THE OPEN OCEANS

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Contents

Summary

Over the past 4×10^9 years, since water first started to accumulate on the crust, the ocean basins have continually been changing their shape, and this has led to the modification of ocean currents, sea levels and climates. The largest changes are due to sea floor spreading and plate tectonics, or the Earth's crustal structure and forces.

The oceans are in constant motion, as they are influenced by the rotation of the Earth, the gravitational pull of the Sun and the Moon and also by the winds. Ocean circulation transports heat from the warmer tropics to the colder, higher latitudes. Such motion not only influences the climate of neighboring landmasses, but it also results in different physical and chemical conditions for life in different parts of the oceans.

The oceans contains 99 per cent of the living space on the planet and the environment of the open oceans varies drastically. Conditions range from the warmer, sunlit surface waters to the dark and colder ocean depths, and from the cold, fresher waters in the polar regions to the warm, saline waters in the subtropical gyres.

Almost all plant life can only be sustained in the euphotic zone where nutrients are generally depleted except in areas with upwelling. Nevertheless, some animal life still exists even in the deepest trenches although plants cannot survive there without any light even if nutrients are abundant. Strange forms of life sustain on chemical energy, rather than energy from the sun, near hydrothermal vents that spew hydrogen sulfide and heavy metals.

1. Introduction

Until very recently, the oceans were seen as invulnerable. In 1818, Lord Byron wrote: Roll on, thou deep and dark blue ocean–roll! Ten thousand fleets sweep over thee in vain; Man marks the Earth with ruin – his control stops with the shore.

Soon afterwards in 1850, however, Matthew Fontaine Maury, a US naval officer and oceanographer, published the first generalized bathymetry, or topographic map of the sea floor, of the North Atlantic. Later, a need for improved communication prompted increased submarine cable laying across the ocean basins. This revealed more knowledge of ocean topography. During the Second World War, submarine warfare and the invention of echo-sounding produced even a much wider coverage of the ocean floors. Humans now know that aside from gentle shelves and very deep abyssal plains there are undersea mountains, ridges, hills, continental slopes and rises, basins, troughs and trenches (see The Oceans, Figure 1).

The advance of theories such as continental drift, sea floor spreading and plate tectonics have also indicated that over time scales measured in millions of years, ocean basins are continually changing, affecting sea levels, ocean circulation and climates. The very origins of the ocean floor, and in fact of life itself, may have come from hydrothermal vents near the sea floor spreading centers two to three kilometers deep. This is explained in later sections.

As stated earlier, life evolved from the oceans and the ever-evolving living organisms in the oceans are closely interrelated, extending from bacteria to phytoplankton to zooplankton to fish to the largest whale. Their distribution depends on seawater temperature, salinity, turbidity, availability of light and nutrients, ocean circulation, and predators, including Humans. There are zones of high primary production which supply a constant amount of protein to Humans, and there are zones which virtually appear to be desolate but nevertheless do contain many small forms of life.

The desire to learn more about the oceans called for large scale, long term and coordinated oceanographic expeditions. A significant step in the direction of international cooperation on large-scale oceanographic projects took place when the International Geophysical Year (IGY) was organized in 1957-58. IGY was followed by deep drilling into the ocean floor under the Deep Sea Drilling Program (DSDP) which evolved into the Ocean Drilling Program. These programs firmly established the concepts of plate tectonics.

From a more practically point of view the International Decade of Ocean Exploration (IDOE) was undertaken in 1969 with the goal to enhance the world's ability to effectively and efficiently use marine resources. Furthermore, the 1982 United Nations Convention on the Law of the Sea has established the right of all States to conduct scientific marine research. In fact, the Convention urges for the promotion of international cooperation on such research, publication and dissemination of information and data. The development and transfer of marine technology knowledge concerning scientific marine research projects are encouraged, and measures are provided to facilitate research and assist research vessels. Large scale, interdisciplinary

and international research projects covering all parts of the oceans are now possible. These include, among others, the Joint Global Ocean Flux Study (with emphasis on biogeochemical cycles of carbon, nitrogen, phosphorus and silicon), Land-Ocean Interaction in the Coastal Zone (emphasizing natural and human interactions), Tropical Ocean-Global Atmosphere (studying climate and hydrological systems in the tropics) and World Ocean Circulation Experiment.

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Biographical Sketch

Born in Changhwa, Taiwan, on 22 April 1949, **Prof. Chen-Tung Arthur Chen**, his wife and two daughters are currently residing in Kaohsiung, where he has been Professor at the Institute of Marine

Geology and Chemistry since 1986. After receiving his B.Sc. degree in Chemical Engineering from National Taiwan University in 1970, Prof. Chen was awarded his Ph.D. degree in Chemical Oceanography from the University of Miami in 1977. In the same year, he was appointed Assistant Professor in the College of Marine Sciences of Oregon State University, where he was later promoted to Associate Professor in 1981. He served as visiting professor at National Sun Yat-Sen University (NSYSU) in Kaohsiung, Taiwan, and as Chargé de recherche (CNRS), Université Pierre et Marie Curie in Paris during 1984-1985. During this period, he founded the Institute of Marine Geology at NSYSU, and served as its director until 1989 when he was made Dean of the College of Marine Sciences, a position he held until 1992.

Prof. Chen has sat on numerous international committees, including the Scientific Committee on Oceanic Research and the World Ocean Circulation Experiment. He also served as one of the executives of the Scientific Steering Committee of the Joint Global Ocean Flux Study (JGOFS) between 1992-1995. Just prior to that, he had helped to form the Joint JGOFS / LOICZ Marginal Seas Task Team in 1991, and served as its chairman until 1995. Prof. Chen is at present one of the editors of *Oceanography Journal* and associate editor of *Marine Chemistry*. Besides having more than 150 of his own scientific papers published, Professor Chen was awarded the highly-coveted Biowako Prize for Ecology from Japan in 1997.