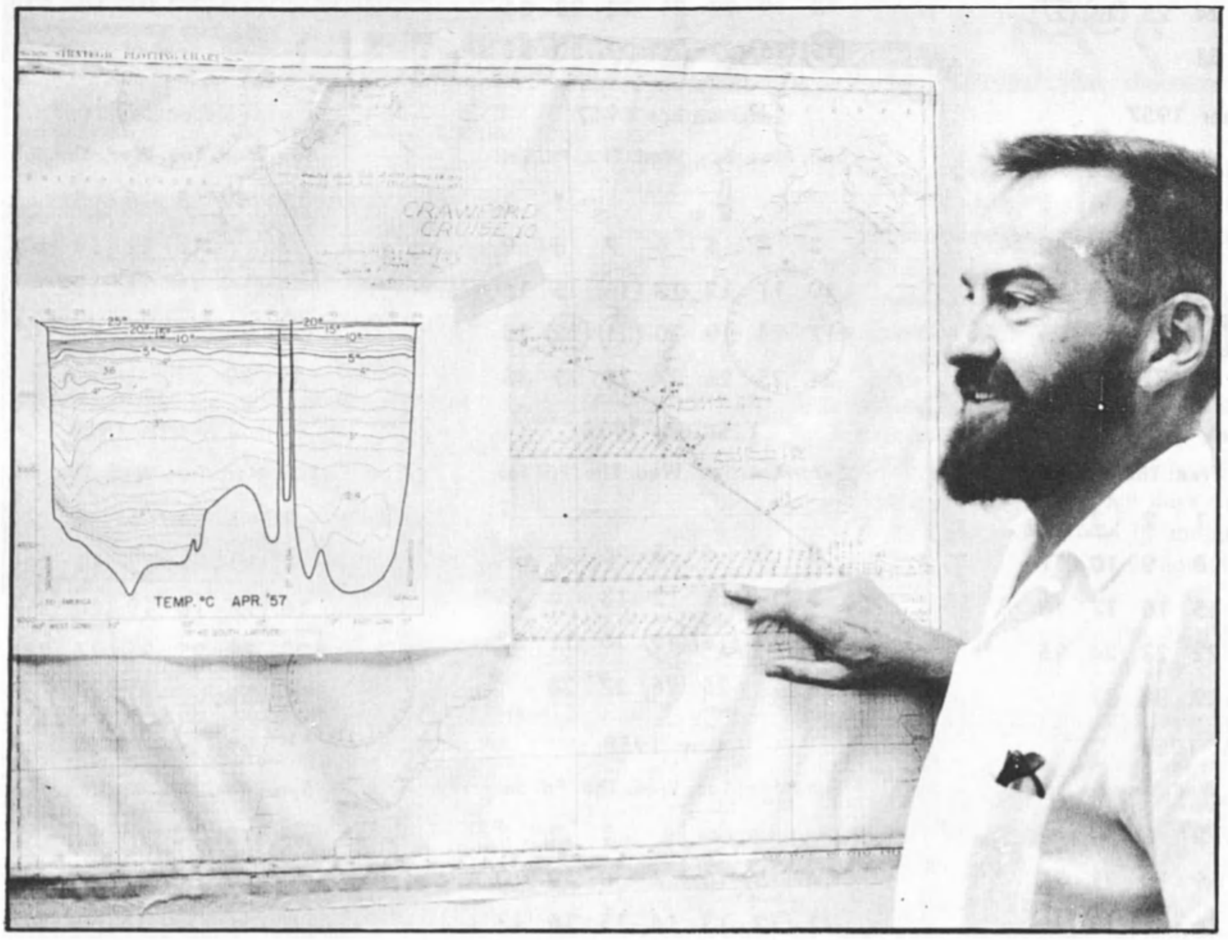
OUR GREAT OCEAN RESERVOIR

A THOUSAND AND ONE SECRETS LOCKED IN WATER, CLOUDS & ICE



Woods Hole Oceanographic Institute

ANATOMY OF THE ATLANTIC was studied by research ship *Crawford*, from Woods Hole Oceanographic Institute (U.S.A.), in 1957. Here, oceanographer shows vessel's track chart across Atlantic. Superimposed on left is chart of deep-water temperatures between Africa and South America. Island of St. Helena, topping a high mountain peak in the mid-Atlantic submarine range contrasts sharply with depths of 15,000 feet surrounding it. At this latitude bottom waters are close to freezing point and only in top 200 metres are ocean waters near the temperature of the atmosphere.

THE immensity of this earth is best appreciated by the men of the sea. From the air it seems small; on the land the expanse is always limited. But the sea is continuous and endless. The continents are only islands in it. Altogether they cover only 57 million square miles. But the ocean area is 140 million square miles—two point five times the land area. And ten percent of the land, six million square miles, is covered with ice that is slowly crawling back to the sea. Almost three quarters of the earth's surface is water or ice.

The volume of water, is even more impressive. In human terms a cubic mile is enormous, for a box one tenth of a cubic mile in size could easily contain the entire human race—though not comfortably. Yet a cubic mile would hardly seem a drop in the world's total of 350 million cubic miles of water. While most of the water is in the great ocean reservoir, of course, about 25 million cubic miles of it is in circulation elsewhere at any moment, making the grand tour up into the skies by evaporation, then falling as rain or snow and returning to the ocean via the rivers. The atmosphere probably contains about 3,600 cubic miles in the form of vapour and clouds. The surface rivers and lakes hold about 55,000 cubic miles. The amount hidden in underground rivers and reservoirs is several hundred times larger and has been estimated at 20 million cubic miles.

But aside from all these mobile forms, there is still about one percent of all the earth's water that is detained in its circuit, frozen, perhaps for centuries, in the form of glaciers and the massive ice cover of Greenland and Antarctica. How much this is nobody knows because the thickness of the Antarctic ice has been measured at very few points. Estimates of the average thickness vary from 2,000 to 5,000 feet but at some points it is certainly 10,000 feet thick. One of the most interesting results of the Year's researches will be the answer to this question. Depending on the thickness, the total volume of Antarctic ice is between 2.4 million and 6 million cubic miles.

If all this ice were permanently frozen in place, it would matter little to human thought or plans. But it is in constant exchange, always growing with snowfall yet always flowing to the sea in glaciers or breaking from the Shelf Ice as icebergs and in sheets that may be several hundred miles in extent and hundreds of feet thick. Part of the snow is blown to sea by high winds. Above all, a rise in temperature causes melting. If it were all melted and ran to the sea the level of the oceans all over the world would rise by 60 to 200 feet. Most of the world's great seaport cities would be inundated. A report to the American Geophysical Union calls the Antarctic glaciers "something of a Sword of Damocles hanging over the heads of all peoples living close to the sea".

It could happen but not soon and only very slowly—conceivably in 10,000 to 20,000 years. In fact, during most of the world's history the earth was probably free of glaciers. But in the past million years there have been four great ice ages when the average temperature was some ten degrees cooler so that ice accumulated and covered a million square miles each in Europe, Siberia and North America. As the ice piled up on the land, the level of the sea dropped to some 300 feet lower than now.

In about 3,000 B.C. the climate was warmer and drier than now and sea level was apparently about six feet higher than now. Then the glaciers grew again and reached a maximum in the 18th century. Since then the glaciers have been receding and the sea level is rising at a rate of about 2.5 inches per century. Since the temperature of the earth is variable, the glaciers come and go and even the "ageless and eternal sea" rises and falls again. Man is powerless to control such vast forces but he has the ability to understand them and to foresee their effects. This is part of the task of the sciences of glaciology and of oceanography during the Year.

Accordingly the Antarctic studies during the Year join with those in the Arctic and with glacier studies throughout the world to determine the life history of the ice, including its rate of formation, its age, and the shifting balance between its growth and its melting. Extended studies are under way by both Soviet and American scientists encamped on floating ice islands to measure their drift and observe their fate as well as to measure the temperature, depth and circulation of the Antarctic and Arctic seas.

★

As for many years, since 1912, the International Ice Patrol will continue its investigation of icebergs in the North Atlantic for the direct benefit of merchant shipping but also to obtain weather data. So glaciology, oceanography and meteorology merge their surveys of ice, water and clouds for the purposes of better forecasting of oceanic conditions and especially of anticipating their changes in the course of years.

Oceanography itself is a many-sided science that includes the geological study of the sea bottom and the geography of its submerged mountain ranges and deep trenches, the variation of the saltiness, chemical composition, and temperature of the waters, the mapping of the great movements of the ocean currents both at the surface and in the deeps, and the study of marine life, both plant and animal, polar and tropical, at the surface and in depth. During the Year, however, it is the ocean itself that will be especially studied, not its life.

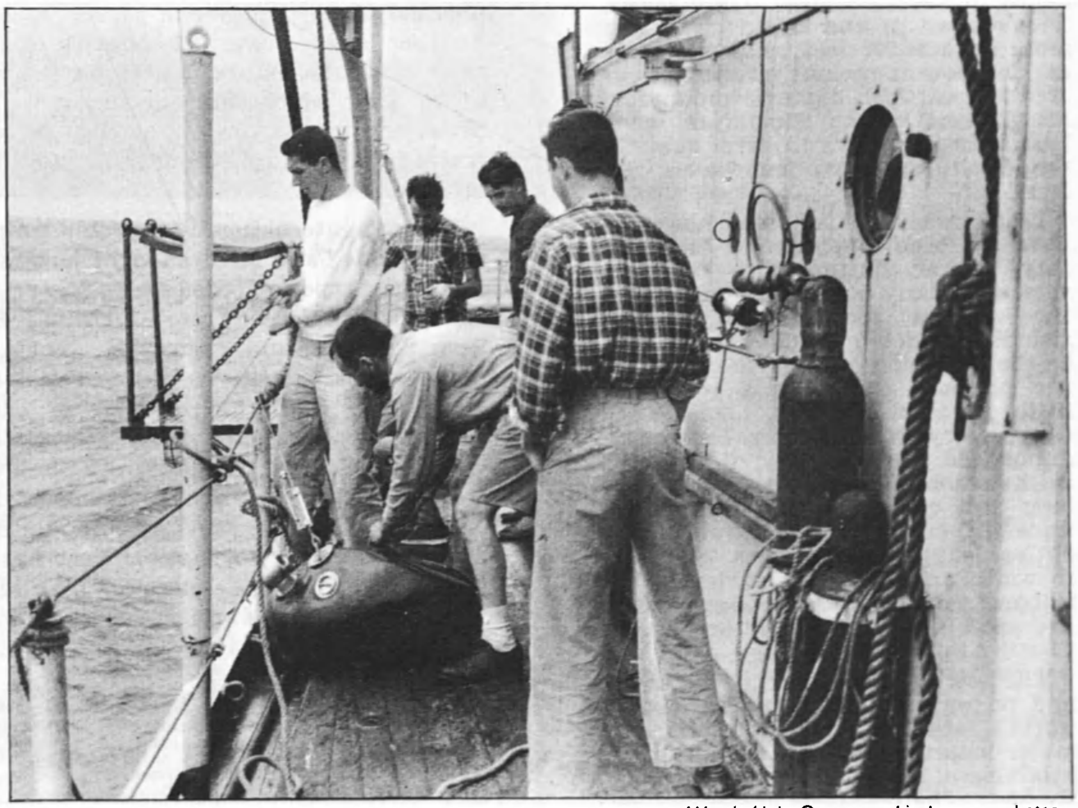
The surface currents of the oceans have a direct effect on the climate and the weather of the continents as the warm tropical waters flow toward the poles, both north and south, and are driven eastward both by winds and by the rotation of the earth. Thus the Gulf Stream in the Atlantic and the Japan Current in the Pacific warm the western areas of both America and Europe.

But cold water from the Polar regions flows toward the tropics in the ocean depths. The British research ship *Discovery II* has recently tracked the deep currents by using a float made of sealed aluminium tubing which is heavier than water at the surface, but can be adjusted to the density of the compressed seawater at any depth and can be effectively suspended at different underwater levels. It drifts with the submerged currents, sending out sound signals which permit the ship to follow it on the surface. In the Gulf Stream there is a strong northward movement at the surface and little movement at depths of 5,000 to 6,000 feet, but at depths between 8,200 and 9,200 feet the movement is southward. At one point the deep float travelled 23 miles in 66 hours. Even 18 inches from the bottom there is noticeable flow to the south.

Thus the ocean "turns over" at a slow pace. The complete top-to-bottom exchange may take from 150 to 1,000 years, bringing the surface plant life to the lower levels and mineral nutrients to the top. It is possible that the fluctuations may be responsible for severe changes in the climate on land. The "age" of the deep waters—i.e. the years since they were at the surface—is measured by bringing up samples from far below, releasing its dissolved carbon dioxide by means of acid, then determining the ratio of the three forms, or isotopes, of carbon in the gas. As the radio-active isotope gradually disappears with the years, the ratio shows how long each sample has been submerged.

Knowledge of the deep currents will also become increasingly important if the practice of disposing of radioactive wastes from nuclear power plants becomes general in the atomic age. It is by no means certain that such materials will long remain where they are dropped. So it is also important to know the nature of the ocean floor. It has usually been assumed to be a thick layer of sediments but there are certainly large areas of bare rock. Samples are gathered by dropping a core-tube to within a few feet of the bottom, suspended on a heavy cable, then releasing a heavy lead weight which drives the core-pipe into the soft sediment. With a

Cont'd on next page



Woods Hole Oceanographic Institute photos

'AGE' OF OCEAN WATERS at great depths—the years since they were at the surface—can now be measured by studying content of radio-active isotopes to determine the "turn over" or complete top-to-bottom exchange which may take from 150 to 1,000 years and whose fluctuations may be responsible for severe changes in climate on land. Above, right, lowering a water sampler from U.S research. ship, *Crawford*, to obtain specimens from the depths. Thousands of observations of temperature, salinity, oxygen content etc., will be made during the I.G.Y. by ships of many nations. Above, left, technician unhooks a "Nansen bottle" used for collecting submarine water.

OCEAN RESERVOIR *(Continued)*

tube, about 3 inches in diameter, samples 100 feet in thickness have been obtained but more recent devices take wider samples of less thickness. Columbia University's research vessel, the *Vema*, has taken samples from the ocean bottom 13,000 feet beneath the surface. Microscopic study of the materials in the samples and of their arrangement in depth reveals their geological history.

Another ocean-bottom device measures the heat that flows to the sea from the relatively thin crust of the earth under it. Because of the vast extent of the oceans this is an important element in the heat balance of the earth. It is the only major source of energy that does not originate on the sun.

★

THE largest task of the oceanographers is to map the geography of the sea bottom over its entire area, which is 70 percent of the area of the earth. It is not flat but, like the land area, has long chains of high mountains, most of them wholly submerged though some extend above the surface as islands in the sea. There is one such range 8,000 miles long, running north and south in the Atlantic between Europe-Africa and the two Americas. Its peaks are 10,000 feet above their base on the Atlantic floor. Another such ridge runs from Japan south to Antarctica and that continent is also joined to South America by an undersea ridge which projects above the surface to form the South Sandwich, South Orkney and South Shetland Islands. But there are also long deep trenches that cut into the sea bottom to a depth of several miles. The deepest is southwest of the island of Guam, more than 34,000 feet below sea-level at the lowest point yet measured. If the earth's highest mountain, Mt. Everest in the Himalayas, were based on this trench, it's summit would still be 5,000 feet below sea level.

Large areas of the sea, however, have not been mapped and surprises may appear during the Year as vessels of many nations continue with the modern technique of echo-sounding which measures the depth by the reflection of sound-waves from the bottom. Earlier this year, for instance, the Lamont Geological Observatory of Columbia University announced the discovery of a "rift" in the sea-bottom that is 45,000 miles long and coincides with the major undersea earthquake zone along its entire length. It averages 20 miles in width and 7,500 feet in depth. It is bordered by mountain ridges that average 6,000 feet in height and about 75 miles in width.

The sea is the source of all rain and no certain understanding of the world's weather is possible without much better knowledge than is now available of the controlling factors in the sea. The relatively unspectacular explorations of the ocean deeps, showing only a white research yacht slowly cruising along, far from the major traffic lanes, are nevertheless one of the most important features of the Year.

UNESCO AND THE I.G.Y.

THE Department of Natural Sciences of UNESCO has no laboratories, observatories or scientific equipment, conducts no researches, and cannot take an active part in the Year. Its function is to advance world science, primarily by means of existing international scientific organizations such as the Scientific Unions that are organized into the International Council of Scientific Unions and the International Council of Medical Sciences. It stimulates international co-operation in the attack on problems that are regional or world-wide. For example, its Advisory Committee on Arid Zone Research has effectively unified the programmes of the 37 nations that are handicapped by deserts or arid lands. Humid tropics, marine biology and the use of radio-isotopes are similar projects.

UNESCO has for the past ten years allocated an annual subvention of around $180,000 from its own limited budget to support the meetings and the headquarters of the International Council of Scientific Unions (I.C.S.U.), which are now in London (1). The council established, the Special Committee on the International Geophysical Year which did its original organization and planning partly on subventions from UNESCO, listed below (larger funds were later supplied by many other scientific organizations and governments):

- $1,400 for the organization of the first meeting of the Committee at Brussels in October, 1952.
- $1,000 for the first preparatory work on the Year in 1953.
- $2,000 for the second meeting of the Committee at Rome, October 1954.
- $20,000 for the establishment of the permanent Committee headquarters, for the work of the Committee and maintenance of its headquarters in 1955.
- $15,000 similarly for 1956.
- $50,000 for the biennium 1957-58.

However, education in science is also an important UNESCO function. This issue of THE UNESCO COURIER, devoted to the International Geophysical Year, is only one aspect of UNESCO's educational support. Another is the newest of UNESCO's famous travelling science exhibitions, dedicated entirely to geophysics and to the scientific activities of the Year, which will tour almost the entire globe in 1957 and 1958. These exhibitions are enormously popular educational displays that travel from country to country at the invitation of the member states of UNESCO.

UNESCO's international fellowship training programme in science has also provided and financed eight fellowships to augment the supply of competent experts needed by the Year's widespread activities. Fellows have been appointed from Argentina, Bolivia, Chile, Egypt, Pakistan, Peru, Thailand and Yugoslavia. They have been in training during the past year at the Institute of Meteorology, Charlottenlund, Denmark; The California Institute of Technology; The U.S. Weather Bureau, Washington; The U.S. National Bureau of Standards, Washington; The University of Colorado U.S.A.; The U.S. Coast and Geodetic Survey; The Carnegie Institution of Washington. In addition to the grants made by UNESCO, the Special Committee for the International Geophysical Year has received annual grants from the I.C.S.U. since 1952, and more than ten countries have made individual contributions varying in size from several hundreds to several thousands of dollars.

(1) The members of the International Council of Scientific Unions are: International Astronomical Union; International Union of Biological Sciences; International Union of Pure and Applied Chemistry; International Union of Crystallography; International Union of Geodesy and Geophysics; International Geographical Union; International Union of the History and Philosophy of Science; International Union of Theoretical and Applied Mechanics; International Union of Pure and Applied Physics; International Scientific Radio Union; International Mathematical Union; International Union of Physiological Sciences; International Union of Biochemistry.