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V.I. Faleev

The World Ocean Atlas - a new cartographic work devoted  
to the nature of the World ocean

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In 1974 the USSR Navy started the issue of the World Ocean Atlas - a new big cartographic work devoted to the nature of the World Ocean.

Participation of the Russian Navy and the USSR Navy in the study of our planet's nature has great traditions. Already during the years of creation of the regular Russian naval fleet, its vessels took an active part in geographical explorations.

An outstanding event in the history of the world geographic science was the first Russian round - the-world expedition under the command of I.F. Krusenstern, the results of which were summarized in the world-known "Atlas of the South Sea", which saw print in 1826. With admiration was accepted the issue of the book "The Vityaz and the Pacific", written by S.O.Makarov, in which he made public the scientific results of his voyages in 1886-1889.

In the still later period the Russian fleet was assigned a task of systematic researches, wherefore special detachments were formed.

But really wide scale of oceanographic researches was attained in our country after the victory of the Great October Socialist Revolution. Hydrographical expeditions and detachments were organized and hydrometeorological observatories were established on all the fleets and by the beginning of the Great Patriotic War they had completed the great work of charting and hydrometeorological researches of the seas bordering on our country.

Peaceful work of our people was interrupted by the attack of Hitler's Germany, and it was possible to resume hydrographic researches only after the victorious ending of the Great Patriotic War.

In the post-war years hydrographic and oceanographic researches were developing at an ever-increasing rate. In 1949 was organised the first Soviet oceanographic expedition for exploration of the North Atlantic. In 1955 the Soviet Union started active participation in exploration of the Antarctic and the adjacent regions of the World Ocean. Since 1957 research oceanographic vessels of the Soviet Union have constantly been taking part in carrying out the majority of international oceanographic programs. As a result of the intensive exploration of the World Ocean over the past two decades a great number of data have been accumulated allowing a new approach to the explanation of some phenomena occurring in the ocean and atmosphere.

In the late sixties - early seventies the USSR Navy in cooperation with the USSR Academy of Sciences and other Soviet scientific and research establishments began developing into a common system all the scientific observations made in the World Ocean in all the history of its exploration. The final aim of this work was creation of a new fundamental scientific work about the ocean - the World Ocean Atlas. The creation of the World Ocean Atlas was headed by the Commander-in-Chief of the USSR Navy Admiral of the Fleet of the Soviet Union S.G.Gorshkov.

By the present time work has been completed on two volumes of the World Ocean Atlas. The first volume (the Pacific Ocean)

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has already seen print, and the second volume (the Atlantic and Indian Oceans) will be issued in 1977.

So what is the new Soviet atlas and what is the difference between it and other existing atlases?

The first difference is that only direct oceanographic observations are used in the construction of the Ocean Atlas, whereas the majority of the existing atlases are based on the generalizing of previously issued literary and cartographic sources. Usage of series of direct oceanographic observations reduced to a common system allowed in the new Atlas to avoid subjective evaluations and extrapolations which are in one or another degree characteristic of all known to us atlases issued in earlier years.

The second difference is that for the first time in the Ocean Atlas are reflected the latest achievements of oceanography.

Such as information about upper layers of atmosphere, new data characterizing hydrological, hydrochemical and hydrodynamical condition of ocean water, bottom sediments, relief and structure of the ocean bed etc.

And finally, the essential difference between the Ocean Atlas and other atlases is that for the first time it contains information not only about the ocean layer and the adjacent atmospheric layer but also about all layers of ocean water up to a depth of 5,000 metres and atmospheric layers up to a height of 16-18 kilometres. In other existing atlases such information is either completely absent or given only for limited areas.

The first two volumes of the Atlas cover approximately



96 % of the World Ocean. They are completely uniform in scaling and arrangement of charts, in symbols and abbreviations, in colouring and all elements of the contents. Even numbering of pages of identical charts coincide in the first and second volumes. This facilitates considerably comparing charts and their combined usage

The following bodies have been taking part in the authorial development and annotation of the charts of the Ocean Atlas; the USSR Main Naval Staff, the Head Department of Navigation and Oceanography of the USSR Ministry of Defence, the Naval Academy and the Military Medical Academy; research institutions of the USSR Academy of Sciences; the Botanical Institute, the USSR Geographical Society, the Geological Institute, the Main Astronomical Observatory (in Pulkovo), the Zoological Institute, the Institute of Geography, the Institute of Geomagnetism, Ionosphere and Radio Wave Propagation, the Institute of Oceanology; research institutions of the Head Department of the Hydrometeorological Service at the Council of Ministers of the USSR: the Arctic and Antarctic Research Institute, the USSR Research Institute of Hydrometeorological Information, the USSR Hydrometeorological Research Centre, the Main Geophysical Observatory, the State Oceanographical Institute, the Leningrad and Moscow State Universities, the USSR Research Institute of Fishery and Oceanography, the Pacific Research Institute of Fishery and Oceanography, the Arctic Research Institute of Geology.

Designing and printing of the charts of the Ocean Atlas is carried out by the cartographic and polygraphic agencies of the USSR Ministry of Defence and of the Head Department of Geodesy and Cartography at the USSR Council of Ministers.

Each volume of the Ocean Atlas consists of seven sections:

1. History of Ocean Exploration (11 plates of charts).
2. Ocean Bed (29 plates of charts).
3. Climate (79 plates of charts).
4. Hydrology (102 plates of charts).
5. Hydrochemistry (11 plates of charts).
6. Biogeography (7 plates of charts).
7. Reference and Navigational-geographical Charts  
(48-50 plates of charts).

Every section of the Atlas is preceded by an explanatory text in which a concise account is given of the materials used for its preparation, methods and special features of chart construction are described and evaluation of accuracy of charts is given.

Allow me now to describe with more details the contents of the first volume of the Ocean Atlas, which has already seen print.

This volume begins with charts showing the most important Russian expeditions in the Pacific Ocean undertaken before the mid-XIX century and the history of discoveries by Europeans of shores and islands of the Pacific. For instance, in detail are shown Russian discoveries in the North Pacific and mid-Pacific, Tuamotu Archipelago, Marshall and Caroline Islands. Separate pages are devoted to the most important Russian and foreign expeditions in the Pacific from the beginning of the XIX century till 1871, from 1872 till 1914 and from 1919 till 1939.

Much attention is given to oceanographic researches in the Pacific after the Second World War. These researches are described on three pages, wherefrom their growing rate is quite evident.

The section "Ocean Bed" includes the topics: bottom relief, earthquakes and volcanoes, tsunami, tectonics, geomorphology, types of coasts and bottom sediments.

Bottom relief is characterized by a collection of bathymetric charts and a chart of bottom dissection, characterising the Pacific Ocean bottom by prevailing types of relief forms and their morphology.

The chart "Earthquakes and Volcanoes" shows geographic distribution of the epicentres of the strong earthquakes and distribution of volcanoes in relation with some elements of tectonics. The chart represents the most important underwater volcanoes having a record of activity and the majority of the active volcanoes on land.

The topic "Tsunami" is represented in the Atlas by two charts characterizing this phenomenon by force and origin. There is a chart in the Atlas, whereon isolines show running time of tsunami waves from the place of origin to the shores of Kamchatka, Kuril and Hawaiian Islands.

The tectonic charts of the Atlas represent the main features of the tectonic structure of the Pacific bottom and the framing Pacific tectonic belt.

A special chart is devoted to the structure of the earth and the earth's crust, and also to the character of thermal flow through the ocean bottom.

The chart "Geomorphology" reflects the main structural



features of the ocean bottom relief and that of the adjacent land. The chart is constructed on the principle of the morphogenetic classification of relief, offered by the Soviet academician I.P.Gerasimov in 1946.

The chart "Types of Coasts" shows navigational characteristics of the coasts and some factors which have conditioned their structure (composition of rock, direction of folds of the adjacent land). Types of coasts are given in classification developed by the Institute of Oceanology of the USSR Academy of Sciences and based on morphogenetic features. For navigational characteristics large-bay and small-bay coasts are indicated and distance is shown of the isobath of 20 metres from the coastline.

The main purpose of the charts "Bottom Sediments" is to show distribution of contemporary sediments and their components on the ocean bottom and also zonation of sediment accumulating processes. The results of analysis of samples, collected during the numerous voyages of the Soviet research vessels "Vityaz" and "Ob", have served as initial data for definition of boundaries of sediment distribution. Besides, data on contemporary sediments, collected by other Soviet and foreign expeditions, have been used.

The topics of the section "Climate" are considerably extended in comparison with the atlases of the similar type. First, the charts of this section show distribution of all most important climatic parameters from the ocean surface to a height 16-18 kilometres, and not only mean values of these parameters but also their extreme values and their recurrence. Secondly, as a rule, annual variation of climatic elements is shown, as the



majority of the charts are made for 12 months.

The section "Climate" consists of three parts having different topics: "Heat Regime of Atmosphere" (oceanic heat balance and atmospheric temperature regime), "Water Regime of Atmosphere" and "Atmospheric Circulation".

The part "Heat Regime of Atmosphere" includes charts showing components of oceanic heat balance, monthly charts of air temperature at the ocean surface and seasonal charts of air temperature on the isobaric surfaces of 500 millibars (5 kilometres), 200 millibars (12 kilometres) and 100 millibars (16 kilometres). Many elements of these charts are published for the first time.

The part "Water Regime of Atmosphere" includes charts of oceanic water balance (volume of precipitates, evaporation, precipitates-evaporation difference), monthly charts of recurrence of precipitates and seasonal charts of absolute and relative air humidity and water contents of atmosphere. Here one can also find charts of thunderstorms, cloudiness, recurrence of fogs and visibility.

Published for the first time for the open ocean are charts of recurrence of precipitates by intensity and phase conditions, charts of absolute and relative air humidity, charts of thunderstorms, water contents and mean cloudiness.

The charts of the part "Atmospheric Circulation" give characteristics of air circulation at the ocean surface (for each month) and on the isobaric surfaces of 500, 200 and 100 millibars (for four months). Included here are also charts of stream currents, vertical cross-sections of atmosphere up to a height

of 18 kilometres along three meridians, charts of types of atmospheric circulation and atmospheric fronts; and concluding the section is the chart of the climatic zones and regions of the Pacific.

The charts of the section "Climate" are quite abundant in complex and versatile information. As an example, one of the monthly charts can be taken of the series "Wind at the Ocean Surface". Shown here on the main chart and on the inserts are: recurrence of direction and speed of wind, its mean and maximum speed, direction, speed and steadiness of the resultant wind, recurrence of storms. Additionally, these charts show main paths and recurrence of tropical and extratropical cyclones and also paths and recurrence of anticyclones and atmospheric pressure.

The section "Hydrology" describes in detail the main parameters of ocean water: temperature, salinity, density, sound velocity along the standard hydrological horizons from the surface up to a depth of 5000 metres. The charts of these parameters are constructed as a result of processing the world hydrological volume of data which includes hydrological observations made in the World Ocean mainly from 1925 till 1972.

One of the advantages of the Atlas is a representation of distribution of temperature, salinity and density by the characteristic seasons or months. These charts should be considered basic or standard for different hydrological calculations.

As is known, the study of interaction of the ocean and atmosphere demands detailed and accurate knowledge of temperature conditions of the boundary layer of these media. Such information

is given on the charts "Water-Air Difference of Temperature".

Characteristic features of spatial structure of ocean waters can be seen on the hydrological cross-sections, oriented mainly by meridians and parallels.

Different aspects of water dynamics are for the first time interpreted in the light of the modern climatic theories and models for the ocean as a whole. The Atlas gives adequately complete characteristics of tidal movement not only for the narrow coastal zone, but also for the open ocean.

By the dynamic method with special consideration of datums elements of water mass transport are calculated at depths of 100, 200 and 500 metres. Such a complex and difficult for charting phenomenon as sea waves is characterized in detail, and for the first time evaluation is given of mean and maximum height of waves and their period for each month of the year.

Mixing processes going on in the ocean, which are very important for vertical distribution of physical and chemical parameters, are represented on the charts of wind mixing and convective mixing.

The chart "Water Structure", showing the main hydrological water structures and ocean water masses, is a great success in systematizing and generalizing oceanic processes.

Data on chemical composition of water, collected by the late sixties and the early seventies, allowed for the first time to give evaluation of hydrochemical regime of ocean waters. This relates to oxygen, carbonate system elements and biogenous compositions. New and interesting are the charts of oxygen minimum and phosphate. The charts of the section "Hydrochemistry"



are of a certain assistance in evaluating biological productivity of ocean waters. Included in the section is the chart of chemical structure of water, showing for the first time ocean zonation by chemical characteristics.

The charts representing organic life in the ocean are combined in the section "Biogeography" and give general description of biological structure of the ocean. It is interesting to note that the very conception of biological structure was worked out about a quarter of a century ago by the Soviet academician L.A. Zenkevich, and this section of the Atlas should be considered as cartographic realization of this idea. The contents of the charts describe in detail the whole chain of organic life in the ocean, from phyto- and zooplankton to marine mammals.

The section "Biogeography" of the Ocean Atlas gives rather wide and complete characteristics of ocean inhabitants. For the first time here quantitative characteristics are given of such complex biological elements as primary production, biomass of zooplankton and of bottom fauna. Quite new is the chart of bottom trophic areas.

In this section the most detailed is the topic "Fish", showing distribution of fish inhabiting the surface layer and deepwater layers of the ocean. Fish living at depths up to 200 metres is represented mainly by commercial species. Besides information about fish, the reader will find in the Atlas detailed information about molluscs, whales, pinnipeds, seabirds and other representatives of oceanic fauna. Information is given about dynamics of whaling, migration paths of seabirds over the ocean etc.

The last section of the Atlas contains reference charts and navigational-geographical charts. Reference charts represent the topics: geomagnetism, astronomy, sea and air communications, medical-geographical conditions, population of Oceania and Australia. The collection of navigational-geographical charts consists of review charts, charts of different regions of the Pacific and plans (mainly of ports).

The charts of geomagnetism show the main elements of the Earth's magnetic field, their annual variation and location of magnetic observatories in the Pacific.

The astronomical charts present diagrams of sunrise and sunset moments, diagrams of navigation twilight and civil twilight duration, time zones of the Earth. There are charts of the star sky and the solar system and of the both semispheres of the Moon.

The chart "Sea Communications" shows the main navigation tracks corresponding to recommended tracks and gives characteristics of the main ports of the Pacific.

The chart "Air Communications" shows the main airlines and airports in the Pacific region and gives characteristics of airdromes of the main international airports.

The chart "Medical-Geographical Conditions" indicates spreading of the most dangerous diseases, both of natural origin and transmissible, location of medical establishments and of the International Health Organization. Specified are areas of spreading of the especially dangerous diseases (plague, yellow fever, cholera), covered by regulations of international conventions. Ports are indicated where plague outbreaks have been

recorded among people or rodents.

A separate chart is concerned with malaria, this disease up to now being one of the most wide-spread in the tropical zone.

The chart "Medical-Geographical Conditions" shows also distribution in the Pacific of sea animals dangerous to man (sharks, poisonous fish and molluscs). All medical-geographical charts are original; they have been constructed in cooperation with the Military Medical Academy.

The chart "Population of Oceania and Australia" gives information about population of Oceania, Australia and the islands of South-East Asia. Classification of the said population is ethnical-linguistical, based on the principle of cognation of languages.

Navigational-geographical charts by their contents and scale are divided into three groups:

1. Review charts, made to a scale of 1:12 000 000 (covering the whole Pacific Ocean).

2. Charts of different regions, made to a scale of from 1: 250 000 to 1:3 000 000.

3. Plans of ports, made to a scale of from 1:25 000 to 1:200 000.

All charts are made in Mercator orthomorphic cylindrical projection.

The Atlas ends with an index consisting of two parts: the first part contains names referring to the charts of those sections of the Atlas which are concerned with certain topics, and the second part contains names referring only to the navigational-geographical charts. There are altogether about



10 000 names in the index.

Such is, in general, the contents of the first volume of the World Ocean Atlas (the Pacific Ocean). The second volume (the Atlantic and Indian Oceans) in contents and volume of data is completely analogous to the first volume.

The new Soviet Atlas is intended for Army and Navy officers, captains and mates of merchant and fishing fleets. The vast cognitive material contained in the Atlas allows to use it successfully as an educational aid for the higher schools of relevant types. The contents of the Atlas will be useful for scientists dealing with problems of studying the ocean and atmosphere, protection of environment, planning and carrying out marine expeditional and research work.

The issuing of the World Ocean Atlas is a contribution of the Soviet Union to the cognition of the nature of our planet. The twenty-fifth Congress of the Communist Party of the Soviet Union held in the beginning of this year, determined the study of the World Ocean as one of the most important fields of the modern science. Marine cartographers consider it a great honour to take part in this work, the results of which are aimed at the benefit of all mankind.

In conclusion, allow me to thank you for your attention and to wish to all present here successful and fruitful work.

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