Essay On The Theory Of The Earth.

By

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Administrator Of The Museum Of Natural History,

Geological Illustrations
By
Professor Jameson.

Fifth Edition.

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Preface To The Fifth Edition.

GEOLOGY, now deservedly one of the most popular and attractive of the physical sciences, was, not many years ago, held in little estimation; and even at present, there are not wanting some who do not hesitate to maintain, that it is a mere tissue of ill observed phenomena, and of hypotheses of boundless extravagance. The work of CUVIER now laid before the public, contains in itself not only a complete answer to these ignorant imputations, but also demonstrates the accuracy, extent, and importance of many of the facts and reasonings of this delightful branch of Natural History. Can it be maintained of a science, which requires for its successful prosecution an intimate acquaintance with Chemistry, Natural Philosophy and Astronomy, with the details and views of Zoology, Botany, and Mineralogy, and which connects these different departments of knowledge in a most interesting and striking manner, that it is of no value? Can it be maintained of Geology, which discloses to us the history of the first origin of organic beings, and traces their gradual development from the monade to man himself,—which enumerates and describes the changes that plants, animals, and minerals the atmosphere, and the waters of the globe—have under-gone from the earliest geological periods up to our own time, and which even instructs us in the earliest history of the human species, that it offers no gratification to the philosopher? Can even those who estimate the value of science, not by intellectual desires, but by practical advantages, deny the importance of Geology, certainly one of the foundations of agriculture, and which enables us to search out materials for numberless important economical purposes?

Geology took its rise in the Academy of Freyberg, with the illustrious WERNER, to whom we owe its present interesting condition. This being the case, we ought not, (as is at present too much the practice), amidst the numerous discoveries in the mineral kingdom which have
been made since the system of investigation of that great interpreter of nature was made known, forget the master, and arrogate all to ourselves. In this Island, Geology first took firm root in the north: in Edinburgh the Wernerian geognostical views and method of investigation, combined with the theory of Hutton, the experiments and speculations of Hall, the illustrations of Playfair, and the labours of the Royal and Wernerian Natural History Societies, excited a spirit of inquiry which rapidly spread throughout the Empire; and now Great Britain presents to the scientific world a scene of geological acuteness, activity, and enterprise, not surpassed in any other country.

On the Continent the writings of Cuvier, distinguished equally by purity and beauty of style, and profound learning, have proved eminently useful in aiding the progress of Geology. In this country Cuvier was first made known as a geologist by the publication of the present essay, which, from its unexampled popularity, has made his name as familiar to us as that of the most distinguished of our own writers.

ROBERT JAMESON.

COLLEGE MUSEUM, EDINBURGH,
25th November 1826.

Advertisement To Fourth Edition

This Fourth Edition of the celebrated Essay on the Theory of the Earth, contains, besides many additional facts and statements in regard to the Natural History of the Earth, also learned discussions by Cuvier, on the newness of the present continents, as confirmed by the history of nations; and on the proofs regarding the antiquity of nations alleged to be contained in their astronomical and other monuments.

ROBERT JAMESON.

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2d April 1822.

Fossil organic remains are the relics of a primeval world long since gone past, proclaiming with a loud voice the instability of earthly affairs, and impressing upon the minds of those who seriously consider them, sentiments of piety and feelings of devotion. If the antiquary digs from among the ruins of Herculaneum a piece of ancient money, a vase, or a statue, we rejoice with him, in finding the mode of life, the manners and arts of an ancient people, placed before our eyes: If he finds an old record, illustrative of the history of his country, however limited in extent that country may be, we are grateful to him for the particle of knowledge he has added to our store; but if, among the ruins of the common country of the human race, we linger at the great sepulchre of animated beings destroyed by the hand of fate, who can look upon it without sentiments of piety! It is not here the statues of Polycletus that we admire, but the admirable monuments of the workmanship of Nature, taken from the ruins of the great Herculeum overwhelmed by the ocean, that we look upon with feelings of the deepest wonder and devotion.
Preface To The Third Edition,

The attention of naturalists was early directed to the investigation of the fossil organic remains so generally and abundantly distributed throughout the strata of which the crust of the Earth is composed. It is not, as some writers now imagine, entirely a modern study; for even so early as the time of Leibnitz, we find that philosopher drawing and describing fossil bones. After this period it continued to interest individuals, and engage the particular attention of societies and academies. The Royal Society of London, by the Memoirs of Sloane, Collinson, Lister, Derham, Baker, Grew, Hunter, Jacobs, Plott, Camper, and many others, afforded satisfactory proofs of the importance attached to this branch of Natural History by philosophers in England; and the Memoirs of M. Graydon, in the Transactions of the Royal Irish Academy, shew that it was not entirely neglected in Ireland. On the continent of Europe the natural history of petrifications was also much studied, as appears from the Memoirs of Hollman, Beckman, and Blumenbach, in the Transactions of the Royal Society of Göttingen;—of Gmelin, Pallas, Herrmann, Chappe, in the Memoirs of the Imperial Academy of Sciences of Petersburg;—of Geoffroi, Buffon, Daubenton, Faujas St Fond, and others of the old French Academy of Sciences;—of Astruc and Riviere, of the Royal Academy of Sciences of Montpellier;—of Collini of the Academia Theodoro-Palatina, at Manheim, &c. But the geognostical relations of the rocks in which these organic remains are contained were but ill understood, until Werner pointed out the mode of investigating them. His interesting and important views were circulated from Freyberg, by the writings and conversations of his pupils, and have contributed materially to the advancement of this branch of Natural History in Germany, France, and also in Great Britain. Petrifications are no longer viewed as objects of mere curiosity, as things isolated and unrelated to the rocks of which the crust of the Earth is composed; on the contrary, they are now considered as one of the most important features in the strata of all regions of the earth. By the regularity and determinate nature of their distribution, they afford characters which assist us in discriminating not only single beds, but also whole formations of rocks; and in this respect they are highly interesting to the geognostical inquirer. To the geologist this beautiful branch of Natural History opens up numerous and uncommonly curious views of nature in the mineral kingdom: it shews him the commencement of the formation of organic beings;—it points out the gradual succession in the formation of animals, from the almost primeval coral near the primitive strata, through all the wonderful variety of form and structure observed in shells, fishes, amphibious animals, and birds, to the perfect quadruped of the alluvial land; and it makes him acquainted with a geographical and physical distribution of organic beings in the strata of the globe, very different from what is observed to hold in the present state of the organic world. The zoologist views with wonder and amazement those hosts of fossil animals, sometimes so similar to the present living species, at other times so far removed from them in form and structure. He compares the fossil orders, genera and species, with those now inhabiting the earth’s surface, or living in its waters, and discovers that there is a whole system of animals in a fossil state different from the present. Even the physiologist, in the various forms, connections, and relations of the parts of those animals, obtains new facts for his descriptions and reasonings. Such, then, being the nature of this branch of Natural History, it is not surprising that, when once understood, it should have many and zealous cultivators, and occupy the talents of men of learning and sagacity. In our time, Cuvier, the celebrated Professor of Natural History in Paris, has eminently distinguished himself by his numerous discoveries, accurate descriptions, and rational views, on this subject. His great work on Fossil Organic Remains, of which a new edition is now in progress, is the most splendid contribution to Natural History furnished by any individual of this age.
The Essay on the Theory of the Earth, now translated, is the introductory part of the great work of Cuvier. The subject of the deluge forms a principal object of this elegant discourse. After describing the principal results at which the theory of the earth, in his opinion, has arrived, he next mentions the various relations which connect the history of the fossil bones of land animals with these results; explains the principles on which is founded the art of ascertaining these bones, or, in other words, of discovering a genus, and of distinguishing a species, by a single fragment of bone; and gives a rapid sketch of the results to which his researches lead, of the new genera and species which these have been the means of discovering, and of the different formations in which they are contained. Some naturalists, as Lamarck, having maintained that the present existing races of quadrupeds are mere modifications or varieties of those ancient races which we now find in a fossil state, modifications which may have been produced by change of climate, and other local circumstances, and since brought to the present great difference, by the operation of similar causes during a long succession of ages,—Cuvier shews that the difference between the fossil species and those which now exist, is bounded by certain limits; that these limits are a great deal more extensive than those which now distinguish the varieties of the same species, and consequently, that the extinct species of quadrupeds are not varieties of the presently existing species. This very interesting discussion naturally leads our author to state the proofs of the recent population of the world; of the comparatively modern origin of its present surface; of the deluge, and the subsequent renewal of human society.

In order to render this Essay more complete and satisfactory, I have illustrated the whole with an extensive series of observations, and have arranged them in such a manner that they will be readily accessible, not only to the naturalist, but also to the general reader.

Since the publication of the former edition of this Essay, many curious discoveries have been made in regard to fossil organic remains:—some of these are included in the Illustrations at the end of the Essay, others want of room forces us to omit.

ROBERT JAMESON.

COLLEGE MUSEUM, EDINBURGH,

19th November 1817.

Preliminary Observations.

In my work on Fossil Bones, the object which I proposed was to discover to what animals the osseous remains, with which the superficial strata of the globe are filled, may have belonged. In pursuing this object, I had to follow a path in which but little progress had hitherto been made. As an antiquary of a new order, I was obliged at once to learn the art of restoring these monuments of past revolutions to their original forms, and to discover their nature and relations; I had to collect and bring together in their original order, the fragments of which they consisted; to reconstruct, as it were, the ancient beings to which these fragments belonged; to reproduce them with all their proportions and characters; and, lastly, to compare them with those which now live at the surface of the globe:—an art almost unknown, and which presupposed a science whose first developments had scarcely yet been traced, that of the laws which regulate the co-existence of the forms of the different parts in organised beings. I had therefore to prepare myself for these inquiries, by others of a far more extensive kind, respecting the animals which still exist. Nothing, except an almost complete review of creation in its present state, could give a character of demonstration to the results of my in-
vestigation into its ancient state; but, from this review, I had at the same time to expect a
great body of rules and affinities not less satisfactorily demonstrated; and it became obvious,
that, in consequence of this essay upon a small portion of the theory of the earth, the whole
animal kingdom would necessarily be in some measure subjected to new laws.

Thus I was encouraged in this twofold investigation, by the equal interest which it
promised to possess, both with regard to the general science of anatomy, the essential basis of
all those which treat of organised bodies, and with regard to the physical history of the globe,
the foundation of mineralogy, geography, and even, it may be said, of the history of Man, and
of all that it most concerns him to know with regard to himself.

If it be so interesting to us to follow, in the infancy of our species, the almost obliterated
traces of extinct nations, why should it not also be so, to search, amid the darkness of the
infancy of the Earth, for the traces of revolutions which have taken place anterior to the exist-
ence of all nations? We admire the power by which the human mind has measured the
motions of the celestial bodies, which nature seemed to have concealed for ever from our
view. Genius and science have burst the limits of space; and observations, explained by just
reasoning, have unveiled the mechanism of the universe. Would it not also be glorious for
man to burst the limits of time, and, by means of observations, to ascertain the history of this
world, and the succession of events which preceded the birth of the human race? Astro-
nonomers have undoubtedly advanced more rapidly than naturalists; and the present period,
with respect to the Theory of the Earth, bears some resemblance to that in which some
philosophers fancied that the heavens were formed of polished stones, and that the moon was
of the size of the Peleponnesus; but after Anaxagoras, came Copernicus and Kepler, who
pointed the way to Newton; and why should not natural history also one day have its
Newton?

Plan of this Essay.

What I especially propose to present in this discourse, is the plan and the result of my
labours regarding Fossil Bones. I shall also attempt to trace a rapid sketch of the efforts that
have been made up to the present day, to restore the history of the revolutions of the globe.
The facts which I have been enabled to discover, form, without doubt, only a small portion of
those which would be necessary to complete this ancient history; but several of them lead to
decisive consequences, and the rigorous manner in which I have proceeded in their determin-
ation, affords me reason to think that they will be regarded as points definitively fixed, and
which in their aggregate will form an epoch in science. Lastly, I trust their novelty will be a
sufficient excuse for me, if I claim for them the earnest attention of my readers.

My object will first be to shew by what relations the history of the fossil bones of
terrestrial animals connects itself with the theory of the earth, and for what reasons a peculiar
importance is to be attributed to it, with reference to this subject. I shall then unfold the
principles upon which is founded the art of determining these bones, or, in other words, of
recognizing a genus, and of distinguishing a species, by a single fragment of bone,—an art,
on the certainty of which depends that of my whole work, I shall give a rapid account of the
new species, and of genera previously unknown, which the application of these principles has
led me to discover, as well as the different kinds of deposits in which they are contained. And
as the difference between these species and those which exist at the present day is bounded by
certain limits, I shall show that these limits much exceed those which now distinguish the
varieties of the same species. I shall therefore make known to what extent these varieties may
go, whether from the influence of time, or from that of climate, or, lastly, from that of domestication.

In this way I shall be enabled to conclude, and to induce my readers to conclude with me, that great events were necessary to produce the more considerable differences which I have discovered. I shall next mention the particular modifications which my researches must necessarily introduce into the hitherto received opinions regarding the revolutions of the globe; and, lastly, I shall inquire how far the civil and religious history of different nations corresponds with the results of observation with regard to the physical history of the Earth, and with the probabilities which these observations afford concerning the period at which societies of men may have found fixed places of abode, and fields susceptible of cultivation, and at which, therefore, they may have assumed a durable form.

First Appearance of the Earth.

When the traveller passes over those fertile plains where gently flowing streams nourish in their course an abundant vegetation, and where the soil, inhabited by a numerous population, adorned with flourishing villages, opulent cities, and superb monuments, is never disturbed, except by the ravages of war, or by the oppression of the powerful, he is not led to suspect that Nature also has had her intestine wars, and that the surface of the globe has been broken up by revolutions and catastrophes. But his ideas change as soon as he digs into that soil which now presents so peaceful an aspect, or ascends to the hills which border the plain; his ideas are expanded, if I may use the expression, in proportion to the expansion of the view, and begin to embrace the full extent and grandeur of those ancient events, when he climbs the more elevated chains, whose base is skirted by these hills, or when, by following the beds of the torrents which descend from those chains, he penetrates, as it were, into their interior.

First proofs of Revolutions on the surface of the Globe.

The lowest and most level parts of the earth, exhibit nothing, even when penetrated to a very great depth, but horizontal strata composed of substances more or less varied, and containing almost all of them innumerable marine productions. Similar strata, with the same kind of productions, compose the lesser hills to a considerable height. Sometimes the shells are so numerous as to constitute of themselves the entire mass of the rock; they rise to elevations superior to the level of every part of the ocean, and are found in places where no sea could have carried them at the present day, under any circumstances; they are not only enveloped in loose sand, but are often inclosed in the hardest rocks. Every part of the earth, every hemisphere, every continent, every island of any extent, exhibits the same phenomenon.

The times are past when ignorance could maintain, that these remains of organized bodies are mere sportings of nature, productions generated in the womb of the Earth, by its own creative powers; and the efforts made by some metaphysicians of the present day, will not probably succeed in bringing these exploded opinions again into repute. A scrupulous comparison of the forms of these remains, of their texture, and often even of their chemical composition, does not disclose the slightest difference between the fossil shells and those which still inhabit the sea: the preservation of the former is not less perfect than that of the latter; most commonly we neither observe detrition nor fracture in them, nothing, in short, that announces a violent removal from their original places; the smallest of them retain their sharpest ridges, and their most delicate spines. They have, therefore, not only lived in the sea, but they have also been deposited by it. It is the sea which has left them in the places where they are now found. But this sea has remained for a certain period in those places; it has
covered them long enough, and with sufficient tranquillity to form those deposits, so regular, so thick, so extensive, and partly also so solid, which contain those remains of aquatic animals. The basin of the sea has therefore undergone one change at least, either in extent, or in situation. Such is the result of the very first search, and of the most superficial examination.

The traces of revolutions become still more apparent and decisive, when we ascend a little higher, and approach nearer to the foot of the great chains. There are still found many beds of shells; some of these are even thicker and more solid; the shells are quite as numerous, and as well preserved, but they are no longer of the same species. The strata which contain them are not so generally horizontal; they assume an oblique position, and are sometimes almost vertical. While in the plains and low hills it was necessary to dig deep, in order to discover the succession of the beds, we here discover it at once by their exposed edges, as we follow the valleys that have been produced by their disjunction. Great masses of debris form at the foot of the cliffs, rounded hills, the height of which is augmented by every thaw and tempest.

These inclined strata, which form the ridges of the secondary mountains, do not rest upon the horizontal strata of the hills which are situate at their base, and which form the first steps in approaching them; but, on the contrary, dip under them, while the hills in question rest upon their declivities. When we dig through the horizontal strata in the vicinity of mountains whose strata are inclined, we find these inclined strata re-appearing below; and even sometimes, when the inclined strata are not too elevated, their summit is crowned by horizontal ones [1]. The inclined strata are therefore older than the horizontal strata; and as they must necessarily, at least the greater number of them, have been formed in a horizontal position, it is evident that they have been raised [2], and that this change in their direction has been effected before the others were superimposed upon them [3].

Thus the sea, previous to the deposition of the horizontal strata, had formed others, which, by the operation of problematical causes, were broken, raised, and overturned in a thousand ways; and, as several of those inclined strata which it had formed at more remote periods, rise higher than the horizontal strata which have succeeded them, and which surround them, the causes by which the inclination of these beds was effected, had also made them project above the level of the sea, and formed islands of them, or at least shoals and inequalities; and this must have happened, whether they had been raised by one extremity, or whether the depression of the opposite extremity had made the waters subside. This is the second result, not less clear, nor less satisfactorily demonstrated, than the first, to every one who will take the trouble of examining the monuments on which it is established.

**Proofs that such revolutions have been numerous.**

But it is not to this subversion of the ancient strata, nor to this retreat of the sea after the formation of the new strata, that the revolutions and changes which have given rise to the present state of the Earth are limited.

When we institute a more detailed comparison between the various strata and those remains of animals which they contain, we presently perceive, that this ancient sea has not always deposited mineral substances of the same kind, nor remains of animals of the same species; and that each of its deposits has not extended over the whole surface which it covered. There has existed a succession of variations; the former of which alone have been more or less general, while the others appear to have been much less so. The older the strata are, the more uniform is each of them over a great extent; the newer they are, the more
limited are they, and the more subject to vary at small distances. Thus the displacements of the strata were accompanied and followed by changes in the nature of the fluid, and of the matters which it held in solution; and when certain strata, by making their appearance above the waters, had divided the surface of the seas by islands and projecting ridges, different changes might take place in particular basins.

Amidst these variations in the nature of the general fluid, it is evident, that the animals which lived in it could not remain the same. Their species, and even their genera, changed with the strata; and, although the same species occasionally recur at small distances, it may he announced as a general truth, that the shells of the ancient strata have forms peculiar to themselves; that they gradually disappear, so as no longer to be seen at all in the recent strata, and still less in the presently existing ocean, in which their corresponding species are never discovered, and where several, even of their genera, do not occur: that, on the contrary, the shells of the recent strata are similar, in respect to their genera, to those which exist in our seas; and that, in the latest and least consolidated of these strata, and in certain recent and limited deposits, there are some species which the most experienced eye could not distinguish from those which are found in the neighbouring seas.

There has, therefore, been a succession of variations in the economy of organic nature, which has been occasioned by those of the fluid in which the animals lived, or which has at least corresponded with them; and these variations have gradually conducted the classes of aquatic animals to their present state, till, at length, at the time when the sea retired from our continents for the last time, its inhabitants did not differ much from those which are found in it at the present day.

We say for the last time, because, if we examine with still greater care those remains of organised bodies, we discover, in the midst of even the oldest strata of marine formation, other strata replete with animal or vegetable remains of terrestrial or fresh-water productions; and, amongst the more recent strata, or, in other words, those that are nearest the surface, there are some in which land animals are buried under heaps of marine productions. Thus, the various catastrophes which have disturbed the strata, have not only caused the different parts of our continents to rise by degrees from the bosom of the waves, and diminished the extent of the basin of the ocean, but have also given rise to numerous shiftings of this basin. It has frequently happened, that lands which have been laid dry, have been again covered by the waters, in consequence either of their being ingulphed in the abyss, or of the sea having merely risen over them. The particular portions also, of the Earth, which the sea abandoned in its last retreat,—those which are now inhabited by man and terrestrial animals,—had already been once laid dry, and had then afforded subsistence to quadrupeds, birds, plants, and land productions of all kinds: the sea which left it had, therefore, covered it at a previous period [4].

The changes in the level of the waters have not, therefore, consisted solely in a more or less gradual, or more or less general retreat; there have been various successive irruptions and retreats, the final result of which, however, has been a universal depression of the level of the sea.

Proofs that these Revolutions have been sudden.

It is of much importance to remark, that these repeated irruptions and retreats of the sea have neither all been slow nor gradual; on the contrary, most of the catastrophes which have occasioned them have been sudden; and this is especially easy to be proved, with regard to
the last of these catastrophes, that which, by a two-fold motion, has inundated, and afterwards laid dry, our present continents, or at least a part of the land which forms them at the present day. In the northern regions, it has left the carcases of large quadrupeds which became enveloped in the ice, and have thus been preserved even to our own times, with their skin, their hair, and their flesh. If they had not been frozen as soon as killed, they would have been decomposed by putrefaction. And, on the other hand, this eternal frost could not previously have occupied the places in which they have been seized by it, for they could not have lived in such a temperature. It was, therefore, at one and the same moment that these animals were destroyed, and the country which they inhabited became covered with ice. This event has been sudden, instantaneous, without any gradation; and what is so clearly demonstrated with respect to this last catastrophe, is not less so with reference to those which have preceded it. The breaking to pieces, the raising up and overturning of the older strata, leave no doubt upon the mind that they have been reduced to the state in which we now see them, by the action of sudden and violent causes; and even the force of the motions excited in the mass of waters, is still attested by the heaps of debris and rounded pebbles which are in many places interposed between the solid strata. Life, therefore, has often been disturbed on this earth by terrible events. Numberless living beings have been the victims of these catastrophes; some, which inhabited the dry land, have been swallowed up by inundations; others, which peopled the waters, have been laid dry, from the bottom of the sea having been suddenly raised; their very races have been extinguished for ever, and have left no other memorial of their existence than some fragments, which the naturalist can scarcely recognize.

Such are the conclusions to which we are necessarily led by the objects that we meet with at every step, and which we can always verify, by examples drawn from almost every country. These great and terrible events are everywhere distinctly recorded, so as to be always legible by the eye skilled to decipher their history in the monuments which they have left behind.

But what is still more astonishing and not less certain, life has not always existed upon the globe; and it is easy for the observer to distinguish the point at which it has begun to deposit its productions.

**Proofs that there have been Revolutions anterior to the existence of living beings.**

If we ascend to higher points of elevation, and advance towards the great ridges, the craggy summits of the mountain chains, we shall presently find those remains of marine animals, those innumerable shells, of which we have spoken, becoming more rare, and at length disappearing altogether. We arrive at strata of a different nature, which contain no vestiges of living beings. Nevertheless, their crystallization, and even their stratification, shew that they have been also in a liquid state at their formation; their inclined position, and the cliffs into which they are broken, shew that they also have been forcibly moved from their original places; the oblique manner in which they dip under the shelly strata, that they have been formed previously to these latter; and lastly, the height to which their rugged and bare peaks rise above all these shelly strata, that their summits had already emerged from the waters, when the shelly strata were forming.

Such are those celebrated Primitive Mountains which traverse our continents in different directions, raising themselves above the clouds, separating the basins of rivers from one another, affording, in their perennial snows, reservoirs which feed the springs, and forming, in some measure, the skeleton, and as it were the rough framework, of the Earth.
The eye perceives from afar, in the indentations with which their ridge has been marked, and in the sharp peaks with which it is bristled, indications of the violent manner in which they have been elevated. Their appearance, in this respect, is very different from that of those rounded mountains, and hills with long flat surfaces, whose less ancient masses have always remained in the situation in which they were quietly deposited by the waters of more recent seas.

These indications become more obvious as we approach. The valleys have no longer those gently-sloping sides, those salient and re-entering angles corresponding on either side to each other, which seem to denote the beds of ancient streams. They widen and they contract without any general rule; their waters, at one time, expand into lakes; at another, fall in torrents; and sometimes their rocks, suddenly approaching from each side, form transverse dikes, over which the waters tumble in cataracts. The dissevered strata, while they shew on one side their edges perpendicularly raised, on the other present large portions of their surface lying obliquely; they do not correspond in height, but those which, on one side, form the summit of the cliff, often dip underneath on the other, and are no longer visible.

Yet, amidst all this confusion, distinguished naturalists have been able to demonstrate, that there still reigns a certain order, and that those immense deposits, broken and overturned though they be, observe a regular succession with regard to each other, which is nearly the same in all the great mountain chains. According to them, Granite, of which the central ridges of the greater number of these chains consist, and which thus surmounts every other rock, is also the rock which is found deepest in the solid crust of the globe. It is the most ancient of those which we have found means of examining in the place assigned them by nature; and we inquire not at present, whether it owes its origin to a general fluid, which formerly held every thing in solution, or may have been the first consolidated by the cooling of a great mass in fusion, or even in a state of vapour [5]. Foliated rocks rest upon its sides, and form the lateral ridges of these great chains; schists, porphyries, sandstones, and talcose rocks, intermingle with their strata; lastly, granular marbles, and other limestones destitute of shells, resting upon the schists, form the outer ridges, the lower steps as it were, the counterforts, of these chains, and are the last formations, by which this unknown fluid, this sea without inhabitants, would seem to have prepared materials for the mollusca and zoophytes, which were presently to deposite upon these foundations vast heaps of their shells and corals.

We even find the first productions of these mollusca and zoophytes appearing in small numbers, and scattered at greater or less distances, in the last strata of these primitive formations, or in that portion of the crust of the globe to which geologists have given the name of Transition rocks. Here and there we meet with beds containing shells, interposed between certain granites of later formation than the others, between schists of various kinds, and between some newer beds of granular marbles. Life, which was in the end to obtain entire possession of the globe, seems, in these primordial times, to have struggled with the inert nature which formerly predominated; and it was not until a considerable time after, that it obtained the ascendancy over it, and acquired for itself the exclusive right of continuing and elevating the solid envelope of the Earth.

Hence, it is impossible to deny, that the masses which now constitute our highest mountains, have been originally in a liquid state; and that they have for a long time been covered by waters in which no living beings existed. Thus, it has not been only since the appearance of life that changes have been operated in the nature of the matters which have been deposited; for the masses formed previous to that event, have varied, as well as those which have been formed since. They have also experienced violent changes in their position,
and a part of these changes must have taken place at the period when these masses existed by themselves, and were not covered over by the shelly masses. The proof of this lies in the overturnings, the disruptions, and the fissures, which are observable in their strata, as well as in those of more recent formations, and which are in the ancient strata even in greater number and better defined.

But these primitive masses have also undergone other revolutions since the formation of the secondary strata, and have, perhaps, given rise to, or at least have partaken of, some of those changes which these strata themselves have experienced. There are actually considerable portions of the primitive formations uncovered, although placed in lower situations than many of the secondary formations; and we cannot conceive how it should have so happened, unless the primitive strata in those places had forced themselves into view, after the secondary strata had been formed. In certain countries, we find numerous large blocks of primitive substances scattered over the surface of secondary formations, and separated by deep valleys, or even by arms of the sea, from the peaks or ridges from which they must have been derived. We must necessarily conclude, therefore, either that these blocks have been ejected by eruptions, or that the valleys (which must have stopped their course) did not exist at the time of their being transported; or, lastly, that the motions of the waters by which they were transported, exceeded in violence any thing that we can imagine at the present day [6].

Here, therefore, we have a collection of facts, a series of epochs, anterior to the present time, of which the successive steps may be perfectly ascertained, although the duration of their intervals cannot be defined with precision. They are so many fixed points, which serve to regulate and direct our inquiries respecting this ancient chronology.

Examination of the Causes which act at present on the surface of the Globe.

Let us now examine those changes which are taking place at the present day upon the globe, investigating the causes which still act in its surface, and endeavouring to determine the possible extent of their effects. This portion of the history of the Earth is so much the more important, that it has long been considered possible to explain the more ancient revolutions on its surface by means of these still existing causes; in the same manner as it is found easy to explain past events in political history, by an acquaintance with the passions and intrigues of the present day. But we shall presently see, that unfortunately the case is different in physical history: the thread of operations is here broken; the march of Nature is changed; and none of the agents which she now employs, would have been sufficient for the production of her ancient works.

There still exist, however, four causes in full activity, which contribute to alter the surface of our continents. These are, rains and thaws, which waste down the steep mountains, and precipitate the fragments to their bottoms; running waters, which carry off these fragments, and deposit them in places where their current is abated; the sea, which undermines the foundations of elevated coasts, forming steep cliffs, and which throws up great banks of sand upon the low coasts; and, lastly, volcanoes, which pierce through the solid strata from below, elevate these strata, or spread over the surface vast quantities of ejected matter.
M. Cuvier adopts the opinion of De Luc, that all the older strata of which the crust of the earth is composed, were originally in an horizontal situation, and have been raised into their present highly-inclined position, by subsidences that have taken place over the whole surface of the earth.

It cannot be doubted, that subsidences, to a considerable extent, have taken place; yet we are not of opinion that these have been so general as maintained by these geologists. We are rather inclined to believe, that the present inclined position of strata is in general their original one; an opinion which is countenanced by the known mode of connection of strata, the phenomena of veins, particularly contemporaneous veins, the crystalline nature of every species of older rock, and the great regularity in the direction of strata throughout the globe.

The transition and floetz-rocks also are much more of a chemical or crystalline nature than has been generally imagined. Even sandstone, one of the most abundant of the floetz-rocks, occasionally occurs in masses, many yards in extent, which individually have a tabular or stratified structure; but, when viewed on the great scale, appear to be great massive distinct concretions. These massive concretions, with their subordinate tabular structures, if not carefully investigated, are apt to bewilder the mineralogist, and to force him to have recourse to a general system of subsidence or elevation of the strata, in order to explain the phenomena they exhibit.

The opinion maintained by some geologists, that certain strata have been formed in the inclined position in which they are now found, admitting it true with regard to some particular strata which might have been crystallized, as Mr Greenough supposes, like the deposit which encrusts the inside of vessels, in which water containing gypsum has been boiled, cannot at least apply to those which contain shells or rolled stones, which could not have waited, so suspended, the formation of the cement by which they were to be agglutinated.

Deluge. There are many facts, some of which are recorded in the Bible, that are hostile to Cuvier and De Luc's opinions stated in the text, viz. that the bed of the ocean was changed at the flood, or last great catastrophe; and that the land, formerly occupied by animals, was henceforth given up to fishes and other marine tribes. We are told, for example, that the dove, which was sent forth from the ark, found an olive-tree, whence it plucked a leaf, to carry back to the patriarch, as a proof that the waters of the deluge were subsiding; and we also find that the Assyrian rivers, which originally marked the situation of Eden, retained the same geographical relations after the earth had been repeopled. The natural history of the fossil organic remains contained in alluvial deposits, is also in opposition to the opinion of De Luc.

The conjecture of the Marquis de la Place, that the materials of which the globe is composed, have perhaps existed at first in the elastic form, and have successively assumed a liquid consistence on cooling, and have at length been solidified, is well supported by the recent experiments of M. Mitscherlich, who has composed, of all sorts of substances, and crystallized by the heat of intense furnaces, several of the mineral species which enter into the composition of primitive mountains.
The Travels of Saussure and Deluc present a multitude of facts of this description. These geologists imagined, that they could only have been produced by enormous eruptions. De Buch and Escher have recently employed themselves upon this subject.