Young Folks' Library:
Wonders of Earth, Sea and Sky

by

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The Marvels Of Nature

By

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The Earth, the Sea, the Sky, and their wonders—these are the themes of this volume. The volume is so small, and the theme so vast! Men have lived on the earth for hundreds of the sands of years; and its wonders have increased, not diminished, with their experience.

To our barbarous ancestors of centuries ago, all was mystery—the thunder, the rainbow, the growing corn, the ocean, the stars. Gradually and by slow steps they learned to house themselves in trees, in caves, in huts, in houses; to find a sure supply of food; to provide a stock of serviceable clothing. The arts of life were born; tools were invented; the priceless boon of fire was received; tribes and clans united for defence; some measure of security and comfort was attained.

With security and comfort came leisure; and the mind of early Man began curiously to inquire the meaning of the mysteries with which he was surrounded. That curious inquiry was the birth of Science. Art was born when some far-away ancestor, in an idle hour, scratched on a bone the drawing of two of his reindeer fighting, or carved on the walls of his cave the image of the mammoth that he had but lately slain with his spear and arrows.

In a mind that is completely ignorant there is no wonder. Wonder is the child of knowledge—of partial and imperfect knowledge, to be sure, but still, of knowledge. The very first step in Science is to make an inventory of external Nature (and by and by of the faculties of the mind that thinks). The second step is to catalogue similar appearances together. It is a much higher flight to seek the causes of likenesses thus discovered.

A few of the chapters of this volume are items in a mere catalogue of wonders, and deserve their place by accurate and eloquent description. Most of them, however, represent higher stages of insight. In the latter, Nature is viewed not only with the eye of the observer, but also with the mind's eye, curious to discover the reasons for things seen. The most penetrating inward inquiry accompanies the acutest external observation in such chapters as those of Darwin and Huxley, here reprinted.

Now, the point not to be overlooked is this: to Darwin and Huxley, as to their remote and uncultured ancestors, the World—the Earth, the Sea, the Sky—is full of wonders and of mysteries, but the wonders are of a higher order. The problems of the thunder and of the rainbow as they presented themselves to the men of a thousand generations ago, have been fully solved: but the questions; what is the veritable nature of electricity, exactly how does it differ from light, are still unanswered. And what are simple problems like these to the questions: what is love; why do we feel a sympathy with this person, an antipathy for that; and others of the sort? Science has made almost infinite advances since pre-historic man first felt the feeble current of intellectual curiosity amid his awe of the storm; it has still to grow almost infinitely before anything like a complete explanation even of external Nature is achieved.

Suppose that, at some future day, all physical and mechanical laws should be found to be direct consequences of a single majestic law, just as all the motions of the planets are (but—are they?) the direct results of the single law of gravitation. Gravitation will, probably, soon be explained in terms of some remoter cause, but the reason of that single and ultimate law of the universe which we have imagined would still remain unknown.

Human knowledge will always have limits, and beyond those limits there will always be room for mystery and wonder. A complete and exhaustive explanation of the world is inconceivable, so long as human powers and capacities remain at all as they now are.

It is important to emphasize such truths, especially in a book addressed to the young. When a lad hears for the first time that an astronomer, by a simple pointing of his spectroscope, can determine with what velocity a star is approaching the earth, or receding from it, or when he hears that the very shape of the revolving masses of certain stars can be calculated from simple measures of the sort, he is apt to conclude that Science, which has made such astounding advances since the days of Galileo and Newton, must eventually reach a complete explanation of the entire universe. The conclusion is not unnatural, but it is not correct. There are limits beyond which Science, in this sense, cannot go. Its scope is limited. Beyond its limits there are problems that it cannot solve, mysteries that it cannot explain.

At the present moment, for example, the nature of Force is unknown. A weight released from the hand drops to the earth. Exactly what is the nature of the force with which the earth attracts it? We do not know, but it so happens that it is more than likely that an explanation will be reached in our own day. Gravity will be explained in terms of some more general forces. The mystery will be pushed back another step, and yet another and another. But the progress is not indefinite. If all the mechanical actions of the entire universe were to be formulated as the results of a single law or cause, the cause of that cause would be still to seek, as has been said.

We have every right to exult in the amazing achievements of Science; but we have not understood them until we realize that the universe of Science has strict limits, within which all its conquests must necessarily be confined. Humility, and not pride, is the final lesson of scientific work and study.

The choice of the selections printed in this volume has been necessarily limited by many hampering conditions, that of mere space being one of the most harassing. Each of the chapters might readily be expanded into a volume. Volumes might be added on topics almost untouched here. It has been necessary to pass over almost without notice matters of surpassing interest and importance: Electricity and its wonderful and new applications; the new Biology, with its views upon such fundamental questions as the origins of life and death; modern Astronomy, with its far-reaching pronouncements upon the fate of universes. All these can only be touched lightly, if at all. It is the chief purpose of this volume to point the way towards the most modern and the greatest conclusions of Science, and to lay foundations upon which the reading of a life-time can be laid.

What The Earth's Crust Is Made Of

"Stand still and consider the wondrous works of God."

What is the earth made of—this round earth upon which we human beings live and move?

A question more easily asked than answered, as regards a very large portion of it. For the earth is a huge ball nearly eight thousand miles in diameter, and we who dwell on the outside have no means of getting down more than a very little way below the surface. So it is quite impossible for us to speak positively as to the inside of the earth, and what it is made of. Some people believe the earth's inside to be hard and solid, while others believe it to be one enormous lake or furnace of fiery melted rock. But nobody really knows.

This outside crust has been reckoned to be of many different thicknesses. One man will say it is ten miles thick, and another will rate it at four hundred miles. So far as regards man's knowledge of it, gained from mining, from boring, from examination of rocks, and from reasoning out all that may be learned from these observations, we shall allow an ample margin if we count the field of geology to extend some twenty miles downwards from the highest mountain-tops. Beyond this we find ourselves in a land of darkness and conjecture.

Twenty miles is only one four-hundredth part of the earth's diameter—a mere thin shell over a massive globe. If the earth were brought down in size to an ordinary large school globe, a piece of rough brown paper covering it might well represent the thickness of this earth-crust, with which the science of geology has to do. And the whole of the globe, this earth of ours, is but one tiny planet in the great Solar System. And the centre of that Solar System, the blazing sun, though equal in size to more than a million earths, is yet himself but one star amid millions of twinkling stars, scattered broadcast through the universe. So it would seem at first sight that the field of geology is a small field compared with that of astronomy....

With regard to the great bulk of the globe little can be said. Very probably it is formed through and through of the same materials as the crust. This we do not know. Neither can we tell, even if it be so formed, whether the said materials are solid and cold like the outside crust, or whether they are liquid with heat. The belief has been long and widely held that the whole inside of the earth is one vast lake or furnace of melted fiery-hot material, with only a thin cooled crust covering it. Some in the present day are inclined to question this, and hold rather that the earth is solid and cold throughout, though with large lakes of liquid fire here and there, under or in her crust, from which our volcanoes are fed....

The materials of which the crust is made are many and various; yet, generally speaking, they may all be classed under one simple word, and that word is—*Rock*.

It must be understood that, when we talk of rock in this geological sense, we do not only mean hard and solid stone, as in common conversation. Rock may be changed by heat into a liquid or "molten" state, as ice is changed by heat to water. Liquid rock may be changed by yet greater heat to vapor, as water is changed to steam, only we have in a common way no such heat at command as would be needed to effect this. Rock may be

hard or soft. Rock maybe chalky, clayey, or sandy. Rock may be so close-grained that strong force is needed to break it; or it may be so porous—so full of tiny holes—that water will drain through it; or it may be crushed and crumbled into loose grains, among which you can pass your fingers.

The cliffs above our beaches are rock; the sand upon our seashore is rock; the clay used in brick-making is rock; the limestone of the quarry is rock; the marble of which our mantel-pieces are made is rock. The soft sandstone of South Devon, and the hard granite of the north of Scotland, are alike rock. The pebbles in the road are rock; the very mould in our gardens is largely composed of crumbled rock. So the word in its geological sense is a word of wide meaning.

Now the business of the geologist is to read the history of the past in these rocks of which the earth's crust is made. This may seem a singular thing to do, and I can assure you it is not an easy task.

For, to begin with, the history itself is written in a strange language, a language which man is only just beginning to spell out and understand. And this is only half the difficulty with which we have to struggle.

If a large and learned book were put before you and you were set to read it through, you would perhaps, have no insurmountable difficulty, with patience and perseverance, in mastering its meaning.

But how if the book were first chopped up into pieces, if part of it were flung away out of reach, if part of it were crushed into a pulp, if the numbering of the pages were in many places lost, if the whole were mixed up in confusion, and if *then* you were desired to sort, and arrange, and study the volume?

Picture to yourself what sort of a task this would be, and you will have some idea of the labors of the patient geologist.

Rocks may be divided into several kinds or classes. For the present moment it will be enough to consider the two grand divisions—*Stratified rocks* and *Unstratified rocks*.

Unstratified rocks are those which were once, at a time more or less distant, in a melted state from intense heat, and which have since cooled into a half *crystalized* state; much the same as water, when growing colder, cools and crystallizes into ice. Strictly speaking, ice is rock, just as much as granite and sandstone are rock. Water itself is of the nature of rock, only as we commonly know it in the liquid state we do not commonly call it so.

"Crystallization" means those particular forms or shapes in which the particles of a liquid arrange themselves, as that liquid hardens into a solid—in other words, as it freezes. Granite, iron, marble, are frozen substances, just as truly as ice is a frozen substance; for with greater heat they would all become liquid like water. When a liquid freezes, there are always crystals formed, though these are not always visible without the help of a microscope. Also the crystals are of different shapes with different substances. Crystallization may take place either slowly or rapidly, and either in the open air or far below ground. The lava from a volcano is an example of rock which has crystallized rapidly in the open air; and granite is an example of rock which has crystallized slowly underground beneath great pressure.

Stratified rocks, on the contrary, which make up a very large part of the earth's crust, are not crystallized. Instead of having cooled from a liquid into a solid state, they have been slowly *built up*, bit by bit and grain upon grain, into their present form, through long ages of the world's history. The materials of which they are made were probably once, long, long ago, the crumblings from granite and other crystallized rocks, but they show now no signs of crystallization.

They are called "stratified" because they are in themselves made up of distinct layers, and also because they lie thus one upon another in layers, or *strata*, just as the leaves of a book lie, or as the bricks of a house are placed.

Throughout the greater part of Europe, of Asia, of Africa, of North and South America, of Australia, these rocks are to be found, stretching over hundreds of miles together, north, south, east, and west, extending up to the tops of some of the earth's highest mountains, reaching down deep into the earth's crust. In many parts if you could dig straight downwards through the earth for thousands of feet, you would come to layer after layer of these stratified rocks, one kind below another, some layers thick, some layers thin, here a stratum of gravel, there a stratum of sandstone, here a stratum of coal, there a stratum of clay.

But how, when, where, did the building up of all these rock-layers take place?

People are rather apt to think of land and water on the earth as if they were fixed in one changeless form,—as if every continent and every island were of exactly the same shape and size now that it always has been and always will be.

Yet nothing can be further from the truth. The earth-crust is a scene of perpetual change, of perpetual struggle, of perpetual building up, of perpetual wearing away.

The work may go on slowly, but it does go on. The sea is always fighting against the land, beating down her cliffs, eating into her shores, swallowing bit by bit of solid earth; and rain and frost and inland streams are always busily at work, helping the ocean in her work of destruction. Year by year and century by century it continues. Not a country in the world which is bordered by the open sea has precisely the same coast-line that it had one hundred years ago; not a land in the world but parts each century with masses of its material, washed piecemeal away into the ocean.

Is this hard to believe? Look at the crumbling cliffs around old England's shores. See the effect upon the beach of one night's fierce storm. Mark the pathway on the cliff, how it seems to have crept so near the edge that here and there it is scarcely safe to tread; and very soon, as we know, it will become impassable. Just from a mere accident, of course,—the breaking away of some of the earth, loosened by rain and frost and wind. But this is an accident which happens daily in hundreds of places around the shores.

Leaving the ocean, look now at this river in our neighborhood, and see the slight muddiness which seems to color its waters. What from? Only a little earth and sand carried off from the banks as it flowed,—very unimportant and small in quantity, doubtless, just at this moment and just at this spot. But what of that little going on week after week, and century after century, throughout the whole course of the river, and throughout the whole course of every river and rivulet in our whole country and in every

other country. A vast amount of material must every year be thus torn from the land and given to the ocean. For the land's loss here is the ocean's gain.

And, strange to say, we shall find that this same ocean, so busily engaged with the help of its tributary rivers in pulling down land, is no less busily engaged with their help in building it up.

You have sometimes seen directions upon a vial of medicine to "shake" before taking the dose. When you have so shaken the bottle the clear liquid grows thick; and if you let it stand for awhile the thickness goes off, and a fine grain-like or dust-like substance settles down at the bottom—the settlement or *sediment* of the medicine. The finer this sediment, the slower it is in settling. If you were to keep the liquid in gentle motion, the fine sediment would not settle down at the bottom. With coarser and heavier grains the motion would have to be quicker to keep them supported in the water.

Now it is just the same thing with our rivers and streams. Running water can support and carry along sand and earth, which in still water would quickly sink to the bottom; and the more rapid the movement of the water, the greater is the weight it is able to bear.

This is plainly to be seen in the case of a mountain torrent. As it foams fiercely through its rocky bed it bears along, not only mud and sand and gravel, but stones and even small rocks, grinding the latter roughly together till they are gradually worn away, first to rounded pebbles, then to sand, and finally to mud. The material thus swept away by a stream, ground fine, and carried out to sea—part being dropped by the way on the river-bed—is called *detritus*, which simply means *worn-out* material.

The tremendous carrying-power of a mountain torrent can scarcely be realized by those who have not observed it for themselves. I have seen a little mountain-stream swell in the course of a heavy thunderstorm to such a torrent, brown and turbid with earth torn from the mountainside, and sweeping resistlessly along in its career a shower of stones and rock-fragments. That which happens thus occasionally with many streams is more or less the work all the year round of many more.

As the torrent grows less rapid, lower down in its course, it ceases to carry rocks and stones, though the grinding and wearing away of stones upon the rocky bed continues, and coarse gravel is borne still upon its waters. Presently the widening stream, flowing yet more calmly, drops upon its bed all such coarser gravel as is not worn away to fine earth, but still bears on the lighter grains of sand. Next the slackening speed makes even the sand too heavy a weight, and that in turn falls to line the river-bed, while the now broad and placid stream carries only the finer particles of mud suspended in its waters. Soon it reaches the ocean, and the flow being there checked by the incoming ocean-tide, even the mud can no longer be held up, and it also sinks slowly in the shallows near the shore, forming sometimes broad mud-banks dangerous to the mariner.

This is the case only with smaller rivers. Where the stream is stronger, the mud-banks are often formed much farther out at sea; and more often still the river-detritus is carried away and shed over the ocean-bed, beyond the reach of our ken. The powerful rush of water in earth's greater streams bears enormous masses of sand and mud each year far out into the ocean, there dropping quietly the gravel, sand, and earth, layer upon layer at the bottom of the sea. Thus pulling down and building up go on ever side by side; and while land is the theatre oftentimes of decay and loss, ocean is the theatre oftentimes of renewal and gain.

Did you notice the word "sediment" used a few pages back about the settlement at the bottom of a medicine-vial?

There is a second name given to the Stratified Rocks, of which the earth's crust is so largely made up. They are called also *Sedimentary Rocks*.

The reason is simply this. The Stratified Rocks of the present day were once upon a time made up out of the sediment stolen first from land and then allowed to settle down on the sea-bottom.

Long, long ago, the rivers, the streams, the ocean, were at work, as they are now, carrying away rock and gravel, sand and earth. Then, as now, all this material, borne upon the rivers, washed to and fro by the ocean, settled down at the mouths of rivers or at the bottom of the sea, into a sediment, one layer forming over another, gradually built up through long ages. At first it was only a soft, loose, sandy or muddy sediment, such as you may see on the seashore, or in a mud-bank. But as the thickness of the sediment increased, the weight of the layers above gradually pressed the lower layers into firm hard rocks; and still, as the work of building went on, these layers were, in their turn, made solid by the increasing weight over them. Certain chemical changes had also a share in the transformation from soft mud to hard rock, which need not be here considered.

All this has through thousands of years been going on. The land is perpetually crumbling away; and fresh land under the sea is being perpetually built up, from the very same materials which the sea and the rivers have so mercilessly stolen from continents and islands. This is the way, if geologists rightly judge, in which a very large part of the enormous formations of Stratified or Sedimentary Rocks have been made.

So far is clear. But now we come to a difficulty.

The Stratified Rocks, of which a very large part of the continents is made, appear to have been built up slowly, layer upon layer, out of the gravel, sand, and mud, washed away from the land and dropped on the shore of the ocean.

You may see these layers for yourself as you walk out into the country. Look at the first piece of bluff rock you come near, and observe the clear pencil-like markings of layer above layer—not often indeed lying *flat*, one over another, and this must be explained later, but however irregularly slanting, still plainly visible. You can examine these lines of stratification on the nearest cliff, the nearest quarry, the nearest bare headland, in your neighborhood.

But how can this be? If all these stratified rocks are built on the floor of the ocean out of material taken *from* the land, how can we by any possibility find such rocks *upon* the land? In the beds of rivers we might indeed expect to see them, but surely nowhere else save under ocean waters.

Yet find them we do. Through England, through the two great world-continents, they abound on every side. Thousands of miles in unbroken succession are composed of such rocks.

Stand with me near the seashore, and let us look around. Those white chalk cliffs—they, at least, are not formed of sand or earth. True, and the lines of stratification are in them very indistinct, if seen at all; yet they too are built up of sediment of a different kind, dropping upon ocean's floor. See, however, in the rough sides of yonder bluff the markings spoken of, fine lines running alongside of one another, sometimes flat, sometimes bent or slanting, but always giving the impression of layer piled upon layer. Yet how can one for a moment suppose that the ocean-waters ever rose so high?

Stay a moment. Look again at yonder white chalk cliff, and observe a little way below the top a singular band of shingles, squeezed into the cliff, as it were, with chalk below and earth above.

That is believed to be an old sea-beach. Once upon a time the waters of the sea are supposed to have washed those shingles, as now they wash the shore near which we stand, and all the white cliff must have lain then beneath the ocean.

Geologists were for a long while sorely puzzled to account for these old sea-beaches, found high up in the cliffs around our land in many different places.

They had at first a theory that the sea must once, in far back ages, have been a great deal higher than it is now. But this explanation only brought about fresh difficulties. It is quite impossible that the level of the sea should be higher in one part of the world than in another. If the sea around England were then one or two hundred feet higher than it is now, it must have been one or two hundred feet higher in every part of the world where the ocean-waters have free flow. One is rather puzzled to know where all the water could have come from, for such a tremendous additional amount. Besides, in some places remains of sea-animals are found in mountain heights, as much as two or three thousand feet above the sea-level—as, for instance, in Corsica. This very much increases the difficulty of the above explanation.

So another theory was started instead, and this is now generally supposed to be the true one. What if instead of the whole ocean having been higher, parts of the land were lower? England at one time, parts of Europe at another time, parts of Asia and America at other times, may have slowly sunk beneath the ocean, and after long remaining there have slowly risen again.

This is by no means so wild a supposition as it may seem when first heard, and as it doubtless did seem when first proposed. For even in the present day these movements of the solid crust of our earth are going on. The coasts of Sweden and Finland have long been slowly and steadily rising out of the sea, so that the waves can no longer reach so high upon those shores as in years gone by they used to reach. In Greenland, on the contrary, land has long been slowly and steadily sinking, so that what used to be the shore now lies under the sea. Other such risings and sinkings might be mentioned, as also many more in connection with volcanoes and earthquakes, which are neither slow nor steady, but sudden and violent.

So it becomes no impossible matter to believe that, in the course of ages past, all those wide reaches of our continents and islands, where sedimentary rocks are to be found, were each in turn, at one time or another, during long periods, beneath the rolling waters of the ocean....