OCEANOGRAPHY

Stealing Neptune's Secrets

Three-Quarters of Earth's Surface Still Unexplored But Scientists Are at Last Mapping Ocean's Depths

By RONALD L. IVES

THE EARTH, we like to tell ourselves, is now pretty thoroughly explored. Gone are the naive pre-Columbian days, when whole continents lay unsuspected beyond the seas. Gone are the secrets of the Poles; they have become mere winter resorts for hardy Russians. Darkest Africa is dark no longer; it is crisscrossed with motor roads. The drone of aircraft motors is heard daily over South America's steaming jungles and towering volcanic peaks.

Yet three-quarters of the surface of the earth's crust is still *terra incognita* to us. We know hardly more about the mountains and canyons, the rocks and sands of the ocean bottom than Alexander the Great knew about Iceland.

We have made some few faint scratches on the great areas on the map that are still shown in blank blue. Soundings have given rough ideas of the shape of the sea bottom along coasts and near harbors, especially where the bottom comes too close to the top, and menaces navigation. Venturesome souls have gone down as much as 500 feet in specially-built diving armor, and to a half mile in a bathysphere. But this is only dipping beneath the surface film. Some of the real deeps in the ocean go farther below sea level than Mount Everest rises above it!

Exploring the Unseen

Although it is quite unlikely that men will ever walk the bottoms of these Titan-drowning abysses, as Jules Verne once fancied they might, nevertheless we are going to learn about them. The blank spaces on the map are some day going to show the close-spaced contour lines that spell hills and valleys to him who knows how to read. And geologists are going to tell us what those hills and valleys are made of.

It's all done with machines. Scientists are ingenious folk; difficulties don't bother them much. If they want to know, they find out. And if they can't get to the "find out" place in person, they invent machines to do the job for them.

More than a century ago, mariners learned that the sands and gravels on the sea bottom were not everywhere the same. A blob of wax on the bottom of the sounding lead brought up sometimes gravel, sometimes sand, occasionally mud. By mapping the sea bottom sediments at different depths, they were able to navigate in dense fogs.

Later, trawlings brought up more sea bottom samples. Small meteorites and the bones of a baby dinosaur were dragged up from the bottom of the sea. What else was there? Diving suits were invented, and the frantic, often futile, attempts to recover the gold in sunken ships began.

Lost Appalachia

Then, only a few years ago, geologists found that certain mountain ranges were built of sediments that must have been washed away from ancient mountains. Tracing the ancient mountains, they found that they must have risen out of what is now the deep sea. Our Appalachian mountains are a good example. Their sediments must have come from an ancient hypothetical land mass called Appalachia. Where was Appalachia? Under the sea, off the Atlantic coast.

Long ago, when the first transatlantic cables were laid, engineers studied and mapped the profile of the sea bottom between Nova Scotia and Ireland. The sea floor was not flat, but had mountains and valleys just like the land. Later findings showed a ridge running the whole length of the Atlantic, from Iceland to east of Cape Horn. Was this the vanished Atlantis, or was it the ridge left when America broke loose from the eastern continents, before they drifted, or slid apart?

Structures under the sea, like the folds of land rocks; granite masses projecting upward through sandstones; great breaks in the bedrock, exposing older beds—these would give the answers. How should they be located? Certainly, wax on a sounding lead wouldn't give any indications of geologic structures, and when a thin layer of mud covered the rock of the sea floor the wax only brought up mud, giving no indication of the slightly-buried bedrock.

First, because it was most important, and because some studies had already been made, the geologists worked out new methods of finding the depth of the sea at any place. The old method, in which miles of cable, with a weight attached to the end, were reeled overside until the weight touched bottom, was too slow and costly. A day or more might be consumed in making one sounding; and when it is recalled that there are 140,000,000 square miles of sea, the hopelessness of getting a clear idea of the topography of the sea floor in any reasonable time, or at any reasonable cost, will be realized.

Cables used in the soundings sometime broke under their own weight. It takes a very strong steel piano wire to hold up the weight of six miles of its length. Soundings taken every mile might very well miss important deep sea structures. A canyon three-quarters of a mile wide might be missed completely by the old method. Tapered cables, becoming thicker near the top, solved part of the breakage problem, but they didn't reduce the time necessary for the making of a sounding. Something else had to be devised.

Sound in Water

Searching for a clue, scientists remembered that sound travels with a constant speed in water. Sound also reflects when the waves reach a hard surface. Why not send a sound wave down from a ship, record the time lapsed between sending it out and receiving the echo, and calculate the depth of the sea? Surely, if a car travels thirty miles an hour, exactly, for ten hours, it has gone 300 miles. If this is the round trip time to somewhere, the place is 150 miles away. Using the same reasoning, they developed a sonic depth finder that can make depth determinations in about as many seconds as the old cable-and-weight method took hours.

Using this sonic depth finder, accurate maps were made of the mouths of the important rivers of the world, and strange canyons, some of them as large as the Grand Canyon of Colorado, were found under the sea. Then, seeking more worlds to conquer, the geologists, most of them working in cooperation with the U. S. Coast and Geodetic Survey, went farther out to sea, explored the bottom of the Pacific, and found that the roughnesses of the sea floor were even greater than the older methods had shown. There are real mountains and valleys under the seas, just as there are on land.

Studies of submarine landscapes are still going on, and still producing surprising and astounding information each season.

While one group of researchers was finding out the shape of the sea floor, another was trying to find out just what rocks it was made of. From this, they hoped to determine just what had happened in the past. Some of this geologic history can be learned from studies of the continents, but the materials washed out to sea in the geologic past are, in general, still there, and only in the depths of the sea can good records of them be found.

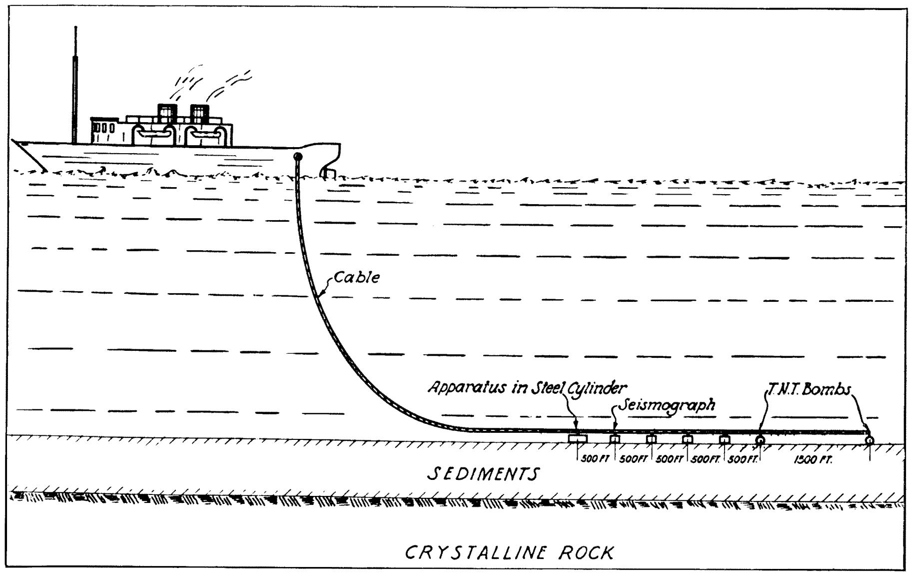
The first attempts at study of the sea bottom after the waxed weight method was made with an automatic "clamshell" bucket, hung below a sounding weight. Triggered like a mousetrap, the clamshell snapped out a sample of the sea bottom when it touched. This, while very successful, did not tell anything of the deeper rocks on the sea floor. Rock more than a few inches down could not be bitten out by any clamshell that could be made. Something else was necessary. What?

Punching Out Cylinders

Certainly, if a cylinder of the sea bottom, say ten feet long, could be drilled out, and brought to the surface, it would reveal much information unavailable by other methods. Geologists on land were already using this method regularly. They called it core drilling. Land methods, however, couldn't be used under the sea. Gasoline engines need air, and electrical equipment couldn't be made to work under the enormous pressures three miles down.

Drilling makes holes—so does punching! Why not punch out the cores with one giant blow, instead of slowly drilling them out? Dr. Charles Piggot, Carnegie Institution of Washington geophysicist, designed a "gun" to punch out the specimens. Using a powerful explosive charge to drive the core tube deep into the sea floor seemed to be the best scheme.

Experimental models didn't work as planned. The gun fired when it touched bottom, but it didn't bring up any core. Something must be wrong—something was! Under great pressure, water doesn't flow very well, and the water in the core tube wouldn't move out to let the rock particles move in.



TRAP FOR WAVES IN BOTTOM ROCK

Diagram shows apparatus designed by Dr. Maurice Ewing, Lehigh University physicist, for producing and studying sea floor artificial earthquakes three miles below the surface. Vibrations set up in the rock by the explosion of the bombs are recorded by the seismographs. All this works automatically after it is lowered to the sea floor.

Ever dive wrong, and land flat? Remember how hard the water was? That's how it acted in the core tube. Redesigning the tube so that the water could escape allowed the tube to be driven into the sea floor, but then it wouldn't pull out. Something else was wrong. When the cable pulled on the core tube, a vacuum was made under it, and it wouldn't pull out of the hole that it had punched in the sea bottom. Another set of openings, to let water back into the hole as the punch was pulled out, stopped this trouble.

Later, a thin brass tube was placed inside the punch part of the core gun. When the gun, with its core inside, was pulled to the surface, the brass tube containing the core could be easily removed from the gun, and used for a packing container until the ship docked.

Tracing Glaciations

Last summer, using this gun, and traveling aboard a cable repair ship borrowed for the purpose, Dr. Piggot took eleven samples of the sea bottom between America and Europe. Later, when the U. S. Geological Survey checked his cores, they found evidence of four ice ages, four warm periods, and two eras of violent volcanic activity. Measuring the cores, and checking the length of the most recent warm period at sea with that of the same period on land, they found that 200,000 years or so of geologic history was recorded in the ten-foot cores. Now Dr. Piggot plans to make a 15-foot core gun, which may extend the range of studies 100,000 years or so.

While the rocks themselves were being studied, the structures, like worn-away mountain ranges, filled river valleys, and volcanic beds, believed to be present under the sea, were not neglected. Geologists knew, from land studies, that certain rocks were heavier than others.

Pull on a Pendulum

If a pendulum clock is placed in an area underlain by abnormally heavy rocks, it will run fast, while if the rocks are abnormally light, the clock will be slow. This is the principle of the gravity method of structure determination used in the hunt for oil fields. Why not apply it to sea studies? Troubles arose. A ship at sea rolled—it couldn't be fastened down very firmly. It might drift. In short, it wasn't a very good station for gravity observations.

Dr. A. Vening Meinesz, Dutch geophysicist, decided that a submarine would be a better ocean laboratory than a ship. It could submerge, escaping the annoying surface disturbances. Designing a special pendulum clock which could not be greatly influenced by slight motion of the sub- (*Turn to page 106*)

From Page 103

marine, Dr. Meinesz dived into the Atlantic's depths, and later came forth with information that Cuba, one range of the Andes, and part of Mexico are geologically connected.

Undersea extensions of the great areas where earthquake movements and volcanic eruptions are most common have already been found, and the studies are only beginning.

Working from the data already at hand, Dr. Richard M. Field of Princeton University's department of geology suggested that there might be, under the Atlantic, a great ancient foundered continent, complete with hills and valleys, river beds and plateaus, just like any other continent. Under this theory, the great mid-Atlantic ridge might very well have once been that continent's backbone.

Artificial Earthquakes

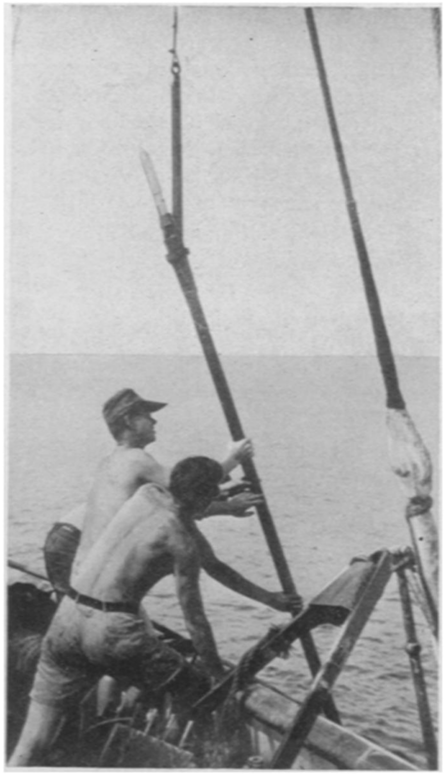
New methods of study are already at hand. Dr. Maurice Ewing, Lehigh University physicist, recently announced the successful completion of a series of machines for creating sea-floor earthquakes and studying them. Geologists on land, from studies of the waves of natural and artificial earthquakes, can locate structures buried too deeply to be found from any surface indications. At sea, the problem is more difficult, but if instruments could be placed on the sea bottom, there was no reason why the same facts might not be learned from them.

Dr. Ewing's problem was very simple. Just work out a way of using the machines several miles below the surface. Easy—well, not quite. Everything had to operate automatically, three miles below the surface. Recently, using instruments and bombs strung out along a cable, which can be lowered to the sea floor, and which will work without human attention after they are in place.

Chemical Oceanography

Dr. Ewing found that the method actually could be made to work in practice. Time bombs, instead of being dread instruments of destruction in wartime, have become useful scientific instruments.

Chemical action in the oceanic depths also interests geologists, who hope to learn from its study just why oceanic deposits differ from land deposits. Perhaps we have, tucked away in some field notebook, the unrecognized evidence of an ancient sea that is now dry land.



NOT VERY EASY

Scientific work is sometimes hard labor. Here, sweating scientists are dragging the bit of a deep sea core gun aboard their ship. Later, the core will be taken out, dried, and carefully kept for study ashore at the end of the field season.

Radium in the sea's depths is present in greater quantities than in any ordinary rock on the land. Microscopic life forms, like those that collect iron and manganese, may, far under the sea, absorb radium, causing this great concentration. Other minerals are present in quantities that are hard to explain. Gold, long known to be present in the sea, is only one of the many minerals that dissolve in sea water—given enough time.

Subsea research is the most recent and until a few years ago the most neglected geologic field. Many generations of work will be necessary before the depths of the sea are as well known as the land areas, but with their clever and costly remote-control instruments, the geologists, geophysicists and oceanographers are recovering lost chapters in earth's history from Davy Jones' Locker.

This article was edited from manuscript prepared by Science Service for use in illustrated newspaper magazines.

Science News Letter, February 12, 1938

CLIMATOLOGY

Years of Drought Coming To Great Basin, is Warning

YEARS of drought, like the seven lean years of Joseph's Egypt, are due to grip the Great Basin area of the West, Dr. Ernst Antevs of the Carnegie Institution of Washington prophesies in a new publication of the American Geographical Society.

Dr. Antevs has made a special study of climatic cycles that swing over long periods of time. He finds that the downcurve in Far Western rainfall has already begun, and states that it is due to reach its climax in a terrific drought about ten years hence.

The region for which Dr. Antevs makes his forecast lies between the Wasatch mountains and the Sierras, comprising a total of about 175,000 square miles in the states of California, Nevada, Utah, Idaho, and Oregon. He feels that farmers and stockmen in this region should make long-range plans to meet the situation.

Science News Letter, February 12, 1938

BIOGRAPHY

American Institute Medal Awarded to Dr. Crocker

THE GOLD medal of the American Institute was awarded to Dr. William H. Crocker, director of the Boyce Thompson Institute for Plant Research at Yonkers, N. Y., at a dinner in New York City on the evening of Feb. 3.

The Institute, which for a century has fostered science and invention in New York City, also granted fellowship awards to Waldemar Kaempffert, science editor of the *New York Times* and to Dr. Raymond L. Ditmars, veteran curator of mammals and reptiles of the New York Zoological Gardens.

Dr. Crocker received the gold medal for his contributions to the knowledge of life processes in plants and his leadership of research at the Boyce Thompson Institute. Mr. Kaempffert, who is also president of the National Association of Science Writers, received his fellowship award for "his scholarly interpretation of scientific advances and for his editorial wisdom." Dr. Ditmars, who is widely known for his popular books on reptiles and other animals, was granted his fellowship award for "his 37 years of distinguished service in the care, understanding and interpretation of the reptile world."

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