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MONOGRAPH ON PROSPECTIVE DEVELOPMENTS IN OCEANOLOGY

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14. Abstract The article consists of excerpts from a chapter of a monograph, "Oceanology in the Year 2000" which has been prepared for publication at the USSR Academy of Sciences' Institute of Oceanology. The author of this chapter is A.S. Monin corresponding member of the USSR Academy of Sciences and director of the oceanology institute. The monograph is said to be the collective work of a group of specialists. Monin views prospective developments of oceanology and oceanology-related R&D biology, technology and expedition research.			
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ON THE PATH TOWARD THE OCEAN

From the List of Prospective Projects for Assimilation of the World Ocean

The interest of researchers and practitioners is increasing in the study and assimilation of various resources of the World Ocean. From the Congress tribunal, the increasing role of science in the assimilation of the depths of the earth, the ocean, space, and in environmental protection and enrichment is stressed.

What are the basic stages of this fascinating work as described by the specialists themselves?

A collective monograph entitled "Oceanology in the Year 2000" has been prepared for publication at the USSR Academy of Sciences Oceanography Institute. Its title is almost identical to the title of the book recently published by UNESCO, "Science of the Ocean by the Year 2000". However, unlike the latter, Soviet Oceanographers have decided to compile their prognosis according to a different principle. In evaluating the international publication, A. S. Monin, director of the Institute of Oceanography and USSR Academy of Sciences corresponding member, notes "the care of extrapolation of current tendencies in oceanography, which evidently is explained by the levelling effect of the collective authorship. Therefore, it is better to dream alone and as a result to give a complete list of ideas, and not an arithmetic mean."

We present individual points from the chapter written by A. S. Moninym

PHYSICS

...For the purpose of obtaining a prediction of the weather for several years ahead, computations will be performed according to full three-dimensional models of the climatic system of the AOL (atmosphere - ocean - land) with degrees of freedom of $10^6 - 10^7$. For this, super computers will be required. Such predictions will take on international significance if we can compile them for a decade--the time of reaction to anthropogenic effects. We would like to hope that by the year 200 the AOL models by their quality may become the scientific basis for long-term weather prediction (DPP)--for a month or for a season. (Today DPP still have no scientific basis, are not compiled in numerous countries, and in our country are compiled only with the aid of poorly confirmed empirical directions).

At the same time, with the application of simplified AOL models, it will become possible to compute climate fluctuations for tens and hundreds of years. A global chronology of climatic events and tendencies (trends) for the 20th century, the "climate of the age", will also be compiled and analyzed.

GEOLOGY

...Detailed maps of significant overall areas of the bottom of oceans and seas, their relief--including canyons--soils, bios, and other peculiarities, will be compiled with the aid of side-scan sonar, multi- and narrow-beam echo sounding devices attached to the bottom of telephoto apparatus, as well as manned underwater craft.

First of all, the sections of the ocean bottom will be charted within the 200-mile national economic zones (according to the 1982 International Convention) of the developed countries, as well as the sections which present particular interest--for example for mining iron-manganese concretions--sections of the bottom of the open sea. Special attention will be given to charting sections of rift zones in mid-ocean underwater ridges which may be promising in terms of sulfide ore, particularly at their intersections with transform breaks.

Modern technology, without a doubt, allows us to manufacture equipment for mining iron-manganese concretions from the ocean floor at depths of around 5 km--for example, suction hydraulics or bottom scraper bulldozers which load a closed chain of containers. Already in the next 2-3 years, each country will compile reliable evaluations of the economic expediency of such mining: capital investments, expenses for operation and amortization of equipment, transporting and processing ore with consideration for the predicted world prices for the extracted metals--copper, cobalt, nickel, and manganese.

...A competing task will become the extraction of iron-manganese crusts from the tops of guyots--underwater mountains--at depths of around 1.5 km. Deposits which are three times more shallow make the work considerably easier. High concentrations of cobalt reduce the necessary volumes of extraction, but the hardness of the crusts creates specific requirements for mining equipment. This is true in large part also for mining phosphites (for example, in the Sea of Japan).

...In certain sections along the axis of separation of the crust (spreading) in the oceans--primarily in the Galapagos Rift, in the East Pacific Ocean uplift, and in the rift zone of the Huan-de-Fuk Ridge--at depths of around 3.5 km, with the aid of manned underwater craft, hydrothermal springs have been discovered--the so-called "black chimneys". These are underwater geysers with very hot water and sediment emitted from them with a rather high concentration of zinc, copper, cobalt, nickel sulfides, and other metals. In two cases we have found deposits of large volumes of sulfide ores. If the dimensions of such deposits turn out to be significant, with a shallower depth of deposit and significantly greater concentration of metals they will be of greater industrial interest than iron-manganese concretions.

...The development of paleoceanography is of great interest. The fact is that the reconstruction of the location, form, bottom relief, conditions of the environment, climate, bios, and ore formation of the paleo-oceans for the last 160 million years--the age of the stratified magnetic anomalies in the modern oceans--is already being completed. This information will be detailed with the aid of new data from deep-water drilling of the ocean floor.

Based on the materials on paleomagnetization of the continental soils and on the soils of the phanerozoic juncture zones, and finally on the results

of mathematical simulation of the paleoclimate, paleoceanological reconstructions will be compiled for a period of 600-160 million years.

(We must note that the very first global reconstruction for an older period--1000-600 million years--has just been completed at the IOAN [Institute of Oceanography imeni P. P. Shirshov, USSR Academy of Sciences].

BIOLOGY

...In the sphere of marine ichtheology, monitoring will be organized--including hydroacoustical and satellite--of a number of basic commercial schools-- and populations of oceanic fish (using mathematical models or even models of ecological systems including these schools). Specifically, methods will be developed for predicting the annual recruitment of fingerlings into these schools, stocking of artificially raised fingerlings, feeding, combatting predators, diseases and parasites.

The possibility of regular commercial krill fishing will be resolved.

...There will be an increased assortment, a greater scope and improved methods--including genetic-selection methods--of artificial breeding of useful marine organisms as applicable to each specific shore aquatoria. This will include the expanded breeding and selection of organisms which perform bioconcentration of valuable substances (after the Japanese example of growing ascidae for concentration of vanadium). The scope of growing microalgae on floating bases will be expanded (marine hydroponics), possibly with the application of fertilizers--primarily nitrates.

...By utilizing a detailed mathematical model of the hydrodynamics of a closed or semi-closed sea, which considers the drainage of rivers and the interaction with the atmosphere (for example, precipitation, evaporation, heat exchange, wind effect...), we may also compute the hydrochemical and hydrobiological processes in the sea and implement total management of

pisciculture and other work.

...The problem of contact with dolphins in their language. This is not merely the tape recording of sound and ultrasound signals and their comparison with the behavior of dolphins or reproduction if needed. It would be desirable using methods of structural linguistics to split the signals into elements (phonemes) which are distinguished, for example, by their spectral composition--basic tones and timbre (including vowel and consonant sounds), their duration and intensity. If we ascribe symbols (letters) to them, decode the sequence of the symbols (words and phrases) and synthesize the phonemes, words and phrases by their recorded letters, then a problem will arise which is related to teaching computers with recorded letters of human speech (typing to dictation) and their reproduction according to the written text (reading aloud). An analogous problem arises also in deciphering the writings of lost civilizations and in creating a written language for languages of existing peoples.

...In the depths of the ocean, under a thousand meters of water, large animals live, and dramas are played out between these inhabitants--sperm-whales and giant squid. And yet we still know very little about the population of these depths, about the make-up of the biomass and the trophic chain. The lack of research on this world allows us to anticipate discoveries.

TECHNOLOGY

...For charting the bottom and for work on the ocean floor we will need improved lateral view locators, multi-beam echo sounders attached to the bottom of television and photo cameras. There will be manned and autonomous automatic--including crawling--underwater apparatus operating at depths of 4 and 6 km.

Autonomous undersea stations of various function--hydroacoustic, seismic, mareographs, etc.--with long-term recorders and energetics will become widespread.

...The ocean's energy will be actively utilized--oceanothermal electricity conversion on low-temperature heat carriers, and floating wave electric generators.

EXPEDITIONS

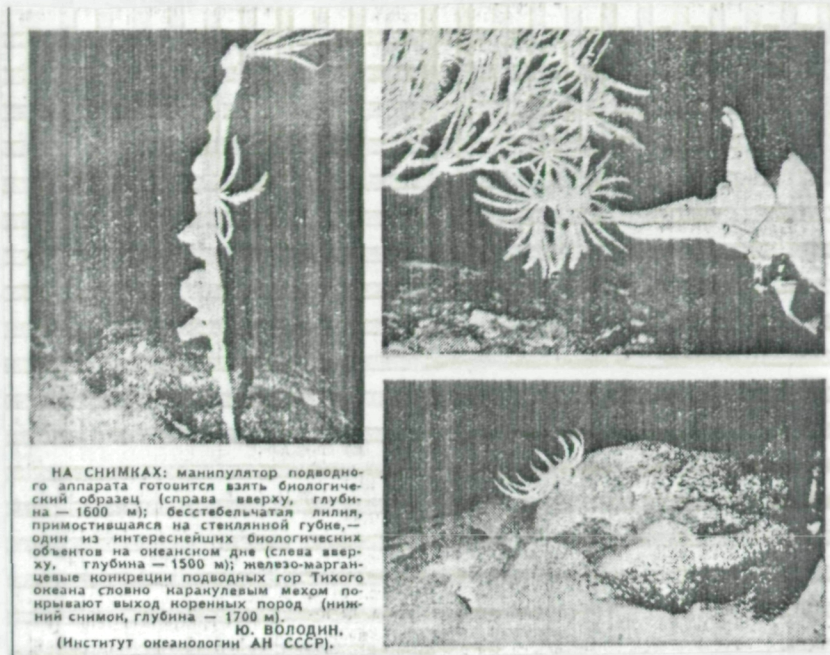
...The typhoon proving ground will take on practical significance. This will consist of placing along the satellite-projected trajectory of a typhoon a series of sunken autonomous buoy stations and Froude beacons (including those with underwater and above-water acoustical indicators to record the "voice of the storm" and the turbulence).

...To warn of storm turbulence, the placement of special free-floating automatic wave-recording buoys (accelemetric or with deeply suspended pressure indicators) will be practiced in storm regions (for example, in the winter in the North Atlantic or in the "howling 40th" latitudes of the southern hemisphere).

...Drilling the bottom of the Baykal presents some interest. This will be done to a depth of 300-400m in the sediment in one to three points which have been prepared ahead of time by seismic profiling. This may possibly be done in the winter, off the ice. It would help to decipher the history of the pleistocene in Eastern Siberia.

...Experiments will be conducted in the fields of subtropical anti-cyclones on enrichment of the upper ocean layer with nitrates and fertilizer complexes--in the form of floating, slowly dissolving granules.

Photo glimpse into the depths:



Photos: manipulator of underwater apparatus prepares to take a biological sample (top right, depth--1600 m); stemless lily resting on glass sponge--one of the most interesting biological objects on the ocean floor (top left, depth--1500 m); iron-manganese concretions of underwater mountains in the Pacific Ocean cover outcroppings of base rock as if with karakul fur (lower photo, depth--1700 m).