

OCEANOGRAPHY AND HYDROGRAPHY

BASIC RESEARCH AND DESCRIPTIVE OCEANOGRAPHY

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The Recent Expansion in Oceanographical Research

Although there are huge areas of dry land which are still only superficially explored because mountains, deserts, jungle or ice make access to them particularly difficult, man is becoming increasingly curious about the enormous masses of water which cover seven-tenths of our globe and is trying to investigate all the unknown phenomena hidden beneath their surface.

Despite the intrinsic value of a knowledge of the hydrosphere, this curiosity is not entirely disinterested. Indeed the little that is already known of "the multitudinous seas" makes it possible to visualise the ocean and its floor as almost inexhaustible reservoirs of food, energy and mineral resources which will be available for exploitation as and when they are better known and facilities for investigation and for the gathering of data and resources are developed and improved. Moreover the oceans of the world which wash every continent and offer maximum secrecy to those venturing beneath their surface bid fair to become an ideal theatre of warfare. Their use for attack and defence raises countless problems in many branches of science and the solutions evolved might profitably be used for peaceful purposes. However much the seas separate men by the distances they set between the continents, they also act as a link by the channels of communication they provide.

Today the ocean has become a focus of interest which has induced maritime nations to make a considerable effort in recent years to develop oceanographical research. Specialised institutions have at their disposal an increasing number of scientists and technicians and are anxious to train more research workers. New professorships and laboratories are being created, research ships are being built in every country and industry is constantly devising new instruments of exploration. And all this eager progress will have to be kept up for years if oceanography is to be fitted to render the services expected of it.

The increasing activity of research workers is directed either towards problems already under study or new objectives conducive to significant discoveries. Among the phenomena on which light has recently been thrown in the field of physical oceanography, mention may be made of the meanderings of the Gulf Stream, the flow of arctic waters over the Faroes-Shetland

sill, the equatorial sub-surface counter-currents and the influence of atmospheric pressure in the western Mediterranean on the flow of water through the Straits of Gibraltar. One of the most remarkable results of exploration of the ocean floor has been the discovery of the narrow submarine valley which follows the mid-Atlantic ridge and probably extends over the whole globe; the submarine canyons which split the continental shelves, the great oceanic trenches, the seamounts, the heat-flow across marine sediment deposits, the distribution of manganese nodules on the sea floor of abyssal basins, and many other phenomena represent fascinating and promising research subjects which are contributing to the development of the new field of geological oceanography.

All this research, unremittingly pursued by numerous teams operating either in the field or in the laboratory and often under international cooperation schemes, is improving our knowledge of ocean-centred phenomena, helping us to understand the process of their formation and development and to discover the laws which govern them. But whatever the scale of the facilities provided to carry them out, these investigations are limited to particular points mostly glimpsed by chance in previous explorations. True, these points span so wide a range that the new curiosities which continue to be discovered can often be related to and explained by those already elucidated. Nevertheless, the perspicacity and keen eyes of the investigators can be relied on to bring to light phenomena as yet undreamed of.

Descriptive Oceanography — Surveys

Our knowledge of the oceans is thus becoming daily more complete, which is the true object of marine science. But there is another aspect of oceanography of the greatest interest to both present and future users of the sea, not only for the purposes of navigation but also for the actual exploitation of its resources. To solve the problems involved it is essential to obtain accurate information on the geographical distribution of certain data relating to one or several branches of marine science, i.e. physics, geophysics, geology or biology and to possess charts or detailed profiles showing the distribution of these data. This information can only be compiled by surveys involving the systematic collection of scientific data in a specific area.

The quality of a survey depends not only on the accuracy with which these data are gathered but also the precision with which observation points are determined.

The spatial sampling density varies considerably according to the nature of the samples and the time and facilities available. Surveys range from simple reconnaissance to minute description but final surveys are generally a lengthy task calling for considerable equipment and elaborate methods, utilised by an appropriate authority. The resulting charts accurately show the geographical distribution of the data studied and, if need be, their variations in the course of time. In many cases they are a national contribution to an international project designed to cover all the seas of the world and in some cases even the whole of the earth's surface.

The main factors for investigation in oceanic areas for the production of charts are :

- the depth of the sea, described in the form of bathymetric or hydrographic charts, when published specifically for navigational needs;
- the immersed ground and underground for which morphological, lithological, sedimentological, geological and other charts are drawn up;
- the marine environment for which hydrological charts of salinity, temperature and density at various depths and at different seasons, hydrological sections, current charts, cotidal lines, etc., are compiled;
- the field of gravity as shown on gravimetric charts;
- the earth's magnetic field, featured on geomagnetic charts;
- the seasonal distribution of biomasses.

Surveys therefore involve a methodical investigation of the area concerned under a definite programme which often covers several years. In the case of a detailed description of elements subject to seasonal or long-term variations, surveys have to be repeated at various seasons of the year or at intervals of several years.

Moreover, as there are considerable differences in the spatial variations of the elements concerned and also in the time required to operate the observation instruments, it is practically impossible to carry out a single investigation covering all the elements to be studied and several surveys, each differently conducted, are absolutely necessary in one and the same area. However, when an expedition is organised to survey one or two specific elements, advantage is taken to collect as much data concerning other elements as is consistent with the efficient achievement of the main task.

Where rapid geographical variations in data and sometimes even discontinuity occur or are likely to occur, it is appropriate to increase the density of sampling by narrowing the intervals between the profiles, but there is no point in this unless the position of the observation vessel is itself accurately determined by the requisite means.

Surveys often reveal local phenomena or peculiarities previously unsuspected and likely to provide the substance for further basic research. For example, most of the known submarine canyons have been discovered in the course of routine bathymetric surveys. But the pursuit of such results is not the essential aim of the surveys; they must be conducted in a spirit of absolute objectivity, with the idea that the absence of noticeable peculiarities is as significant as their presence.

The utility of surveys is not always obvious to contemporaries. Although they take the resulting documentation for granted, they do not always realise the magnitude of the work involved and have little interest in its extension to unexplored areas. They doubtless feel that the time taken to carry out the new surveys will preclude them from reaping the benefit themselves. New surveys are thus essentially a long-term investment. Those being undertaken today will not cover all the oceans for several decades to come; they will be the basis of the charts of the year 2000. The actual beneficiaries will be the generations to come, who would be justified in reproaching our own for failing to undertake these surveys at the first opportunity. This distant aim must obviously not prevent surveys being so

phased as to give priority to those which are most directly useful. A system of priorities is, moreover, rendered necessary in most cases by the technical circumstances prevailing at the time.

The Two Parallel Aspects of Oceanography

This brings us to the distinction between two typical forms of oceanographical activity, i.e. basic research and descriptive oceanography. A totally different approach has to be adopted in each of these fields of study. The means of investigation are the same in most cases, but the methods of collecting and analysing data arise from a different outlook and call for different qualities and aptitudes from the staff. In particular, the study of a basic research problem is primarily the work of one man or of a team supervised by a scientist who organises operations with reference to the desired objective and adapts the methods as the work proceeds. A survey, however, is merely a contribution to a joint task, which, to be homogeneous, must involve a definite programme extending over many years and modified only from time to time to allow for the development of measuring instruments. Surveys therefore have an impersonal character in contrast to the individual approach to basic research. The latter has a more direct appeal to those participating, but methodical prospecting is far from being a thankless task, not only because of its ultimate objective but considering the discoveries to which it may occasionally lead.

In view of their organisation, equipment and staff, the oceanographical institutions are capable of conducting research in the various branches of oceanography. However, they do not appear able to cooperate effectively, with the necessary continuity and on the scale required, in extensive surveying schemes for which they perhaps do not feel themselves suited. Their attitude is to some extent illustrated by the oceanographical work done in the International Indian Ocean Expedition, which was originally designed to obtain a better knowledge of the ocean about which least was known at that time. One of the essential tasks planned by the organisers of the expedition was the systematic exploration of the whole Indian Ocean at each of the two monsoon periods, based on a comparatively tight grid of meridians and parallels, so as to establish a network of bathymetric and hydrological sections, providing in some detail the first general picture of the submarine topography and dynamics of that ocean. In actual fact, although the Expedition has already been in progress for several years, with active international support, its programme is far from being completed or even from being adhered to in a disciplined manner. On the research vessels sent by oceanographical institutions in many countries, the teams of scientists have mostly devoted their attention to such specific problems as subsurface equatorial currents, seamounts or trenches in particular areas, oxygen content, etc. These problems have generally been suggested by previous observations and their more or less complete solution would undeniably be scientifically valuable; nevertheless there still remain vast unexplored zones in the Indian Ocean, contrary to the aims of the initiators of the Expedition.

Many research workers are, however, aware of the importance of methodically exploring little-known areas, prior to any thorough local study. Thus a Canadian oceanographer, who in 1961-1962 took part in the British research in the Indian Ocean, recently concluded an article on the geophysical investigation of this ocean with a brief review of future work designed "to investigate further many fascinating puzzles on the bottom of the Indian Ocean". He also laid emphasis on the need to "carry out, above all, systematic, detailed surveys and investigations of selected portions of the ocean floor, in spite of the difficulties, cost and tedious nature of the work". "Progress", he added, "can be based only on factual survey information".

Possible Cooperation of the Hydrographic Services in Surveys

It may be wondered who will be responsible for the progressive surveying of the world's oceans which, in view of the prospects for the future, must be put in hand without delay. In a number of maritime countries, thoughts are turning towards the hydrographic services which seem to be the only bodies able to carry out this task methodically and persistently over a period of years. True, these organisations are primarily responsible for navigational security but their duties lead them to perform close surveys of submarine topography, which are bound to extend increasingly towards the deepest areas of the ocean as a result of the use of echo-sounding navigational methods and the considerable development of submarine navigation. It is now part of the programme of each hydrographic service to make a detailed survey of the sea floor of all the maritime areas for which it is responsible. The surveys are carried as far as accurate methods of position fixing can take them, and the range of these methods is being increasingly extended. This work, which is coordinated where appropriate by the hydrographic services of several countries, provides initial data for a topographical chart of the world's oceans, one of the specific charts which, as we emphasised above, will be needed in the by no means distant future. The depth of the sea is the most important of all the factors which have to be studied in connection with the marine environment and the ocean bottom, and the topographical chart of underwater relief is a basic document for all other research, its value being proportionate to its accuracy.

The high quality of the bathymetric work done by the hydrographic services is due partly to the fact that they take full responsibility for the charts compiled from their surveys. It is also a result of the experience — often century-old — which they have acquired in their particular domain and which ensures that all the operations they undertake, from the collection of information at sea to its processing ashore, are efficiently organised. Little by little they have evolved a whole doctrine, gradually adapting their methods to the march of science and technology and to the new prospects these have opened up. Their specialisation may appear narrow but coupled with the continuity of their work it is a guarantee of high standards and steady output. A hydrographic expedition or a marine cartographic service are bodies which have been set up and trained for a

specific purpose and their results could never be achieved by improvised organisations. Their whole procedure is characteristic of a public service and differs basically from that of the research institutions whose objectives are essentially variable and whose structure and working methods have to be constantly adapted to the diversity of those objectives. The procedures of the hydrographic services could easily be directed towards other than bathymetric surveys, and these establishments would have little difficulty in converting to other purposes an organisation almost exclusively devoted to surveys of marine depths and the preparation of marine charts. Indeed, this has already occurred in the case of some services which for some time have been making gravimetric, geomagnetic and hydrological surveys at the request of national or international scientific organisations. This extension in the original scope of the hydrographic services seems to be the most reliable if not the only way of securing the fullest possible descriptive knowledge of the world's oceans within a reasonable space of time.

However, the acquisition of this knowledge which is of obvious importance to all nations calls for work on such a scale that the cooperation of all the hydrographic services seems essential. In point of fact, this cooperation already exists in bathymetry. The world's marine charts represent a real international undertaking, the gradual achievement of which is being increasingly facilitated by the International Hydrographic Bureau. This body was set up about forty years ago by the hydrographic services for the express purpose of improving the coordination of their activities and, in particular, of standardising their observation methods and the presentation of their results.

If the hydrographic services were to extend their interest to fields other than the depth of the sea, the International Hydrographic Bureau would still serve a useful purpose in the development of these new activities, in particular by providing the hydrographic services at the outset with the standards needed to create a consistent world-wide body of documentation.

Admittedly, any increase in the responsibilities of the hydrographic services and the International Hydrographic Bureau may well bring staffing and financial problems in their train. Such practical difficulties are inevitable and will disappear only when governments have been convinced of the advantages of having specific ocean charts, as numerous, varied and accurate as those which are being increasingly compiled for land areas.

It is for oceanographers and hydrographers to bring home to the public and the appropriate authorities the need to couple basic oceanographical research with a whole series of surveys indispensable to the effective exploitation of the sea's riches in the comparatively near future. A few years ago, United States oceanographers, competing for funds with space research promoters, were moved to declare that it is more important for humanity to explore the floor of the ocean than the other side of the moon. It is surely possible to avoid such rivalries in the scientific field and to find arguments, perhaps less laconic but just as decisive, in favour of investigations which are absolutely vital to future generations in full demographic expansion.

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IHB Note

This article by Ingénieur Général GOUGENHEIM is briefly commented upon by the Bureau.

He states :

- 1) That the systematic investigation of the oceans has become a vital necessity — possibly involving the survival of mankind.
- 2) That the hydrographic offices are the organisations in the best position to undertake this investigation through systematic large-scale surveys in the fields of physical oceanography, geophysics, geology, etc., and to a lesser extent marine biology.
- 3) That the IHB should encourage and promote this objective with the aim to eventually provide States Members with standards of accuracy and specifications for oceanographic investigations.

The IHB has recognised the rapidly expanding role of oceanography and the contributions that can be made by hydrographic offices in extending their surveys into the disciplines of oceanography. We feel that we have taken the initial step of informing our States Members through the medium of the Bulletin, the Review and by correspondence.

The eighth International Hydrographic Conference adopted Resolution J 4.1 : Oceanographic Observations. " It is resolved that the hydrographic services of the States Members be encouraged to give increased emphasis to the subject of oceanography. They should make every effort in connection with normal hydrographic operations to obtain oceanographic observations, wherever possible, along their coastal waters and adjacent seas. The results of such observations should be communicated to other nations for maximum utilization by government organizations, fishery interests and scientists in general. "

A number of States Members are now engaged in extending their survey activities at sea into several fields of oceanography, both on a national and international scale. However, the possibility of expanding into other fields with the concurrent need to recruit scientists is quite dependent upon states' governments authorizing such activities, appropriating the funds and the need for modernization or construction of new ships suitable to make oceanographic investigations.

Certainly the subject of Ingénieur Général GOUGENHEIM's article will receive close attention at the next International Hydrographic Conference in 1967.