

Many problems regarding the origin of continents and oceans have remained unsolved. As knowledge about the Earth's structure increased, more and more ideas about the distribution and origin of continents and oceans were also presented. Among these, **continental drift** theory and **plate tectonics** theory became widely accepted. There are various landforms on the Earth such as continents, oceans, mountains, valleys, plateaus, plains, etc. These distinct landforms differ from each other in their characteristics such as shape, rock structure, height, amount of plane surface, slope, etc. Hence they are known as landform. Landforms of the Earth's surface are divided into 3 groups (1) Landforms of first order (2) Landforms of second order (3) Landforms of third order.

The landforms that were formed first after the origin of the Earth, such as continents and ocean basins are known as landforms of first order. With time first order landforms such as continents and oceans experienced endogenic earth movements to form mountains, plateaus, plains, rift valleys, etc. which are known as landforms of second order. After a long time, these second order landforms under the influence of exogenic forces (river, glacier, wind, ground water and sea waves, etc.) undergo denudation and deposition to form landforms of third order. Ravines, deltas, valleys, small hills, etc. and such other landforms were formed. Under the influence of Earth movements, a major part of the Earth's crust got fragmented. These fragmented continents were drifted in various directions and were placed at various locations. Water was filled in low lying areas. The land masses above the water level are known as **continents** and areas of huge water masses are known as **oceans**.

#### Characteristics of Distribution of Continents and Oceans

The total area of the Earth's surface is about 50.68 crore square km. Out of this about 36.60 crore square km area is occupied by seas and oceans. It is known as the hydrosphere. Continents spread over an area of about 14.08 crore square km. Percentage area of seas-oceans and continents is respectively 71 % and 29 % respectively.

The equator divides the Earth into two equal parts, the northern hemisphere and the southern hemisphere. The northern hemisphere is known as the **land hemisphere**. About 81 % of the Earth's land area lies in this hemisphere. Here lie the continents of North America, Europe, Asia and parts of Africa and South America. In the southern hemisphere there is a predominance of water bodies, hence it is known as the **water hemisphere**. If water and land areas are compared, we see that it has about 90.5 % water area and only 9.5 % land area. In northern hemisphere, between 20 and 90 degree latitudes, and in southern hemisphere, between 70 and 90 degree latitudes, there is predominance of land. The Pacific, Atlantic, Indian and Arctic these four oceans together occupy about 92.7 % area of the Earth's total water area. Continents and oceans are almost triangular in shape. Oceans are broad towards their southern side and become narrower towards the north. Continents are broad in the north and narrow in the south.

On the earth, the oceans and continents are almost arranged diametrically opposite to each other. Oceans occupy more area in the south, while less area in the northern hemisphere.

#### Theories about Distribution of Continents and Oceans

Theories about distribution of continents and oceans are helpful in solving the problems of their origin. Solace, Green, Gregory, Kelvin, Harry Hess, Wegener and other scholars have presented their views on the origin of landforms of first order.

The continents located far and wide away from each other, besides showing variations in their vegetation, geological structure, animals, landforms and other aspects exhibit similarities as well. Marsupials, found in Australia's forests have also been found as fossils in South America. Evidences show that the

coal found from the Appalachians in North America and that from west Europe was formed during the same period. Evidences also indicate that climate of some regions was quite different in the past than that from the present. This is possible only if (1) there was a fundamental change in climate or (2) in the remote past, the present continents were located somewhere else and displaced later on.

Keeping in view the second possibility, German meteorologist Alfred Wegener presented his Continental Drift Theory explaining the origin and distribution of continents and oceans in 1912. After its translation to English in 1924, it became popular.

### Continental Drift Theory by Wegener

Before Wegener presented his Continental Drift Theory, Snaidor, Fisher, Taylor, Bacon and other geographers had also presented their views about this. The Earths geological and natural history is preserved in its rocks in the form of fossils of ancient animal and plant life. Fossils have been found from various parts of different continents that show resemblance. Based on this, an idea developed in 1912 that about 20 crore years in the past, the present continents were joined with each other. There was one and only one continent on the Earths surface which Wegener termed as the **'Pangaea'**. Pangaea is a German word, which means a primitive continent. According to the Continental Drift Theory, northern part of the Pangaea is known as **'Laurasia'** and the southern part is known as **'Gondwanaland'**. Between these two land masses and extending east-west was the **Tethys Sea**. Laurasia to the north of Tethys comprised of todays North America, Europe and Asia continents. Gondwanaland to the south of Tethys comprised of South America, Africa, Peninsular India, Australia and Antarctica continents. The super continent, Pangaea was surrounded on all sides by a shallow sea known as the Panthalassa. At this time, Antarctica continent was situated near the southern coast of south Africa. This concept provides latest information about the shape of coasts of continents, composition, vegetation, animal life, location, etc. With the passage of time, as the Pangaea fragmented, continents and oceans were formed. Wegener was a climatologist and a geophysicist. He gave evidences from geomorphology, geophysics, geology, climatology and other sciences in support of his Continental Drift Theory. Fig. 5.1 makes clear the theory of Continental Drifting.



5.1 Position of continents about 20 crore years before present



During the Mesozoic Era, because of the Earth's gravitation and other forces, the Pangaea was fragmented. The fragmented continents were floating on the Sima below them like huge rafts. Some continents after being detached from the supercontinent, began drifting in the direction of the force. North America and South America after separating from Europe and Africa, began drifting westwards. Africa and Europe moved towards the equator. During the Tertiary Period, Australia and Antarctica drifted southwards. The Indian sub-continent separated from Africa and drifted north-eastwards. With time, the



continents attained their present positions. Vacant areas were formed between continents. Water was filled in these vacant areas to form oceans and seas.

Wegener's views on Continental Drift were presented in 1912. Originally written in German language, the book was later on translated to English. The views presented by him got acceptance. American geologists were not ready to accept Wegener's views. However due to Blackett's concept of Polar Wandering (1950-1960), Harry Hess' concept of Sea-floor Spreading, (1960), Tetrahedral Theory of Green and Gregory, etc., continental drift theory began to be accepted.



**5.2 (a) Pangaea (b) Laurasia & Gondwanaland (c) Continents after drifting**

Wegener explained that if the divided continents were properly rearranged they will fit into one complete figure. For this he made use of the Jig-saw fit puzzle. If different pieces were to be placed in their proper places as per Pangaea, a shape as shown in fig. 5.2 is formed. In his opinion, South America and western Africa on either sides of Atlantic Ocean, have shapes that fit well into one another. Similarly, North America and Greenland along with Europe form one whole shape. The shape of northern coast of Australia fits well with the Bay of Bengal.

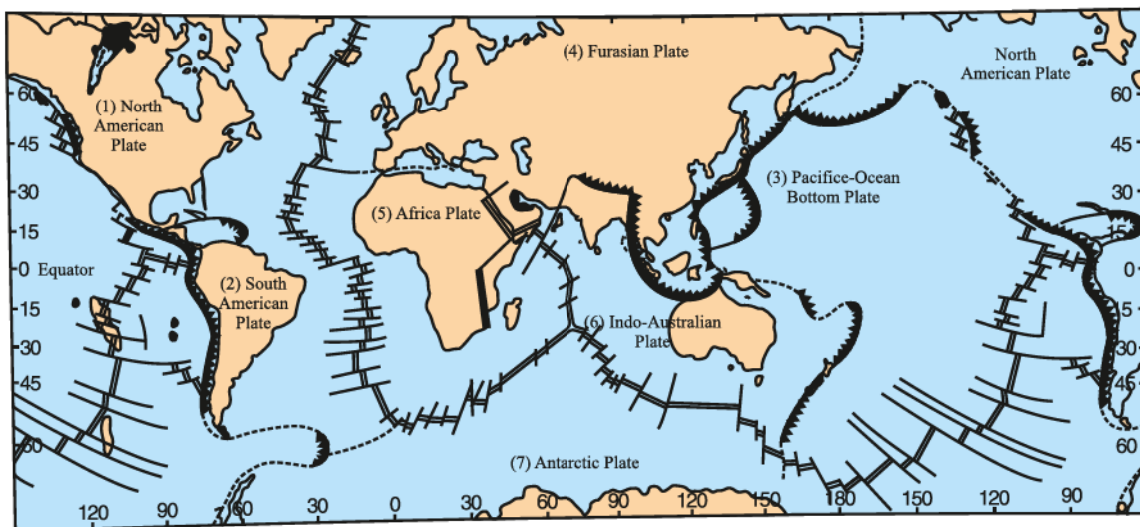
In the opinion of **Swess**, Sial is spread over the entire Earth including the ocean bottoms. Sima is denser compared to Sial. Central Africa and Brazilian Highlands are composed of similar ancient hard igneous rocks. The geological composition of both coastal regions of the Atlantic Ocean resembles one another. The Arabian Plateau, Peninsular plateau of India and the vast west Australian Plateau are also made of ancient igneous rocks. Also, similarities exist in moraines of these regions. Coal belonging to the

same period has been found from the Appalachians of North America and mountainous areas of Europe and British Islands. There is similarity in fossils of ancient vegetation and animals, insects found from coastal regions on either sides of the Atlantic. Some animals and birds even after centuries continue to migrate to their native. Mice and other reptiles of Scandinavia migrate westwards to Iceland, the homeland of their ancestors. Some animals of Iceland resemble to those of north Scandinavia. Above examples provide evidences in support of Wegener's Continental Drift Theory. **'Sea floor Spreading'** and **'Plate Tectonics Theory'** have also increased the significance of continental drift theory. Still some questions about the theory have remained unsolved.

**Plate Tectonics Theory :** Continents and ocean floors are known to drift as a unit. It also includes the Asthenosphere lying above the mantle. Such rigid landmasses are known as **‘Plates’**. This theory provides information about global expansion or contraction of land effects of tidal forces due to the Moon, upliftment of extensive parts of the Earth's surface, drifting of continents, sea floor spreading, etc. There are seven major plates : (1) North American Plate (2) South American Plate (3) Pacific Plate (4) Eurasian Plate (5) African Plate (6) Indo-Australian Plate (7) Antarctic Plate. Besides there are another twenty minor plates. These plates are separated from each other by mountain ranges, young fold mountain ranges on land, submerged trenches, etc. After all plates are structural forms. Ridges, trenches, volcanic islands, seismic areas, rift valleys, etc are associated with plate margins.

Plates vary in their areas. Some plates have an area of 10,000 square km or less area, while some other plates extend for more than 10 crore square km area. Pacific, African, Eurasian, etc. are major plates, while Bismark, Solomon, Somalian, Nazca, Cocos, Arabian, Fiji, Phillipines, Caroline, etc are minor plates.

If two plates are moving in opposite directions with respect to each other, they are known as **Divergent Plates**. If two plates are moving towards each other, they are known as **Convergent Plates**. The thickness of plates is likely to be 47 km or more, because the average thickness of continents is 40 km and that of ocean bottom is 7 km. Yet another estimate puts the thickness of plates at 70 km below oceanic areas and 150 km below the continents.



### 5.3 Major Plates of the Earth

Evidence regarding plate movement is provided by a chain of extinct volcanic mountain chains. It is believed that convection currents originating in the Asthenosphere keep the plates moving. There is very hot matter in the mantle, which provides source for origin of volcano. Volcanoes located on drifting plates when get displaced from very hot central parts become extinct. According to some geographers, convection currents are not responsible for plate motion. In their opinion the magma in the mantle erupts from fissures in the Pyrosphere, forming new ocean bottom. It drifts in the direction of slope under the push of lava. New ocean bottom acts like a conveyor belt. The plates move on it like steps of a ladder.

In the plate tectonics theory, an attempt is made to jointly justify Sea-floor spreading and Continental Drift theory. This is the most important scientific concept explaining the origin and distribution of continents and oceans as well as orogenic process.

### **Drifting of the Indian Plate**

There are seven major plates in the world. Indian Plate is one of them. This plate comprises of the Indian sub continent, Australia continent, Tasmania, New Zealand, ocean bottoms of the Indian Ocean and parts of south-western Pacific Ocean. As the Indian Plate drifts north-eastwards, pressure develops between the Indian and Eurasian plates. This has resulted in the formation of the Himalayas. The Nepal earthquake of April, 2015 is the result of this process. The Indian Plate is believed to have separated from Antarctica about 75 million years before present. This plate has covered a distance of some 5000 km so far.

The Himalayas lie to the north of the Indian Plate, while to the west and south are the Indian Ocean ridges. (1) Ninety East Ridge and (2) Mascarene Ridge lie on the bottom of Indian Ocean. These ridges are part of the global volcanic belt.

### **EXERCISE**

#### **1. Answer the following questions in detail :**

- (1) Explain the characteristics of distribution of continents and oceans.
- (2) Explain the Continental Drift Theory.

#### **2. Write to-the-point answer of the following questions :**

- (1) What is a landform ? Mention the types of landform.
- (2) What is a plate ? Which are the major plates ?
- (3) Explain motion of the Indian Plate.

#### **3. Answer the following questions in brief :**

- (1) Explain the meaning of Pangaea.
- (2) Write information about Gondwanaland.
- (3) Which hemisphere is known as the Water hemisphere ? Why ?

#### **4. Answer the following questions in one-two sentences :**

- (1) Continental Drift Theory can be explained on the basis of which theory ?
- (2) Which are landforms of the second order ?
- (3) Which concept has lent support to the Continental Drift Theory ?
- (4) Which are the major plates ?



**5. Select the correct option from the options given and write the answer :**

- (1) What is the number of major plates ?  
(a) 7 (b) 8 (c) 9 (d) 15
- (2) What is the total % area of Hydrosphere on the Earth's surface ?  
(a) 70 (b) 72 (c) 71 (d) 80
- (3) Pangaea means ...  
(a) Tethys Sea (b) Ancient super continent (c) Panthalassa (d) Water hemisphere
- (4) In which ocean is the Mascaren Ridge located ?  
(a) Pacific (b) Atlantic (c) Arctic (d) Indian Ocean
- (5) Who was the German scientist that gave Continental Drift theory ?  
(a) Alfred Wegener (b) Gregory (c) Solace (d) Harry Hess

**Activity**

- Make **Jig-saw-fit** Puzzle under the guidance of a teacher.
- Prepare a diagram of major plates of the Earth

