OCEANOGRAPHY

Ocean Floor Deposits

Core Samples, Brought Up by Deep Sea Gun, Reveal Secrets of Strange Red Clay Under Deepest Waters

A STRANGE carpet covers the floor of Neptune's realm—ultimate retreat of darkness and silence in the great ocean deeps.

It is woven in various patterns from fine threads spun out through millions of years by the chemical weavers of life, and spread over the bottom of the seas. Great patches are composed of the shells of tiny sea-dwelling plants and animals. But strangest of all is the extremely fine "clay," containing no coarse sand or bits of shells, that is found under some of the deepest waters, especially in the Pacific.

This material turns a rusty red when brought to the surface and exposed to air. For this reason it is called "red clay," although it cannot be considered clay in the strict sense of the word as used by mineralogists. The thickness of the covering of the deep sea bottom rocks is as yet uncertain, but it may amount to several hundred feet.

That there is such a carpet has been known for more than half a century, since the time when the first specimens were obtained by the British Challenger expedition. New light on the nature and properties of this material has come from recent investigations of Dr. Charles S. Piggot and Dr. William D. Urry of the Geophysical Laboratory of the Carnegie Institution of Washington.

Unknown Until Recently

Until about five years ago the sea bottom at great depth was essentially unknown. The best samples that could be obtained were shallow scrapings, or bites from its surface. From these had to be derived all man's knowledge of nearly three-fourths of the surface of the planet on which he lives. New knowledge can now be had through the invention by Dr. Piggot of a deep sea gun by which core samples as long as fifteen feet have been obtained, and even longer ones may be secured in the future.

In several fields of oceanography Dr. Piggot's gun already has brought significant results. Cores with alternating layers of silt, sand, and shells from the North Atlantic, for example, have provided a new calendar of the distant past with its recurring ice ages. But probably the most significant new knowledge is now coming from studies by Dr. Piggot and Dr. Urry on the radioactivity of the various samples, and their efforts to resolve an apparent paradox arising from the extreme richness in the element radium relative to the content of this element in sea water and land rocks.

Rains and winds are continually sweeping the mud and dust of the earth into the sea through the processes of erosion. A minute portion of this material consists of the element uranium, together with traces of its daughter element, ionium, and its granddaughter element, radium. The uranium apparently remains dissolved in the sea water but the ionium and radium do not. They settle slowly to the bottom to become part of the covering of the ocean floor.

Follows Usual Fate

But the uranium in the sea suffers the fate of uranium everywhere. As in the case of certain other elements its atoms are unstable, this instability being measured by the length of time during which half of its atoms are changed into other substances. During approximately 4,500,000,000 years half the atoms of any given amount of uranium explode to produce atoms of the daughter element, ionium. About half of these ionium atoms explode during 82,000 years to produce the granddaughter element, radium. Once the ionium comes into existence, it settles to the bottom and produces radium there. Thus for two reasons, the radium is concentrated in the surface of the carpet covering the ocean floor. Millenium after millenium the process continues while the carpet is being woven thicker and thicker.

In rocks on land there is an established relation between the content of radium and uranium. When radium itself breaks up—its half life is 1700 years—it changes into a form of lead. The amount of this lead relative to the amount of uranium constitutes a quite exact measure of the age of the rocks.

But in the seas is found a paradox. There is about fivefold as much uranium as is needed to maintain the radium content of the water. This content is very low indeed, only about a thousandth of the radium content of sedimentary rocks on land and a ten-thousandth that of igneous rocks, such as the granites. But it is only a 170,000th of the radium content of the red clay found in the ocean deeps and only a 60,000th of that of the globigerina ooze which occurs in shallow water.

The reason for these differences becomes clear from the present studies of Dr. Piggot and Dr. Urry. Sea water does not hold radium and does not release uranium. Thus the radioactivity of the bottom constantly is being built up at the expense of the radium content of the ocean itself.

The red clay of the deep sea bottoms is about fifteen fold richer in radium than the average rocks on land, but the total amount is so small that it is entirely impossible to detect it by present methods of chemical analysis. The amount can be measured quite accurately, however, by various physical devices, and it turns out to be about two ounces in a million tons. The same amount can be extracted from a few tons of a good uranium ore, such as pitch-blende, which is found in the Belgian Congo and at Great Bear Lake in northern Canada. Even if the sea bottom could be reached easily, radium mining there would remain a poor field for investment.

The radium constantly accumulating in the sea floor suffers the same fate as other radium. In 1700 years half of any given amount "explodes" and ultimately becomes lead. Thus if the hypothesis of Piggot and Urry is correct, one would expect that the richest deposits would be nearer the surface and that they would grow poorer and poorer with depth until eventually they reached about the average concentration of rocks on land. This is exactly what the core measurements show.

Two Implications

This has two important implications, one negative and one positive. When the radium richness of the bottom was first discovered and before any adequate theory had been formulated to account for it, a geologist might have assumed that the same condition held through the entire thickness of the deposited materials. This would have implied an enormous concentration of radium and an enormous generation of energy in the form of heat from its disintegration, that might have had far-reaching geophysical effects, but this hypothesis can now be discarded.

The second implication is that science now has a tool to aid in measuring the age of the sea bottoms and, indirectly, of the seas themselves. Knowing the rate of transmutation of ionium to radium, and assuming that the rate of deposition of the radioactive materials has been fairly constant, the time required for the accumulation of a given thickness of the deposited material can be calculated from its radium content. The principal ocean basins, many geologists now believe, always have been in the approximate positions they now occupy. Hence if the thickness of the carpet and its rate of growth can be ascertained, the age of the sea itself can also be calculated. This, in turn, will be an approximate measure of the time since the cooling of the earth.

The manner in which the red clay is formed remains a mystery, although some speculations are now in order.

First, Drs. Piggot and Urry explain, it has been found only under deep water, far from land. Presumably the floor of the ocean is built up slowly, millenium after millenium, from the debris of the land sinking slowly to the bottom. Near the shores where the water is relatively shallow, not much more than two miles deep anywhere, this debris consists of the varied materials which the continents give to the seas, through the mouths of their great rivers, the winds sweeping seaward, the icebergs dislodged from the glaciers with all that they have scraped from the land over which they have moved. All this will be found in the bottom sediments modified by such changes as have been brought about by the chemical action of sea water. There will also be found here the skeletons and shells of the creatures that have lived and died in the sea, a very significant fact indeed for the paleontologist who, by means of these skeletons or their preserved imprints in the mud, is able to reconstruct a picture of life on earth for millions of years.

But the red clay of the ocean depths is not of the same character as the debris of the continents deposited within a few hundred miles of the shores. Furthermore, there is little direct evidence of the remains of life in it—just bacteria and some lowly worms. This was a rather astonishing fact when first ascertained, because the upper waters of the oceans teem with life everywhere. Especially abundant are those almost microscopic plants, the diatoms, and minute, shell-covered animals, the foraminifera. But the red clay gives almost no evidence of their remains, although such skeleton debris makes up almost entirely another type of sea bottom material, the so-called globigerina oozes, which are found under shallower waters. The hypothesis that now is taking shape is that the red clay is some subtle death distillate out of life and the sea waters themselves. Of the actual process there is as yet no definite understanding. But countless billions of tiny plants and animals are constantly dying and sinking slowly to the bottom. It may require years for them to sink through miles of water and during this time their shells may dissolve and disappear. Meanwhile the water acts on the bits of organisms which filled the shells, perhaps entering into chemical reactions with them, to form the red clay which carpets the deep ocean floor. It is not yet proved that the clay is formed in this way, but such a line of reasoning provides a satisfactory working hypothesis.

SAMPLING THE DEPTHS

This is a mobile deep-sea sounding winch, which may be moved from one vessel to another. In this photograph, it is shown operating on the S. S. American Seaman in Nark Deep off Puerto Rico. The winch contains 5,300 fathoms of wire rope.

The red clay is found, so far as is known, nowhere else on earth but on the bottoms of the deep oceans. This in itself is highly significant, since it indicates that the ocean basins have remained essentially in their present positions since first being formed. Sea bottom, of course, constantly is being upheaved to form mountains and mountains are becoming sea bottom. For example, the present Appalachians, as is evident from the marine fossils in their rocks, have been under shallow seas at various geological periods and much of North America has been covered by the sea, not only once but several times. But this does not affect the broad picture of the essential permanence of the major parts of the principal oceans themselves. There is a constant interchange between the continents and the edges of the seas which wash their shores, but there is no indication that the bottom of the ocean deeps has ever been dry land. There are various reasons for believing this, and the failure of geologists to find the red clay strata anywhere else goes far towards confirming it.

Presumably, Drs. Piggot and Urry say, the ocean came into being as soon as the surface of the earth cooled below the condensation point of water, and the red clay under the deeper portions has been in process of formation ever since.

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