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## THE ORGANIC ORIGIN OF THE EARTH'S CRUST.

A popular theological dogma declares that life is the grand object of creation, that the composition as well as the contour of the earth's surface has special reference to its habitability, and that all things show a ruling design to fit the world to be the home of sentient creatures, more especially of man.

Strictly speaking, Science has nothing to do with such dogmas. It has no means of discovering the ultimate purposes of things, and no time to waste on their discussion. Nevertheless it is difficult sometimes not to take an indirect interest in the claims of those who presume to decide such questions, at least so far as to notice how aptly the facts of Nature contradict their assertions. Thus in the present case, it would be much easier to sustain the contrary thesis, namely, that so far from having been made what it is that it might be inhabited, the earth became what it is through being inhabited; in short, that life has been the means, not the end, of the earth's development.

In the light of recent discoveries, Byron's poetic extravagance: "The dust we tread on was alive!" becomes a simple statement of observed fact. And the earlier and more paradoxical assertion of Linnæus, that not the superficial dust merely but the very framework of the earth is the product of life, would seem to be equally true. "Fossils are not the children but the parents of rocks," he said; and Huxley declares that the whole effect of the discoveries made since his day has been to complete a larger and larger commentary on his words. The deeper we go into the history of the earth's crust, the greater the part we find to have been played by life in determining its composition and character. Even the rocks heretofore accounted azoic, and of an age anterior to the beginning of life, are now shown to be, in all probability, of organic origin; still more remarkable, as in process of formation to-day.

The observations of Dr. Hooker during Sir James Ross's voyage of antarctic exploration, confirmed by those of Dr. Wyville Thompson on the Challenger expedition, leave no doubt that the antarctic sea bottom, from the fiftieth parallel to the eightieth, perhaps to the pole, if the sea extends so far, is being covered with a fine deposit of silicious mud composed of the shells of diatomaceous vegetation, the skele-

tons of radiolarian animals (all microscopic and inhabiting the surface water) with the spicula of sponges which live on the bottom. In many parts of the arctic sea beds, a similar deposit is known to be in process of formation. Thus, through the agency of minute life, immense beds of silicious rock are forming in the polar regions, similar in character to those of early geological strata. In many cases the soft and friable fine-grained sandstones thus formed in fresh water have been changed by the action of percolating water into a dense, semi-transparent, opaline stone; and there is no reason to doubt that the same metamorphic agencies may convert the polar deposits likewise into a form of quartzite, a kind of rock whose organic origin was formerly unsuspected.

Throughout the broad belt of warmer water between the polar caps of silicious mud, the same accumulations are going on, but they are obscured and overpowered by an immensely greater amount of calcareous sediment, chiefly composed of the skeletons of dead *foraminifera*, also microscopic. This forms the *globigerina* ooze, containing a large percentage of carbonate of lime and a small percentage of silica: a chalky deposit capable of conversion into limestone and even crystalline marble by ordinary metamorphic agencies.

The formation of coral reefs has long been a favorite illustration of the gigantic results effected by minute organisms; but great as these are—and the longest coral reef extends, like a huge wall two thousand feet high, as far as from Boston to Chicago—the work of the little reef builders becomes insignificant in comparison with the *débris* of microscopic life which covers the beds of all the seas to unknown depths; while the coralline limestones of the continents, vast and massive as they are, are immensely overbalanced by the strata which undoubtedly owe their existence to minute plants and animals.

The cretaceous *globigerina* ooze is the most widely spread material of the sea bottom throughout all the great oceans, at depths from a few hundred to over two thousand fathoms. In shallower waters—and they are extensive—the gray ooze is slowly transformed into a green deposit identical in character with the greensands of the geologists: a formation which Ehrenberg found to be mainly made up of casts in a silicate of lime and alumina of the interior cavities of *foraminifera*, after Professor Baily had discovered that such was the origin of the greenish mud from the sea bottom off the Florida coast. "In these casts, the minutest cavities and finest tubes in the *foraminifera* were sometimes reproduced in solid counterparts of the glassy mineral, while the calcareous original had been entirely dissolved away." In other places, in the Gulf of Mexico, in the South Atlantic, and in the Pacific, the same transformation of *globigerina* ooze to greensand is going on.

But the most remarkable change goes on in the extreme depths of the sea, especially below 3,000 fathoms. Professor Thompson reports that, in crossing from the shallower regions occupied by the ooze into the deeper surroundings, the calcareous formation is found universally to pass gradually into an extremely fine, pure clay, which occupies, speaking generally, all depths below 2,500 fathoms, and consists almost entirely of a silicate of a red oxide of iron and alumina. "The transition is very slow, and extends over several hundred fathoms of increasing depth; the shells gradually lose their sharpness of outline, and assume a kind of 'rollen' look and a brownish color, and become more and more mixed with an amorphous red-brown powder, which increases steadily in proportion until the lime has almost entirely disappeared." The geological importance of this red clay formation is shown by the fact that, in sounding between Teneriffe and Sombbrero, a distance of about 2,700 miles, two areas of red clay (aggregating 1,900 miles across) were discovered.

From his studies of the character and distribution of the red clay, Professor Thompson concludes that it is not a substance introduced from without, but that it is produced by the removal, by some means unknown, of the carbonate of lime which forms something like 98 per cent of the material of *globigerina* ooze; that it is, in fact, the ash or insoluble residue of calcareous organisms: a supposition sustained by the reddish mud, consisting of silica, aluminas, and red oxide of iron, that remains after treating the ooze with a dilute acid. But one test remains to be tried to give, if successful, the highest probability to Professor Thompson's conclusion; and that is the chemical examination of *globigerina*, diatoms, and the rest, taken in the open sea for the constituents of the red clay. This done, we might rest satisfied that the clay is, as Professor Thompson believes, an essential element of the organic part of the ooze, and therefore to be classed, with chalk, as an organic product, not, as heretofore supposed, as in all cases the result of the disintegration of older rocks. The significance of this admission of clay to the list of organic products can scarcely be over-estimated, for it compels us to push back the probable antiquity of life to periods so remote that the Lower Silurian epoch becomes relatively modern. It is, as Professor Thompson observes, impossible to avoid associating the red clays of existing deep seas with the fine, smooth, homogeneous clays and schists of the remotest geological periods, formations which, more or less metamorphosed, obtain such a vast thickness in the so-called azoic strata.

Reviewing the results of the Challenger expedition in this field of research, Professor Huxley, assuming the correctness of Professor Thompson's hypothesis, shows how, by the agency of the microscopic plants and animals which are filling existing seas with silicious, cretaceous, and clayey sediments, the entire crust of the earth might have been developed. "Just as a silicious deposit may be metamorphosed into opal or quartzite," he says in conclusion, "and chalk

into marble, so known metamorphic agencies may metamorphose clay into schist, clay slate, slate, gneiss, or even granite. And thus by the agency of the lowest and simplest of organisms, our imaginary globe might be covered with strata of all the chief kinds of rocks of which the known crust of the earth is composed, of indefinite thickness and extent."

The agency of organic acids in precipitating from chalybeate and other mineral waters our beds of iron ore, our veins of copper and other metals, according to Professor T. Sterry Hunt, falls in here as another indication of the vast, almost omnipotent, influence of life in determining the earth's mineral character, and consequently its geology, geography, flora, fauna, and the rest.

## PROGRESS OF RAPID TRANSIT IN NEW YORK CITY.

The State Legislature has granted authority to the Elevated Railway Company, to extend its line northerly to the Harlem river, and it is said that the new work will soon be commenced. At present there is a single track supported on single iron posts over the sidewalk, commencing at the southerly end of Greenwich street, near the North river, and extending north as far as 30th street on Ninth avenue, a distance of 3½ miles. It is well patronized, but its capacity is limited. Under the new powers given to the corporation, the work is to be enlarged. The company has lately repaired the present track, put on wooden crossties, changed the gage, etc. A small space is left between each crosstie, and the bed of the road is not, therefore, quite a complete deck. The *Railroad Gazette* questions the propriety of using these crossties, believing them to be unnecessary in respect to strength, and likely to result in annoyance to pedestrians, owing to the drip caused by rain and snow.

With a view to strengthen the track, the Company has also lately added four braces or struts to each column, extending from the upper part of the column to the under sides of the track girders, with a longitudinal reach of about three feet. The *Gazette* says: "Whatever may be the object of these struts, their actual effect is the transmission of unbalanced longitudinal side thrusts to the columns, which bend, quite perceptibly, from the direction of approaching trains. These columns are ill suited to withstand side thrusts, and the frequent application of such can hardly fail to prove injurious. As every train bends all the columns over which it passes, more or less, it may be found a wise economy, in prolonging the life of the structure, to entirely remove these struts, which have just been attached at no small expense."

We are sorry that our cotemporary is not better satisfied with the improvements that have been made. Its fears as to the effects of the struts on the stability of the columns are in our view unnecessary. The Company appears to have done the best it knew how under the circumstances, and all the patrons of the road are pleased with the improvements.

A portion of the new Underground Railway, on Fourth avenue, has just been opened for traffic, namely, from the Grand Central Depot at 42nd street, northerly to 98th street, over two miles. All the trains of the Harlem, Hudson River, and New Haven Companies now run underground, and their withdrawal from the surface of Fourth avenue gives great satisfaction to the inhabitants residing on the line. The vibration produced by the passage of trains is scarcely noticeable in the adjoining houses. The avenue surface above the railway tunnels is now being repaved, and will soon present a most beautiful, attractive appearance. A stranger in passing through this portion of the avenue would be surprised if told that, directly under his feet, the trains of three great railways were flying along at lightning speed. The forty-two locomotives are no longer seen or heard.

The underground tunnels are three in number, built side by side, consisting of a central single arch tunnel of 26 feet 8 inches width in the clear, for two tracks, and two single-track tunnels, 16 feet wide, one on each side of the central. The central tunnel is spacious, well aired, and tolerably well lighted, by frequent central openings through the roof. It is a complete success, being much more pleasing to the traveler, and far better ventilated, than any of the tunnels of the London Underground railways. The single track tunnels, however, are defective in respect to ventilation; but they could be easily rendered satisfactory by the use of mechanical means for introducing additional air.

The value of property along this portion of the line has augmented since the tunnels were authorized. The same may be said of property at the northerly or Harlem portion of the avenue, where the tracks, although not arched, are placed below the street surface, and bridged at the street crossings. But the contrary is the case along that portion occupied by the viaduct, from 98th to 116th street. The solid granite walls of this structure occupy the central portion of the avenue, for a width of 50 feet, and rise from 10 to 30 feet above the street surface. The prospect of a blank stone wall directly in front of one's window is not considered very inviting by householders, and the price of property here is comparatively low.

The State Legislature has also passed a general law, under which commissioners may be appointed in any city in the State, with power to locate a steam railway, and convey a franchise for construction, to stock subscribers.

## GREAT GUNS.

It was thought by our government, not long ago, that a 15-inch cast iron gun, able to throw a 500 lbs. ball a distance of three miles, was about as big a thing in the way of armament as would ever be wanted. And so the forts in New York harbor and other places were supplied with them at great expense. The visitor at Forts Hamilton and Tompkins, down the bay, will see long rows of these grim monsters, arranged in battle line, vainly waiting for employment