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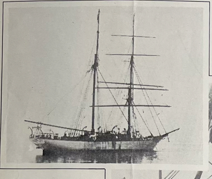
THE CRUISE OF THE "CARNEGIE"



How would you like to spend the next three years making a trip around the world on a sailing ship? This is to be the experience of eight men selected by the Carnegie Institution of Washington who sailed last Tuesday (May 1) on the non-magnetic yacht *Carnegie* from the Seventh Street wharves at Washington. This vessel has already made six voyages during 1909-1921, covering about 290,000 miles, in a magnetic and electric survey of the oceans. She was specially constructed and equipped for making these investigations, brass and copper being used in her construction instead of iron and steel, since the latter metals cause uncertain errors in the delicate instruments used in making the observations.

So, after an interval of over six years, the *Carnegie* is once more to wander down the latitudes in quest of general scientific information. With her crew of 17 men besides the eight scientists she will sail first for England and Germany, and then for Iceland.

As the sun goes southward next fall, the *Carnegie* will work south to the West Indies and Panama, spending next winter in the South Pacific visiting the Society Islands, Easter Island, and Peru, and coming north again to Japan and California next summer. And so on around the world, following the sun in order to avoid storms and delays due to wintry weather and to improve the conditions for making her investigations. Among the places to be visited after leaving California are Honolulu, Samoa, New Zealand, Cape Horn, South Georgia, South Africa, Ceylon, India, Western Australia; across the South Pacific again and around the Horn to Buenos Aires, Argentina, St. Helena, Azores, Madeira, and back to Washington in September, 1931.

But you must not be too envious of these men, because this is not to be a pleasure jaunt. It is an expedition to be devoted entirely to scientific research work at sea. This means that every man will be so busy that he will not have time even to get seasick. Perhaps you would like to hear why they are going, and what they are to investigate. We shall let Captain Ault, the commander, and chief of the scientific staff, tell about the program. Captain Ault has been in command of the *Carnegie* on three cruises, each of the two latter lasting two years. He says:

Magnetic and Electric Conditions

"First, we are going to find out what changes have taken place in the magnetic elements over the various ocean areas since the previous cruises of the *Carnegie*. This information is of interest to the student of the earth's magnetism in his study of the many unsolved problems in this science, and it will supply the values needed to keep the navigation charts up to date. These charts are used by the air pilot as well as by the sea pilot.

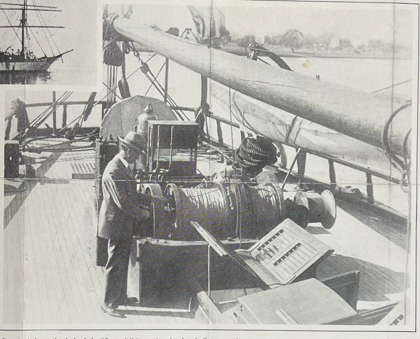
"Among these unsolved problems are: the origin of the earth's magnetic field, the causes of the daily and seasonal changes in this field, the close relation between magnetic storms and the occurrence of polar lights and changes in the condition of the sun, and why we have eleven-year periods in magnetic changes and disturbances coincident with the well-known eleven-year periods in sunspot activity. To obtain the maximum of data regarding these changes, it has been planned to retrace to a large extent the tracks of former cruises. The causes of these changes and variations are not yet known, and their explanation constitutes one of the chief problems in the science of terrestrial magnetism.

"The second important investigation will consist of a continuation of study of the earth's electric field. The importance of investigations such as this has increased in recent years because of the close relation between variations in atmospheric-electricity and variations in magnetic conditions. Also recent theories regarding the nature of electricity and constitution of matter and the rapid advances made in radio transmission have given added stimulus to these studies.

"The electric elements which we are to investigate again include the amount of electric charge in the air which increases with height above the earth's surface, being about 100 volts at the height of one meter. There are present in the air at all times both positively and negatively charged particles called ions, about 1,000 of each kind in a cubic centimeter of air, or 16,000 to the cubic inch, and with our instruments it is possible to count the number with fair accuracy.

"Intimately connected with the number of ions in the air is its electric conductivity, or its ability to carry an electric current. Whether penetrating radiation, or "cosmic rays" coming into the earth's atmosphere from outer space can be one of the causes of ionization of the air which increases its conductivity is another of the problems to be investigated.

"The amount of radio-active materials, such as radium and thorium, present in our atmosphere is collected and measured, this being another source of ionization. These investigations show that, under normal conditions, there is everywhere an electric current passing from the air into the earth. There is not enough of this current, however, to operate anything but a toy motor and we need never fear electrocution from this cause.



Captain Ault on the deck of the "Carnegie" inspecting the electrically operated non-magnetic winch which is equipped to reach a depth of 20,000 feet. The line was specially manufactured in Germany of aluminum-bronze which is also non-magnetic.

Radio Transmission Problems

"Recent investigations of variations in radio transmission with changing magnetic and electric conditions have led us to install a very complete radio equipment on the *Carnegie* for the first time. Short wave broadcasts will be received during the entire cruise and a definite program of transmission and reception is being arranged with the Naval Research Laboratory in Washington. Thus we will carry out experiments and investigations on the important problems of skip-distances and of variations in signal-intensity. Time signals will be received daily, thus adding to the accuracy of our time-keeping and consequently to the reliability of our geographical positions at sea.

"The mysteries of this vast, practically unknown expanse of atmosphere above the earth's surface and of the equally unexplored depths of the ocean await the pioneering spirit of a Langley or the inventive ingenuity of a Lord Kelvin. When inventive genius makes it possible to investigate the modifications in magnetic and electric variations due to change in altitude, many new and important discoveries will be made.

"The third general scientific problem to be investigated is known as oceanography, and we shall confine our attention to the physical and biological phases of this science. This will be a new field of research for the *Carnegie*.

"In spite of the considerable amount of information which has been accumulated by the various expeditions since the time of the *Challenger* voyage in 1872 to 1876, we have only a general idea of the contours of the ocean bed, and only a meager knowledge of the bottom sedimentary deposits which are of peculiar interest in the study of the age and formation of the earth and the changes which time has witnessed. The mapping of the configuration of these great basins covering over two-thirds of the earth's surface should be as important as the mapping of the land masses which occupy less than one-third. Such information will be useful in the study of movements within the earth's crust and of the origin, history, and probable future development of submarine earthquakes.

"So we have installed one of the recently perfected sonic depth-finders, loaned by the U. S. Navy Department, and we can determine in a few moments the depth of the ocean as the vessel is proceeding on her course. The method consists of measuring very accurately the time it requires for a signal sent out from the ship to travel to the bottom of the ocean and the echo to return to the ship again. Sound travels at the rate of about 4,800 feet, a little less than one mile, per second, so that if the time between the signal and the echo is two seconds, the depth is about 4,800 feet.

The Saltness of the Sea

"Some corrections to this assumed velocity are necessary on account of varying conditions of temperature and salinity, or salt content of the water, but we expect to measure these variations from time to time at various levels from the surface down to the bottom. We have limited ourselves to four miles of wire only so the bottom of the sea will be out of reach in some of the greater depths. Approximately six miles is the greatest depth yet measured by wire, the location being near the Philippine Islands.

"Water samples and temperatures will be secured by Nansen water-bottles and deep-sea reversing thermometers sent down to various levels, ten bottles being used on the wire at one time. The salinity and chemical content of each water sample will be determined immediately on board the vessel.

"Changes of temperature and salinity in vast bodies of water cause vertical movements which, combined with other relative movements due to wind and tide, make the ocean with its vast capacity for carrying heat a powerful factor in its influence upon practically every phase of life upon the earth, in its control of climate, and in its determining effect upon man's migration and habitation.

"Samples of muds and sediments from the bottom will be secured by use of various devices sent down on the end of the sounding wire. One sampler resembles the jaws of a turtle and is sent down open. When it strikes the bottom a spring catch is released and a specimen is snapped up in the jaws. In another device, a tube is forced into the bottom mud by a lead weight and a vertical section several inches long is brought up, the lead weight which forced the tube down being released and left on the bottom. It is now known that bottom-living creatures feed on organic matter found in bottom muds, and that these muds are often teeming with life. From a study of these organisms and fossil remains, together with borings from oil wells, important conclusions have been reached regarding the origin of oil-producing deposits.

The "Grass of the Sea"

"Perhaps the most fascinating study connected with the sea is the multitudinous life found in all oceanic waters from the surface down to the deepest abyss yet explored. Physical and chemical changes in the ocean-waters have profound influences upon marine life, its variety, its amount and its distribution. A knowledge of these influences will contribute in many ways not only to the study of evolutionary processes taking place in the sea but also to the practical problem of economic use of the ocean's food supply.

"The problems in marine biology are so many and so far-reaching that it has been necessary to confine our attention chiefly to microbiology, to determine the abundance and distribution of the so-called "grass of the sea," the plankton, and other small organisms such as diatoms, copepods, and foraminifera, which ultimately constitute the food supply of fishes and so for our own Friday dinner-tables.

"Silk tow-nets of various sizes, dip-nets, and water-bottles will be used to collect these organisms. A special double boat boom, called by Beebe a boom walk or glorified pirates' plank, has been rigged so that we can walk out over the water 30 feet from the ship's side, perhaps with more faith than did Peter of old, and there we may dip up surface swimming organisms or operate the surface nets, well away from the disturbing influences of the ship and its motion through the water. A diving helmet is a part of our equipment, so that in warm, clear, tropical waters we may descend 30 to 50 feet below the surface among the fishes, learn how they live and study and describe the wonders of the under-water world.

Conditions Affecting Climate

"A more extensive program of investigation in meteorology is being planned, in view of the important influence upon climate of mass movements of large bodies of heat-bearing oceanic waters. The study of the physical interchange of heat and moisture between the surface of the ocean and the air above it is important in the study of atmospheric circulation and the disturbances over the entire surface of the earth because of the fairly normal conditions which exist at sea.

"Variation in the amount of solar radiation received at the earth's surface and the influence of such variations upon world-wide weather conditions have been the subject of much study in recent years. It has been thought worth while to include such observations in our meteorological program, together with observations of cloud systems, rainfall, evaporation, dust-content and carbonic-acid content of the atmosphere. Increased data of these kinds over the great oceanic areas to be covered during this 110,000 mile cruise of the *Carnegie* may be extremely valuable in the comparison of world weather with solar variation, in the determination of the rate at which the atmosphere is being charged with water vapor so vital to life on the continents, and in the study of the dynamics of atmospheric circulation over the oceans."

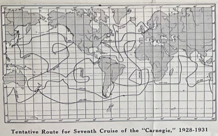
The Staff of Scientists

And so last Tuesday morning (May 1) this little vessel with her party of 25 men slipped quietly out into the Potomac, bound on a three-year cruise which it is hoped will add much of permanent value to our knowledge of the physical world, information that ultimately will be applied to the improvement of mankind.

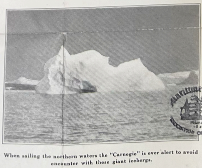
The scientists who have been selected to make the investigations are:

- Captain J. P. Ault, commander, and chief of scientific staff;
- Wilfred C. Parkinson, senior scientific officer (atmospheric electricity and photography);
- Oscar W. Torreson, navigator and executive officer (magnetism, navigation, and meteorology);
- F. M. Soule, observer and electrical expert (magnetism and physical oceanography);
- H. R. Seiwell, chemist and biologist (oceanography);
- J. H. Paul, surgeon and observer (medical work, meteorology, and oceanography);
- W. E. Scott, observer (navigation and commissary);
- Lawrence A. Jones, radio operator and observer (radio conditions and communication).

The Institution is fortunate in again having obtained the services of three officers of the sailing staff who were on board during the entire two years of the last cruise of the vessel. They are: A. Erickson, first watch-officer; C. E. Leyer, chief engineer; and F. Lyngdorf, steward.



Tentative Route for Seventh Cruise of the "Carnegie," 1928-1931



When sailing the northern waters the "Carnegie" is ever alert to avoid encounter with these giant icebergs.