

Quadrant II – Notes

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Unit III - Earth Systems II

Module Name: Relief and Configuration of Atlantic Ocean

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The Atlantic Ocean located between North and South Americas in the west and Europe and Africa in the east covers an area of 82,000,000 km² which is 1/6th of the geographical area of the globe and half of the area of the Pacific Ocean. The 'S' shape of the ocean indicates the fact that landmasses (continents) on its either side were once a contiguous part. The Atlantic Ocean was formed due to drifting of North and South Americas to the west due to plate tectonics.

The ocean widens to the south of equator and attains the maximum width of 5,920 km at 35°S latitude. It narrows down towards the equator. It is only 2560 km wide between Liberian coast and Cape Sao Roque. The width further increases northward and it becomes 4800 km at 40°N latitude. It narrows down in the extreme north where it maintains its contact with the Arctic Ocean through Norwegian Sea, Denmark Strait and Davis Bay.

The average depth of the ocean is less than the Pacific Ocean because of extensive continental shelves and marginal and enclosed seas. About 24 per cent of the Atlantic Ocean is less than 915m deep. The Atlantic Ocean was first formed about 700 million years ago due to seafloor spreading and westward movement of the Eurasian and African plates from the mid-Atlantic ridge. About 300 million years BP (before present) the Atlantic Ocean was closed due to convergence of the American and Eurasian-African plates. The ocean again started to open about 150 million years BP due to the movement of aforesaid plates in opposite directions. The widening of the ocean still continues which is evidenced through seafloor spreading at an average rate of 4 cm per year.

Continental Shelf:

Continental shelves have developed along both the coasts of the Atlantic Ocean and the width ranges from 2-4 km to more than 80 km. In fact, the width of continental shelves has been largely controlled by the reliefs of the coastal lands. These become significantly narrow where mountains and hills border the coasts e.g., the African shelves between Bay of Biscay and Cape of Good Hope and Brazilian shelves between 5°S and 10°S latitudes. The shelves become 200 to 400 km wide along the north-eastern coast of North America and the north-western coast of Europe. Extensive shelves are found around Newfoundland (Grand Bank) and British Islands (Doggar Bank). Similarly, the continental shelves around Greenland and Iceland are quite wide. Very extensive continental shelves are found in the South Atlantic Ocean mainly between Bahia Blanca and Antarctica.

Many marginal seas are located on the continental shelves in the North Atlantic but such seas are practically absent in the South Atlantic. Among the continental shelf-seated seas significant are the Hudson Bay, the Baltic Sea, the North Sea, the Davis Strait, the Denmark Strait etc. The Caribbean and Mediterranean seas represent enclosed seas.

There are several islands which are located on the continental shelves e.g. British Isles, Iceland, Faeroes, Azores, Ascension, Tristan da Cunha, Newfoundland, West Indies, Maderia, St. Helena, Trinidad, Falkland, South Orkneys, Shetlands, Georgia, Sandwich, Canaries, Cape Verde etc. are significant islands representing different locations and origin.

Mid-Atlantic Ridge:

The mid-Atlantic ridge representing the zone of divergent or constructive plate margins (American plates moving westward and Eurasian and African plates moving to the east) is the most striking relief feature which having S shape extends for 14,450 km from Iceland in the north and to Bouvet Island in the south. Though swinging west and east it maintains its central position and nowhere goes down more than 4000m below sea level. The ridge is known as Dolphin Rise to the north and Challenger Rise to the south of equator. It is known as Wyville Thompson Ridge between Iceland and Scotland. The ridge becomes quite extensive to the south of Greenland and Iceland and is called Telegraphic Plateau because first cables were laid down in this area.

A significant branch emerges from this central ridge near 50° latitude and extends north-westward as Newfoundland Rise and continues up to New-found-land. Another important branch known as Azores Rise bifurcates from the mid- Atlantic Ridge to the south of 40°N latitude and extends up to Azores Islands. At the equator the ridge sends off two branches. Sierra Leone Rise

extends towards north-east and Para Rise stretches in northwest direction. Guinea Ridge, a minor branch of the central ridge, runs north-eastward and extends up to Guinea coast. Two significant branches come out of the central ridge near 40°S latitude. The Walvis Ridge extends towards north-east and merges with African continental shelf while Rio Grande Rise extends towards South American coast.

Though major part of the mid-Atlantic Ridge is submerged under oceanic water but a host of peaks and sea mounts project well above the water surface and form islands. The Pico Island of Azores is the highest peak which rises 8,229.6m (27,000 feet) above the sea floor and 213.36m to 243.84 m above sea level. Besides, the mid-Atlantic Ridge has several well-marked fracture zones e.g. Gibbs Fracture Zone (near 40°N), Atlantis Fracture zone (near 30°N), Oceanographic Fracture Zone (32°N), Kane Fracture Zone (25°N), Vema Fracture Zone (10°N), Romanche Fracture Zone (near equator) etc. As regards the origin of this unique feature all the previous theories based on compressive and tensional forces stand redundant due to advent of plate tectonic theory. The mid-Atlantic Ridge is the result of westward movement of American plate and eastward movement of Eurasian and African plates.

Ocean Basins:

1. Labrador basin extends between the continental shelf of Greenland in the north and Newfoundland Rise in the south covering latitudinal extent of 40° N to 50°N where the depth of the basin ranges from 4,000 to 4,500m.
2. North American basin is the most extensive basin of the Atlantic Ocean and extends between 12°N and 40° latitudes. The east-west section lies between the continental shelves off the east coast of N. America and 50°W meridian. The depth of the basin is more than 5000m but a few deeps measure more than 6000m depth.
3. Brazilian basin is confined between the equator and 30°S latitude and east coast of Brazil in the west and Para Rise in the east. The depth is more than 4,000m.
4. Spanish basin is located between the mid- Atlantic Ridge and Iberian Peninsula. It is bordered by Azores Rise in the south and extends up to 50°N latitude. The average depth is 5,000m.
5. North and South Canary basin is comprised of two almost circular basins and is 5,000m deep.

6. Cape Verde basin is located between the mid -Atlantic Ridge and west African coast and extends from 10° N to 23.° N. Average depth is 5000 m but at few places it becomes 5000 m or more.

7. Guinea basin extends from north-east to southwest in elongated shape between Guinea Ridge and Sierra Leone Rise and measures 4,000 to 5,000 m in depth.

8. Angola basin is located between the equator and 30°S latitude. It stretches from the African coast in the north-east to the knot of the mid-Atlantic Ridge and Walvis Ridge in the south-west. The basin is most extensive near the African coast and narrows down towards south-west. The average depth is 5,000m.

Ocean Deeps:

The number of deeps in the Atlantic Ocean is far less than in the Pacific Ocean because of the absence of the effects of Tertiary orogenic movements along the Atlantic coasts. Murray has identified 29 deeps upto the depth of 3,000 fathoms (5,486.4m) in the Atlantic Ocean. Nares Deep (6,000m), Puerto Rico Deep (8,385m), Hatteras Deep (5,445m), Columbia Deep (5,125m, south of Haiti), Valdivia Deep (3,134 fathoms), Tizard or Romanche Deep (9,370m), Buchanan Deep (3,063 fathoms), Moseley Deep (3,309 fathoms), Vema Deep (4,900m) etc. are a few important ocean deeps of the Atlantic Ocean.

The Mediterranean Sea, Caribbean Sea and Gulf of Mexico are significant marginal seas in the Atlantic Ocean. The Mediterranean Sea is divided into two major basins (East and West Basins) by 4,000m deep mid-sea ridge which runs from the southern Italian coast to the north African coast. The East Mediterranean Basin is further divided into Ionian (4,600m deep) and Levantine Basins (2,000-3,000m deep) by the ridge located between the southern coast of Greece and the northern coast of Africa. The West Mediterranean Basin is divided into two sub-basins (Algiers- Provençal Basin and Tyrrhenian Basin) by a 1,000 m deep ridge running between Italy and Tunisia. Broad continental shelves (80km to 240km wide and 1,000m deep) are found along Spanish (eastern), Italian (western), Greek (western), Egyptian (northern), Tunisian and Lybian (north-eastern) coasts. The Gulf of Mexico and Caribbean Sea are separated by a 1,600 m deep ridge running between Yucatan Peninsula and Cuba Island. The prominent basins are Mexico basin and Caribbean basin. The latter is further divided into four sub-basins e.g. Yucatan basin, Cayman trough, Columbia basin and Venezuela basin.