Ocean

An ocean is a vast expanse of water between two continents, and covering several climatic zones. In Greek mythology the ocean is the titan Oceanus, son of Gaia (the Earth) and Uranus (the sky) and consort to his sister, Tethys (marine goddess). Oceanography distinguishes ocean from sea by the surface area of the continental shelf, generally less then 10-15% for the ocean. The ocean in thus characterised by extensive abyssal areas. However, oceans and seas are often gathered under the term marine spaces in oceanographic studies. Oceans account for around 90% of the total volume of water present on Earth, and cover 71% of its surface area, which is why out planet is known as the "blue planet, pinpointing the predominance of the ocean in overall planetary dynamics.

Ocean waters are characterised by three parameters – temperature, salinity and pressure. While the parameters linked to temperature are easy to apprehend when they are related to depth and solar radiation, the salinity of the ocean (34.7g/kilo of sea water in average) is a rather more complex parameter. The equilibrium of the concentration of salt, which is very stable over time, results from the combination of two main source of supply and several phenomena of loss. The flow of rivers to the ocean causes alterations in the continental rock formations and frees sediments loaded with ions of calcium, sodium, magnesium and potassium. In addition, chloride, bromine and sulphate ions derive from gaseous emissions from volcanic activity underpinning the formation of the oceans. By agglomerating, these ions form, among other things, sodium chloride and magnesium chloride, which account for 90% of the salts dissolved in sea water. These regular contributions are compensated by losses, maintaining a stable concentration in dissolved salts. For instance, calcium is captured by marine micro-organisms, potassium ions are adsorbed, i.e. retained on the surface by clays, while sodium and magnesium ions are exchanged between aqueous environments and the warm lithosphere by infiltration of the sea water into dorsal fissures.

These three parameters determine the density of ocean waters, that is to say the ratio between the mass of one cubic metre of sea water and the mass of one cubic metre of distilled water at 4Â°C under atmospheric pressure. It is thus considered that an increase in density of around one unit can occur either if there is a reduction in the temperature of 5Â°, or an increase in the salinity of 1g per kilo of water. Variations in ocean density have a considerable impact on the distribution of water masses. These are subject to the Coriolis force, and generate marine currents tens or hundreds of kilometres wide, moving at speeds between 1 and 3 m/s. These marine currents have a role in the thermal regulation of the planet via transfers of energy from the high to the low Â«latitudesÂ».

From a structural viewpoint, the ocean is in perpetual movement on a geological time-scale Oceans have a life cycle of around 300 to 400 million years. This cycle most often originates from the formation of a continental rift that widens to reach maximum extent after 180 to 200 million years, and then disappearing after 150 to 200 million years more. Our knowledge of this cycle only dates back to the 1970s, but oceanography had developed spectacularly from 1878 with the British Challenger expedition, during which the ship covered nearly 120 000 km between 1873 and 1876. This expedition evidenced the existence of abysses more than 8000 metres deep, and of thousands of marine species. At the start of the 20th century, the first geological maps of the sea floor appeared, such as those produced by the Frenchman Dangeard (1889-1897) or the American Heezer (1924-1977), along with theories on the origins and the processes of formation of the oceans. Wegener put forward the theory of continental drift, basing himself on several observations: the similarity in outline of the two sides of the Atlantic, traces of former glaciation in the southern parts of Africa and America, or again the correspondences between geological structures in North America and Europe. Considered far-fetched, Wegener's hypothesis was rejected, until the American geologist H.H. Hess (1906-1969), using his research on magnetic anomalies in the depths of the ocean, was able to confirm that these anomalies were reiterated from the dorsal ridges to the ocean trenches. Hess's theory on the expansion of the sea floor was later supported by the work by the British researchers F. Vine and D. Mathews in 1968, when they were able to provide evidence to go had in hand.

Until the end of the 1960s, oceanographic tools were restricted to local measures and surveying, performed by scientific vessels that moved from station to station in conditions that were not always favourable. To enable continuous observations over time, anchored devices and weighted floats were distributed through levels of water reaching 1000 m depth. These technique, which are still used today, are extremely valuable because they enable biological and chemical analyses of water masses. But at the turn of the 1970s, the arrival of satellites triggered a veritable revolution in the study of the oceans. This tool enabled the characteristics and complex dynamics of all the oceans to be apprehended in continuous manner. Satellites were able to accurately and more regularly measure surface temperatures, colours, levels of chlorophyll or primary production, or again provide a dynamic topography of the oceans by way of the altimetric satellites such as Topex-Poseidon, launched in 1992. Satellites have enabled major scientific advances, in particular a comprehension of the oceanic system and the existence of numerous marine currents (the Gulf Stream (warm), the Humboldt current (cold), the occurrence of upwellings, etc.). On the scale of the planet, the thermohaline circulation of intermediate waters, also known as the "*ocean conveyor belt*", was evidenced, and appears today as an essential element in the oceanic system across the planet. Further to this, in coastal areas, the marine currents have an influence on the patterns of rainfall. Warm currents, such as the Guinea current, favour evaporation, with rising air and the formation of a depression system leading to heavy rains. Conversely, cold currents halt the evaporation, and the absence of precipitation generates particularly arid coastal deserts such as Atacama in Chile. The improvement of research techniques has also enabled a better understanding of variations or anomalies in ocean/atmosphere interactions. The warm oceanic current El Nino, which runs along the Peruvian coast in the southern hemisphere winter was for instance linked in the 1990s to Walker's pressure index, established in 1923 by this British meteorologist. The interaction between the atmosphere and the Pacific Ocean in its southern tropical part has thus been named ENSO (El Nino Southern Oscillation). Usually, the Trade Winds blow from east to west, shifting the warm waters in the west Pacific and enabling an upwelling, that is to say a rise to the surface of colder waters rich in fish along the Peruvian coast. In an El Nino period, the Southern Oscillation Index, which measures the difference in pressure between Tahiti (in the middle of the Pacific) and Darwin (Australia), decreases, and at the same time so do the Trade Winds, so that they no longer have the strength to shift the mass of warm water of the size of the continent of Europe. This translates into an accumulation of warm water, and rising warm air generating a depression and heavy rainfall. The El Nino phenomenon today explains more fully the variations in the ocean/atmosphere interaction across the planet: exceptional drought in Australia, the Nordeste, Ethiopia and India, cyclones on Polynesia, and devastating torrential rains in Peru and Chile.

These scientific and technical advances have generated a dual, paradoxical dynamic. On the one hand, they have widened the scope for the exploitation of the oceans, no longer seen as merely a horizontal space for maritime communications, but now also envisaged as a vertical space affording a food reserve (industrialisation of fishing), a source of energy (offshore gas and petroleum), and a potential reservoir of minerals (including polymetal nodules containing manganese, essential for the manufacture of batteries). In order to transport these new commodities, sea transport increased ninefold between 1960 and 2012. This can be explained by the low cost of maritime transport, which is also less demanding than land haulage systems which require numerous infrastructures. There is a standardisation of containers, which are ever larger and enable the simultaneous transport of very varied goods. In addition, to reduce the distance from one ocean to another and thus the time in transit, several transoceanic links, such as the Panama canal and Suez, have been deepened. Over the same period, offshore drilling for petroleum and gas, which amounted to 10% of the global offer in 1960, has also increased markedly to reach 30% and 27% respectively today. The realisation of the wealth of the oceans has thus engendered growing appetites, and there is a race for the appropriation of maritime spaces, so that the oceans have become a world-wide geopolitical issue.
In order to regulate this appropriation without foregoing the principle of free circulation dating from the 18th century, the notion of the Exclusive Economic Zone was officialised in 1982 by the International Convention of Montego Bay, which came into force in 1994. This zone starts beyond the territorial waters and the contiguous zone (12 + 12 marine miles) and extends a maximum of 200 marine miles. It grants the sovereign State the right to exploit the resources present in the water column and the sea bed. Beyond this zone, the sea bed is declared world heritage. In addition, to facilitate maritime transport, and in particular to standardise the legal frameworks, the division onto five oceans was recognised internationally from 1928, in the wake of creation of the International Hydrographic Bureau (1921) which became the International Hydrographic Organisation (IHO). It is thus the IHO that precisely maps out the oceanic boundaries. This accuracy is required, among other things, for insurance purposes, since insurance premiums depend on the spaces crossed. These efforts to reach international agreement began in London in 1845, but it was only achieved in the context of the Versailles Treaty at the international hydrographic conference, also held in London, in 1919.

In the face of this increasing exploitation, the need to protect ocean resources became crucial. In a few decades, the oceans have become the receivers of a variety of pollutions (voluntary or accidental discharge of petroleum products, immersion of plastic waste making the ocean the "first plastic continent"), and they are also over-exploited, with a tendency to exhaust fish resources, despite the face that they are essentially renewable if the approach is reasoned. According to FAO, in 2012, 29% of the world stocks of fish were over-exploited, and one in three fish species threatened with extinction. Numerous agreements, conventions and measures, supported by the creation of numerous environmental protection associations, appeared in the course of the second half of the 20th century to attempt to regulate the exploitation of the oceans. In 1973 the International Maritime Organisation adopted the international MARPOL convention, a reference frame for the prevention of pollution of the oceans by petroleum products. In 1992 the Rio Summit produced Agenda 21, in which chapter 17 focuses on the protection of the oceans via a rational use and exploitation of the biological resources. The creation of Protected Marine Areas was then encouraged, and relayed on European scale by the Natura 2000 network for the sea. Yet in 2013, only 3% of marine surface areas were subject to protection, versus a target of 15% in the Johannesburg Summit in 2002.

The on-going global warming, which appears to have an impact on oceanic circulation on global scale, could also reinforce the paradox. The scope for opening new maritime routes and exploiting the sea bed in the Arctic regions needs to be approached in reasoned and responsible manner, to avoid the pitfall of a system tending to destroy and then rehabilitate these huge reservoirs of life. In this sense, and although the oceans were not in fine at the heart of the climate negotiations during the COP21, the focus on these issues by several conferences and debates can but reflect the general concern.

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Bibliographie

-Archambeau A.-S., 2004, Les ocÃ©ans, PUF, coll. Que sais-je ?, 125 p.

-Costa S., Gueben-VeniÃ¨re S., Mercier D., Goeldner-Gianella L., 2015, Â« Mouvements de la surface des mers et des ocÃ©ans et consÃ©quences Ã l'interface Terre-Mer Â» in Escash (dir.), GÃ©ographie des mers et des ocÃ©ans, Dunod, Paris, pp. 102-133.

-Deboudt Ph., Meur-FÃ©rec C., Morel V. (dir.), 2014, GÃ©ographie des mers et des ocÃ©ans, Paris, Armand Colin.

-Miossec A. (dir.), 2014, GÃ©ographie des mers et des ocÃ©ans, Rennes, PUR.

-FrÃ©mont A., FrÃ©mont-Vanacore A., 2015, Â« GÃ©ographie des espaces maritimes Â», La documentation photographique, dossier nÂ°8104, Paris, 64 p.

-Louchet A., 2014, La planÃ¨te ocÃ©ane, prÃ©cis de gÃ©ographie maritime, Armand Colin, coll.U, Paris, 559 p.

-RÃ©gnauld H., Tabeaud M., 1999, OcÃ©anographie, Armand Colin, coll. SynthÃ¨se, Paris, 96 p.

-Valette Ph., 2013, Â« Vers la Â« Blue Society Â», VertigO, Hors-sÃ©rie 18, 5 p.

-Woessner R. (dir.), 2014, GÃ©ographie des mers et des ocÃ©ans, Atlande, coll. ClÃ©s concours, Neuilly, 445 p.

-Organisation Hydrographique Internationale : https://iho.int