the rise and an fall of water, energy can be generated. France and Japan produce tidal energy.
2. Some of the big harbours are situated at river mouths at greater distances from the sea. During tides, ships can easily navigate inside, through tidal waters.
3. Sailors safely go for fishing in open sea during high tide and return safely to the coast with ebb.
4. The receding tides carry away most of rubbish of the coastal towns to sea.

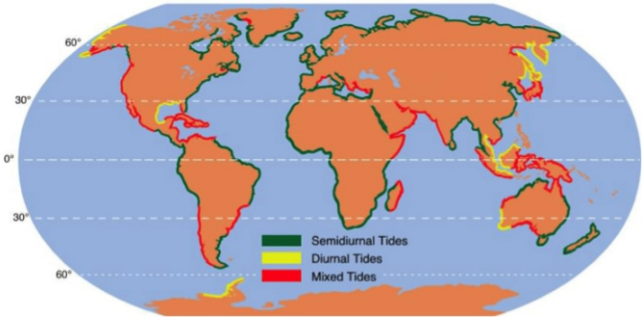

Fig.18.3 : Distribution of Tides in the world

5. The receding Tides, leave many sea products such as shales etc on the coast.
6. Due to Tides the sea water remains moving and clean and water does not freeze.65

Ocean Currents

The continous flow of the ocean water in a definite direction from one part to another part of ocean, is called ocean current. The water remains stable beneath the current and along its margins. In other words, ocean currents are similar to rivers, but they are are much more extensive than the rivers flowing on the land mass. According to Monkhouse, the of a mass of circulation of ocean current occurs in a definite direction." The movement of the water in the ocean currents is not only on the surface but also at greater depth. On the basis of temperature, the ocean currents are of two types-(1) Warm ocean currents and (2) Cold ocean currents. They vary in speed, size and direction.

(1) Warm ocean current

They flow from warm regions towards colds regions. They move from equatorial regions towards polar regions. As the temperature of these currents is higher, they also increase the temperature of coastal area from where they flow.

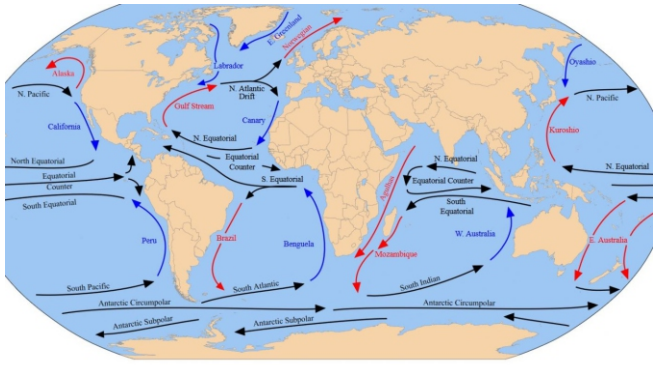

Fig. 18.4 : Ocean Currents

(2) Cold ocean current

These currents flow from colder regions towards warmer regions. They flow from poles towards the equator. The temperature of water of these currents remains low. Thus it also lowers the temperature of the areas in which they flow.

Factors responsible for the origin of ocean currents

1) Nature of Earth- Gravitation and Rotation
2) External Oceanic Factors- Air Pressure, Winds, Evaporation and Rainfall.
3) Internal Oceanic factors-Pressure, Temperature, Salinity, Density, melting of the Glacier.
4) Factors that transforms Ocean Currents- Shape of the coastline, Change of Seasons, structure of ocean bottom.

Currents of Atlantic Ocean

The Atlantic Ocean is divided into two parts-North Atlantic ocean and South Atlantic ocean.

Ocean currents of North Atlantic Ocean

1. North equatorial warm current

This current flows between 5° to 20° north latitudes near the equator. This current flows in the east from African coast to west Indies in the west. Fidley in 1853, was first to mention about this ocean current.

2. Antillies Ocean current

The south equatorial current is divided into two branches near Sao Roque of Brazil. The northern branch merges with North equatorial current and enters in Caribbean Sea and Gulf of Mexico. The other part flowing on the eastern margins of west Indies, is known as Antilles current.

3. Florida current

It is actually the extension of north equatorial current which flows through Yucatun channel and enters into gulf of Mexico. It possesses similar characteristics of equatorial watermass.

4. North Atlantic Ocean current

The influence of the westerlies on Gulf stream, away from Grand Bank is quite visible. It flows towards east.

5. Warm Gulf Stream

The ocean current from cape Hatteras up to Grand bank is called Gulf stream. The Gulfstream receives sufficient amount of hot water in the Gulf of Mexico, which is carried by it to cold areas.

6. Canary Current

This current flows along the Western coast of North Africa between Maderia and Cape Verde islands. The warm water of Gulf Stream convert into cold wateras it reaches here. This ocean current finally merges with North equatorial current. There are seasonal changes in this current.

7. Labrador cold current

This is a cold current of North Atlantic Ocean which flows from the gulf of Baffin to Davis strait in the south. This current balances the ocean bottom. Thick fog is formed due near New Foundland. It creates ideal conditions for fishing.
near New Foundland. It creates ideal conditions for fishing to confluence of warm and cold currents.

8. Sargasso Sea current

The calm and motionless waters found in the North Atlantic ocean between the circular motion of Gulfstream, Cannery and North equatorial current, is called Sargasso sea. A type of oceanic grass grows on its coast which is called Sargassum in Portuguese. Its name is after the Sargasso sea is named after the grass. Its area is about 11000 sq. km.

Ocean currents of South Atlantic Ocean

1. South equatorial current (Warm)

This current flows in east-west direction the south, in the suth of equator almost parallel to it.

2. Brazilian warm current

The South equatorial current after reaching West, flows along the coast of Brazil. It is a weak ocean current.

3.Falkland Cold Current

It flows along the south-east coast of South America from South to North. It brings along with it, the icebergs from Antarctic region. Fog appears as the warm and cold currents merge here.

4. Benguela Cold Current

This current flows northward along the South West Coast of Africa. It is an irregular and weak ocean current.

5. South Atlantic Drift

This ocean current flows under the influence of westerlies between 40° to 60° south, from west to east direction. It is actually the eastern extension of Brazilian current but its nature is totally different.

Ocean currents of Pacific Ocean

In order to study, the currents of the Pacific Ocean are also divided into north and south ocean currents, which are as follows:-

1. North equatorial current

This current originates on the western coast of Central America and flowing from east to west direction reaches Philippines.

2. Kuroshio Warm currents

The north equatorial current after reaching the Philippine Islands, starts flowing towards north along the coasts of Taiwan and Japan and is known as Kuroshio current.

3. North Pacific warm current

After reaching the south east coast of Japan, under the impact of westerlies, Kuroshio current start flowing from west to east direction.

4. California cold current

It is regarded an extension of north Pacific current because it flows from cold regions to warmer regions. Therefore it is called cold current of California.

5. Alaska current

Another branch of north Pacific ocean current, flowing anticlockwise on the west coast of North America, turns towards north.

6.Oyasiwo cold current

It is a cold current that starts from Bering Strait and flows southward near the coast of Kamchatka Peninsula.

7.Okhotsk or Kurile cold current

It starts from Okhotsk sea and flows along the east coast of Skhalin Island, where it merges with Oyasiwo cold current near Hokkaido island of Japan.

South Pacific ocean currents

1. South equatorial warm current

This is a warm current , which flows in the east from the coast of Central America to east coast of Australia in the west.

2. South Pacific ocean current

When the east Australian current near Tasmania, comes under the influence of westerlies and start flowing from west to east, it is known here as South Pacific current.

3. East Australian warm current

It flows along the Eastern coast of Australia. It is a warm current.

4. Cold current of Peru

It turns towards north after reaching on the Southwest of South America and flows along the coast of Peru. It flows from cold region towards warm region.

Ocean currents of Indian Ocean

Indian ocean is just half an ocean. It is surrounded by India in the north,by Australian in the east, and by Africa in the west. It has less extension in the north of equator, therefore it's currents are affected very much by monsoon winds. With the change in the direction of winds during, Summer and Winter seasons, the currents also change their direction. When the currents are affected by monsoon winds, it is called monsoon drift. Similar to Pacific and Atlantic Ocean,the ocean currents of Atlantic oceans are also divided into two parts-

(1) North Indian ocean currents

(2) South Indian ocean currents

(1) North Indian ocean currents

1. North East Monsoon Drift

It is also called North East monsoon drift. It starts from Malakka strait and flows along the Bay of Bengal and enters Arabian Sea.

2. Counter Equatorial Current

It starts in the west, near the islands of Zanzibar and flows towards east.

(2) South Indian ocean currents

1. South Equatorial Current

It flows south of equator from east to west

2. Madagascar warm current

The southern branch of South equatorial current which flows near the eastern coast of Madagascar Island is called Madagascar current.

3. Mozambique Warm Current

The South equatorial current after reaching near the Madagascar Island, divides into two branches. One of it's branch turns towards the south from the islands and the other branch enters Mozambique channel.

4. Agulhas current

Mozambique current and Madagascar current join each together beyond Madagascar Islands in the south, and thus the combined current is called as Agulhas current.

5. Westerlies drift

It flows from west to east in the south of the Indian Ocean and reaches the southern end of the west coast of Australia.

6. West Australian Cold Current

One of branches of Westerly drift flows through the south of Australia and the other branch turns towards north from the western coast of Australia. Its second branch is called west Australian cold current.

Effects of ocean currents

The ocean currents affect the climate of nearby coastal areas the coastal margins of the continents. They affect the temperature, humidity and rainfall. Cold currents of Polar and sub polar regions bring along with them planktons which is a source of food for fishes. This results in the increase of fishes in the region. The major sea routes follow these currents.

Important points

1. The factors that affect the origin of ocean currents are-
   (A) Factors related to rotation of the earth.
   (B) Factors related to oceans - difference in temperature and salinity
   (C) External factors related to oceans- direction of prevailing winds other secondary factors that causes hindrance
   (D) Transforming factors- shape of the coast, and bottom and seasonal changes.

2. The rise of the sea water is called tide and its fall is called ebb. Originating factors are due to the gravitational force and the centrifugal force.
3. The same tide is delayed by 52 minutes on the same place ,due to the revolution of moon. The direct tide occurs due to gravitational force and indirect tide occurs due to the centrifugal force.
4. When sun, moon and earth are in a straight line high Tides occur and when they are in perpendicular position , low tides occur. It is called Syzygy and conjuction respectively.

Exercise

Multiple choice questions

1. How many movements occur in ocean waters-
   (A) 1 (B) 2 (C) 3 (D) 4
2. What is the cause of High Tide-
   (A) indented coastline
   (B) when sun, earth and moon are inperpendicular position
   (C) when sun, earth and moon are in straight line
   (D) none of the above
3. What is the interval of occurrence of tides?
   (A) 12 hours 26 minutes
   (B) 12 hours 56 minutes
   (C) 12 hours 36 minutes
   (D) 12 hours 46 minutes

4. Gulfstream is a-
   (A) Cold current (B) Warm current
   (C) Humid (D) Temperate

5. Which of the following is not the current of Atlantic Ocean?
   (A) Gulf Stream (B) Labrador
   (C) Falkland (D) Kuroshio

Very Short type questions

6. Write the major movements of oceans.
7. What are the causes of origin of ocean waves?
8. What is tidal range?
9. What are the types of tides?
10. Which currents are called warm currents?

Short Type questions

11. What is the difference between wave crest and trough?
12. What are the different types of the waves?
13. What are tides?
14. What is the difference between high and low tide?
15. What are ocean currents?

Essay type questions

16. Describe the movements of ocean water and waves and explain the types of waves.
17. What are tides? Explain its origin and types.
18. Define ocean currents and write the description of the currents of the oceans of the world.

Answer key

1. C. 2.C. 3.A. 4.B. 5.D.