Quadrant II – Transcript and Related Materials

Programme: Bachelor of Arts (F. Y. B. A. & B. Sc.)

Subject: Geography

Paper Code: SGC101 & GEC101

Paper Title: Introduction and Fundamentals of Geography

Unit: Unit 1 – Domains of earth

Module Name: Distribution of Oceans and Continents

Module No: 28 & 29

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Glossary of terms/words:

Continental Crust: Granitic portion of the Earth's crust that makes up the continents. Thickness of the continental crust varies between 20 - 75 km. See SIAL layer.

Pangea (Pangaea): Hypothetical parent continent, enduring until near the close of the Mesozoic era and consisting of the continental shields of Laurasia and Gondwana joined into a single unit.

Radiometric Dating: Method of determining the geologic age of a rock or mineral by measuring the proportions of certain of its elements in their different isotopic forms.

Possible misconceptions/clarification

NA

Case Studies and Additional Examples/Illustrations

1. There is overwhelming dominance of land areas in the northern hemisphere. More than 75 per cent of the total land area of the globe is situated to the north of the equator (i.e., in the northern hemisphere). Contrary to this water bodies dominate in the southern hemisphere. If we divide the globe in two such hemispheres where the north pole stands located in the English Channel and the south pole near New Zealand, then the northern hemisphere would be 'land hemi-sphere' while the southern hemisphere as 'water hemi-sphere'. Thus, the land hemisphere would represent 83 per cent of the total land area of the globe while the water hemisphere would carry 90.6 per cent of the total oceanic areas of the globe.
2. Continents are arranged in roughly triangu-lar shape. Most of the continents have their bases (of triangle) in the north while their apices are pointed towards south. If we take North and South Americas together, they represent equilateral triangles, the base of which would be along the arctic sea while the apex would be represented by Cape Horn. If we take these two continents separately, again they form two separate triangles. Similarly, Eurasia also assumes the form of a triangle the base of which is along the arctic sea while its apex is near East Indies. The base of African triangle is towards north while its apex is the Cape of Good Hope. Australia and Antarctica are the exceptions to this rule.
3. Roughly, the oceans are also triangular in shape. Contrary to the continents the bases of oceans are in the south while their apices are in the north. The base of the Atlantic Ocean extends between Cape Horn and Cape of Good Hope while its apex is located to the east of Greenland. The base of the Indian Ocean is in the south but its two apices are located in the Bay of Bengal and Arabian Sea. The apex of the Pacific Ocean is near Aleutian Islands while its base lies in the south.
4. The North Pole is surrounded by oceanic water while South Pole is surrounded by land area (of the Antarctic continent).
5. There is antipodal arrangement (situation) of the continents and oceans. Only 44.6 per cent oceans are situated opposite to oceans and 1.4 per cent of the total land area of the globe is opposite to land area. More than 95 per cent of the total land area is situated diametrically opposite to water bodies.

There are only two cases of exceptions to this general rule i.e.:

i. Patagonia is situated diametrically opposite to a part of north China, and
ii. New Zealand is situated opposite to Portugal and Spain (the Iberian Peninsula).

6. The great Pacific Ocean basin occupies almost one-third of the entire surface area of the globe.

The validity and authenticity of any hypothesis or theory dealing with the origin and evolution of the continents and the ocean basins would be determined in the light of aforesaid characteristics of the distribu-tional pattern of the continents and o

Continental Drift

Observe the shape of the coastline of the Atlantic Ocean. You will be surprised by the symmetry of the coastlines on either side of the ocean. No wonder, many scientists thought of this similarity and considered the possibility of the two Americas, Europe and Africa, to be once joined together. From the known records of the history of science, it was Abraham Ortelius, a Dutch map maker, who first proposed such a possibility as early as 1596. Antonio Pellegrini drew a map showing the three continents together.

However, it was Alfred Wegener—a German meteorologist who put forth a comprehensive argument in the form of "the continental drift theory" in 1912. This was regarding the distribution of the oceans and the continents. According to Wegener, all the continents formed a single continental mass and Mega Ocean surrounded the same. The super continent was named PANGAEA, which meant all earth. The mega-ocean was called PANTHALASSA, meaning all water. He argued that, around 200 million years ago, the super continent, Pangaea, began to split. Pangaea first broke into two large continental masses as Laurasia and Gondwanaland forming the northern and southern components respectively. Subsequently, Laurasia and Gondwanaland continued to break into various smaller continents that exist today. A variety of evidence was offered in support of the continental drift. Some of these are given below.

The shorelines of Africa and South America facing each other have a remarkable and unmistakable match. It may be noted that a map produced

using a computer programme to find the best fit of the Atlantic margin was presented by Bullard in 1964. It proved to be quite perfect. The match was tried at 1,000- fathom line instead of the present shoreline.

The radiometric dating methods developed in the recent period have facilitated correlating the rock formation from different continents across the vast ocean. The belt of ancient rocks of 2,000 million years from Brazil coast matches with those from western Africa. The earliest marine deposits along the coastline of South America and Africa are of the Jurassic age.

This suggests that the ocean did not exist prior to that time. It is the sedimentary rock formed out of deposits of glaciers. The Gondawana system of sediments from India is known to have its counter parts in six different landmasses of the Southern Hemisphere. At the base the system has thick tillite indicating extensive and prolonged glaciation. Counter parts of this succession are found in Africa, Falkland Island, Madagascar, Antarctica and Australia besides India. Overall resemblance of the Gondawana type sediments clearly demonstrates that these landmasses had remarkably similar histories. The glacial tillite provides unambiguous evidence of paleoclimates and also of drifting of continents.

Placer Deposits

The occurrence of rich placer deposits of gold in the Ghana coast and the absolute absence of source rock in the region is an amazing fact. The gold bearing veins are in Brazil and it is obvious that the gold deposits of the Ghana are derived from the Brazil plateau when the two continents lay side by side.

Distribution of Fossils

When identical species of plants and animals adapted to living on land or in fresh water are found on either side of the marine barriers, a problem arises regarding accounting for such distribution. The observations that Lemurs occur in India, Madagascar and Africa led some to consider a contiguous landmass “Lemuria” linking these three landmasses. Mesosaurus was a small reptile adapted to shallow brackish water. The skeletons of these are found only in two localities: The Southern Cape Province of South Africa and Iraver formations of Brazil. The two localities presently are 4,800 km apart with an ocean in between them.

Force for Drifting

Wegener suggested that the movement responsible for the drifting of the continents was caused by pole-fleeing force and tidal force. The polar-fleeing force relates to the rotation of the earth. You are aware of the fact that the earth is not a perfect sphere; it has a bulge at the equator. This bulge is due to the rotation of the earth. The second force that was suggested by Wegener—the tidal force—is due to the attraction of the moon and the sun that develops tides in oceanic waters. Wegener believed that these forces would become effective when applied over many million years. However, most of scholars considered these forces to be totally inadequate.

Post-Drift Studies

It is interesting to note that for continental drift, most of the evidence was collected from the continental areas in the form of distribution of flora and fauna or deposits like tillite. A number of discoveries during the post-war period added new information to geological literature.

Particularly, the information collected from the ocean floor mapping provided new dimensions for the study of distribution of oceans and continents.

Convectional Current Theory

Arthur Holmes in 1930s discussed the possibility of convection currents operating in the mantle portion. These currents are generated due to radioactive elements causing thermal differences in the mantle portion.

Holmes argued that there exists a system of such currents in the entire mantle portion. This was an attempt to provide an explanation to the issue of force, on the basis of which contemporary scientists discarded the continental drift theory.

Mapping of the Ocean Floor

Detailed research of the ocean configuration revealed that the ocean floor is not just a vast plain but it is full of relief. Expeditions to map the oceanic floor in the post-war period provided a detailed picture of the ocean relief and indicated the existence of submerged mountain ranges as well as deep trenches, mostly located closer to the continent margins.

The mid-oceanic ridges were found to be most active in terms of volcanic eruptions. The dating of the rocks from the oceanic crust revealed the fact that they are much younger than the continental areas. Rocks on either side of the crest of oceanic ridges and having equi-distant locations from the crest were

found to have remarkable similarities both in terms of their constituents and their age.

Ocean Floor Configuration

In this section we shall note a few things related to the ocean floor configuration that help us in the understanding of the distribution of continents and oceans. You will be studying the details of ocean floor relief in Chapter 13. The ocean floor may be segmented into three major divisions based on the depth as well as the forms of relief. These divisions are continental margins, deep-sea basins and mid-ocean ridges.

Continental Margins

These form the transition between continental shores and deep-sea basins. They include continental shelf, continental slope, continental rise and deep-oceanic trenches. Of these, the deep-oceanic trenches are the areas which are of considerable interest in so far as the distribution of oceans and continents is concerned.

- ✓ Continental crust does not sink because of its relatively low density and so it is permanent. Whereas oceanic crust does sink and is continually being formed and destroyed.
- ✓ Continental plates, such as the Eurasian Plate, may consist of both continental and oceanic crust.
- ✓ Continental crust may extend far beyond the margins of the landmass.
- ✓ Plates cannot overlap. Either they are pushed upwards to form mountains or downwards into the mantle and destroyed.
- ✓ No gaps may occur so if plates are moving apart new oceanic crust must be formed.
- ✓ If new oceanic crust is being formed, elsewhere it must be destroyed.
- ✓ Plate movement is slow, but usually continuous.
- ✓ Most significant landforms are at boundaries. Major landforms at plate