GOSSE PHILIP HENRY

OMPHALOS: AN ATTEMPT TO UNTIE THE GEOLOGICAL KNOT

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Содержание

I 5
II 14
III 20
Конец ознакомительного фрагмента. 32

Philip Henry Gosse
Omphalos: An Attempt to Untie the Geological Knot

I
THE CAUSE

"Is there not a cause?" – 1 Sam. xvii. 29

An eminent philosopher has observed that "nothing can be more common or frequent than to appeal to the evidence of the senses as the most unerring test of physical effects. It is by the organs of sense, and by these alone, that we can acquire any knowledge of the qualities of external objects, and of their mutual effects when brought to act one upon another, whether mechanically, physically, or chemically; and it might, therefore, not unreasonably be supposed, that what is called the evidence of the senses must be admitted to be conclusive, as to all the phenomena developed by such reciprocal action.

"Nevertheless, the fallacies are numberless into which those are led who take what they consider the immediate results of sensible impressions, without submitting them to the severe control and disciplined analysis of the understanding."[1]

If this verdict is confessedly true with regard to many observations which we make on things immediately present to our senses, much more likely is it to be true with respect to conclusions which are not "the immediate results of sensible impressions," but are merely deduced by a process of reasoning from such impressions. And if the direct evidence of our senses is to be received with a prudent reserve, because of this possibility of error, even when we have no evidence of an opposing character, still more necessary is the exercise of caution in judging of facts assumed to have occurred at a period far removed from our own experience, and which stand in contradiction (at least apparent, *primâ facie*, contradiction) to credible historic testimony. Nay, the caveat acquires a greatly intensified force, when the testimony with which the assumed facts are, or seem to be, at variance, is no less a testimony than His who ordained the "facts," who made the objects of investigation; the testimony of the Creator of all things; the testimony of Him who is, from eternity to eternity, "Ὁ ἈΨΕΥΔΗΣ ΘΕΟΣ"!

I hope I shall not be deemed censorious in stating my fear that those who cultivate the physical sciences are not always sufficiently mindful of the "*Humanum est errare*." What we have investigated with no little labour and patience, what we have seen with our eyes many many times, in many aspects, and under many circumstances, we naturally believe firmly; and we are very prone to attach the same assurance of certainty to the inferences we have, *bonâ fide*, and with scrupulous care to eliminate error, deduced from our observations, as to the observations themselves; and we are apt to forget that some element of error may have crept into our actual investigations, and still more probably into our deductions. Even if our observations be so simple, so patent, so numerous, as *almost* to preclude the possibility of mistake in them, and our process of reasoning from them be without a flaw, still we may have overlooked a principle, which, though perhaps not very obvious, ought to enter into the investigation, and which, if recognised, would greatly modify our conclusions.

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[1] Dr. Lardner; Museum of Science and Art, vol. i. p. 81.

In this volume I venture to suggest such a principle to the consideration of geologists. It will not be denied that Geology is a science that stands peculiarly in need of being cultivated with that salutary self-distrust that I have above alluded to. Though a strong and healthy child, it is as yet but an infant. The objects on which its senses have been exercised, its τα βλεπομενα, are indeed plain enough and numerous enough, when once discovered; but the inferences drawn from them, its βεβαια, find their sphere in the most venerably remote antiquity, – an antiquity mensurable not by years or centuries, but by *secula seculorum*. And the dicta, which its votaries rest on as certitudes, are at variance with the simple literal sense of the words of God.

I am not assuming here that the Inspired Word has been rightly read; I merely say that the plain straightforward meaning, the meaning that lies manifestly on the face of the passages in question, is in opposition with the conclusions which geologists have formed, as to the antiquity and the genesis of the globe on which we live.

Perhaps the simple, superficial sense of the Word is not the correct one; but it is at least that which its readers, learned and unlearned, had been generally content with before; and which would, I suppose, scarcely have been questioned, but for what appeared the exigencies of geological facts.

Now while there are, unhappily, not a few infidels, professed or concealed, who eagerly seize on any apparent discrepancy between the works and the Word of God, in order that they may invalidate the truth of the latter, there are, especially in this country, many names of the highest rank in physical (and, among other branches, in geological) science, to whom the veracity of God is as dear as life. They cannot bear to see it impugned; they know that it cannot be overthrown; they are assured that He who gave the Word, and He who made the worlds, is One Jehovah, who cannot be inconsistent with Himself. But they cannot shut their eyes to the startling fact, that the records which *seem* legibly written on His created works do flatly contradict the statements which *seem* to be plainly expressed in His word.

Here is a dilemma. A most painful one to the reverent mind! And many reverent minds have laboured hard and long to escape from it. It is unfair and dishonest to class our men of science with the infidel and atheist. They did not rejoice in the dilemma; they saw it at first dimly, and hoped to avoid it.[2] At first they believed that the mighty processes which are recorded on the "everlasting mountains" might not only be harmonized with, but might afford beautiful and convincing demonstrations of Holy Scripture. They thought that the deluge of Noah would explain the stratification, and the antediluvian era account for the organic fossils.

As the "stone book" was further read, this mode of explanation appeared to many untenable; and they retracted their adherence to it. To a mind rightly constituted, Truth is above every thing: there is no such thing as a pious fraud; the very idea is an impious lie: God is light, and in Him is no darkness at all; and that religion which can be maintained only by dissembling or denying truth, cannot proceed from "Him that is Holy, Him that is True," but from him who "is a liar, and the father of it."

Many upright and ardent cultivators of the young science felt that truth would be compromised by a persistence in those explanations which had hitherto passed current. The discrepancy between the readings in Science and the hitherto unchallenged readings in Scripture, became manifest. Partisans began to array themselves on either side; some, jealous for the honour of God, knew little of science, and rushed into the field ill-prepared for the conflict; some, jealous for science, but little conversant with Scripture, and caring less for it, were willing to throw overboard its authority altogether: others,

[2] As Cuvier, Buckland, and many others. On the question whether the phenomena of Geology can be comprised within the short period formerly assigned to them, the Rev. Samuel Charles Wilts long ago observed: "Buckland, Sedgwick, Faber, Chalmers, Conybeare, and many other Christian geologists, strove long with themselves to believe that they could: and they did not give up the hope, or seek for a new interpretation of the sacred text, till they considered themselves driven from their position by such facts as we have stated. If, *even now, a reasonable, or we might say* possible *solution were offered, they would*, we feel persuaded, *gladly revert* to their original opinion." —*Christian Observer*, August, 1834.

who knew that the writings were from the same Hand, knew therefore that there must be some way of reconciling them, and set themselves to find it out.

Have they succeeded? If I thought so, I would not publish this book. Many, I doubt not, have been convinced by each of the schemes by which the discrepant statements have been sought to be harmonized. Each of them has had sufficient plausibility to convince its propounder; and, probably, others too. And some of them have attained a large measure of public confidence. Yet if any one of them is true, it certainly has not commanded universal assent. Let us examine how far they agree among themselves, who propose to reconcile Scripture and Science, "the Mosaic and the Mineral Geologies."

And first, it is, perhaps, right to represent the opinions of those who stand by the literal acceptation of the Divine Word. There have been some, indeed, who refuse to entertain the question of reconciliation, taking the high ground that, as the Word of God is and must be true, it is impious to set any evidence in competition with it. I cannot but say, my sympathies are far more with these than with those who, at the opposite pole of the argument, would make scientific deduction paramount, and make the Word go to the wall. But, then, we ought to be quite sure that we have got the very Word of God; and, so far from being impious, it seems highly proper and right, when conflicting evidence appears to flow out of what is indubitably God's *work*, to examine afresh the witnesses on both sides, that we may not make either testify what it does not.

Those good men who merely *denounce* Geology and geologists, I do not quote. There are the facts, "written and engraven in stones," and that by the finger of God. How can they be accounted for?

Some have recourse to the assumption that the natural processes by which changes in the earth's surface are now going on, may have operated in antediluvian times with a rapidity and power of which we can form little conception from what we are cognisant of. The Rev. J. Mellor Brown takes this ground, adducing the analogies of steam-power and electricity, as effecting in a few moments or hours, what formerly would have required several days or weeks to accomplish.

"God's most tremendous agencies may have been employed in the beginning of his works. If, for instance, it should be conceded that the granitic or basaltic strata were once in a state of fusion, there is no reason why we should not call in the aid of supposition to produce a *rapid* refrigeration. We may surround the globe with an atmosphere (not as yet warmed by the rays of the newly kindled sun) more intensely cold than that of Saturn. The degree of cold may have been such as to cool down the liquid granite and basalt in a few hours, and render it congenial to animal and vegetable life; while the gelid air around the globe may have been mollified by the abstracted caloric."[3]

A writer in Blackwood (xli. 181; xlii. 690), in like manner, adheres to the literal sense of Genesis and the Decalogue, and alludes to "the great agencies – the magnetic, electrical, and ethereal influences – probably instrumental in all the phenomena of nature," as being far more powerful than is generally suspected.

Mr. Macbrair – who does not, however, appear, from the amount of his acquaintance with science, competent to judge of the physical evidence – supposes stratification to have proceeded with immense rapidity, because limestone is now deposited in some waters at the rate of six inches per annum. Because a mass of timber, ten miles in length, was collected in the Mississippi, in thirty-eight years, he considers that a "capital coal field" might be formed in a single century. Alluvial strata are mud lavas ejected from volcanoes. The whole difficulty of fossil remains is got rid of by ignoring the distinctions of species, and assuming that the ancient animals and the recent ones are identical. The Pterodactyle and the Plesiosaurus he does not allude to.[4]

According to Dr. Ure, – "The demiurgic week … is manifestly composed of six working days like our own, and a day of rest, each of equal length, and, therefore, containing an evening and a

[3] Reflections on Geology.

[4] Geology and Geologists.

morning, measured by the rotation of the earth round its axis… Neither reason nor revelation will justify us in extending the origin of the material system beyond six thousand years from our own days. The world then received its substance, form, and motions from the volition of the Omnipotent."

His theory of the stratification extends over the whole antediluvian era. He supposes that successive irruptions of the central heat broke up the primitive strata and deposited the secondary and tertiary. "The basaltic or trap phenomena lead to the conclusion that such upheavings and subversions were not confined to one epoch of the antediluvian world, but that, coeval with its birth, they pervaded the whole period of its duration… The Deluge – that universal transflux of the ocean – was the last and greatest of these terraqueous convulsions."[5]

Another class of this school of interpreters refers the stratification of the earth, either to the deluge alone, or to that convulsion conjoined with the one which is considered to have taken place on the third day of the Mosaic narrative. Perhaps the most eminent writer of this class is Mr. Granville Penn, whose opinions may be thus condensed.

He supposes that this globe has undergone only two revolutions. The first was the violent rupture and depression of the surface to become the bed of the sea, and the simultaneous elevation of the other portion to become dry land, – the theatre of terrestrial existence. This first revolution took place before the creation of any organized beings. The second revolution was at the Noachic Flood, when the former bed of the sea was elevated to become the dry land, with all its organic accumulations of sixteen centuries, while the former land was correspondingly depressed and overflowed. "The earth must, therefore, necessarily exhibit manifest and universal evidences of the vast apparent ruin occasioned by its first violent disruption and depression; of the presence and operation of the marine fluid, during the long interval which succeeded; and of the action and effects of that fluid in its ultimate retreat."[6]

Mr. Fairholme[7] so nearly agrees with the above, that I need not quote his opinions in detail.

Another class, represented by Dr. Young and the Rev. Sir W. Cockburn, Dean of York, have maintained with considerable power, backed by no mean geological knowledge, that the deluge is a sufficient *vera causa* for the stratification of the globe, and for the fossilization of the organic remains.

Dr. Young supposes that an equable climate prevailed all over the globe in the antediluvian period. "Were the highest mountains transferred to the equatorial regions, the most extensive oceans removed towards the poles, and fringed with a border of archipelago, – while lands of moderate height occupied most of the intermediate spaces, between these archipelagos and the equatorial mountains; then a temperature, almost uniform, would prevail throughout the world." This "perpetual summer" would account for the prodigious quantities of animal and vegetable remains: – every region teemed with life.

At the Flood, "the bed of the ocean must have been elevated, and the dry land at the same time depressed," an expansive force acting from below to heave up the ocean's bed. To this agency are attributed the vast masses of granite, gneiss, basalt, and other rocks of igneous origin, which seem to have been forced upwards in a state of fusion, into their present lofty stations. The ancient bed of the ocean may have consisted of numerous layers of sand, clay, lime, and other substances, including corals and marine shells, – to a certain degree consolidated into rocks. By the progressive rising of the waters and the currents so made, fresh materials would be conveyed to the depths of the ocean, so that the magnesian limestone, the saliferous beds, the lias, &c., would be deposited.[8]

The Dean of York, in like manner, considers that the convulsions produced by the Deluge, are sufficient to account for all the stratification and fossil remains. That the gradual rise of the waters,

[5] New System of Geology.

[6] Mineral and Mosaic Geologies, p. 430.

[7] Geology of Scripture.

[8] Scriptural Geology, *passim.*

and their penetration into the recesses of the rocks, would cause successive volcanic eruptions; the earlier of which would inclose marine fishes and reptiles; then others in turn, the pachyderms and great reptiles of the plains; and, finally, the creatures more exclusively terrestrial. That these repeated heavings of mighty volcanoes raised great part of what had been the bottom of the sea, above its level, and that hence the present land had been for sixteen centuries under water. That the animals which entered the ark, were not selected till after many species had already perished in the earlier convulsions, and hence the number of extinct species now exhumed.[9]

My reader will kindly bear in mind that I am not examining these opinions; I adduce them as examples of the diversity of judgment that still prevails on a question which some affect to consider as settled beyond the approach of doubt.

A totally different solution of the difficulty has been sought in the hypothesis, that the six "days" of the Inspired Record signify six successive periods of immense though of undefined duration. This opinion is as old as the Fathers at least,[10] and not a few able maintainers of it belong to our own times. It has been put forth, however, with most power, by a late lamented geologist, whose wonderful vigour of description and felicity of illustration, have done, perhaps, more than the efforts of any other living man, to render his favourite science popular.

Perhaps I can scarcely set his views in a more striking light than he himself has done in his own peculiarly graphic report of a conversation, which he sustained with some humble inquirers in the Paleontological Gallery of the British Museum.

"I last passed," says Mr. Hugh Miller, "through this wonderful gallery at the time when the attraction of the Great Exhibition had filled London with curious visitors from all parts of the empire; and a group of intelligent mechanics, fresh from some manufacturing town in the midland counties, were sauntering on through its chambers immediately before me. They stood amazed beneath the dragons of the Oolite and Lias; and, with more than the admiration and wonder of the disciples of old, when contemplating the huge stones of the Temple, they turned to say, in almost the old words, 'Lo! master, what manner of great beasts are these?' 'These are,' I replied, 'the sea-monsters and creeping things of the second great period of organic existence.' The reply seemed satisfactory, and we passed on together to the terminal apartments of the range appropriated to the tertiary organisms. And there, before the enormous mammals, the mechanics again stood in wonder, and turned to inquire. Anticipating the query, I said, 'And these are the huge beasts of the earth, and the cattle of the third great period of organic existence; and yonder in the same apartment, you see, but at its farther end, is the famous fossil Man of Guadaloupe, locked up by the petrifactive agencies in a slab of limestone.' The mechanics again seemed satisfied; and, of course, had I encountered them in the first chamber of the suite, and had they questioned me respecting the organisms with which *it* is occupied, I would have told them that they were the remains of the herbs and trees of the *first* great period of organic existence. But in the chamber of the mammals we parted, and I saw them no more."[11]

A large and influential section of the students of Geology regard this hypothesis as untenable. Generally they may be described as holding that the history which is recorded in the igneous and fossiliferous strata does not come into the sacred narrative in any shape. As, however, that narrative commences with "the beginning," and comes down to historic times, the facts so recorded must find their chronology within its bounds. Their place is accordingly fixed by this school of interpretation between the actual primordial creation (Gen. i. 1), and the chaotic state (ver. 2).

Let us hear an able and eloquent geologist, Professor Sedgwick, on the hypothesis just mentioned of the elongation of the six days: —

[9] Letter to Buckland, 15, *et seq.*

[10] Origen, Augustine, &c.

[11] Testimony of the Rocks, p. 144

"They [certain excellent Christian writers on the subject of Geology] have not denied the facts established by this science, nor have they confounded the nature of physical and moral evidence; but they have prematurely (and, therefore, without an adequate knowledge of all the facts essential to the argument) endeavoured to bring the natural history of the earth into a literal accordance with the Book of Genesis; first, by greatly extending the periods of time implied by the six days of creation; and secondly, by endeavouring to show that under this new interpretation of its words, the narrative of Moses may be supposed to comprehend, and to describe in order, the successive epochs of Geology. It is to be feared that truth may, in this way, receive a double injury; and I am certain that the argument just alluded to has been unsuccessful." – "We must consider the old strata of the earth as monuments of a date long anterior to the existence of man, and to the times contemplated in the moral records of his creation."[12]

Many able theologians, who, though well acquainted with natural science, can scarcely be considered as geologists, have been satisfied with this solution of the problem.

Thus Sharon Turner: —

"What interval occurred between the first creation of the material substance of our globe, and the mandate for light to descend upon it, whether months, years, or ages, is not in the slightest degree noticed [in the Sacred Record]. Geology may shorten or extend its duration, as it may find proper."[13]

Thus the present Archbishop of Canterbury: —

"We are not called upon to deny the possible existence of previous worlds, from the wreck of which our globe was organized, and the ruins of which are now furnishing matter for our curiosity."[14]

Thus Dr. Chalmers: —

"The present economy of terrestrial things was raised about six thousand years ago on the basis of an earth then without form and void; while, for aught of information we have in the Bible, the earth itself may before this time have been the theatre of many lengthened processes, the dwelling-place of older economies that have now gone by, but whereof the vestiges subsist even to the present day, both to the needless alarm of those who befriend Christianity, and the unwarrantable triumph of those who have assailed it."[15]

Thus Dr. Harris: —

"The first verse of Genesis was designed to announce the absolute origination of the material universe by the Almighty Creator; and, passing by an indefinite interval, the second verse describes the state of our planet immediately prior to the Adamic creation; and the third verse begins the account of the six days' work."[16]

Thus Mr. Gray: —

"That an antecedent state of the earth existed before the recorded Mosaical epoch, will clearly come out to view by the consideration of the terms used in the second verse. There was at that period, according to the express Mosaic record, anterior to the six days' reduction into order, *existing earth* and *existing water*."[17]

Probably the majority of our ablest geologists, men who have devoted their lives to the study and elucidation of geological phenomena, are to be found among those who advocate this scheme of reconciling those phenomena with the statements of the Holy Scriptures. Thus one of the earliest cultivators of the science, the Rev. Dr. Conybeare: —

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[12] Discourse (5th Ed.), 115.

[13] Sac. Hist. of World.

[14] Rec. of Creation.

[15] Nat. Theology.

[16] Pre-Adamite Earth.

[17] Harmony of Scripture and Geology.

"I regard Gen. i. 1 as an universal proposition, intended to contradict all the heathen systems which supposed the eternity of matter or polytheism; and ver. 2 I regard as proceeding to take up our planet in a state of ruin from a former condition, and describing a succession of phenomena effected in part by the laws of nature (which are no more than our expression of God's observed method of working), and in part by the immediate exercise of Divine power in directing and creating."[18]

Dr. Hitchcock, President of Amherst College, U.S., gives in his adhesion to this principle. After summing up the evidence in favour of the earth's high antiquity, he inquires, "Who will hesitate to say that it ought to settle the interpretation of the first verse of Genesis, in favour of that meaning which allows an intervening period between the creation of matter and the creation of light? This interpretation of Genesis is entirely sufficient to remove all apparent collision between Geology and revelation. It gives the geologist full scope for his largest speculations concerning the age of the world. It permits him to maintain that its first condition was as unlike to the present as possible, and allows him time enough for all the changes of mineral constitution and organic life which its strata reveal. It supposes that all these are passed over in silence by the sacred writers, because irrelevant to the object of revelation; but full of interest and instruction to the men of science who should afterwards take pleasure in exploring the works of God.

"It supposes the six days' work of creation to have been confined entirely to the fitting up the world in its present condition, and furnishing it with its present inhabitants. Thus, while it gives the widest scope to the geologist, it does not encroach upon the literalities of the Bible; and hence it is not strange that it should be almost universally adopted by geologists, as well as by many eminent divines."[19]

Dr. Pye Smith, accepting the immense undefined interval between the event of the first verse, and the condition chronicled in the second, held the somewhat remarkable opinion that the term "earth" in that verse, and throughout the whole description of the six days, is "designed to express the part of our world which God was adapting for the dwelling of man and the animals connected with him." And that portion he conceived to have been "a part of Asia, lying between the Caucasian ridge, the Caspian Sea, and Tartary on the north, the Persian and Indian Seas on the south, and the high mountain ridges which run at considerable distances on the eastern and western flank."

The whole of the six days' creation was confined, on this hypothesis, to the re-stocking, with plants and animals, of this limited region after an inundation caused by its subsidence. The flood of Noah was nothing more than a second overflowing of the same region, by "an elevation of the bed of the Persian and Indian Seas, or a subsidence of the inhabited land towards the south."[20]

The author of "The Protoplast" has made the very original suggestion, that the geological periods may have occurred during the paradisaical condition of man, which he thinks was of an indefinitely protracted duration, human chronology commencing at the Fall.

"We have no data in Scripture from which to gather certain information, and Adam may have lived unfallen *one day*, or *millions of years*." The years of the first man's mortal life began to be reckoned when his immortality ceased. He was nine hundred and thirty years *old*:[21] he had been nine hundred and thirty years gradually decaying, slowly dying.

"It may, indeed, be said that no man could have survived those convulsions of nature, of which traces have been discovered in the earth's crust. I would reply to this; – First, that we have no reason to suppose that these changes affected the whole globe *at once*; they may have been *partial and successive*; and the world's Eden may have been a spot peculiarly exempted from their influence.

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[18] Christian Observer, 1834.

[19] Religion of Geology, Lect. ii.

[20] Scripture and Geology.

[21] I am not *replying* to any of these conflicting opinions; else, with respect to this one, I might consider it sufficient to adduce the *ipsissima verba* of the inspired text. Not a word is said of Adam's being "nine hundred and thirty years *old*;" the plain statement is as follows: – "And *all the days that Adam lived* were nine hundred and thirty years." (Gen. v. 5.)

Secondly, that Adam's body before the fall was not constituted as ours now are; it was incorruptible and immortal: physical phenomena could have had no deleterious effect upon him." "Why should we find any difficulty in supposing that the geological changes which appear to have passed upon the globe, *after* its creation, and *before* its curse, were to the first man sources of ever-renewing admiration, delight, and advantage?

"Inclining to the belief that both the animal fell and the animal curse were considerably antecedent to the sin of Adam, I see no difficulty in the admission, that animal death may also have prevailed prior to that event."[22]

While all those writers whose opinions I have cited, feel it more or less incumbent on them to seek a reconciliation between the words of Inspiration and the phenomena of Geology, there are not a few who decline the task altogether. Some eminent in science seem, by their entire avoidance of the question, to allow judgment to go by default. Others more boldly deny that the two can be accommodated.

Mr. Babbage appears to think the archaic Hebrew so insuperably obscure a language, that no confidence can be put in our constructions of its statements; an opinion which, if true, would make the revelation of God to us, with all its glorious types, and promises, and prophecies, more dubious than the readings of Egyptian papyri, or the decipherment of Assyrian cuneiforms.

On this notion, however, Dr. Pye Smith observes: – "All competent scholars, of whatever opinions and parties they may be in other respects, will agree to reject any imputation of uncertainty with respect to the means of ascertaining the sense of the language."

Others find no difficulty in understanding the Hebrew, but in believing it.

Professor Baden Powell sees in the plain, unvarnished narrative of the Holy Spirit, only myth and poetry: it "was not intended for an historical narrative" at all; and he thinks (I hope incorrectly), that there is a pretty general agreement with his views.

"Most rational persons," he says, "now acknowledge the failure of the various attempts to reconcile the difficulty [between Geology and Scripture] by any kind of verbal interpretation; they have learnt to see that the 'six days of thousands of years' have, after all, no more correspondence with anything in Geology than with any sane interpretation of the text. And that the 'immense period at the beginning,' followed by a recent literal great catastrophe, and final reconstruction in a week, is, if possible, more strangely at variance with science, Scripture, and common sense. Yet while they [viz. the 'rational persons,'] thus view the labours of the Bible-geologists as fruitless attempts, they often do not see – ," &c. &c.[23]

Of course this gives up the authority of Scripture altogether; and, consistently enough, the author is severe upon the prevalent "indiscriminate and unthinking Bibliolatry." "If in any instance the letter of the narrative or form of expression may be found *irreconcilably at variance with physical truth*,[24] we may allow, to those who prefer it, the alternative of understanding them either as religious truths, represented under sensible images, or as descriptions of events according to the preconceptions of the writers, or the traditions of the age."

The author of "Vestiges of the Natural History of Creation" propounds a theory of organic origin much more worthy of God, than that "mean view," which supposes Him "to come in on frequent occasions with new fiats or special interferences." Coolly bowing aside His authority, this writer has hatched a scheme, by which the immediate ancestor of Adam was a Chimpanzee, and his remote ancestor a Maggot!

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[22] "Protoplast," pp. 58, 59; p. 325; 2d. Ed.

[23] Unity of Worlds (1856), pp. 488, 493.

[24] "A geological truth must command our assent as powerfully as that of the existence of our own minds, or of the Deity himself; and any revelation which stands opposed to such truths *must be false*. The geologist has therefore *nothing to do with revealed religion* in his scientific inquiries." —*Edinb. Review*, xv. 16.

In reviewing this array of opinions, is there not sufficient ground for regarding with caution the claim to certainty which has been boldly put forth for the conclusions of Geology? It cannot be denied that there is here room for a very considerable amplitude of choice among discordant hypotheses. All cannot be true, unless on the principle which was claimed for the Church by the Council of Trent – "*Cum enim ecclesia duarum expositionum ubertate gaudeat, non esse eam ad unius penuriam restrigendam!*" I do not for a moment intend to put all these hypotheses and assumptions on the same level. They vary widely as to their tenableness, and as to their prevalence. But if we leave out of view the fears of those who, from insufficient acquaintance with science, are not competent to adjudicate on its positions, and those who despise or decline Biblical authority altogether on this subject, we have still a somewhat wide range to choose from. Shall we accept the *antediluvian*, or the *diluvian* stratification? the six *ages* or the six *days* of creation? the irruptions of internal fire that occurred chiliads *before Man was made*– those during his protracted *paradisaic state*, or those at the time *of the Flood*? – the extension of the Mosaic record *to universal nature*, or its limitation to a region of *south-western Asia*?

I am not blaming, far less despising, the efforts that have been made for harmonizing the teachings of Scripture and science. I heartily sympathise with them. What else could good men do? They could not shut their eyes to the facts which Geology reveals: to have said they were not facts would have been simply absurd. Granting that the whole truth was before them – the whole evidence – they could not arrive at other conclusions than those just recorded; and, therefore, I do not blame their discrepancy *inter se*. *The true key has not as yet been applied to the wards.* Until it be, you may force the lock, but you cannot open it. Whether the key offered in the following pages will open the lock, remains to be seen.

II
THE WITNESS FOR THE MACRO-CHRONOLOGY

"You shall well and truly try, and a true deliverance make… and a true verdict give, according to the evidence." —
(Jury Oath.)

A High Court of Inquiry has been sitting now for a good many years, whose object is to determine a chronological question of much interest. It is no less than the age of the globe on which we live. Counsel have been heard on both sides, and witnesses have been called, and most of the judges have considered that an overwhelming preponderance of testimony is in favour of an immeasurably vast antiquity. A single Witness on the other side, however, has deposed in a contrary sense: and, though he has said but little, some of those who have heard the cause attach such weight to his testimony, that they do not feel satisfied to let it be overborne. Counsel on the former side have, indeed, cross-examined the Witness, and dissected his testimony with much skill, and they contend that what he said has been misunderstood by the minority; and that, as his words may at least bear a sense which would not contradict those of the opposing witness, the clear, copious, and unvarying deposition previously made, ought to command the verdict of the Court.

The minority are silenced, but not satisfied; they know not how to give up the Witness on whose veracity they have been wont to rely; but they are unable to answer the arguments brought against him.

Counsel for the Brachy-chronology speaks. "We respectfully ask the Court for another hearing. Will our learned brother permit his witness briefly to recapitulate his testimony, and we will endeavour to examine it once more; for we think we shall be able to detect some flaw in it?" Rule granted.

WITNESS FOR THE MACRO-CHRONOLOGY.

The following, then, is the substance of what the witness deposes. He is not a living witness; his testimony, therefore, is not oral, but written – lithographed, in fact. It consists of a number of documents, which are couched in a language and character not to be understood without some previous study, but yet very capable of translation – very clear and unmistakeable. The following, I say, is a condensed summary of the leading points.

If a curious person had watched the process of making the excavations that were preliminary to the boring of the Thames Tunnel, he would have observed that the labourers exposed successive layers of earth, differing much in colour, consistency, and general character. First, an accumulation of soil, consisting of decayed vegetable and animal matter, mingled with broken pottery, and other rubbish of man's production, was removed; then a layer of sand, gravel, and river mud; then a bed of reddish clay; then a layer of clay, mixed with silt or fine sandy mud; then a thin layer of silt, much filled with shells; then a stratum of stiff blue clay; then a layer of clay of more mottled character, containing a portion of silt, and some shells; then a stratum of very firm clay, so solid that it required to be broken with wedges; then a bed of gravel and sand of a green colour; and finally, a similar layer, but of a coarser texture.

In the course of the hundred feet or so of perpendicular depth thus exposed, he would have seen a succession of layers, apparently deposited upon one another. But as yet he would have formed a very inadequate notion of the stratification of the earth's crust.

With the knowledge thus gained, however, let him now make a little excursion into Hertfordshire; we will suppose at the time when the cuttings for the Great Northern Railway were being made. When he came near Cheshunt, he would see that the London clay, which he found underlying the Thames, crops out, or disappears by the stratum coming obliquely to the surface. He would see, however, another bed of clay – the plastic clay – beneath this, which now forms the

superficial stratum, and continues to do so, till he gets beyond Hertford. There this stratum crops out; and the chalk, which for some time he has seen to underlie the plastic clay, now comes to the surface.

Business or pleasure calls him to Bridlington on the Yorkshire coast; and he determines to make a pedestrian tour across the diameter of England to Whitehaven. He soon recognises the chalk, which constitutes the Wolds, and rises to about 800 feet above the sea level. Below its escarpment he traces the Kimmeridge clay, the uppermost of a series of strata more than 2,000 feet in thickness, that constitute the Oolitic system – including, among others, the coralline oolite, the calcareous grit, the cornbrash, thin, but rich in fossils; the lower sandstone and coal of the Cleveland hills, the alum shale, the marlstone, and the lower lias shale.

Then comes a stratum of the saliferous system or the new red sandstone, with the red marls, perhaps not much short of a thousand feet deep. Below them the observer finds the strata of the magnesian limestone formation, for nearly 400 feet, resting on the great coal formations of vast depth. Of these the coal field of the West Riding is not less than 4,000 feet in depth, and beneath it lie the millstone grit, and the mountain limestone, 2,500 feet more, the latter displayed in noble grandeur on the faces of those wall-like precipices that inclose the romantic dales of the Swale and the Ure, and that subsequently tower in magnificent altitude on the sides of Pennygant and Ingleborough.

On the western escarpment of the Pennine ridge, just as the traveller is entering Westmoreland, he would detect the bottom of the limestone; and here he would have an opportunity of seeing, what is rare in these parts, a stratum of the old red sandstone, lying between the former and the slaty rocks of the Cumbrian formations. And here at length, in the wild and magnificent scenery of these mountains, he sees the primitive and transition series, the greenstone, the sienite, and the granite, each of which is discernible in succession on the face of one or other of the lofty Fells of Cumberland.

Our traveller now comes home, and, musing on what he has seen, counts up some thirty or more distinct strata lying in regular succession one on another. But he has not seen all the world, nor even all England; but he reads the results of many independent observations, and finds that while, for the most part, the strata which he has seen are common to the whole surface of the globe, and while the order of their superposition is invariable everywhere, others are in some parts added, while perhaps some of those which he has observed are locally absent. Thus he is able to form a more distinct idea of the stratification of the earth's crust as a whole. It is composed of about forty distinct formations, generally increasing in thickness as we go downwards, so that the whole cannot be much less than ten miles in depth, supposing them in any locality to be all present, and to be lying in the horizontal plane.

Mathematicians have satisfactorily determined that the mean density of the globe is about five-and-a-half times that of water, or about twice that of granite, a fact inconsistent with any other supposition than that the interior is occupied by substances maintained in a fluid state by intense heat. The lowest point that has yet been patent to human observation is occupied by the granite, a compound rock, which bears evident marks of having been once in a state of fusion, and of having cooled slowly, and that under immense pressure, contracting and crystallizing as it parted with its heat. There is every reason to believe that the granite is not defined at its inferior surface, but that it merges into the molten mass, probably still solidifying.

After the outer portion of the granite had cooled sufficiently to become solid, there is evidence that it was covered by water, agitated by powerful currents, and probably in a heated state. The action of these currents disintegrated the rock, and deposited the constituent substances at the bottom of the sea – on the surface, and in the hollows, of the granite. For there is reason to think that the contraction of the primitive rock in the process of cooling, produced irregular undulations or crumplings of the surface, and frequent fractures and dislocations, elevating some parts and depressing others. The gneiss, the mica-schist, and the clay-slate, which are found immediately overlying the granitic rock in strata of vast thickness, are but the components of granite, separated and rearranged. "If we imagine common granite coarsely pounded, and thrown into a vessel of water, it will arrange itself at the bottom of the vessel in a condition very much like that of gneiss, which is indeed nothing else than

stratified granite. If the water in which the pounded rock is thrown is moving along at a slow rate, and the clayey portion of the granite, called *felspar*, happens to be somewhat decomposed, as it often is, then the felspar (which is so truly *clay* that it makes the best possible material for the use of the potteries) and the thin shining plates of mica, will be carried further by the water than the lumps of white quartz or flint sand, which, with the other two ingredients, made up the granite; and the two former will be deposited in layers, which, by passing a galvanic current through them, would in time become mica-schist. If the mica were absent, or if the clay were deposited without it, owing to any cause, then a similar galvanic current would turn the deposit into something like clay-slate."[25]

The deposition of these strata, being formed out of granite, supposes the pre-existence of that rock; and as they occur in vast thicknesses, even of many thousand feet, then separation, deposition, and reconsolidation must have occupied, however rapidly we may suppose the processes to have been accomplished, considerable periods of time.

In these lower rocks, no trace of organic remains has been found. The shoreless ocean that covered the cooling surface of the earth's crust, harboured no polype or sponge, no rhizopod or infusorium, and the angles and clefts of the granite were fringed by no fucus, or conferva: all was waste and void. And if certain parts were elevated above the waters, the bleak and barren points were not clothed with grass, or moss, or even a lichen, and no animal wandered over their ridges. Or, if such did exist, either in land or water, all vestiges of their presence have been destroyed by the agency of the intense heat that subsequently prevailed.

But, in the numerous strata that overlie the rocks of granitic origin, there are found, in varying abundance, proofs that, when they were deposited, the surface of our earth had become the abode of organic life. Zoophytes lived in the ocean, some of which were engaged in secreting lime from the water, and depositing it in coral-reefs; stalked and jointed Star-fishes waved like lilies of stone from the submerged rocks; Sea-worms twined over the mud; mailed Crustaceans swam to and fro; and Mollusks, both bivalve and univalve, crawled over the ledges or reposed in the crevices. The remains of these occur in the Silurian rocks that lie immediately on the primitive granitic formations of Cumberland and North Wales. The construction of the coral-reefs of that deposit, in particular, must have occupied a lengthened period, continuing to go on, "month after month, year after year, century after century, until at length the depth changed, in which they could most conveniently live, or, owing to some other cause, their labours were brought to a close, and they disappeared from amongst existing species."[26]

Not a single species, or even a single genus of those early strata, is identical with any that exists now. The Coral-polypes, for instance, while allied to ours, are quite distinct from them, though endowed with similar powers and habits, so that we may reason from analogy on the laws of their deposits. The Trilobites were allied to the tiny water-fleas (*Entomostraca*) of the present day: like the *Oniscidæ* (wood-lice, buttons, &c.) of our gardens, they had the habit of rolling their plated bodies into a ball. These are found in great numbers, their remains often heaped on one another. The Mollusca of those seas were chiefly of the class *Cephalopoda*– one of the least populous now-a-days, but then existing in vast number and variety; the Brachiopoda, Conchifera, and Gastropoda, were, however, well represented also.

Such were the inhabitants of the sea during the Silurian period, in which a series of solid deposits were made, the aggregate, probably, exceeding 50,000 feet in thickness. Each deposit, though not more than a few inches in depth, "is provided with its own written story, its sacred memoranda, assuring us of the regularity and order that prevailed, and of the perfect uniformity of plan."

Over all these, however, we see laid the strata of the Devonian system, especially the old red sandstone, which in some places attains a thickness of 10,000 feet. It is composed of a coarse

[25] Ansted's Ancient World, 18.

[26] Ansted's Ancient World, 30.

agglomeration of broken fragments of the old granitic rocks, rolled and tossed about, apparently by the ever-breaking waves of shingle-beaches, until the hardest stones are worn into rounded pebbles by long and constant attrition.

An examination of the old red sandstone, as is seen in Herefordshire, will aid us in forming a notion of the time required for its production. It is composed of fragments obtained by the disintegration of more ancient rocks, which, by a long process of rolling together in a breaking sea, or in the bed of a rapid current, have lost all their angles. The pebbles, thus worn, have at length settled, – the heaviest lowest, – and the whole has been consolidated into firm rock. "In many places," says Dr. Pye Smith, "the upper part of this vast formation is of a closer grain, showing that it was produced by the last and finest deposits of clayey and sandy mud, tinged, as the whole is, with oxides and carbonates of iron, usually red, but often of other hues. But, frequently, the lower portions, sometimes dispersed heaps, and, sometimes, the entire formation, consist of vast masses of conglomerate, the pebbles being composed of quartz, granite, or some other of the earliest kinds; and thus showing the previous rocks, from whose destruction they have been composed. Let any person first acquire a conception of the extent of this formation, and of its depth, often many hundreds, and, sometimes, two or three thousand feet; (but such a conception can scarcely be formed without actual inspection;) then let him attempt to follow out the processes which the clearest evidence of our senses shows to have taken place; and let him be reluctant and sceptical to the utmost that he can, he cannot avoid the impression that ages innumerable must have rolled over the world, in the making of this single formation."[27]

Here, Fishes are added to the Invertebrate Animals. A sort of Shark with the mouth terminal, instead of beneath the head, was the earliest representative of this class. But closely following on this, were some curious species, enveloped in plate mail, and remarkable for the singularity of their forms, as the *Cephalaspis* and the *Pterichthys*.

This great period passed away, and was succeeded by that of the Carboniferous deposits, indicative of a vast change in the physical character of the earth's surface and atmosphere. This change of character may be briefly summed up as consisting of an immense abundance of lime in the ocean, and of an equally vast charge of carbonic acid in the atmosphere.

Strata of limestone, 2,500 feet in thickness, were accumulated in the ocean by the labours of Coral-polypes, allied to, but totally distinct from, those which had previously existed in the primary system. On the floor of a shallow sea, which then occupied the middle of what is now England, the coral reefs rose perpetually towards the day, atom by atom, the strata on which they were founded slowly and steadily sinking ever to a lower level, while successive generations of the industrious zoophytes wrought upwards, to maintain their position within reach of the light and warmth. What period of time was requisite for the aggregation of coral structure to the perpendicular thickness of 2,500 feet?

While this was going on, other Invertebrata were living in the shallow seas, mostly differing from the older species, which had become by this time extinct. Encrinites and Sea-urchins existed; some *Foraminifera* were astonishingly abundant; the *Cephalopoda* and the *Brachiopoda* presented a vast variety of species; and about seventy sorts of Fishes, mostly Sharks, characterised the age.

On the coral limestone lies a sort of conglomerate, known as the millstone grit; and on this is laid that source of Britain's eminence, the *coal*. The coal measures of South Wales are estimated at 12,000 feet in thickness. The profusion of vegetable life that must have combined to make the coal in these, has no parallel in this age; no, not in the teeming forests of South America, or the great isles of the Oriental Archipelago. The circumstances which favoured this enormous development of plants, seem never to have been repeated in subsequent ages, since the coal measures which are found in the later strata are thin and inconsiderable, compared with those we are considering.

[27] Scripture and Geology, 371. (Ed. 1855.)

M. Adolphe Brogniart suggests that in this period, from some source or other, carbonic acid was generated in vast abundance; or, at least, that it existed in the air, in a far greater proportion than it does now; and it is singularly confirmatory of his view, that terrestrial animals, to which this gas is fatal, have left almost no traces of their existence, during the age of these vast forests – a circumstance otherwise strange and unaccountable.

"Those parts," says Mr. Ansted, "of the great carboniferous series which generally include the beds of coral, consist of muddy and sandy beds, alternating with one another, and with the coal itself. Some of them would appear to be of fresh-water, and some of marine origin; and they abound, for the most part, with remains of the leaves of Ferns and fern-like trees, together with the crushed trunks of these and other trees, whose substance may have contributed to form the great accumulations of bituminised and other vegetable carbon obtained from these strata.

"It is not easy to communicate such an idea of beds of coal as shall enable the reader to understand clearly the nature of the circumstances under which they may have been deposited, and the time required for this purpose. The actual total thickness of the different beds in England varies considerably in different districts, but appears to amount, in the Lancashire coal-field, to as much as 150 feet. In North America there is a coal-field of vast extent, in which there appears at least as great a thickness of workable coal as in any part of England; while in Belgium and France the thickness is often much less considerable, although the beds thicken again still further to the east.

"But this account of the thickness of the beds gives a very imperfect notion of the quantity of vegetable matter required to form them; and, on the other hand, the rate of increase of vegetables, and the quantity annually brought down by some great rivers, both of the eastern and western continents, is beyond all measure greater than is the case in our drier and colder climate. Certain kinds of trees which contributed largely to the formation of the coal, seem to have been almost entirely succulent, and capable of being squeezed into a small compass during partial decomposition. This squeezing process must have been conducted on a grand scale, both during and after the formation of separate beds; and each bed in succession was probably soon covered up by muddy and sandy accumulations, now alternating with the coal in the form of shale and grit-stone. Sometimes, trunks of trees caught in the mud would be retained in a slanting or nearly vertical position, while the sands were accumulating round them; sometimes the whole would be quietly buried, and soon cease to exhibit any external marks of vegetable origin.[28]

"To relate the various steps in the formation of a bed of coal, and the gradual superposition of one bed upon another, by which at length the whole group of the coal-measures was completed, would involve an amount of detail little adapted to these pages; and when it is remembered that the woody fibres, after being deposited, had to be completely changed, and the whole character of the vegetable modified, before it could be reduced to the bituminous, brittle, almost crystalline mineral now dug out of the earth for fuel, it will rather seem questionable whether the origin of coal was certainly and necessarily vegetable, than reasonable to doubt the importance of the change that has taken place, and the existence of extraordinary means to produce that change. Nothing, however, is more certain than that all coal was once vegetable; for in most cases woody structure may be detected under the microscope; and this, if not in the coal in its ordinary state, at least in the burnt ashes which remain after it has been exposed to the action of heat, and has lost its bituminous and semi-crystalline character. This has been too well and too frequently proved by actual experiment, to require more than the mere statement of the fact."[29]

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[28] "It is by no means unlikely that some beds of coal were derived from the mass of vegetable matter present at one time on the surface, and submerged suddenly. It is only necessary to refer to the accounts of vegetation in some of the extremely moist, warm islands in the southern hemisphere, where the ground is occasionally covered with eight or ten feet of decaying vegetable matter at one time, to be satisfied that this is at least possible."

[29] Ansted's Anc. World, 75.

An eminent practical geologist thus essays to guess the age of the coal-fields, and of the sandstone that underlies it.

"The great tract of peat near Stirling has demanded [for its formation] two thousand years; for its registry is preserved by the Roman works below it. It is but a single bed of coal. Shall we multiply it by 100? We shall not exceed, – far from it, – did we allow 200,000 years for the production of the coal-series of Newcastle, with all its rocky strata. A Scottish lake does not shoal at the rate of half a foot in a century; and that country presents a vertical depth of far more than 3,000 feet in the single series of the oldest sandstone. No sound geologist will accuse a computer of exceeding, if he allow 600,000 years for the production of *this series alone*. And yet what are the coal deposits, and what the oldest sandstone, compared to the entire mass of the strata?"[30]

The conjecture, that the whole of the vegetable material now constituting the coal, was the growth of the antediluvian centuries, and that it was floated away and deposited by the flood, is untenable. In not a few instances trunks are found broken, and worn by water-action; but the great mass warrants the conclusion that trees of vast dimensions and of close array – dense, majestic forests, such as now occur only in the most humid regions of the tropics – were submerged in their native abodes, lying where they fell, and where they have left the impressions, side by side, on the upper and under surfaces of the shale, of their delicate peculiarities of structure, which would have been totally obliterated, if the trees had been sea-borne and shore-rolled, as pretended. The result of a careful and minute examination of the phenomena of coal, by Mr. Binney, is, that the vegetable matter now forming coal had grown in vast *marine* swamps, subjected to a series of *subsidences* with long intervals of repose; that the trees, and perhaps smaller plants, were submerged under *tranquil* water, in the places of their growth; and that very inconsiderable portions, if any, of the beds, are owing to drifting.[31]

While the coal was in process of deposition, the sea was occupied with Invertebrata, not widely differing from those which had marked the previous eras.

Fishes, however, were advancing in development; and several new and strange forms, some of them of gigantic dimensions and formidable armature, were introduced. These were chiefly remarkable for their affinities with Reptiles (whence they are often called *Sauroid* Fishes); and one of them —*Megalichthys*– was famished with jaws of serried teeth, surpassing those of the crocodile. With these were associated other and more ordinary Fishes; and swarms of Sharks of many species, and varying much in size, roved through the sea, maintaining the same pirate character as their representatives of our modern seas – fierce, subtle, voracious, and powerful.

At this time, too, appeared the earliest Reptiles, chiefly of the Amphibia sub-class. Some of these are known only by their foot-prints; and the late Hugh Miller has graphically described the appearance of some of these, which, he met with marking the roof of a coal-mine, four hundred feet below the surface. These must have been *Batrachia* of large size, as the fore feet were thirteen inches apart across the breast.[32] They will be alluded to again.

With these exceptions, remains of terrestrial animals are, as has already been observed, rare in this formation.

[30] M'Culloch's System of Geology, i. 506.

[31] Origin of Coal.

[32] Testimony of the Rocks, p. 78.

III
THE WITNESS FOR THE MACRO-CHRONOLOGY

(CONTINUED.)

> "Always distrust very plain cases: beware lest a snake suddenly start out upon you, in the shape of some concealed and utterly unexpected difficulty." —
> *Warren: Law Studies.*

We have hitherto been considering the strata as if they had remained permanent when once deposited, subject to no change, save the successive superposition of other strata upon them. But this is very far from being true. Enormous displacements, upheavings, contortions, and fractures, are observed in the strata, which tell of mighty forces having been at work upon them after their formation. The explanation of these phenomena is due to the internal heat, which ever and anon seems to concentrate its action on some special point, seeking and finding vent for itself by some alteration in the already consolidated crust.

Sometimes, the mode of action has been the transmission of undulations through the crust, producing earthquakes, cracking and forcing apart strata already petrified, and bending and variously contorting those that have but partially become solid. Sometimes, the fiery impulse is sufficiently concentrated to break through the superincumbent materials, forcing a passage for the molten and incandescent rock, which then flows forth from the surface, penetrates into the cracks and fissures of the fractured strata, and frequently spreads into the hollows and over the summits of the latest formations.

It is owing to such causes as these, that we find the rocky layers so often inclined at various angles to the horizon, instead of being parallel to it, as they would be of course deposited; occasionally standing quite perpendicularly, and even to a small extent reversed. The outcropping of formations, the long lines of cliff running across a country in parallel series, ("crag and tail,") the dipping of strata from some central point or ridge, and the non-correspondence between the bottom of one stratum and the top of the underlying one, – are all phenomena of this sort of powerful action, which has been more or less energetic at all periods.

After the deposit of the Old Red Sandstone, the internal fire appears to have enjoyed a lull of its energy, if not a complete cessation, until the Coal Measures were complete. Then the long tranquility was again broken, and concussions so extensive and violent ensued, that hardly a single square mile of country can anywhere be found which is not full of fractured and contorted strata, the record of subterranean movements, which mostly occurred between the Carboniferous and the Premian deposits.

The effects of these convulsions were manifest in the changed relations of land and sea, existing continents and islands being dislocated, severed, and swallowed up, while others were elevated from the depths of the previous ocean.

It was from the wave-worn materials thus obtained from pre-existing strata, that the New Red Sandstone was consolidated. It consists chiefly of sand and mud, with few organic remains; and the hiatus thus found, in animals and vegetables, seems to be almost a complete one between the organisms of the preceding and the succeeding periods.

The most interesting traces of the earth's tenants during the New Red formation, consist of foot-tracks impressed by the progress of animals along the yielding mud between the ranges of high and low tide. They afford a remarkable example (not, I think, sufficiently dwelt on) of the

extreme rapidity with which deposits were consolidated; since the tracks must have been made, and the material consolidated, during the few hours, *at most*, that intervened between the recess and the reflux of the tide; since, if the mud had not so soon become solid, the flow of the sea would have instantly obliterated such marks, as it does now on our shores.

The principal animal, whose foot-prints have been identified, was an enormous Frog (*Labyrinthodon*), as big as a hippopotamus, but apparently allied, in its serried teeth, and in the bony plates with which it was covered, to the Crocodiles, which were its associates.

It is curious that marks in the same material have chronicled the serpentine trail of a Sea-worm, the scratchings of a Crab, the ripple of the wavelets, and even the drops of a passing shower; the last revealing, by their margins, the direction of the wind by which the slanting rain was driven.

If the Triassic formations display but little evidence of organic existence, the lack is supplied by the abundance of such records, which is contained in the Oolitic system, and specially in its lowest component, – the Lias. Animals now existed in profusion, but of species which were for the most part peculiar. The coral-making Polypes existed not (or very rarely) in the seas of that age, but lime was secreted by an unusual number of Crinoid Echinoderms, which seem to have fringed the rocks and floating pieces of timber, much as Barnacles do now.

Among the Mollusca now began to appear the inhabitants of those very elegant shells, the *Ammonites*, allied to the Nautilus of our Southern seas, which may be considered as the lingering representative of those swarms of shelled Cephalopoda. They were accompanied by their near relations, the *Belemnites*, more resembling a Cuttle, with a long internal, pointed shell.

Fishes, chiefly belonging to a curiously armed tribe of Sharks, together with some enclosed in bony-mail like pavement, were present in the shallows, where the Lias was probably deposited.

But the most characteristic animals were great marine Reptiles, of strange and uncouth forms, to which the present world presents us no known analogy. One of these was the *Ichthyosaurus*, which closely resembled a porpoise in form, but thirty or forty feet in length, with a vertical fish-like tail, and two pairs of paddles; a mouth set with stout crocodilian teeth, and enormous eyes. Another form was that of the *Plesiosaurus*, scarcely less in size than its fellow, which in the outline of its body it resembled: it was distinguished, however, by an extraordinary length of neck, slender and swan-like, consisting of thirty or forty vertebræ.

It adds to the interest of these great marine Reptiles, that around their fossil skeletons are preserved pellets of excrement (known as Coprolites) containing fragments of bone, teeth, and scales of fishes, which clearly reveal the nature of their food. In some instances, the stomach and intestines of these great carnivorous creatures, filled with half-digested food, have left indubitable traces of their presence *in situ*.

Again, the geography of the Globe changed. New lands arose from the sea, and old lands partially or wholly sank. The German Ocean, and part of Western Europe, of our maps, were a great group of islands. The Oolitic formation was deposited. The general character of the organization of this period differed little from that of the Lias. New forms of plants, such as *Cycadeæ*, were abundant, with, considerable numbers of Corals, Encrinites, Sea-urchins and Mollusks. Macrurous Crustacea, much like those of our times (but essentially different in species), inhabited the sea, and some Beetles and Flies represented the Insects of the land. The Fishes and Marine Reptiles were pretty much the same with those of the Lias, though they received some important additions.

It is, however, among the terrestrial Vertebrata that we must look for the characteristic organisms of this age. And these are, still, Reptiles. The huge *Megalosaurus*, with a body as big as an elephant's, stood high on his legs, and stretched open a pair of gaping jaws, set with jagged teeth. The *Pterodactyles* flew about, – carnivorous lizards, with the body and wings of bats,[33] except that the

[33] Mr. Newman suggests that they were "marsupial bats" (Zoologist, p. 129). I have adopted his attitudes, but have not ventured to give them mammalian ears.

membrane was stretched upon the enormously developed little finger; – creatures, perhaps, the most unlike to anything familiar to us, of all fossil forms. And, in the marshy margins of the great river valley which formed the Wealden of our South-eastern districts, the giant *Iguanodon*, and his fellow, the *Hylæosaurus*, waged their peaceful warfare on the succulent plants that became their unresisting prey.

The circle of animal life was completed in this epoch, thus far, that every class was represented by some one or more of its constituent species. No fossil skeletons of Birds have, indeed, been found so low as the Oolite, but numerous foot-prints of some of the Grallatores are found in a sandstone of this period; and in the Stonesfield slate, which is contemporary with it, a genus of Mammalia has been discovered, – a small Marsupial, allied to the Opossums of America.

The duration of the Oolitic period must have been considerable. "The lias sea-bottom was succeeded first by a sandy, and then by a calcareous deposit, and the animals were modified accordingly." The deposit of carbonate of lime, which took place under circumstances that caused it to attract around its nodules the organic particles, whence the name *oolite* (egg-stone) is derived, was not continuous, but repeated at intervals. The shells of Mollusks were developed in great abundance, and accumulations of these formed thick bands, which consolidated into layers of shell-limestone. Three hundred feet of strata, largely composed of organic remains, were formed before the clay was deposited which made the Stonesfield and contemporaneous slates.

Once more the dry land sank, probably by slow successive subsidences, and the sea flowed many fathoms deep above the great European archipelago. And upon its quiet bottom settled down, first a few sandy and clayey beds, and then the great layer of the Chalk.

Creatures of very minute size and low grades of organization were now playing a very important part. A large portion of the lime that was deposited, in the form of a pure carbonate, was doubtless supplied by the Coral structures, which, were exceedingly numerous; the polypidoms being gnawed down by strong-jawed fishes that fed upon the Zoophytes. *Foraminifera* also were abundant, and contributed to the supply.

Nodules of flint exist in the Chalk, sometimes scattered, sometimes arranged in bands. Two sources are indicated for this substance. One is Sponge, the most common kinds of which are composed of skeletons of siliceous spicula; and these can be discerned with the microscope in the interior of the chalk-flints. But millions upon millions of Infusoria swam through the waters, and many of these were encased in siliceous loricæ, while the rocks and sea-weeds were fringed with as incalculably numerous examples of siliceous *Diatomaceæ*, whose elegant forms are recognisable without difficulty throughout the Chalk. The inconceivable abundance of these forms may be illustrated by the often-cited fact, that whole strata of solid rock appear to be so exclusively composed of their solid remains, that a cube of one-tenth of an inch is computed by Ehrenberg to contain five hundred millions of individuals.

The increase of these organisms is very rapid, and their duration proportionately short; but allowing for this, what period would elapse before the successive generations of entities, of which forty-one thousand millions are required to make a cubic inch, would have accumulated into solid strata fourteen feet in thickness?

Without pausing to examine the whole Cretaceous fauna, we may observe that the Mollusca with chambered shells – the Ammonites and their allies – were developed in singular variety and profusion during this period, after which they suddenly disappeared from the ocean. The Fishes present little that is remarkable; of Birds, few, and of Mammals, no remains exist; and the Reptiles, while not absolutely extinct, are few and rare. One great marine form, however, the *Mosasaurus*, was added to their number.

At length the sea ceased to deposit chalk, and its bed appears to have been slowly elevated, until all the animals that had inhabited the waters of that formation were destroyed; so that their race and generation perished.[34] The grand epoch of Secondary Formations was closed.

It was followed by an extensive disruption of the then existing strata, and by changes and modifications so great as to alter the whole face of nature. "It would appear that a long period of time elapsed before newer beds were thrown down, since the chalky mud not only had time to harden into chalk, but the surface of the chalk itself was much rubbed and worn." During this protracted period, eruptions of molten rock occurred of enormous extent, producing the Basaltic formation which covers the Chalk in the north of Ireland, and in some of the Hebrides. In the south of Europe the Pyrenees were elevated, and the Apennines and Carpathians were pushed to a greater altitude than before, if they were not then formed. The Alps and the Caucasus also experienced a series of upward movements, continuing through a considerable range of the Tertiary epoch.

The rich collections of vegetable remains – chiefly fruits and seeds – that have been made from the London Clay, show that the earliest land of this period was clothed with a great abundance and variety of plants; and these are of such alliances as would now require a tropical climate. Many species of Palms, Screw-pines, Gourds, *Piperaceæ*, *Mimoseæ*, and other *Leguminosæ*, *Malvaceæ*, and *Coniferæ*, dropped their woody pods and fruits where now these pages are written; and the animals manifest no less interesting an approximation to existing forms than the plants. The Zoophytes, the Echinoderms, the Foraminifera, the Worms, the Crustacea, the Mollusca, the Fishes and the Reptiles of the Eocene beds, exhibit a great preponderance of agreement with those that now exist, *so far as genus is concerned*, though the *species* are still almost wholly distinct. The approximation is particularly marked in the Molluscous sub-kingdom, by the almost entire disappearance of the hitherto swarming Brachiopod and Cephalopod forms, and the progressive substitution for them of the *Conchifera* and *Gastropoda*, which had, however, throughout the Secondary epoch, been gradually coming forward to their present predominance in nature.

Among the Fishes, the Placoid type was diminished in number; and those that were produced were mostly Sharks and Rays, of modern genera; but the chief difference was the paucity of those mailed forms (Ganoids), which were so abundant during the Oolitic period. On the other hand, the Ctenoid and Cycloid forms, which had begun to make their appearance in small numbers in the Chalk, are well represented. In both this deficiency and this plenitude, there is a very decided approach to existing conditions; for the Ganoids are almost unknown with us, while the last-named two orders are abundant. Representatives of our Perches, Maigres, Mackerels, Blennies, Herrings, and Cods, were numerous; *distinct, however, from the present species*. But not a single member of the great Salmon family was yet introduced.

The great Saurian Reptiles had entirely disappeared, and were quite unrepresented in the tertiary beds, except by a Crocodile or two, and a small Lizard. Turtles were, however, numerous, both of the marine and lacustrine kinds; and there is an interesting stranger, in the form of a large Serpent, allied to our Pythons, some twenty feet in length.

Birds and Mammals began now to assume their place on the land. The London Clay presents us with a little Vulture; and the Paris basin contains remnants of species representing the Raptores, the Rasores, the Grallatores, and the Natatores.

The Quadrupeds came in in some force; not developed from the lowest to the highest scale of organization; for the Monkey and the Bat occur in sands, certainly not later, if not earlier, than the London Clay, contemporaneously with the Racoon, and before the existence of any Rodent or Cetacean. Some Carnivora, as the Wolf and the Fox, roamed the woods, but the character of the epoch was given by the Pachyderms.

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[34] In Tennant's "List of Brit. Fossils" (1847), but two species – a Brachiopod and a Gastropod – are mentioned as common to the Chalk and the London Clay. They are *Terebratula striatula*, and *Pyrula Smithii*.

These, however, were not the massive colossi that browse in the African or Indian jungles of our days; no Elephant, no Rhinoceros, no Hippopotamus was as yet formed. But several kinds of Tapir wallowed in the morasses; and a goodly number of largish beasts, whose affinities were with the Pachydermata, while their analogies were with the Ruminantia, served as substitutes for the latter order, which was wholly wanting. These interesting quadrupeds, forming the genus *Anoplotherium*, were remarkable for two peculiarities, – their feet were two-toed, and their teeth were ranged in a continuous series, without any interval between the incisors and the molars. They varied in size from that of an ass to that of a hare.

The physical conditions of our earth, when it was tenanted by these creatures, is thus described: – "All the great plains of Europe, and the districts through which the principal rivers now run, were then submerged; in all probability, the land chiefly extended in a westerly direction, far out into the Atlantic, possibly trending to the south, and connecting the western shores of England with the volcanic islands off the west coast of Africa. The great mountain chains of Europe, the Pyrenees, the Alps, the Apennines, the mountains of Greece, the mountains of Bohemia, and the Carpathians, existed then only as chains of islands in an open sea. Elevatory movements, having an east and west direction, had, however, already commenced, and were producing important results, laying bare the Wealden district in the south-east of England. The southern and central European district, and parts of western Asia, were the recipients of calcareous deposits (chiefly the skeletons of *Foraminifera*), forming the Apennine limestone; while numerous islands were gradually lifted above the sea, and fragments of disturbed and fractured rock were washed upon the neighbouring shallows or coast-lines, forming beds of gravel covering the Chalk. The beds of Nummulites and Miliolites, contemporaneous with those containing the Sheppey plants and the Paris quadrupeds, seem to indicate a deep sea at no great distance from shore, and render it probable that there were frequent alternations of elevation and depression, perhaps the result of disturbances acting in the direction already alluded to.

"The shores of the islands and main land were, however, occasionally low and swampy, rivers bringing down mud in what is now the south-east of England, and the neighbourhood of Brussels, but depositing extensive calcareous beds near Paris. Deep inlets of the sea, estuaries, and the shifting mouths of a river, were also affected by numerous alterations of level not sufficient to destroy, but powerful enough to modify, the animal and vegetable species then existing; and these movements were continued for a long time."[35]

After the elevation of the mountain summits of Europe above the sea, and while the same causes were still in operation, deposits were being made in the narrow intervening seas of the Archipelago, such as the present south of France, the valleys of the Rhine and Danube, the eastern districts of England and Portugal. These deposits were partly marine and partly lacustrine; the former consisting largely of loose sands, mingled with shells and gravel. In Switzerland is a thick mass of conglomerate; and in the district around Mayence, there is a series of fresh-water limestones, and sandstones charged with organic remains.

The changes which took place during this comparatively recent epoch were not sudden, but gradual; the results of operations which were probably going on without intermission, and perhaps have not yet ceased. The land was more and more upheaved, till at length, what had been an archipelago of islands became a continent, and Europe assumed the form which it bears on our maps.

The most interesting addition to the natural history of the Miocene, or Middle Tertiary period, was the *Dinotherium*– a huge Pachyderm, twice as large as an elephant, with a tapir-like proboscis, and two great tusks curving downward from the lower jaw. It was, doubtless, aquatic in its habits, and possibly (for its hinder parts are not known), it may have been allied to the Dugong and Manatee, those whale-like Pachyderms, with a broad horizontal tail, instead of posterior limbs.

[35] Ansted's Anc. World, 267.

Other great herbivorous beasts roamed over the new-made land. The Mastodons, closely allied to the Elephant, had their head-quarters in North America, but extended also to Europe. And the Elephants themselves, of several species, were spread over the northern hemisphere, even to the polar regions. The Hippopotamus, the Rhinoceros, and other creatures, now exclusively tropical, were also inhabitants of the same northern latitudes.

From some specimens of Elephants and Rhinoceroses of this period, which seem to have been buried in avalanches, and thus to have been preserved from decomposition, even of the more transitory parts, as muscle and skin, we learn something of the climate that prevailed. The very fact of their preservation, by the antiseptic power of frost, shows that it was not a tropical climate in which they lived; and the clothing of thick wool, fur, and hair, which protected the skin of the Mammoth, or Siberian Elephant, tends to the same conclusion. At the same time, those regions were not so intensely cold as they are now. For the district in which the remains of Elephants and their associates are found, in almost incredible abundance, is that inhospitable coast of northern Asia which bounds the Polar Sea.

The trees of a temperate climate – the oak, the beech, the maple, the poplar, and the birch – which now attain their highest limit somewhere about 70° of north latitude, and there are dwarfed to minute shrubs, appear then to have grown at the very verge of the polar basin; and that in the condition of vast and luxuriant forests, perhaps occupying sheltered valleys between mountains whose steep sides were covered with snow, already become perennial, and ever and anon rolling down in overwhelming avalanches, such as those which now occasionally descend into the valleys of the Swiss Alps.

The coast of Suffolk displays a formation known as the Crag – a local name for gravel – which rests partly on the chalk; but, as it lies in other parts over the London Clay, it is assigned to the later Tertiary, or what is called the Pleiocene period. It is divided into the *coralline* and the *red* crag, the latter being uppermost where they exist together, and therefore being the more recent. The Coralline Crag is nearly composed of corals and shells, the former almost wholly extinct now; but the latter containing upwards of seventy species still existing in the adjacent seas. The Red Crag contains few zoophytes, but is remarkable for the remains of at least five species of Whales. Other Mammalia occur in this formation, among which are the red deer and the wild boar of modern Europe.

The gradual but rapid approximation of the Tertiary fauna to that of the present surface is well indicated by Mr. Lyell's table (1841) of recent and fossil species in the English formations: —

Periods.	Localities.	Per-centage of recent.	No. of fossils compared.
Eocene	London and Hampshire	1 or 2	400
Miocene	Red and Coralline Crag, Suffolk	20 to 30	450
Older Pleiocene	Mamaliferous or Norwich Crag	60 to 70	111
Newer Pleiocene	Marine strata near Glasgow	85 to 90	160
Post Pleiocene	Fresh-water of the valley of the Thames	99 to 100	40

It is to this period that are assigned the animals whose bones are found in astonishing numbers in limestone caverns, as, for example, that notable one at Kirkdale, in Yorkshire, which was examined by Professor Buckland.

This is a cave in the Oolitic limestone, with a nearly level floor, which was covered with a deposit of mud, on which an irregular layer of sparry stalagmite had formed by the dripping of water from the low roof, carrying lime in solution. Beneath this crust the remains were found.

Of the animals to which the bones belonged, six were *Carnivora*, viz. *hyæna*, *felis*, bear, wolf, fox, weasel; four *Pachydermata*, viz. elephant, rhinoceros, hippopotamus, horse; four *Ruminantia*, viz. ox, and three species of deer; four *Rodentia*, viz. hare, rabbit, water-rat, mouse; five Birds, viz. raven, pigeon, lark, duck, snipe.

The bones were almost universally broken; the fragments exhibited no marks of rolling in the water, but a few were corroded; some were worn and polished on the convex surface; many indented, as by the canine teeth of carnivorous animals. In the cave the peculiar excrement of hyænas (*album græcum*) was common; the remains of these predacious beasts were the most abundant of all the bones; their teeth were found in every condition, from the milk-tooth to the old worn stump; and from the whole evidence Dr. Buckland adopted the conclusion, in which almost every subsequent writer has acquiesced, that Kirkdale Cave was a den of hyænas during the period when elephants and hippopotami (not of existing species) lived in the northern regions of the globe, and that they dragged into it for food the bodies of animals which frequented the vicinity.[36]

Thus in these spots we find, observes Professor Ansted, "written in no obscure language, a portion of the early history of our island after it had acquired its present form, while it was clothed with vegetation, and when its plains and forests were peopled by many of the species which still exist there; but when there also dwelt upon it large carnivorous animals, prowling about the forests by night, and retiring by day to these natural dens."

In our own country, and in many other parts of the world, we find fragments of stone distributed over the surface, sometimes in the form of enormous blocks, bearing in their fresh angles evidence that they have been little disturbed since their disruption, but sometimes much rubbed and worn, and broken into smaller pieces, till they form what is known as gravel. In many cases the original rock from which these masses have been separated does not exist in the vicinity of their locality; and it is not till we reach a distance, often of hundreds of miles, that we find the formation of which they are a component part.

Various causes have been suggested for the transport of these erratic blocks, of which the most satisfactory is the agency of ice, either as slow-moving glaciers, or as oceanic icebergs.

"The common form of a glacier," says Professor J. Forbes, "is a river of ice filling a valley, and pouring down its mass into other valleys yet lower. It is not a frozen ocean, but a frozen torrent. Its origin or fountain is in the ramifications of the higher valleys and gorges, which descend amongst the mountains perpetually snow-clad. But what gives to a glacier its most peculiar and characteristic feature is, that it does not belong exclusively or necessarily to the snowy region already mentioned. The snow disappears from its surface in summer as regularly as from that of the rocks which sustain its mass. It is the prolongation or outlet of the winter-world above; its gelid mass is protruded into the midst of warm and pine-clad slopes and green-sward, and sometimes reaches even to the borders of cultivation."[37]

The glacier moves onward with a slow but steady march towards the mouth of its valley. Its lowest stratum carries with it numerous fragments of rock, which, pressed by the weight of the mighty mass, scratch and indent the surfaces over which they move, and sometimes polish them. These marks are seen on many rock-surfaces now exposed, and they are difficult to explain on any other hypothesis than that of glacial action.

But the alternate influence of summer and winter – the percolation of rain into the mountain fissures, and the expansion of freezing – dislodge great angular fragments of rock, which fall on the glacier beneath. Slowly but surely these then ride away towards the mouth of the valley, till they reach a point where the warmth of the climate does not permit the ice to proceed; the blocks then are deposited as the mass melts. But if the climate itself were elevated, or if the surface were lowered so as to immerse the glacier in the sea, it would melt throughout its course, and then the blocks would be found arranged in long lines or *moraines*, such as we see now in many places.

If the glacier-valley debouch on the sea, the ice gradually projects more and more, until the motions of the waves break off a great mass, which floats away, carrying on its surface the

[36] Reliquiæ Diluvianæ.

[37] Travels through the Alps, p. 19.

accumulation of boulders, gravel, and other *débris* which it had acquired during its formation. It is now an iceberg, which, carried by the southern currents, approaches a warmer climate, melts, and deposits its cargo, perhaps hundreds of leagues from the valley where it was shipped, and as fresh as when its component *frusta* were detached from the primitive rock.

If the abundance of such erratic blocks and foreign gravel seem to require a greater amount of glacial action than is now extant, it has been suggested that the volcanic energy which elevated Europe may have been succeeded by a measure of subsidence before the land attained its present permanent condition. Hence there may have been, during the Tertiary epoch, mountain chains of great elevation, sufficient to supply the glaciers, which, on their subsidence, melted on the spot where they were submerged, or floated away as icebergs on the pelagic currents, till they grounded on the bays and inlets of other shores, which were subsequently elevated again.

Thus a large portion of the animals which then inhabited these islands (up to that time, perhaps, united to the continent) would be drowned, and many species quite obliterated, a few alone remaining to connect our present fauna with that of the submerged area, when the land rose again to its existent state.

It would not materially augment the force of the evidence already adduced on the question of chronology, to examine in detail the fossil remains of South America, Australia, and New Zealand. The gigantic Sloths[38] of the first, the gigantic Marsupials of the second, and the gigantic Birds of the third, however interesting individually, and especially as showing that a prevailing type governed the fauna in each locality then as now – are all formations of the Tertiary period, and some of them, at least, seem to have run on even into the present epoch. Indeed, it is not quite certain that the enormous birds of New Zealand and Madagascar are even yet extinct.

The phenomenon of raised sea-beaches is one of great interest, and seems to be connected with the alternate elevations and depressions of the Tertiary epoch, perhaps marking the successive steps of the upheaval of the land. In several parts of England the coast-line exhibits one or more shelves parallel with the existing sea-beach, and covered with similar shingle, sand, and sea-shells. And the same phenomenon is exhibited on a still more gigantic scale in South America. Mr. Darwin[39] found that for a distance of at least 1,200 miles from the Rio de la Plata to the Straits of Magellan on the eastern side, and for a still longer distance on the west, the coast-line and the interior have been raised to a height of not less than 100 feet in the northern part, but as much as 400 feet in Patagonia. All this change has taken place within a comparatively short period; for in Valparaiso, where the effect is most considerable, modern marine deposits, with human remains, are seen at the height of 1,300 feet above the sea.

At what exact point, geologically, the period of human history begins, it is impossible to say. No evidence of Man's presence has occurred older than the latest Tertiary deposits, which insensibly merge into the Alluvial. It seems certain that human remains have been found in chronological association with those of animals long extinct, and there appears no reason to doubt that some species of animals, as the Irish Deer, the Moa of New Zealand, and the Dodo of the Mauritius, have disappeared from creation within a period of a few centuries.[40] It is not improbable that the last of the Moho race may have lived only long enough to grace the pages of the "Birds of Australia."

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[38] Prof. Owen, in his admirable account of the *Mylodon*, has mentioned a fact which brings us very vividly into contact with its personal history. He shows that the animal got its living by overturning vast trees, doing the work by main strength, and feeding on the leaves. The fall of the tree might occasionally put the animal in peril; and in the specimen examined there is proof of such danger having been incurred. The skull had undergone two fractures during the life of the animal, one of which was entirely healed, and the other partially. The former exhibits the outer tables of bone broken by a fracture four inches long, near the orbit. The other is more extensive, and behind, being five inches long, and three broad, and over the brain. The inner plate had in both these cases defended the brain from any serious injury, and the animal seems to have been recovering from the latter accident at the time of its death.

[39] Naturalist's Voyage, *passim*.

[40] The Indians of North America knew that the Mastodon had a trunk; a fact which (though the anatomist infers it from the bones of the skull) it is difficult to imagine them to be acquainted with, except by tradition from those who had seen the living animal.

It is as important as it is interesting, to observe that the same kinds of physical operations have been, within the present epoch, and are still, going on, as those whose results are chronicled in the rocks. Strata of alluvium are constantly being formed on a scale which, though it does not *suddenly* affect the outline of coasts, and therefore appears small, yet is great in reality.

The Ganges is estimated to pour into the Indian Ocean nearly 6,400 millions of tons of mud every year; and its delta is a triangle whose sides are two hundred miles long. The delta of the Mississippi is of about the same size, and it advances steadily into the Gulf of Mexico at the rate of a mile in a century.

The accumulation of river-mud is gradually filling up the Adriatic Sea. From the northernmost point of the Gulf of Trieste to the south of Ravenna, there is an uninterrupted series of recent accessions of land, more than a hundred miles in length, which, within the last twenty centuries, have increased from two to twenty miles in breadth.

The coral-polypes are working still with great energy. Mr. Darwin mentions two or three examples of the rate of increase, one of which only I shall cite. In the lagoon of Keeling Atoll, a channel was dug for the passage of a schooner built upon the island, through the reef into the sea; in ten years afterward, when it was examined, it was found almost choked up with living coral.

Volcanic action is busy in many parts of the earth, pouring forth clouds of ashes and torrents of molten rock; and instances are not wanting in which new islands have been raised from the bed of the ocean by this means, within the sphere of history.

Slow and permanent changes of level are still being produced on the earth's crust. The bottom of the Baltic has been, for several centuries at least, in process of continuous elevation, the effects of which are palpable. Many rocks formerly covered are now permanently exposed; channels between islets, formerly used, are now closed up, and beds of marine shells have become bare. On the other hand, the whole area of the Pacific Polynesia seems subsiding.

Deposits are being made by waters which hold earthy substances in solution. The principal of these is *lime*. Several remarkable examples of this kind are quoted by Sir Charles Lyell, in one of which there is a thickness of 200 or 300 feet of travertine of recent deposit, while in another a solid mass thirty feet thick was deposited in about twenty years. He also states that there are other countless places in Italy where the constant formation of limestone may be seen, while the same may be said of Auvergne and other volcanic districts. In the Azores, Iceland, and elsewhere, *silica* is deposited often to a considerable extent. Deposits of *asphalt* and other bituminous products occur in other places.[41]

The floors of limestone caverns are frequently strewn with fossil bones, which are imbedded in stalagmite, and this incrustation is still in progress of formation. It is remarkable that in this deposit alone we obtain the bones of Man in a fossil condition. The two creations, – the extinct and the extant, – or rather the prochronic and the diachronic – here unite. But there is no line of demarcation between them; they merge insensibly into each other. The bones of Man, and even his implements and fragments of pottery, are found mingled with the skeletons of extinct animals in the caves of Devonshire, in those of Brazil,[42] and in those of Franconia. In Peru, some scores of human skeletons

[41] Ansted; Phys. Geography, 82.

[42] An interesting fact relating to the Brazilian caves was communicated to Dr. Mantell. "M. Claussen, in the course of his researches, discovered a cavern, the stalagmite floor of which was entire. On penetrating the sparry crust, he found the usual ossiferous bed; but pressing engagements compelled him to leave the deposit unexplored. After an interval of some years, M. Claussen again visited the cavern, and found the excavation he had made completely filled up with stalagmite, the floor being as entire as on his first entrance. On breaking through this newly-formed incrustation, it was found to be distinctly marked with lines of dark-coloured sediment, alternating with the crystalline stalactite. Reasoning on the probable cause of this appearance, M. Claussen sagaciously concluded that it arose from the alternation of the wet and dry seasons. During the drought of summer, the sand and dust of the parched land were wafted into the caves and fissures, and this earthy layer was covered during the rainy season by stalagmite, from the water that percolated through the limestone, and deposited calc-spar on the floor. The number of alternate layers of spar and sediment tallied with the years that had elapsed since his first visit; and on breaking up the ancient bed of stalagmite, he found the same natural register of the annual variations of the seasons; every layer dug through presented a uniform alternation of sediment and spar; and as the botanist ascertains the age of an ancient dicotyledonous tree from the annual circles of growth, in like manner the geologist attempted to calculate the

have been found in a bed of travertine, associated with marine shells; the stratum itself being covered by a deep layer of vegetable soil, forming the face of a hill crowned with large trees.

From a very interesting paper by M. Marcel de Serres, it appears indubitable that the existing shells of the Mediterranean are even now passing in numbers into the fossil state, and that not in quiet spots only, but where the sea is subject to violent agitations. Specimens of common species, "completely petrified, have been converted into carbonate of lime at the same time that they have lost the animal matter which they originally contained. Their hardness and solidity are greater than those of some petrified species from tertiary formations."

"In the collection of M. Doumet, Mayor of Cette, there exists an anchor which exhibits the same circumstances, and which is also covered with a layer of solid calcareous matter. This contains specimens of *Pecten*, *Cardium*, and *Ostrea*, completely petrified, and the hardness of which is equal to that of fossil species from secondary formations. On the surface of the deposit in which the anchor is imbedded, there are *Anomiæ* and *Serpulæ*, which were living when the anchor was got out of the sea; these present no trace of alteration."[43]

Thus we have brought down the record to an era embraced by human history, and even to individual experience; and we confidently ask, Is it possible, is it imaginable, that the whole of the phenomena which occur below the diluvial deposits can have been produced within six days, or seventeen centuries? Let us recapitulate the principal facts.

1. The crust of the earth is composed of many layers, placed one on another in regular order. All of these are solid, and most are of great density and hardness. Most of them are of vast thickness, the aggregate not being less than from seven to ten miles.

2. The earlier of these were made and consolidated before the newer were formed; for in several cases, it is demonstrable that the latter were made out of the *débris* of the former. Thus the compact and hard granite was disintegrated grain by grain; the component granules were rolled awhile in the sea till their angles were rubbed down; they were slowly deposited, and then consolidated in layers.

3. A similar process goes on again and again to form other strata, all occupying long time, and all presupposing the earlier ones.[44]

4. After some strata have been formed and solidified, convulsions force them upward, contort them, break them, split them asunder. Melted matter is driven through the outlets, fills the veins, spreads over the surface, settles into the hollows, cools and solidifies.

5. After the outflowing and consolidation of these volcanic streams, the action of running water cuts them down, cleaving beds of immense depth through their substance. Mr. Poulett Scrope, speaking of the solidified streams of basalt, in the volcanic district of Southern France, observes: —

> "These ancient currents have since been corroded by rivers, which have worn through a mass of 150 feet in height, and formed a channel even in the granite rocks beneath, since the lava first flowed into the valley. In another spot, a bed of basalt, 160 feet high, has been cut through by a mountain stream. The vast excavations effected by the erosive power of currents along the valleys which feed the Ardèche, since their invasion by lava-currents, prove that even the most recent of these volcanic eruptions belong to an era incalculably remote."[45]

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period that had elapsed since the commencement of these ossiferous deposits of the cave; and although the inference, from want of time and means to conduct the inquiry with precision, can only be accepted as a rough calculation, yet it is interesting to learn that the time indicated by this natural chronometer, since the extinct mammalian forms were interred, amounted to many thousand years." – (*Petrifactions and their Teachings*, p. 481.)

[43] Bibliothèque Univers., March, 1852.

[44] "It is now admitted by all competent persons, that the formation even of those strata which are *nearest the surface*, must have occupied vast periods, probably millions of years, in arriving at their present state." – Babbage, *Ninth Bridgewater Treatise*, p. 67.

[45] Geology of Central France.

6. A series of organic beings appears, lives, generates, dies; lives, generates, dies; for thousands and thousands of successive generations. Tiny polypes gradually build up gigantic masses of coral, – mountains and reefs – microscopic foraminifera accumulate strata of calcareous sand; still more minute infusoria – forty millions to the inch – make slates, many yards thick, of their shells alone.

7. The species at length die out – a process which we have no data to measure,[46] though we may reasonably conclude it very long. Sometimes the whole existing fauna seems to have come to a sudden violent end; at others, the species die out one by one. In the former case suddenly, in the latter progressively, new creatures supply the place of the old. Not only do species change; the very genera change, and change again. Forms of beings, strange beings, beings of uncouth shape, of mighty ferocity and power, of gigantic dimensions, come in, run their specific race, propagate their kinds generation after generation, – and at length die out and disappear; to be replaced by other species, each approaching nearer and nearer to familiar forms.

8. Though these early creatures were unparalleled by anything existing now, yet they were animals of like structure and economy essentially. We can determine their analogies and affinities; appoint them their proper places in the orderly plan of nature, and show how beautifully they fill hiatuses therein. They had shells, crusts, plates, bones, horns, teeth, exactly corresponding in structure and function to those of recent animals. In some cases we find the young with its milk-teeth by the side of its dam with well-worn grinders. The fossil excrement is seen not only dropped, but even in the alimentary canal. Bones bear the marks of gnawing teeth that dragged them and cracked them, and fed upon them. The foot-prints of birds and frogs, of crabs and worms, are imprinted in the soil, like the faithful impression of a seal.[47]

9. Millions of forest-trees sprang up, towered to heaven, and fell, to be crushed into the coal strata which make our winter fires. Hundreds of feet measure the thickness of what were once succulent plants, but pressed together like paper-pulp, and consolidated under a weight absolutely immensurable. Yet there remain the scales of their stems, the elegant reticulated patterns of their bark, the delicate tracery of their leaf-nerves, indelibly depicted by an unpatented process of "nature-printing." And when we examine the record, – the forms of the leaves, the structure of the tissues, we get the same result as before, that the plants belonged to a flora which had no species in common with that which adorns the modern earth. Very gradually, and only after many successions, not of individual generations, but of the cycles of species, genera, and even families, did the vegetable creation conform itself to ours.[48]

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[46] "Though perfect knowledge is not possessed, yet there are reasons for believing that the duration of life to testacean individuals of the present race is several years. But who can state the *proportion* which the average length of life to the individual mollusc or conchifer, bears to the duration appointed by the Creator to the species? Take any one of the six or seven thousand known recent species; let it be a *Buccinum*, of which 120 species are ascertained, (one of which is the commonly known *whelk*;) or a *Cypræa*, comprising about as many, (a well-known species is on almost every mantel-piece, the *tiger-cowry*;) or an *Ostrea* (*oyster*), of which 130 species are described. We have reason to think that the individuals have a natural life of at least six or seven years; but we have no reason to suppose that any one species has died out, since the Adamic creation. May we then, for the sake of an illustrative argument, take the duration of testacean species, one with another, at one thousand times the life of the individual? May we say six thousand years? We are dealing very liberally with our opponents. Yet in examining the vertical evidences of the cessations of the fossil species, marks are found of an entire change in the forms of animal life; we find such cessations and changes to have occurred many times in the thickness of but a few hundred feet of these late-rocks." – Dr. J. Pye Smith, *Scripture and Geology*, 5th Ed. p. 376.

[47] "One of the laminated formations [in Auvergne] may be said to furnish a chronometer for itself. It consists of sixty feet of siliceous and calcareous deposits, each as thin as pasteboard, and bearing upon their separating surfaces the stems and seed-vessels of small water-plants in infinite numbers; and countless multitudes of minute shells, resembling some species of our common snail-shells. These layers have been formed with evident regularity, and to each of them we may reasonably assign the term of one season, that is a year. Now thirty of such layers frequently do not exceed one inch in thickness. Let us average them at twenty-five. The thickness of the stratum is at least sixty feet; and thus we gain, for the whole of this formation alone, eighteen thousand years." – Dr. J. P. Smith, *Scripture and Geology*, 5th Edition, p. 137.

[48] "This fact has now been verified in almost all parts of the globe, and has led to a conviction that at successive periods of the past the same area of land and water has been inhabited by species of animals and plants as distinct as those which now people the antipodes, or which now co-exist in the arctic, temperate, and tropical zones. It appears that from the remotest periods there has been ever a coming in of new organic forms, and an extinction of those which pre-existed on the earth; some species having endured for a

longer, others for a shorter time; but none having ever re-appeared, after once dying out." – Lyell's *Elements of Geology*, p. 275.

Конец ознакомительного фрагмента.