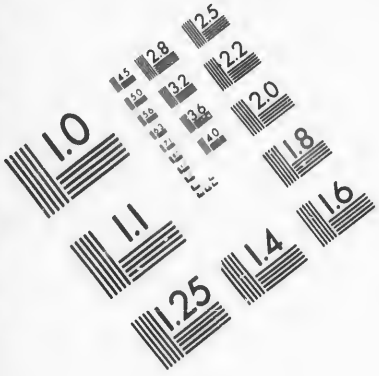


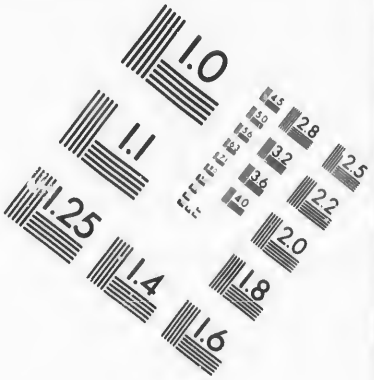
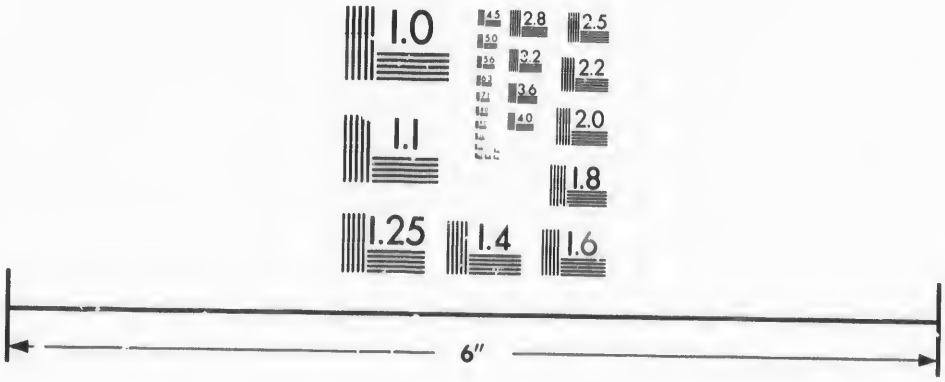
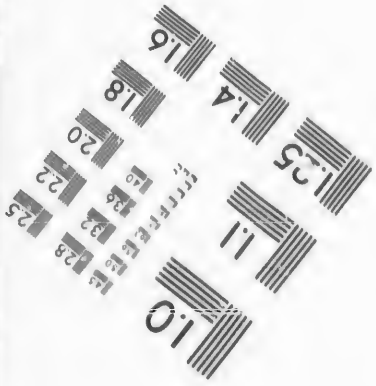
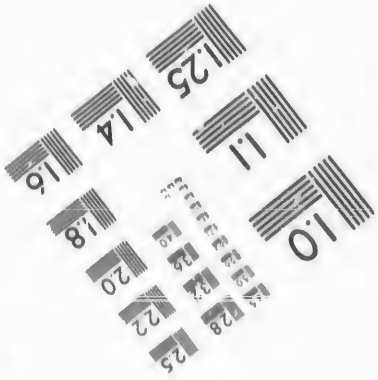


IMAGE EVALUATION TEST TARGET (MT-3)







Photographic Sciences Corporation

23 WEST MAIN STREET
WEBSTER, N.Y. 14580
(716) 872-4503

Technical and Bibliographic Notes/Notes techniques et bibliographiques

The Institute has attempted to obtain the best original copy available for filming. Features of this copy which may be bibliographically unique, which may alter any of the images in the reproduction, or which may significantly change the usual method of filming, are checked below.

- ☐ Coloured covers/ Couverture de couleur
- ☐ Covers damaged/ Couverture endommagée
- ☐ Covers restored and/or laminated/ Couverture restaurée et/ou pelliculée
- ☐ Cover title missing/ Le titre de couverture manque
- ☐ Coloured maps/ Cartes géographiques en couleur
- ☐ Coloured ink (i.e. other than blue or black)/ Encre de couleur (i.e. autre que bleue ou noire)
- ☐ Coloured plates and/or illustrations/ Planches et/ou illustrations en couleur
- ☐ Bound with other material/ Relié avec d'autres documents
- ☐ Tight binding may cause shadows or distortion along interior margin/ La reliure serrée peut causer de l'ombre ou de la distorsion le long de la marge intérieure
- ☐ Blank leaves added during restoration may appear within the text. Whenever possible, these have been omitted from filming/ Il se peut que certaines pages blanches ajoutées lors d'une restauration apparaissent dans le texte, mais, lorsque cela était possible, ces pages n'ont pas été filmées.
- ☐ Additional comments:/ Commentaires supplémentaires:

L'Institut a microfilmé le meilleur exemplaire qu'il lui a été possible de se procurer. Les détails de cet exemplaire qui sont peut-être uniques du point de vue bibliographique, qui peuvent modifier une image reproduite, ou qui peuvent exiger une modification dans la méthode normale de filmage sont indiqués ci-dessous.

- ☐ Coloured pages/ Pages de couleur
- ☐ Pages damaged/ Pages endommagées
- ☐ Pages restored and/or laminated/ Pages restaurées et/ou pelliculées
- ☑ Pages discoloured, stained or foxed/ Pages décolorées, tachetées ou piquées
- ☐ Pages detached/ Pages détachées
- ☑ Showthrough/ Transparence
- ☑ Quality of print varies/ Qualité inégale de l'impression
- ☐ Includes supplementary material/ Comprend du matériel supplémentaire
- ☐ Only edition available/ Seule édition disponible
- ☐ Pages wholly or partially obscured by errata slips, tissues, etc., have been refilmed to ensure the best possible image/ Les pages totalement ou partiellement obscurcies par un feuillet d'errata, une pelure, etc., ont été filmées à nouveau de façon à obtenir la meilleure image possible.

This item is filmed at the reduction ratio checked below/
Ce document est filmé au taux de réduction indiqué ci-dessous.

10X 14X 18X 22X 26X 30X

12X 16X 20X 24X 28X 32X

The copy filmed here has been reproduced thanks to the generosity of:

The Nova Scotia
Legislative Library

The images appearing here are the best quality possible considering the condition and legibility of the original copy and in keeping with the filming contract specifications.

Original copies in printed paper covers are filmed beginning with the front cover and ending on the last page with a printed or illustrated impression, or the back cover when appropriate. All other original copies are filmed beginning on the first page with a printed or illustrated impression, and ending on the last page with a printed or illustrated impression.

The last recorded frame on each microfiche shall contain the symbol → (meaning "CONTINUED"), or the symbol ∇ (meaning "END"), whichever applies.

Maps, plates, charts, etc., may be filmed at different reduction ratios. Those too large to be entirely included in one exposure are filmed beginning in the upper left hand corner, left to right and top to bottom, as many frames as required. The following diagrams illustrate the method:

L'exemplaire filmé fut reproduit grâce à la générosité de:

The Nova Scotia
Legislative Library

Les images suivantes ont été reproduites avec le plus grand soin, compte tenu de la condition et de la netteté de l'exemplaire filmé, et en conformité avec les conditions du contrat de filmage.

Les exemplaires originaux dont la couverture en papier est imprimée sont filmés en commençant par le premier plat et en terminant soit par la dernière page qui comporte une empreinte d'impression ou d'illustration, soit par le second plat, selon le cas. Tous les autres exemplaires originaux sont filmés en commençant par la première page qui comporte une empreinte d'impression ou d'illustration et en terminant par la dernière page qui comporte une telle empreinte.

Un des symboles suivants apparaîtra sur la dernière image de chaque microfiche, selon le cas: le symbole → signifie "A SUIVRE", le symbole ∇ signifie "FIN".

Les cartes, planches, tableaux, etc., peuvent être filmés à des taux de réduction différents. Lorsque le document est trop grand pour être reproduit en un seul cliché, il est filmé à partir de l'angle supérieur gauche, de gauche à droite, et de haut en bas, en prenant le nombre d'images nécessaire. Les diagrammes suivants illustrent la méthode.

THE DI

THE AN

M

A

TREATISE

ON

GEOLOGY;

IN WHICH

THE DISCOVERIES OF THAT SCIENCE ARE RECONCILED WITH THE SCRIPTURES,

AND

THE ANCIENT REVOLUTIONS OF THE EARTH ARE SHOWN TO BE SOURCES OF BENEFIT TO MAN.

BY

THOMAS TROTTER,

MINISTER OF THE PRESBYTERIAN CHURCH,
ANTIGONISH, NOVA-SCOTIA.

PRINTED BY

GELDERT & PATTERSON,

Eastern Chronicle Office,

PICTOU, N. S.

MDCCCXLV.

PREFACE.

THE FOLLOWING TREATISE, though complete by itself, was originally designed to form a part of a more varied and extended work; and it is to this circumstance that it owes both its existence and its form. I have long thought that the leading events recorded and foretold in the Sacred Scriptures, by being all exhibited as parts of a whole, and having their relation to a common object pointed out, would be placed in a far more interesting and instructive light, than that in which it is possible for them to appear as isolated occurrences; and for many years I have felt an increasing desire to attempt it. A comprehensive, connected, and scientific view of these events, if properly executed, would render an important service to Religion, by silencing many of the cavils of the Infidel, and solving some of the greatest difficulties which perplex the mind of the inquisitive Christian. To execute such a work properly, would require a greater command of time than I have at my disposal, and the possession of talents beyond what I can pretend to; and under these circumstances it may be the wiser course to call the attention of others to it, who are better qualified to do it justice. At the same time, as the following Treatise contains my views in regard to the physical history of the earth, a highly important department of the work—as many of these views are new—as I believe them to be just, and as the Treatise is a specimen of what the Work would be were

it completed, I have determined to publish it, such as it is, in this separate form.

A short account of the physical changes which the earth has undergone, and by which it has become a proper theatre for the developement of the great arrangements of Providence, would form a suitable introduction to a general and connected view of these arrangements; and in the latter part of the following Treatise, I have traced the bearing of the revolutions of the earth on the accomplishment of the great end of its creation, but with what success, must be determined by less partial judges.

A fuller account than is here given, of the different races of plants and animals which once existed on the face of the earth, but have long been extinct, would have rendered the work more interesting to many; but my object was not, to write the Natural History of a former world, but to select such facts as were calculated to throw light upon its physical condition; and I have not omitted a single fact, known to myself, that would have given additional light to what is here given. The philosophical historian, a designation which I would be most happy to merit, whose object is to analyse the different elements of improvement—to ascertain the combinations of which they are susceptible, and to trace the progress of these combinations to their ultimate consequences, selects such facts as are suited to his purpose, and sufficient for its attainment, and passes over the rest as redundancies, and calculated only to encumber his march.

My materials have been collected from different sources, and at different times; and it would now be impossible for me to refer every statement I have made to its proper origin; but so far as I can now recollect, I have acknowledged the extent of my obligations to other writers, with the exception of Dr. Lyell, and the Edinburgh Review. To the one I am largely indebted for facts, and I have adopted a number of important views and suggestions from the other; and have preferred making a general acknowledgement to both, to having quoted so often as would have been necessary. I have understood that the friends of the former still call him

Mr. Lyell, which must therefore be considered as most agreeable to himself; and as I wish to treat him with the highest respect, I should have conformed to the practice had I known it in time.

I am aware that the opinion respecting the age of the earth which I have adopted, does not stand high with geologists in general; and I scarcely expect the arguments here adduced in support of it to be treated with the respect to which I am fully satisfied they are entitled; but that does not shake my confidence in their truth. It cannot be denied that the Pre-adamite theory has been too often assailed by ignorance, and its supporters branded with a leaning to Infidelity; but they have not always shown that courtesy towards their opponents with which men of science should treat one another. I refer as an instance to the personalities heaped upon the Dean of York, for advocating the Adamite Theory at the British Association. His views of Geology may be crude and erroneous, and he may be a Pluralist and hold different livings, but what connection has a man's habits with a scientific truth? and for what purpose are these habits dragged into light in a scientific discussion, unless it be to silence opposition by means of intimidation? Such practices cannot be too severely reprobated, on whichsoever side they are resorted to.

All the revolutions which the earth has undergone have contributed more or less directly to the convenience of man, and to his advancement in intellectual and moral improvement; and we may therefore regard the increase and improvement of the human race as the ultimate object of these changes; but the adaptation to this end into which the earth has evidently been brought by its repeated revolutions, must be limited in respect of duration,—for some of its most important mineral resources are so very far from being inexhaustible, that they are comparatively limited, and show that the earth is intended to continue in that state, for which its repeated revolutions have prepared it, only for a proportionally limited time. Now it would be contrary to all analogy, and a complete anomaly in the [illegible] of nature,

if many millions of years were spent in preparation for a state that was to continue but for so many thousands; and this consideration, independent of every thing else, should induce us to pause, and examine with the greatest vigilance and deliberation, the foundations of a theory which is so far from according with the Sacred Scriptures, that those of its supporters who maintain its reconcileability with the Scriptures, differ so widely from one another in regard to the manner in which the reconciliation is to be effected, that others of them, and those by no means of an inferir grade, regard the point as unattainable, and allow the Scriptures to be written not in conformity with the fact, but with the traditionary accounts and prejudices of the age to which they are to be referred.

I am satisfied that whatever opposition may appear between the Scriptures and any science in its infancy, it will gradually disappear in proportion as that science advances; and when a reconciliation is effected, they will be mutually serviceable to one another, and promote the great object of both. Geology and the Scriptures illustrate each other, and give a clear, consistent, and interesting view of the early condition of the earth—of the revolutions it has undergone, and the great end for which they have been brought about.

T. T.

Antigonish, 12th August, 1845.

CONTENTS.

BOOK III.

OF THE IDENTITY OF THE REVOLUTIONARY PERIODS OF THE EARTH WITH THE ANTEDILUVIAN AGE OF THE SACRED SCRIPTURES.

Chap. VII.

Chap. VIII.

objections considered.

BOOK IV.

OF THE BENEFITS WHICH THE PRESENT INHABITANTS OF THE EARTH DERIVE FROM THE PHYSICAL CHANGES IT HAS UNDERGONE.

GEOLOGY.

INTRODUCTION.

THE uniform regularity of the course of nature, and general stability and tranquillity of the earth, warrant the supposition, that the latter has continued in a state of repose since the date of its creation, when all things rose into existence at the fiat of Omnipotence. That it has however undergone a series of violent and extensive mutations, before attaining to its present state of rest, appears very plainly, from the ruptured and dislocated condition of the strata; and as many of these revolutions have evidently exercised a beneficial influence, and contributed to the convenience of its present inhabitants, it is proper to enquire into their number and extent, the causes in which they have originated, the effects they have produced, and other interesting circumstances connected with them.

The Science of Geology, which treats of these matters, is yet in its infancy; and as may be reasonably supposed, it has given rise to a variety of conflicting theories, by which its progress has been partly promoted and partly retarded. It is the opinion of many, that the revolutions of the earth have occurred at very distant periods from one another,—that they have been respectively attended by new creations of organized forms, both animal and vegetable,—and that, beginning with the simplest, the types of every new creation have approached more nearly than those of its immediate predecessor in the series, to the races which still continue

in existence. Had not this theory been entitled to the support of very plausible arguments, it could never have gained so many truly eminent friends in this enlightened and scientific age. Yet as great minds have often been misled, and as arguments equally if not more conclusive, may be produced against it, both sides should be fairly examined before we come to a decision respecting it. But before the reasoning on either side can be properly understood, and the force of the arguments duly appreciated, it is necessary that we possess a general acquaintance with the form, composition, and structure of the earth, the revolutions it has undergone in the structure of its crust, and the known or probable causes of these revolutions.

BOOK I.

OF THE FORM, COMPOSITION, AND STRUCTURE OF THE EARTH.

§ 1. Of the Form of the Earth.—Little requires to be said on this point. The earth is called an Oblate Spheroid. It is a ball slightly flattened at the ends. A line drawn through its centre, from pole to pole, would not be so long as another drawn through its centre in any other direction, and more especially under the equator. Whether this form was immediately given to it at the creation, or resulted from the laws of matter in motion, is a problem which we have not the means of solving; but it is of no consequence in the present investigation, as neither of the suppositions, though fully established, would serve to shed any certain light on the darker periods of the history of the earth. It may be observed, however, that the form of the earth serves different important purposes in the economy of nature, and may therefore be regarded as a wise and benevolent provision of nature. It increases the length of the day, for instance, in the higher latitudes during the summer, and in some measure compensates for the diminished power of the sun's rays in those bleak regions.

§ 2. Of the Composition of the Earth.—This is a point of far more importance in Geology. More than two thirds of the surface of the earth are covered with water, and the remainder only is dry land.

The mean depth of the sea was estimated by La Place at twelve miles, which he considered necessary to account for the ordinary phenomena of the tides, but which is generally thought to be too high. Mr. Whewell reduces it to nine miles; and as his estimate is said to be generally correct,

wherever it can be tested by means of sounding, it seems to be only fair to receive it, till its incorrectness has been proved.

I am not aware, that any estimate has ever been made of the mean height of the dry land, above the level of the sea, but it will not bear a comparison with the mean depth of the latter. One mile is in all probability beyond the truth; and this for no more than one third of the surface of the Globe. If then there were no inequalities on the surface of the earth—were the waters spread over it at an equal depth, they would form a covering to it of six or seven miles of thickness.

The greater part of the dry land is covered with soil, chiefly composed of siliceous, argillaceous, and calcareous earths; generally mixed, but differing in their proportions in different places; and possessing more or less adhesiveness, according as one or another predominates. These mixtures are in general loose and incompact near the surface, but they have all been consolidated and hardened into rock, at a greater or less depth below it; and, in their friable state, their mean density, as compared with their volume, is considerably less than that of their indurated and petrified condition. They consist chiefly of metallic oxides, and have in general been reduced to metallic bases. Though Oxygen in a rarified or fluid state, as it exists in the atmosphere, is much expanded, and consequently very light, it may be greatly condensed by means of combination with different metals, and in this state of combination it forms a large proportion of the ponderable materials of which the crust of the earth is composed.

The interior of the earth is beyond our research, and we cannot attain to certainty respecting it; but there are different well established facts, which warrant the conclusion that it is a vast mass of solid substances, specifically heavier in a high degree than the materials of its crust. Taking water, as usual, for the standard of comparison, and counting it 1, the mean density of the great majority of the known rocks is about 2½; but Dr. Maskelyne and others have shown, by their observations on the attraction of mountains, that the mean density of the earth is 5, or twice that of the

materials of its crust, even in their most compacted form. The influence of the earth on the motions of the moon has directed astronomers to the same conclusion; and it may therefore be received as nearly if not perfectly correct.

Considering then that the volume of water contained in the ocean, which is included in the estimate, is equal to six or seven miles at the circumference of the circle, and counts but 1, and that the crust of the earth, which is several miles more in thickness, counts but 2½, it is evident that the remainder, after these deductions are made, must be considerably upwards of 5,—that it must approximate the density of a great proportion of the known metals; and considering, moreover, that the greater part of the known earths are metallic oxides, and also that all metallic veins, as will be shown hereafter, have been filled from the interior, it appears exceedingly probable that the interior of the earth consists of a vast collection of metals, or of substances possessing metallic properties.

§ 3. Of the Structure of the Earth.—This is a subject of still more importance in Geological enquiries than even its Composition, and throws more light upon its past history. We cannot penetrate into the interior of the earth, or obtain information respecting the disposition of the materials contained in it; but its crust has become more accessible to our researches, through the revolutions it has undergone; and many important particulars have been ascertained respecting its structure. In the crust of the earth there are three great classes of rocks, having each a different origin, and a different texture; and being distinguishable from one another by their respective peculiarities.

Geological Science is still in an infant and unsettled state, being constantly receiving new accessions, and undergoing new modifications and changes, both in regard to classification and arrangement; and as no particular nomenclature has been agreed upon, or generally adopted by those who have discovered or expounded its facts, it is exceedingly difficult, or rather impossible, to present a general view of those facts, without appearing to give a preference to some par

ticular theory, which is not intended in this dissertation. But some nomenclature must be used, and some arrangement must be adopted; and without intending to prefer one theory to another, the course shall be followed which in regard to these matters appears to be on the whole most generally approved.

It is allowed on all hands that the crust of the earth is composed of three great classes of rocks; namely, the Stratified, the Coralline, and the Crystalline.

Of the Stratified Rocks.—This is the most numerous, and by far the most important class of rocks, and consists of a long succession of beds, differing from one another in regard to composition, texture, thickness, and position; but appearing everywhere to have been formed agreeably to a certain order, which is rarely departed from, though the series is in many situations incomplete. They are by some divided into three, and by others into four distinct serieses; and each series is subdivided into a number of groups, systems, or formations; all occupying different positions, and distinguished from one another by different names.

Of the first, or lowest series of Stratified Rocks.—Observing the order of superposition, the lowest series is generally if not universally called the primary; and comprehends five or six different beds: Gneiss being the first or lowest in the order, Mica Slate the second, Hornblende Slate the third, Clay Slate the fourth, to which Quartz Rock and Primary Limestone are to be added, the last of which, instead of always retaining the same position, sometimes alternates with other beds. Many of these beds are very thick, and the greater part of them have a slaty texture, and are partially crystallized, as if they had been subjected to an intense and powerful pressure, subsequent to their formation.

Of the Transition Series.—Those who admit of a fourth give to the next the name of the Transition Series, from an idea that, during the time of its formation, the earth was passing from an uninhabitable into a habitable state; and because that the rocks belonging to it, partly partake of the compact and slaty texture of the foregoing, and at the same

time contain fossil organic remains, like all those of a later date, or which lie between them and the surface. The Greywacke system, otherwise called the Silurian, is the first or lowest in this series, and it is immediately followed by the Old Red Sandstone, which is succeeded in its turn by the Carboniferous system, containing the great Coal Formation, in many respects the most important of the three.

Of the Secondary Series.—This is the third in the order of succession, and begins with the New Red Sandstone, and ends with the Cretaceous, or Chalk Formation. Between these are the Lias, and Shelly Limestone, the lower and upper Oolites, and different other limestones and sandstones, which Geologists have little difficulty in distinguishing. Though the first in the series is generally called the New Red Sandstone, it contains other beds of rock, besides sandstone, and the sandstone is not always red, but often grey, and in many localities they alternate with Conglomerate, Rock Salt, Gypsum, and some other useful minerals.

Of the Tertiary Series.—This consists of Limestone, Sandstone, Gypsum, Marl Clay, Gravel, and in some localities an inferior kind of coal; but as different beds may have been formed simultaneously, though in different places, it would not be easy to arrange them according to a particular order, or to ascertain what are their respective ages, as compared with one another.

General Observations on the Stratified Rocks.—Though they succeed one another in a certain order, they are neither all of the same thickness nor superficial extent. Beginning with the lower or Primary Series, and ascending to the upper or Tertiary, they gradually diminish in both respects, and in any extensive valley, bounded by great mountain chains, the strata may not be unfitly compared to a series of cups placed within one another, and all regularly diminishing in size, so that the brim of the largest rises higher than that of the next, and so on of all the rest to the last, which has not only a less area, but also a less elevation than any of the others. Though the strata of the primary series are the lowest in point of order, and actually underlie all the rest,

their edges run up on the flanks of the mountains to a much greater height than those of any of the rest, and it is there chiefly that they are exposed to view. The Transition Series rests on the Primary, and the edges of the Greywacke, or Silurian System, are also seen most frequently in the higher grounds, though much below those of the Gneiss and Mica Slate. The edges of the Secondary Strata are still lower than those of the Transition, and the Tertiary are lower than any of the rest. The Primary Series commencing on the shoulders of the higher mountains, where the Crystalline masses have broken through them, and sloping downwards till they meet with the first of the Transition Series, they enter the latter, and of course disappear, and running along at a great depth below the surface, they again emerge, and come into view on the shoulder of the next mountain ridge, which bounds the opposite side of the valley. The Transition, and all the rest in succession, follow in their turns, so that near their edges, they rise to the surface, and are exposed to view, while the intervening space is generally covered. The consequence is, that the superficial extent of every succeeding series is proportionally less than that of its more immediate predecessor; and for the most part their thickness is reduced as much as their area.

It is chiefly to this contraction of the area of the strata, that we owe our acquaintance with the structure of the Earth. Had it not been for this, the older beds would have been inaccessible to our researches, on account of their depth, and we must have either been wholly ignorant of, or but very imperfectly acquainted with them. It is not, however, on the shoulders of the great mountains only, that the primary rocks come into view. Portions of them have been occasionally forced upwards into view, in the low grounds, and there are different localities in which ancient mountains of the primary order have subsided to the level of the lower grounds, and left nothing but their original summits and shoulders uncovered, to tell where they have been; and there we may meet with the primary strata resting against the crystalline masses, which have penetrated through them.

The order of the strata is seldom inverted, but sometimes a particular group, and at other times a whole system, may be wanting; and it frequently happens that strata which are wanting in one place, are present in another, and *vice versa;* in consequence of which arrangement we may meet with beds of an older date, where we expected to find more recent formations, while in other situations the recent formations are wanting, and the intermediate or even the ancient rise to the surface.

Though the different formations follow the order of superposition, they do not all lie in the same planes. They are not parallel to one another. The beds of one series, or group, have in many instances changed from a horizontal to an inclined, or even a vertical position, before the succeeding group was deposited; and the consequence is, that the edges of the one come in contact with the inclined face of the other, and form angles of greater or less acuteness with them.

Again, from the greywacke formation, which is the first of the transition, to the last of the tertiary, all the strata are fossiliferous, or contain fossil organic remains; and these remains, whether animal or vegetable, though they have a general resemblance, are not precisely alike, or the same in all, but appear to differ specifically in different formations. The organic remains which occur in the transition series, which contains the oldest fossiliferous strata, are not the same with those of the secondary series; and those of the secondary differ as much, if not more, from those of the tertiary; and even the remains of the earlier periods of the tertiary series, are not the same with those of the later periods, when they begin to approximate more nearly to existing races, and may in many instances be identified with them. There thus appears to have been a constant change in organic life, whether vegetable or animal, from the earliest times in which the earth was inhabited, till that in which existing races made their first appearance; and though the two extremes in the chain of being are specifically dissimilar, they have not only a generic resemblance, but are connected

by a chain of intermediate links, in which there is neither any want of continuity, nor any violent or abrupt transition from one to another; but an easy gradation from type to type, till we almost insensibly arrive at the termination. These facts are of the utmost importance in the study of Geology, from the light which they throw on the early condition and revolutions of the earth.

Of the Coralline Rocks.—This class of rocks has been formed by the labours of marine insects, denominated Zoophites, because they unite some of the peculiar properties of plants with those of animals. Like plants they are attached to the rock, but not for the same purpose; for they do not extract from it the means of their subsistence, but increase its dimensions; and like plants they may be propagated by a division of their parts, as well as by reproduction.

They belong to the order of radiated animals; and are divided into a number of genera, or races, which differ from one another in regard to their form, size, and habits. They consist of a kind of gelatinous substance, which is constructed on the simplest form of organization, and possess the power of secreting the carbonate of lime, of which they form habitations for themselves on the surface of the rock; leaving them as an addition to the mass, at their decease. In this way does every generation, after spending an ephemeral existence, contribute something to the common property, which accordingly continues to advance in its progress upwards, till it rises to the surface of the water, when it stops.

A coral reef is a massy wall, raised from the bottom of the sea, or built on the top of some submarine mountain, and generally encloses more or less perfectly a certain area, which is greater or smaller, according to the taste or abilities of the colony employed in its construction. Some are only a few miles in length, while others extend to as many hundreds. Some are erected in the form of a circle, others in that of an oval, and others again in that of a crescent, with its convex side facing the current. But whether this diversity is the effect of accident, or results from the sagacity of instinct, in providing against the influence of currents, has not been ascertained.

The outer or exposed face of the wall generally rises more abruptly, while the other slopes toward the centre, which not only gives a stronger support to the mass, against the force of the current, but assists in filling up the interior, and bringing it sooner to the form of an island. As the polypifer does not live out of water, the upward progress of the building ceases when it reaches the surface; but is continued laterally towards the interior, till, with the addition of sand and other materials washed in by the tides, the space is filled up, and the completion of the work is left to the elements. Sand, mud, and other substances, are deposited on the reef, till it rises above water, and becomes dry ground. Seeds are floated to it by the waves, or dropt upon it by birds, and it becomes in time clothed with vegetation.

In this manner, have many islands been already formed, and others are now in the course of being formed, in the equatorial seas; but it does not follow, as some Geologists allege, that these are additions to the solid globe. They are only a restoration of what has previously been taken from it, and moved from one place to another. The carbonate of lime secreted by the polypifer, is carried down from the land, and held in solution by the waters of the sea; and all that the coral insect accomplishes, is its separation from the waters, and restoration to solidity, a change that would have been accomplished by precipitation or otherwise, when the sea became overcharged with it.

If the statement of Mr. Darwin be correct, that the polypifer does not live at a greater depth than 200 feet below the surface, there must either be many submarine mountains in the tropical seas, whose pointed summits serve as foundations for coral reefs, or the bed of these seas must have repeatedly subsided, as many of the reefs are now known to be upwards of 1000 feet in height, below the waters; but it is not improbable that the love of theory, as often happens, has had some influence in modifying the facts on which that opinion is founded. There can be little doubt that numbers of the ancient limestone rocks are coralline structures, but it would be difficult to determine what proportion of them

are to be referred to this origin. Many of them are stratified, and therefore sedimentary; but others of them are massive, and may belong to this class, although they have been altered; and there are others again, about which there cannot be the slightest doubt.

Of the Crystalline Rocks.—Next to the Stratified, the Crystalline Rocks are the most numerous and important; and their formation has exercised the greatest influence in modifying the condition of the crust of the earth. They are distinguished by their compact and crystalline structure, and the total absence of organic remains.

There can be little doubt that they have had an igneous origin; and that they have been thrown up from the interior of the earth in a melted state, which has occasionally given to them an appearance of stratification. When a stream of liquid minerals issues from the same aperture at different times, and overflows a space around the aperture at every new eruption, a succession of beds will be formed, as if they had been deposited in water. The currents of lava, which issue from the craters of active volcanoes, are often laid in beds over one another.

The crystalline rocks have been divided into two classes by Geologists, and distinguished by the names of Plutonic and Volcanic. Those which belong to the first class are supposed to have been thrown up from a greater depth in the interior of the earth, and this is intended to be expressed by their name.

Granite is the principal of the plutonic rocks, and there are several varieties of it, which differ chiefly in the size of their crystals and the hue of their feldspar. This rock has been supposed by some to form the nucleus of the earth, because it appears to underlie all other rocks, and evidently possesses extraordinary thickness; but the nucleus of the earth, if it have a nucleus, must be composed of materials of far greater density than those of granite. It is probable, however, that it forms the inner coat of the crust of the earth, and encloses within it the metallic bases of all the rocks. So far as is known, it underlies all the stratified

rocks; but in most of the great mountain chains it has risen upwards, ruptured and dislocated all the strata, forced its way through them, and pushed its jagged and pinnacled summits to a great height above the highest elevation to which their uplifted and broken edges attain.

Syenite is another of the plutonic rocks. It bears a striking resemblance to granite, for which it may be very easily mistaken; but its mineral composition is considerably different, as it contains hornblende, which is wanting in granite, and has no mica which granite has.

The principal of the volcanic rocks are, Porphyry, Trap, Greenstone, Basalt, Amygdaloid. &c., which are intimately connected, and frequently graduate into one another. They differ from the plutonic rocks in being less perfectly crystallized, and more porous in their texture, which is supposed to have been occasioned by the expansion of gases confined in them, at the time of their refrigeration. They are believed to have cooled more rapidly, and under an inferior degree of compression, which admitted of a greater expansion of the gases; and from this, in connection with other circumstances, it has been inferred that they did not ascend from the same depth, and that the disturbing forces which pushed them upwards were seated proportionally nearer to the surface.

This reasoning is certainly ingenious, and it may be just; but there are some facts which seem at least to militate against it. In the Andes, for instance, the porphyry has been thrown up subsequently to the granite, and it rises to an immense height above it; and as it has evidently passed through the granite, it must have either ascended from the interior of the mass, or it must have come from beneath it. It may be taken for granite altered by volcanic agency, but it contains minerals that are not in the granite. Again, there are veins of trap in the Isle of Arran, which spring from the very base of the mountain, and penetrate upwards through the granite mass, till they emerge in the lofty summits of the Goatfell. Their formation must therefore have been posterior to that of the granite mass; and they appear

at least to have come from below it. Were we allowed to speculate about their different origins, we might perhaps suppose that the plutonic masses have been thrown up in a more general, and the volcanic in a local or more limited disturbance; and that the depth in the interior, from which they have ascended, depended on circumstances. The plutonic masses usually rise in extended and lofty mountain chains; while the volcanic rocks have a variety of forms. They are common in all parts of the world, and form the majority of the secondary and inferior elevations, which serve to diversify the surface of the earth. Sometimes they intersect a district in low dykes, which do little more than give a swelling and undulating appearance to the ground. Sometimes they stand up in majestic columns; and at other times rise in bold relief from the middle of a plain, in lofty cones, with pointed, truncated, or crater-shaped summits, and having nothing in their neighbourhood that bears an affinity to them, either in composition, structure, or form.

Whatever may be the age of the crystalline rocks at an inaccessible depth below the surface, all those parts of them which appear above the sedimentary strata have been elevated subsequently to the formation of the latter; and their intrusion among them has, in most instances, been forcible. Besides, they have not all risen contemporaneously from the interior, but at different times. Masses of granite are occasionally intersected by walls of porphyry, and dykes of trap; and very often by granite veins, which differ from the mass in hue and texture; and there are instances in which older veins are cut by others of the same materials, but of a more recent date. "Near Heidelberg," says a well informed writer, in the Edin. Rev. vol. lxix. p. 423, "the granite consists of three varieties: one consisting of the general mass; a second occurring in veins which cut through the mass alone; and a third in other veins cutting through both the original mass and the first set of veins. We recollect some remarkable appearances of this description at Kelling, near Dublin, where also, the granite mass is cut through by two sets of veins different in hue and texture. There is

another instance at Mount Battock, in the Eastern Grampians. That the matter of these veins was ejected from the interior in a melted state, appears from the compactness with which they are joined to the original mass, and the manner in which they have penetrated every fissure and interstice, along their course; and as they are sometimes of great thickness, their injection into the mass must have increased its volume, and the dimensions of the mountain of which it forms the major part.

BOOK II.

OF THE PHYSICAL REVOLUTIONS WHICH THE EARTH HAS UNDERGONE.

It would be impossible to form anything like a probable theory of the earth, or one that is either consistent with well established facts, or calculated to account for them, without admitting that it has undergone a number of extensive revolutions; and a general acquaintance with these would be useful to us, in giving a more full and detailed account of the discoveries of Geology.

CHAP. I.

PROOFS THAT THE EARTH HAS UNDERGONE A NUMBER OF EXTENSIVE REVOLUTIONS BEFORE COMING TO ITS PRESENT STATE OF REST.

§ 1. It is generally if not universally admitted that the Stratified Rocks are aqueous deposits, and must have been originally formed in a horizontal position, or one that was very slightly inclined; for it is in this form that all sediments are deposited in water. But instead of remaining in a horizontal position, a great proportion of the strata have been fractured, dislocated, and thrown into confusion, in almost every variety of way; which cannot be accounted for on any other supposition than that of having been accomplished by some very powerful and extensive disturbance.

§ 2. Some have indeed alleged, that, as the apparently dislocated condition of the strata serves different important purposes in the economy of nature, they may have been originally formed in that state, as the state that was on the whole best adapted to the end of their existence. But besides

that they exhibit many unequivocal tokens of their dismemberment, they contain, as was formerly stated, a vast number and endless variety of organic remains, both animal and vegetable; and these in such a state of preservation that the skilful and experienced Naturalist seldom experiences any great difficulty in referring the specimens to the different orders, and even genera and species, of the plants and animals to which they belong. This is a well established fact, and cannot be denied; but some have supposed these remains to be a kind of subterranean *lusus naturæ*. This, ridiculous as it may appear, is infinitely less so than that which the flippant ignorance of Voltaire attempted to palm upon the age in which he lived, as a satisfactory solution of a difficulty which had puzzled some of the greatest men of his time· namely, that the fossil shells of Mount Cenis, which were then beginning to attract attention, were either muscle shells from the neighbouring Lakes, though known to have been oyster shells, or that they had fallen from the hats of weary pilgrims, in their passage to and from the Holy Land. Had these remains been found only near the surface of the earth, they could not have been admitted as legitimate evidence of its ancient revolutions; but they occur at a great depth below the surface, and are often enclosed in the heart of its most solid and compact rocks; and as it does not appear that they have any particular function to perform in the economy of nature, we must either infer that she has formed them where they are in some unaccountable freak, as a sort of parodies on her living productions, or that they were once actual plants and animals, and have been entombed in some mighty revolution of the earth; and no man of intelligence will hesitate for a moment which alternative to adopt.

Though entire specimens, both of plants and animals of different orders, are occasionally discovered in a fossil state, mutilated and partially decayed fragments are much more common. They are sometimes found encrusted with marine, lacustrine, or fluviatile productions, as if they had been lying in water before being enclosed in the heart of the strata; while instances occur in which animals appear to have been

entombed alive, as they are not only unchanged in appearance, but even retain the most vivid indications of those muscular contortions which usually accompany a violent death. Trees and plants of smaller dimensions occur in a high state of preservation, having their purest and most delicate parts entire; while others have been fractured and torn to pieces, and their dissevered parts huddled and jammed together into a mass, as if they had been subjected to the action of a powerful current. Such facts show clearly that the crust of the earth has undergone one or more revolutions. Without some great change the lower strata could neither have been brought to the surface, nor could the plants that once grew, and the animals that moved on the face of the earth, have found their way to a depth of hundreds of feet below it, and into the heart of the most solid and compact rocks.

§ 3. The same kind of evidence that will prove the occurrence of one revolution, will prove that of a number. After the derangement of one series of strata, another series has in different instances been deposited over it; and in all such cases the lower beds of the more recent series have taken their shape from the unequal floor formed by the dislocated fragments of the more ancient series. Every series can therefore be distinguished, both from the one that precedes and the one that follows it, by this circumstance, and also by the state and direction of its beds. Had the strata remained in their original positions, this could not have been the case, for they would have all run in parallel lines, being regularly placed over one another like the leaves of a book when laid on its side; and it would have been impossible to have determined where one series ended and another began.

Besides, as has been repeatedly stated already, the organic remains of one series of strata are seldom the same with those of another. This shows that the earth has passed through a number of mutations, before coming to its present state; and that in the course of these mutations, it was better adapted to one race at one time, and to another at a different one. It is partly by means of these phenomena that we are

able to determine the relative ages of the different formations.

Some contend for the Diluvian origin of the greater part if not the whole of the Stratified Rocks; but there are unanswerable objections to this theory. Nothing can be more evident than this, that the Crystalline masses have burst through the superincumbent strata, at different periods. There have been different sets of extensive eruptions, which after having reached what was really the surface of the earth, at their respective dates, and overflowed it to a greater or less distance from their different centres, have been allowed to cool and harden into solid and compact rocks, before other strata, in many cases of great thickness, were deposited over them.

In every series, and in many of their subdivisions, there are occasionally beds of breccia, and frequently vast formations of conglomerate, both of which are composed of fragments of other rocks, cemented and compacted into a solid mass. Had these been all formed by the deluge, they must in general have contained fragments of all the rocks that were in existence at the beginning of that event, and of no other. They could not have been composed of fragments of rocks that were made on the same occasion with themselves. The pebbles of the conglomerates have been first broken up, and then rolled in water till they became round and polished, before being again deposited in their existing form; and all the rocks, of which they contain pieces, must have been in existence before this process commenced. They appear to have been formed at different times, as those which belong to one series contain only fragments of rocks of an older date than themselves; and their respective ages can be determined by this criterion.

Another clear and decisive proof that the strata could not all have been formed by the deluge, is the fact, that the footmarks of various animals have been discovered on rocks, in different parts of the world, over which other strata of great thickness have been subsequently deposited. These impressions must have been made when the rocks were in a

soft and pasty condition, or in a state to admit of them; but they could not have been made during the time of the deluge, when the whole face of the earth was inundated; and it is equally certain that they and the strata which rest upon them could not have been deposited at the same time. When birds and beasts were walking over them, they must either have been uncovered, or at the most but lightly covered by water; and they must have been deeply covered by water afterwards, or the more recent strata could not have been laid down upon them. It is inferred from these and other facts which might be produced, that the earth has undergone a number of revolutions.

§ 4. According to Dr. Lyell, who is high authority in Geological questions, the mutations of the earth have been effected in a gradual and imperceptible manner, rather than by paroxysms. He believed that the agents are still in operation which have in the lapse of time produced these mighty changes, and consequently that the changes are still in progress, and must continue so while the world remains in its present state. He does not indeed avowedly assail the theory of violent and periodical revolutions, but artfully endeavours to sap its foundation, by collecting a vast number of important facts, and exhibiting them in a light that is favourable to his views; while everything that militates against these views is passed in silence. He has shown a disposition rather to blink the question, than to encounter its difficulties. His industry in collecting facts deserves the highest praise, and he has certainly made a very dexterous use of them in support of the unceasing mutation of the earth.

That a number at least of the elements of change have existed, and been in operation from the earliest times to the present day, is undeniable; but besides these there have been other and still more powerful agents, acting intermittently. Ever since the bed of the ocean was formed, and its waters collected into it, they have been acting on its shores, and producing partial changes along the coast, and innumerable rivers have been rolling down masses of mud and sand, and depositing them within its limits; and the obvious ten-

dency of these operations is to diminish its depth, to increase its area, and at the same time to contract the boundaries of the dry land. Place any solid body in water, and the latter will be raised in proportion to the volume of that body; and if the trough have sloping sides, like the greater part of the sea shore, the surface of the water will also be enlarged. The sea ought therefore to be constantly rising to a higher level from the masses of sediment annually deposited in it, and increasing on the limits of the dry land. But instead of this, there is no fact better established in Geological science, than that the sea has fallen from time to time, and that the height and extent of the dry land have increased in proportion. It is equally certain that the land and sea have repeatedly changed places, and this could only have been occasioned by some violent and extensive convulsion.

That the disturbing forces should have acted intermittently, is in accordance with the phenomena of volcanic eruptions: they have their paroxysms and their times of repose, though the circumstances by which these are determined, are in all probability beyond our research.

Besides, though some of the agents which have assisted in changing the crust of the earth are still in operation, they have for ages past lost much of their ancient intensity. The greatest masses known to have been thrown up in modern times from the interior of the earth, sink into insignificance when compared with the lofty mountain chains, which rose up in a single paroxysm of the disturbing forces of ancient times. These chains have no doubt, in many instances, been subsequently increased by the injection of additional matter into their interior, in the form of veins; but the original or parent mass, which always constitutes by far the greater part of the whole, has invariably risen in one convulsion. The primary mountain chains are numerous, and they evidently rose in one general convulsion of the earth. There have also been extensive upliftings at later periods, as appears from the fractures and dislocations of the strata; and tertiary deposits are often found in very elevated situations, which shows clearly, either that the waters, after having

fallen to a much lower level, had again risen to these heights, or that the land had subsided below the level of the waters, and subsequently regained its present position. These facts are universally admitted; and they show that the earth has undergone revolutions, in ancient times, from which it now appears to be exempted; and therefore that the elements of these revolutions have either ceased to operate or lost a great portion of their intensity.

Allowing the slow and gradual rise which is said to be taking place in the Scandinavian Peninsula to be fully proved, it is but a local and isolated fact, and cannot support a general theory of the earth. But has it been fairly established? May it not be found on a more careful enquiry to be a false assumption? That the relative position of the land and water in the Gulf of Bothnia is subject to change may be a fact, and yet result from the depression of the water in that particular locality, rather than from the rising of the land. The Baltic is an inland sea, connected with the Ocean by a narrow channel, which is in a great measure blocked up by islands. Many large rivers fall into it, and it loses comparatively little by evaporation. Now, should the channel be too narrow to allow the free exit of its superabundant waters, they will necessarily stand at a higher level than those of the Ocean; and should either the breadth or the depth of the channel be increasing, the level of the water will become proportionably lower, as a matter of course. But Dr. Lyell alleges, that while the land is rising at the Northern extremity of the Gulf, it is subsiding at the Southern; and if so, this solution is inadmissible. The fact however does not appear to be fully established.

There is another way of solving the difficulty, which is not liable to the same objection: "The waters of the Baltic being almost fresh, must stand about one-fortieth part higher, above the level of the Ocean, in order to preserve the hydrostatic equilibrium. Were the Baltic, therefore, estimated to have only a depth of forty fathoms, it would subside one fathom upon becoming equally salt as the Ocean. May we not therefore suppose that it is becoming salter gra-

dually, and consequently sinking in the same proportion?" (Edin. Rev. vol. xxiv., p. 170)

The waters of the German Ocean contain about three per cent. of saline matter, while those of the Baltic contain little more than one, and are consequently of an inferior specific gravity; and the waters of the Gulfs of Bothnia and Finland are still fresher than those of the Baltic, and may be consequently liable to greater fluctuations. The saltness of both depends partly on the direction of the wind, and must therefore be variable. With a high Westerly wind, it increases, and the level of the water is also raised, because the waters of the German Ocean are driven in; and the opposite effects are produced by a high Easterly wind, because it drives out the waters. Whether the general saltness of the Baltic be increasing or remaining stationary is not known, but there is reason to believe that it is increasing. Professor Wilke found that it varied from 1.0047 to 1.0060, with an Easterly wind, and rose to 1.0189 when Westerly winds had for some time prevailed. And when M. Von Buch afterwards examined it, he found it to be 1.00937. The former drew the water which he examined from the Sound, in the neighbourhood of Landscrona; and the other from the Baltic, off the island of Laaland. The latter should of course be the freshest of the two, and as it happens to be a little salter than the former, it favours the supposition that the general saltness of the Baltic may be increasing and its level falling in the same proportion.

That the level of the Norwegian coast has been stationary for the last 800 years is evident from this, that Monkholm in the harbour of Drontheim, on which Canute the Great erected a monastery in 1028, has still the same area and the same height above the level of the sea as at that time. If therefore the land be rising, as Dr. Lyell supposes along the Gulf of Bothnia, the declivity of that side of the peninsula must be diminishing, and that of the other side increasing. But the Dr. alleges that the rising is continued along the whole length of the peninsula from its southern to its northern extremities. "The upheaving movement may be con-

tinued," says he, "from Gotenburg to Torneo, and from thence to North Cape, the rate of elevation increasing always as we proceed farther Northwards." If it be rising at all at the rate which he supposes in the Gulf of Bothnia, the rate of elevation must either be increasing as we proceed Northwards, and have already attained to many hundreds of feet on the Northern coast, or there must be some point in the intervening space where it comes to its maximum, and begins to decrease; and in this place there must be a chasm of continually increasing dimensions; for though the sedimentary strata possess a certain degree of elasticity, and may be bent upwards into the form of an arch, that elasticity has its limits, which cannot be passed without producing a fracture, and in this case we may reasonably believe the limits to have been exceeded. The terraces of Altonfiord on the Northern coast, show that the land has risen in that quarter, but neither to the height nor yet in the manner that Dr. Lyell supposes. The rise has not been continuous but intermittent; it has been occasioned by two separate paroxysms of the disturbing forces, and they have operated in both with more intensity in one direction than in the other, for the terraces are not quite horizontal, and the one is more inclined than the other. They are much more ancient than the supposed upheavals on the Gulf of Bothnia, and their elevation is much below what it should have been on Dr. Lyell's supposition.

§ 5. While there are many facts which tend to prove that the earth has undergone a series of great revolutions, separated from one another by intervening periods of comparative tranquillity, there is no decisive evidence to the contrary; and we may therefore believe that such revolutions have occurred in ancient times, till the contrary be proved, or till the effects attributed to these revolutions be otherwise accounted for. It also appears that a number at least, if not each of these revolutions, have been respectively accompanied by extensive inundations or submersions of the land, in which whole races of animals have perished. Beds of conglomerate frequently intervene between one division of the strata and

another, and from the lines by which they are separated; and Conglomerates are only masses of gravel, which, after being deposited in the localities they occupy, have been cemented and compacted into a species of rock. They have in all instances been deposited by currents of sufficient strength and rapidity to roll the pebbles till more or less polished, and to hold the finer particles in suspension till the rougher settled and became consolidated. Beds of Conglomerate might have been formed without any inundation, had pebbles existed in sufficient numbers, and been so disposed as to admit of consolidation without the action of a powerful current. But the pebbles of all Conglomerates have been rounded and polished by rubbing upon one another, and we know of no other agents, but rapid currents, which could have accomplished this; and the great extent and thickness of such rocks, and their occurrence in every quarter of the earth, exclude the idea of their being formed by the action of fluviatile currents. And though we should impute them to the operation of oceanic currents, it would be impossible to account for their occurrence only at particular times, and that in all parts of the world, without assuming the existence of currents at these particular times, which did not exist at any other time.

§ 6. While the earth was undergoing a series of revolutions, it was gradually approaching a more tranquil and settled condition; and its organised productions, both animal and vegetable, were making a similar progress, and becoming more and more adapted to the peaceful and improved condition to which it ultimately attained. At the commencement of animal and vegetable life, the simplest forms of organization predominated; and they gradually receded before the approach of more complicated and finished types. When the earlier races became extinct, and their remains cease to occur in the strata, later races come in their place; and a continual and unbroken succession of races, gradually approaching to a nearer resemblance to those which still exist in the earth, was coming in and going out, from the beginning to the end of the revolutionary ages.

In the fossil remains of the Tertiary era, we have the clearest evidence of the existence of various races of animals, which seem to have disappeared in the great catastrophe in which it closed, as their remains do not occur in any deposits of a later date. There is no proof whatever of their existence subsequent to that catastrophe, and it is therefore concluded that they perished in it. That catastrophe was accompanied by an extensive if not a universal inundation, and this fact is sufficient to account for the destruction of so many races of animals. Other causes may have contributed, along with it, to their destruction; but it is not necessary to search for them. There have been other and more ancient inundations, but probably not upon the same scale, and also extensive destructions of animal life; and though it would be difficult at this distance of time to establish a positive connection between these earlier submersions and destructions, yet as striking changes took place in organic existence, either simultaneously with the formation of extensive beds of conglomerate, or at no great distance from it, it is at least probable, if not certain, that they had a common origin.

CHAP. II.

OF THE PRINCIPAL AGENTS IN THE REVOLUTIONS OF THE EARTH.

There have been two distinct classes of agents engaged in the revolutions which the earth has undergone—an external, and internal; or one that has acted on the surface only, and another which has affected the surface by acting in the interior. There appear to have been three of the former, namely: Water, Wind, and Landslips; and two of the latter, namely: Heat and Compression.

§ 1. Water has exerted a powerful influence on the surface of the earth. It has transported vast masses of matter from place to place, arranged them in a different order, mixed them in different proportions, and deposited them in a new form. There are times when every running stream cuts

away parts of its banks, or deepens its channel, and removes the materials detached from their bed to a different locality, and the more majestic and rapid the current, all other things being equal, the greater is its excavating and transporting power. Dr. Lyell has shown, in his Principles of Geology, that the Ganges alone carries annually to the sea an amount of sediment sufficient to cover 600 acres of land, to the depth of 500 feet. This may be regarded as an extreme case, but it shows what a current of water can do.

That a great part of the dry land has been repeatedly submerged, since it first rose above the level of the sea, has been already stated; and it is clear from the composition of a vast proportion of the strata which constitute the crust of the earth. Marine productions, both animal and vegetable, are preserved in great numbers and variety in localities which are now thousands of feet above the level of the sea; and the sea must either have risen to them, or they must have descended to it; for it could not have deposited its contents upon them unless its waters had overflowed them at the time. In many places the older strata are intersected by deep and extensive valleys, which have been scooped out since the time of their deposition; and parts only of this formation remain, to attest the fact of its past existence. If, in passing over an undulating country, we examine the composition of its rising grounds, we will often meet not only with a general similarity in their structure, but such a perfect correspondence between one and another, in regard to the number, thickness, order, and inclination, of their respective strata, as to place their identity in the clearest light, as remaining parts of an ancient and continuous series of strata, in which intersecting lines have been excavated by the action of some powerful current.

It is easy to account for the excavation of valleys through extensive beds of horizontal strata. When the ground, after having been drenched with water, dries and hardens, it is generally rent in different directions, and if suddenly overflowed while in this state every rent becomes a channel, which is progressively enlarged by the force of the cur-

rent, till masses of gravel and ponderous fragments of loosened rocks, rolling through it, give a greatly increased and accelerating rapidity to the process of demolition, and render the destruction far more extensive than it otherwise would have been.

In this way have whole formations been broken up and removed from particular places; but there are places in which they have partially escaped, and in which their remains continue as undoubted memorials of their past existence, and of the mighty changes which the localities have undergone. Intersecting channels have been first opened, and in consequence of their enlargement the intervening spaces have been gradually reduced, till they have either disappeared or been left in small rounded hills, by the retreating waters, at the close of the catastrophe. In some instances, valleys and troughs thus excavated have been partially filled by more recent deposits, but in others they are still empty; and it is easy to ascertain the characters of the strata, and the series or group to which they belong.

In all cases of denudation a change must occur in more localities than one, for the materials removed from one place must be deposited in another, and the surface of the latter may be as much changed as that of the former. All such mutations consist chiefly in the shifting of materials from place to place, and the arranging of them in a different order. Nothing is taken from the general mass or added to it, for the loss at one place is always compensated, and no more than compensated, by the gain at another; and in proportion to the magnitude of the demolition in the one, is the reconstruction in the other.

But, besides acting in this more violent and obvious way, water produces considerable changes in a more gentle and imperceptible manner. It holds a proportion of lime, silex, and other earths, in a state of solution; and in that state all the streams that run into the sea are continually carrying more or less of these earths into that great reservoir. In filtering through the strata, to the springs by which they are collected into brooks and rivers, they become impregnated

with these substances; and when the sea becomes overcharged with them, the excess is necessarily deposited in its bed. It is from the lime thus carried down to the sea, and held in a state of solution by its waters, that the coral insects and all the different races of shell-fish construct their habitations. I shall have occasion hereafter to show that the early condition of the earth was much more favourable, than its present state, to these interesting processes; and that they were conducted on a much larger scale, and with far more rapidity than at present.

§ 2. Considerable changes on the surface of the earth have been effected by the agency of the wind. But this has been too much overlooked by Geologists. There are at present, and there have always been some where or other, extensive oceans of drifting sand, which are continually in motion, and forever breaking up and reconstructing their strata. We have instances of these in the boundless deserts of Northern Africa, in the interior of Arabia, in Central Asia, and in the East Indies. In all these sterile regions, the sand is loc : and continually in motion. Those of the Lybian deserts have, from time immemorial, been encroaching on Egypt, till they have at last reduced it to a belt of 600 miles in length, and not more than 10 in breadth, at an average. In former times it was much more extensive, and yielded subsistence to a dense population, of whose skill and industry many unequivocal vestiges remain, as proofs of the change which the country has undergone." "Nothing," says De Non, "can be more melancholy than to walk over villages that have been swallowed up by the sands of the desert, to trample under foot their roofs, to strike against the summits of their Minarets, to reflect that yonder were cultivated fields, that here were the dwellings of men, and that all have vanished." In his Travels to Bokhara, the ill-fated Burnes gives the following account of the valley of the Oxus:—"For a great part of the night, our route led us through vast fields of soft sand, formed into ridges, which exactly resembled, in colour and appearance, those on the verge of the ocean. The belt of these sand hills, which lie between Bokhara and the Oxus,

varies in breadth from twelve to fifteen miles. They were utterly destitute of vegetation. There was a remarkable uniformity in their shape; the whole of them had that of a horse-shoe, the outer rim presenting itself to the North, the direction from which the winds of the country blow. On this side the mounds sloped, while the interior of the figure was invariably precipitous; but loose sand will ever take its position from the prevailing winds. None of the hills exceeded the height of fifteen or twenty feet, and they all rested on a hard base. The wind was high, and the particles of sand moved from one mound to another, wheeling in the eddy, or interior of the semicircle, and having now and then, particularly under the rays of the sun, much the look of water." After having advanced farther into the desert, he says, "Some of the sand hills now attained to the height of sixty feet; but at that elevation they were invariably bare of all vegetation." Vol. iii. pp. 1, 2, 14.

In such countries, sand hills take their commencement from different circumstances. Sometimes a whirlwind raised a moving column to the clouds, which runs to and fro with great rapidity, till it suddenly falls in a shapeless pile, which intercepts the course of the winds, and detains the rolling sand in its shelter, till it accumulates into a mound of considerable dimensions. At other times a commencement is made by the body of a camel, or of an unfortunate traveller, who has sunk under the fatigues and privations of the desert, or by any other solid object which chance has deposited; and the process being commenced, goes on with more or less rapidity, according to circumstances, till entire beds, of great thickness, are completely removed from their older positions, and re-constructed in different situations.

If such changes be going on at present, we may suppose the case to have been the same in the more ancient periods of the earth. Extensive regions must have then been subject to degrees of heat which proved destructive of every living thing, and converted the ground into sand and dust; and there are extensive beds of these materials in some localities, which could hardly have been deposited by any other

agent than the wind. The remains of ancient forests, for instance, are sometimes found standing in immense beds of sandstone, in the very position in which they grew; and any current of water, sufficiently deep and powerful to have deposited such masses of sand about them, would have leveled the forest itself, and swept it before it. The sand has evidently been deposited among the trees by such an agent as a moderate wind, which, after burying them to a certain depth, has ceased to operate. They have died in consequence of having had their roots too deeply covered; and in this situation their wood has wasted away and disappeared, leaving their bark, which appears to have been more durable, standing like so many hollow cylinders, as high as their trunks happened to be covered; and these have been filled up in their turn, at some subsequent period, by the passing of a more recent wave of sand over the district.

There are often extensive beds of sand on the sea shore, near to the mouths of considerable rivers, and from these the wind sometimes forms mounds at no great distance, which are covered with a thin and coarse vegetation, that merely serves to arrest the progress of the rolling sand, and promote its accumulation in such localities. An ancient forest, standing in the line of a current of sand, must have had a similar effect.

The layers of some sandstone formations bear a striking resemblance to drifted snow, and could hardly have been deposited by any other agent, known to us, than the wind. Some of them lie in one direction, and others in a different one, though no rupture or dislocation has occurred to produce such a change, nor any thing else, to which it may be attributed with an appearance of probability, but a change in the direction and strength of the wind.

There are many places in which there are extensive beds of rock, which appear to have had this origin.

§ 3. The external appearance of the earth seems to have been partially affected by landslips. Excepting on a very small scale, these occurrences are at the present time chiefly confined to Alpine regions. They depend much on the po-

sition of the strata, and are in some instances favoured by their composition. When strata recline on the flank of a mountain, at a very high angle with the horizon, and if some of them be composed of soft materials, the water enters more easily from above, penetrates between them, destroys their adhesion, and by reducing a softer one to a slippery mud, facilitates the launch of the superincumbent mass, into the plain below. After a heavy fall of rain longitudinal rents are opened along the brow of the mountain, which, by affording a readier admission to the water, both increases the weight of the mass and its tendency to move, and lubricates the ways on which it is to slide from its present position. The rents in the surface become wider and deeper, fastening after fastening gives way, the moving becomes perceptible, is slow at the first, but increases with an accelerating rapidity, till the whole breaks up into shattered fragments, and lights in a confused and shapeless mass at the base of the declivity. Such occurrences are not uncommon among precipitous mountains, and they are sometimes attended with the most disastrous consequences. M. Simond has given us a most interesting account of one that happened in Switzerland, in 1806, when a part of the Rossberg slipt into the Lake of Lawertz, and occasioned an immense loss both of life and property in the neighbourhood; and of another which fell into Lake Lucerne, in 1801, and created a surge on the opposite shore that drowned eleven persons, and destroyed a great amount of property.

It is highly propable that landslips were more frequent in early times, and that they have contributed materially to the rounding of the mountains, and more especially of the inferior elevations which serve to diversify the face of the earth. There is a small round hill in my neighbourhood which is separated from another of larger dimensions by a narrow valley that runs between them. Both are composed of gypseous clay, and belong to the new red sandstone formation. They appear to be remnants of an extensive deposit which has been in a great measure swept away, and the valley between them is partially filled with a diluvian

deposit. Two wells were formed in this valley about the same time, and at no great distance from one another, the first was near the middle of it, and the second close to the base of the lesser hill. Water was obtained a little below the surface in the former, and before the diluvian deposit was perforated. The other was commenced on a gentle rise that fringes the skirt of the hill on that side, and at a very small depth the workmen fell in with the gypseous clay, and continued to dig without finding water till they descended to the depth of thirty-two feet. Here they found a tree in good preservation, embedded on the surface of the diluvian deposit, on which the earlier formation was discovered to rest. It thus appears that the side of the hill facing the valley has been precipitous, and that after the valley had begun to be filled with the diluvian formation, a part of the brow of the hill had slipped down. This must have happened before the final retreat of the ocean to its present bed, as the rest of the valley has been subsequently filled by diluvian deposits, to the depth of nearly thirty feet.

This is not likely to be a singular instance. It is highly probable that the gentle swell that fringes the skirts of so many of our lower hills had a similar origin. Though the mass of a large proportion of these hills had a volcanic origin, not a few of them are remnants of sedimentary beds, which have escaped the catastrophe that swept the greater part away. When these hills rose as islands in the bottom of the water, and the valleys by which they are separated from one another were channels in which impetuous currents flowed, their sides were precipitous, and sometimes overhanging, and when the waters subsided and left them without support, the higher parts slipt from their positions, and now lie around their base. This has given to many of these hills a more rounded and graceful appearance; but when the adhesion of the upper strata was greater, they remained in the state in which the water left them, presenting a bold and rugged face, and frowning over the plains below in sullen grandeur.

§ 4. Besides the agents whose influence has been limited

to the surface of the earth, there is a class which has powerfully affected its surface, by acting in its interior; and so far as is yet known, this class consists of heat and compression. They depend upon each other, and generally act in concert, and cannot therefore be separately considered.

The Crystalline Rocks have all come from the interior of the earth, and they have been ejected from it in a melted state, or in a liquid form. They have not only in many instances overflowed the surface to a greater or less distance from the vent through which they have issued, but have penetrated into all the fissures along the line of their passage upwards, and filled them as other liquids would have done. The matter ejected in volcanic eruptions is known to be generally in a melted state, and the larger the mass thrown up at a time, the slower is the process of cooling and hardening. It was fifty years before the temperature of Jorullo fell to an equilibrium with the surrounding atmosphere.

The greatest difficulty is, to account for the existence of such a heat in the interior of the earth as would suffice to have melted the vast masses that have risen to the surface. But the power of heat to fuse minerals may be greatly increased by means compression, or the resistance presented to the expansion of the heated bodies, and the escape of the gases evolved in the process. It is well known to the burners of lime, that when a large mass of stone is deposited in a close kiln, where the heat and other elements disengaged are more confined, care must be taken to keep the heat moderate, lest the whole should be melted and converted into marble, and the kiln made useless. Sir James Hall has shown that the most refractory substances may be reduced by means of heat and compression; and that the same degree of heat, combined with different degrees of compression, will produce very different effects on the same substance. With a heat of 25° of Wedgewood, under a compressive force equal to the weight of 52 atmosphere, he converted chalk into limestone. With the same degree of heat, under the pressure of 82 atmosphere, it became marble; and under 173 atmosphere, calcareous spar.

From this it appears that the influence of heat is increased or diminished by the amount of compression to which it is subjected; and consequently, that a less degree of heat, if placed under an increased pressure, will in some cases produce the very same effect as a greater heat under an inferior pressure. Allowing the degree of heat to have been less, the resistance presented to its expansive influence by the immense thickness and tension of the strata, combined with the confinement of the gases evolved, might have increased it to an amount sufficient to have rent the solid globe.

Earthquakes are often felt at a very great distance from the axis of the movement, which shows that they begin at an immense depth in the interior of the earth, and that the heaving is resisted by a degree of pressure, of the amount of which we can hardly form a distinct idea. The Earthquake which destroyed the city of Caraccas in, 1812, was felt at Honda, on the banks of the Magdalena, a distance of 600 miles, and along the whole course of the movement the agitation was increased by the tension of the strata, and moderated whenever they are more elastic. In the Cordilleras, where the formations chiefly belong to the primary series, and are in general more compact, the agitation was proportionally more violent; and in the Savannahs, where they are more recent, and possess a greater degree of elasticity, it was more gentle. Another occurred on the coast of Chili, in November 1822, which was felt simultaneously along a line of 1200 miles from North to South.

The hardest and most compact rock, that we know, is intersected by joints, which are easily perceived when it is broken into fragments, as their sides have invariably a different colour from the more solid parts. This change has been produced by the passage of some gaseous substances through these joints, on their way to the surface; and nothing but an exceedingly powerful pressure could have forced them through them. Before the strata were relaxed to the degree to admit of their escape, the expansive power must have acquired an inconceivable intensity, and met with a resistance which nothing but the crust of the earth could have presented to it.

These terrible convulsions are often productive of great changes on the surface of the earth. In one which occurred in South America, in 1822, a tract on the coast of Chili, supposed to extend to 100,000 square miles, was permanently raised to the height of several feet above its former level, as compared in both cases with that of the sea; and part of the same tract was again raised several feet more on the 20th of February, 1835; and a third time, on the 7th November, 1837. In consequence of these upraisings, the depth of the sea along the whole coast has been diminished, and several rocks that were formerly covered with water have become exposed. A remarkable instance of the rising of the land in consequence of an Earthquake occurred in the Runn of Cutch, on the Lower Indus, in 1819, when a ridge, since called the "Ullah Bund," or Mound of God, which is 50 miles in length, 16 in breadth, and from 10 to 12 feet in height, suddenly rose across the country, and for some time blocked up one of the branches of the Indus.

When a district is elevated above the former level, the earth must either become cavernous at a greater or less depth below it, or a correspondent depression must take place in the neighbourhood, in order that the space from which the uplifted materials have been removed may be refilled by others. When a great thickness of strata have been raised up, but more especially when they have been fractured and displaced, their broken edges may be so jammed against one another as to prevent their return to their former position; and they may form an arch, and leave a vacant space below, which in course of time becomes filled with water. That there are many such subterraneous lakes in volcanic regions, appears from this, that vast quantities of muddy water have in various instances been forced to the surface in the time of Earthquakes. When the "Ullah Bund" was thrown up in 1819, the ground in the neighbourhood, to a great extent, was rent in all directions, and an immense quantity of black and muddy water rushed up through the chasms to the surface, and overflowed the country to the depth of three feet for a number of days. At the

eruption of Tunguragua, in 1797, the ground at the base of the mountain was rent in different places, and floods of muddy and fetid water burst through the openings, and filled some valleys in the neighbourhood to the depth of 600 feet. But at other times elevations have been accompanied with corresponding depressions in their immediate vicinity. When the Ullah Band rose to the height of 10 feet above its former level, the neighbouring country, as far as the eye can reach in every direction from the fort of Sindree, subsided so low as to be overflowed by the Indus to the average depth of three feet.

One of the most frightful eruptions on record occurred in the island of Sumbawa, in the summer of 1815, when the volcano of Tomboro was in a state of the most intense activity. Its roarings were heard from Sumatra on the one hand, to Ternate on the other, a distance of 1600 miles. It was not accompanied by a rising of the land, but such immense quantities of scoriae, dust, and ashes, were emitted by it, as to occasion the most profound darkness in Java, at the distance of from two to three hundred miles; and the face of the ocean was so thickly covered with them, at the distance of more than 1000 miles, that it was with difficulty that vessels could force their way through them. At the same time, a great extent of country was overrun by a stream of lava; and out of a population of 12,000 inhabitants, only 26 escaped with their lives; and the town of Tomboro, with the land in the neighbourhood, subsided, and became submerged to the depth of 18 feet.

These, it must be admitted, are but local changes, or revolutions in miniature; but the disturbing force that produced them did not differ in kind, from that which raised the Himmaleh Mountains; and it might have been increased to a degree sufficient to have revolutionized the whole earth, to have raised the ocean bed into Alpine chains; and to have sunk the Andes or the Indian Caucasus, far below the level of the sea. If Etna and Vesuvius have required ages to rise to their present height, a new island rose from the sea, in the neighbourhood of Unalaschka, in 1814, to the

height of 3000 feet above the water; and Jorullo rose from the table land of Mexico in 1759, and in the course of four months from the commencement of the eruption, it covered an area of from three to four square miles, and attained an elevation of 1640 feet.

It was the site of an Indigo and Sugar Plantation till September 1759. In the months of June and July of the same year, it had been for the first time disturbed by earthquakes and subterraneous sounds, which alarmed the inhabitants. These, however, had died away, and the tranquillity of the district seemed to be restored; but on the 28th of September the subterranean sounds were again heard, and became so frightful as to induce the inhabitants to fly for safety; and scarcely had they escaped to the mountains, when the face of the plain began to undulate, like the waves of the sea, and a space in the centre, about four miles square, to rise up in the shape of a dome, to the height of 500 feet. This was divided by a frightful chasm, out of which six cones or peaks arose, the largest of which attained to the height of 1640 feet above the level of the plain. The whole mass was thrown up in an incandescent state, and it was fifty years before its temperature fell to an equilibrium with the surrounding atmosphere. This shows that the phenomena are occasioned by heat.

§ 5. Here a question arises to which we cannot give a positive answer. How is such a heat produced? In what does it originate? Probability in regard to this point is all that is attainable.

The permanent existence of a great central heat in the interior of the earth, which is assumed by many distinguished Geologists, would, if fully ascertained, solve a considerable number of the difficulties by which the subject is beset; but besides being purely hypothetical, it is liable to very formidable objections. Had such a degree of heat been in existence as would have been sufficient to produce such effects, it must, from the diffusive nature of that element, have been approaching nearer and nearer to the surface; whereas the temperature of the surface is evidently lower than it has

formerly been. The plants and animals, whose remains have been preserved in the older strata, belong to orders which prefer a warmer climate, and cannot subsist in a temperate, and much less endure the rigours of a cold one; and according as we descend to more recent times, we find them supplanted by others that possess a greater power of accommodating themselves to the present state of things.

It is alleged that rocks are bad conductors of heat; but unless they can be shown to be non-conductors, this will not account for the progressive refrigeration of the crust of the earth, with an intense heat existing in its interior. Wherever the crystalline masses have intruded among the sedimentary strata, they have altered them to an extent corresponding with their own dimensions. A dyke of porphyry, trap, or greenstone, passing through coal, converts it into coke, on both sides of its course; through a bed of limestone, it changes it into marble; and through greywacke, or claystone, it renders them schistose. Now, if the heat of an injected vein of incandescent minerals of moderate thickness will penetrate the adjoining rocks along its course, if it diffuse itself to a distance on both sides among these rocks, and give them somewhat of a crystalline appearance, what could prevent it from passing from the nucleus of the earth into its crust? Some days before the great eruption of Cotopaxi, in 1803, the snow which had rested upon it for ages, and accumulated to a great depth, disappeared from its sides in one night; which shows that before the heat got vent, or while it was under a high pressure, it diffused itself through the mass of the peak, and raised its temperature to a great degree. A vast amount of heat must have been absorbed in the melting of the snow, as there are few changes in which more is expended; yet the temperature of the mountain was kept up till the snow disappeared, and much of the water was converted into steam. It would be difficult to reconcile this fact with the confinement of a powerful heat in the interior of the earth. Allowing rocks to be bad conductors, no one can deny that they will transmit and retain heat; and if the mass of a large volcanic mountain may be heated, a

permanent heat in the interior of the earth must in the course of time make its way to the surface, and reduce the whole to an equilibrium.

Besides, admitting the existence of a central heat, it would be impossible to account for its intense activity at one time, and total or almost total inactivity at another. In whatever the disturbing forces originate, they are subject to effervescence. They slumber at one time, and act with intense energy at another. Nothing can be more certain than this, that volcanic agency is intermittent; that it has its times of activity, and its times of repose. If plutonic and volcanic agency be not essentially the same, they are evidently attended with similar phenomena; and we believe that they are subject to the same laws. The dislocated strata have not risen in an easy and imperceptible manner to their present positions. One series has been tilted up, and placed on their edges, or at a greater or less angle with the horizon, before another was deposited over it. A more recent series have been subsequently formed, in a state of peace; and after having attained to a certain thickness, they have been ruptured and displaced by a new convulsion.

Now, the theory of a permanent central heat does not account for occasional convulsions. The idea that paroxysms result from pressure is unsatisfactory; for whatever changes take place in the crust of the earth, they do not originate in any additional pressure. The force of compression is invariably the same. Nothing is either added to or taken from the mean density of the earth. Whatever is deposited in one locality has been transported from another; new combinations result from equivalent decompositions; and the general mass remains the same. For these reasons, the theory in question appears to be inadmissable.

But we may succeed in overturning one system without being able to replace it by a better; yet even this negative achievement is an important service to the cause of truth. By disproving a false hypothesis, we so far contract the limits of error, make the truth lie within a narrower circle, and make its discovery both easier and more certain. There

can be no doubt that the earth contains within its own bowels all the elements of the great revolutions it appears to have undergone, and also the means of rousing these elements into the most intense activity. Unslacked lime, at the temperature of the atmosphere, neither emits heat nor undergoes any change while it is kept perfectly dry, and the air is excluded from it; but no sooner does it absorb water than it spontaneously heats, cracks, expands, and dissolves into powder. Now, if such phenomena be produced by such a simple experiment, what might be the consequence of the admission of a due proportion of water into a vast subterranean magazine of lime? There are many other minerals besides lime which possess the power of decomposing water, by combining with its oxygen, and forming oxides; and in every such process heat is evolved, and may be increased to a degree perfectly sufficient to produce combustion, ebullition, expansion, and fusion, and any other phenomenon that heat will produce. Earthquakes, unless when they are very slight, seldom terminate in a single shock; and volcanic eruptions are for the most part fitful and intermittent. Now, supposing them to originate in the admission of water into a magazine of substances capable of decomposing it, the first movement, by opening a freer entrance to the water, will occasion a second, the second a third, and every succeeding one another, till either the elements of expansion are exhausted—the entrance of the water stopped, or a passage opened through the ruptured stratu, for the free escape of the liberated gases.

This account of the origin of earthquakes and volcanic eruptions was first proposed by Sir Humphrey Davy; and though subsequently abandoned by that distinguished chemist, on the supposition of its not being properly supported by the nature of volcanic productions, it has been revived and successfully defended by Dr. Daubeny, and employed by him in accounting for many volcanic phenomena; and Dr. Lyell regards it as unobjectionable. "There appears," says he, "no sound objection to the doctrine, that chemical changes, going on at various depths in the earth, may be the

cause of volcanic action; and that the contact of water with the unoxidated metals of the earths and alkalies may give rise to the heat required. The hydrogen evolved during the process of saturation may, on coming afterwards in contact with the heated metallic oxides, reduce them again to metals; and this circle of action may be one of the principal means by which internal heat and the stability of volcanic action are preserved."

BOOK III.

OF THE IDENTITY OF THE REVOLUTIONARY PERIODS OF THE EARTH WITH THE ANTEDILUVIAN AGE OF THE SACRED SCRIPTURE.

CHAP. I.

PRELIMINARY OBSERVATIONS.

§ 1. It has been already stated, that many distinguished geologists believe that the revolutions of the earth have in general occurred at very distant periods respectively from one another, that each has been followed by a new creation of organized forms, and that the types of every succeeding creation bear a nearer resemblance to existing forms than those of any of its predecessors. Among those who entertain these opinions, there are some who discard or overlook the Sacred Narrative altogether, as being either irreconcilable with geological facts, or unworthy of attention in any attempt to classify and account for them; and others who allege that it admits an interpretation by which the principal difficulties may be obviated.

§ 2. Those who pursue the latter course differ among themselves with regard to the explanation by which this reconciliation is to be effected. Some maintain that the six days of the Mosaic creation are to be understood as so many periods of indefinite length; and others that Moses, after giving a concise and very general account of the primary creation of all things, in the initial sentence of the Book of Genesis, "In the beginning God created the heavens and the earth," passes over all the intermediate periods of the earth's existence, and their respective mutations, as matters in which we are not concerned, and gives us a particular

account of the last reorganization, which forms the commencement of the present system.

§ 3. Either of these explanations, if properly established, would go far to answer the end proposed; but both of them are liable to such formidable objections as cannot fail to leave the impression on the inquisitive mind that the object is not yet attained, and that there are some difficult problems to be solved before the matter be finally set at rest. To the first it may be objected, that though the Hebrew term rendered "day," may have sometimes been used to denote a period of indefinite duration, as in 1 Sam. ix. 27, where it means "a while," it is clearly shown by the fourth commandment of the Decalogue to have its more common and precise acceptation in the account of the creation. The command to labour on six successive days of the week, and rest on the seventh, can obviously refer to no other divisions of time than those which are measured by the rotations of the earth; and nothing could be more at variance with the canons of a sound and rational criticism and exegesis, than the supposition that the same word may be understood in very different ways, in a concise, plain, and practical direction, in which there is neither trope nor metaphor, nor any thing to intimate that a diversity of meaning may be intended.

§ 4. The other supposition, namely, that Moses, after giving a concise account of the primary creation, passes over all that happened between that event and the commencement of the existing state of the earth, is free from this objection, but open to one of a different kind, and which would appear much stronger to Geologists. The Mosaic account of the creation opens with a view of the state of the earth, that is perfectly irreconcilable with the existence of our present terrestrial animals at the time. The earth was universally covered with water, and otherwise in a completely uninhabitable state; and if it had been previously inhabited, there were no means in existence at the time by which any number of its inhabitants could have been saved, and survived the catastrophe. Now, though Geology may appear

to favour the idea that there has been a series of creations, with longer or shorter intervening periods—that new races have from time to time been called into existence, as the earth became gradually prepared for their reception, it shows decidedly, that there has been no epoch from the foundation of the globe to the present day, at which animal life became extinct; and that terrestrial quadrupeds have never wholly quit the stage, since the first moment of their entrance upon it. There has repeatedly been a coming in and a going out—one race has followed another, and the earth appears again and again to have changed its inhabitants; but we cannot condescend on a single period, when the succession came to a pause, as it must have done at the Mosaic creation, and again commenced anew. No one race appears wholly to have left the stage before another had entered upon it; and the in-coming generally makes its appearance before the out-going has suffered any irreparable reduction; and if this be true of the extinct races, it is still more so of those which are in existence. Their remains are found in ossiferous caves and other situations, being copiously intermixed with those of numbers of the extinct races. Some have indeed alleged, that though the genera are the same, the species are different; but Cuvier, who was qualified for the examination of this point beyond most other men, and who, having no favourite theory to warp his mind, contented himself with the collection, arrangement, and exposition of facts, has given his verdict in favour of their identity; and from his decision there is no appeal. But I shall have occasion to return to this subject hereafter.

The Sacred Narrative not only opens with a view of the condition of the earth, that would have been quite incompatible with the existence at the time of any of those races of terrestrial animals by which it is now inhabited, but it expressly represents the creation of these animals as a posterior event. As existing races were then in being, anterior to the last destruction and reorganization of Geologists, that could not by any means have corresponded with the Mosaic creation.

§ 5. Every person who regards the Scriptures as a revelation from heaven, and rests his faith and hopes on their truth, must devoutly wish to see them reconciled with the real and incontestible discoveries of Science; for it is not every one who can adopt or be satisfied with the loose opinion of Professor Sedgewick, as announced in his answer to the Dean of York, namely: that the Scriptures were written rather in accordance with the state to which human knowledge had attained, and the sentiments that were prevalent in the world at the time, than agreeably to the real facts of the case. It is undeniable that they are written in popular language, and that they speak in a popular way of many of the common phenomena of nature; and the philosopher speaks in the same way, but not when scientific precision is required. The account of the creation is not to be understood in the same light as when the rising and setting of the sun are spoken of, but as a literal and veritable relation of facts; and if we regard it in the light of a popular tradition, we surrender its inspiration, and abandon its authority, as a highly interesting and important part of a Divine Revelation.

But for this very reason, the endeavours of those who believe in the Scriptures and venerate their authority, to reconcile them with science, are necessarily exposed to the suspicion of being less or more directed by feeling, and should therefore be conducted in the most dispassionate, vigilant, and impartial manner; carefully sifting every argument for and against the point at issue, and allowing to each its due weight. The inspiration of the Scriptures has too often been advocated with a degree of temper which they do not authorise, instead of becoming calmness and candour; and on all such occasions their cause has been injured rather than advanced. "The wrath of man worketh not the righteousness of God." There is a spurious liberality which is also to be avoided on the other hand, a disposition to surrender some of the outworks of Divine truth, and expose even the citadel itself to danger, under the pretence of removing difficulties and making all things plain.

§ 6. The discoveries of science have been repeatedly supposed, in the first instance, to be at variance with the Scriptures, and after being more fully clearly and developed, and understood in all their points and bearings, all appearance of discrepancy has vanished, and they have been found not only to be in perfect accordance, but even to confirm and explain one another. It is to be hoped that this will yet be the case with Geology; and, with the view of affecting a consummation so desirable, I shall endeavour first to ascertain as far as possible what the discoveries of the Science amount to; what is the sum of the information they afford respecting the ancient condition of the earth, the revolutions it has undergone, the manner in which they have been brought about, and the general and permanent effects which have resulted from them; and then compare this information with such notices as are interspersed through the Scriptures, respecting these different points. By pursuing this course in a calm, deliberate, and cautious manner, we will come directly to the point at issue, and perceive at once the agreement or discrepancy.

§ 7. It should however be kept in mind, that important as the science of Geology is, and fascinating as its discoveries may appear, the Sacred Scriptures have an infinitely higher object to serve, than to record its facts or explain its mysteries; and that when they advert to such matters, they do it incidentally, and therefore in a slight and passing manner. They give us a detailed account of the deluge, because that catastrophe was introductory to a new order of things, and intended to exercise a powerful influence over the destinies of man. There was only one other catastrophe, namely: the cursing of the ground for the first offence, that will bear the slightest comparison with the deluge; and it is therefore rather by indirect inference from an induction of particulars, that we can come to any information respecting them, than otherwise. More than slight and indirect references are not therefore to be expected; but it will be found on examination, that such references are both more numerous and striking than is commonly supposed.

CHAP. II.

OF THE STATE OF THE EARTH DURING THE ERA OF THE PRIMARY FORMATIONS, AND OF THE MANNER IN WHICH THAT ERA TERMINATED.

§ 1. The primary strata, like the crystalline masses, are completely destitute of organic remains; and we do not possess the slightest evidence of the existence of either plant or animal at the time of their deposition. This is universally admitted by Geologists. Now, as all the superincumbent strata are fossiliferous, it is fair to conclude from this fact, that the deposition of the primary strata was anterior to the creation of organic forms. In no other way can we account for the difference. "The state of the Globe," says Professor Phillips, "during the period of the production of the primary strata, may never be fully disclosed by Geological enquiry, aided by higher departments of knowledge; yet, as a view of the successive conditions of the Globe, however imperfect, constitutes the very essence of Philosophical Geology, it is necessary to ascertain what progress has been made in this dark research, into some of the earliest actual records of the creation. It is remarkable that the lowest of all known systems of stratified deposits should be at once the most extensive, the most nearly universal, the most uniform in mineral character, the only one from which organic life seems to have been totally excluded, and in which the character of mechanical aggregation is the most obscure," pp. 94, 95. Dr. Buckland also says, "As in the consideration of other strata, we find abundant evidence in the presence of organic remains in proof of the exercise of creative power, wisdom, and goodness, attending the progress of life, through the stages of its advancement on the surface of the Globe; so from the absence of organic remains in the primary strata, we may draw an important argument, showing that there was a point of time in the history of our planet (which no other researches but those of Geology can possibly reach,) antecedent to the beginning of either animal or vegetable life," pp. 51, 53.

§ 2. In the foregoing quotations, Professor Phillips men-

tions another fact of great importance respecting the primary strata, namely: that they are "the most extensive, and most nearly universal" of all the sedimentary deposits of which the crust of the earth is chiefly composed. They cover a far greater extent of the nucleus of the globe than is covered by any posterior formation. In most of the great mountain chains, the crystalline masses have broken through them, but in such a manner as to show that they were originally continuous, and extended round the whole globe. Now if they were deposited in this state, the water must have overflowed and encompassed the whole globe at the time, otherwise their deposition to such an extent must have been impossible.

§ 3. Again, if the primary strata were deposited by water, as geologists maintain, the different earths of which they are composed must have been suspended in the water at the time of their deposition, in the state of mud, or fine sand. They are composed of the same substances with the plutonic masses on which they chiefly rest, and differ from them only in being less crystallized; and in being mechanically rather than chemically constructed. The materials of some of them, such as the clay slate for instance, having been reduced to finer particles, and possessing less specific gravity, have floated longer than those of others, and consequently been deposited over them. We may therefore conclude that they were all originally derived from the nucleus of the earth, to which they bear such a strong affinity, and that they had been converted into mud and sand by the action of currents. Unless the water had been violently agitated, to keep the lighter particles longer afloat, they could hardly have been deposited in the regular order which they every where exhibit.

§ 4. Moreover, if they were all suspended in the water, it must have been in a very turbid condition at the time. They must have nearly corresponded with the view presented to us in the traditionary account transmitted by Ovid:

"Quaque fuit tellus, illic et pontus, et aer
Sic erat instabilis tellus, innabilis unda,
Lucis egens aer, nullis sua forma manebat."

"The land, the sea, and the air, were blended in *one* confused mass; so that the land had no solidity, and the waters were unnavigable; the air was in a state of perfect darkness, and nothing possessed its proper form." Allowing the mean depth of the sea to be nine miles, or even less, and a large proportion of the primeval waters to have been decomposed, in the oxydising of those metals which are now the bases of the earths and alkalies, and consequently that they were more abundant than at present, the vast masses of materials that were suspended in them must have rendered them turbid in a very high degree; for the primary strata, besides extending over the whole of the dry land, have a mean thickness of many thousands of feet; and, in consequence of having been repeatedly heated and compressed, they have been rendered more compact than the strata of any later series.

§ 5. We have no means whatever of forming any thing like a probable estimate of the length of this period; for nothing could be more preposterous than to reason from the ordinary phenomena of nature, to a state of things so completely isolated. Even though we admit that the materials of every subsequent formation were carried down from the land into the sea, and that time was required for such a process, it must have been different when the whole earth was submerged, and the materials that were deposited by the sea had their origin in it. The period may therefore have been longer or shorter than we could suppose.

§ 6. But whatever was its duration, it terminated in a general and violent revolution. The new formed strata, in which the nucleus of the globe was enveloped, were burst asunder in many places, and thrown into disorder, by the expansion of the masses on which they rested. In some localities they were raised up into an inclined, or even a vertical position; and in others, they were bent and thrown over on their backs, while their ruptured edges were exposed to view. The surface of the earth thus become diversified,—being here elevated into lofty mountains, and there depressed into deep valleys; and the waters, in obedience to

the law to which all liquids are subject, left the uplifted portions uncovered, and sought their level in the lower grounds.

§ 7. Having thus stated the principal facts deducible from Geology, respecting the primeval condition of the earth, let us compare them with such as may be collected from the Scriptures, respecting the earliest periods of which they give us an account, and see how far they correspond with one another. The Sacred Narrative commences thus:—"In the beginning God created the heavens and the earth; and the earth was without form, and void," or rather, unorganized and uninhabitable, "and darkness rested on the surface of the mass." That it was enveloped in an unbroken sheet of water is clear from the whole account; and its being "without form, and void," means that its elements had not been separated, or reduced to order,—the waters being mixed with other substances, which had not assumed their proper forms, or taken their places in the system of nature. It is stated, moreover, that the waters were agitated by a mighty wind, which, in the fervid style of the sacred writer, is called "The spirit," or rather, the breath "of God," which means a hurricane, or violent tempest. (Compare 2 Kings ii. 11, 16.

The Scriptures give us as little information respecting the duration of this state of the earth as we can collect from Geology. If light was then in existence, the atmosphere did not transmit, and the surface of the globe did not reflect it; and days had not begun to be numbered, nor years to run. We can therefore run no risk in allowing its duration to have been sufficiently long for the deposition of all the primary strata, whatever time may have been necessary for it.

§ 8. Moses gives us only a very concise and general account of the manner in which this primeval condition of the earth terminated; but he states a fact which makes it clear that an extensive revolution took place: "The waters were gathered together into one place, and the dry land appeared." Without a change in the crust of the earth this could not have happened. Unless it had been raised above its

former level in some places, and depressed below it in others, the waters must have continued still to overflow it. In Ps. 104, several important particulars are supplied, which Moses has omitted. The Psalmist refers to the primeval condition of the earth, and the change by which it became habitable, and represents it as being divided into sea and land—into mountain and valley, by a convulsion which affected its whole surface. He writes as one who had been present at the time, to have heard the rolling of the subterraneous thunders, which gave the first intimation of the impending shock—to have felt the mighty convulsion that followed—to have seen the waters rushing away in all directions from particular centres, and to have beheld in each of these centres vast masses of incandescent minerals, in a liquid state, bursting from the deep, and rising up into continents and islands, with their conical hills and lofty mountains, from the pinnacled summits of some of which one half of the globe may be surveyed. "He hath settled the earth on its foundation; it shall not be moved for ever. Thou coveredst it with the deep as with a garment; the waters stood above the mountains. At thy rebuke they fled; at the voice of thy thunder they hasted away. *The mountains rose up, and the valleys sunk down*, to the places which thou hadst appointed for them."*

This is just such an account as a modern geologist would have given of such an event, and such an account as a geologist of high standing has given, without suspecting that he was writing a just and eloquent comment on a passage of the Bible. The only difference between the text and the comment is, that in the former the ideas are concentrated and condensed, and embodied in a few energetic expressions; whereas in the latter they are dilated and amplified, and stretched to the utmost, and arranged with an evident view to effect. "In the state of tranquil equilibrium," says Dr.

* In verse 8, in the above quotation, I have followed the Greek Translators, and Ainsworth, in preference to the text of our common version. Our Translators have come nearer to the original in their marginal reading, which is also more intelligible.

Buckland, "which our planet has attained in the region we inhabit, we are apt to regard the foundation of the solid earth as an emblem of duration and stability. Very different are the feelings of those whose lot is cast near the face of volcanic eruptions,—to them the earth affords no stable resting place, but, during the paroxysms of volcanic activity, reels to and fro, and vibrates beneath their feet—overthrowing cities—yawning with dreadful chasms—converting seas into dry land, and dry land into seas. To the inhabitants of such districts we speak a language which they fully comprehend, when we describe the crust of the earth as floating on an internal nucleus of molten elements. They have seen these elements bursting forth in liquid streams of lava, they have felt the earth beneath them quivering and rolling as if upon the billows of a subterraneous sea, they have seen mountains raised and valleys depressed almost in an instant of time, and they can duly appreciate, from sensible experience, the force of the terms in which geologists describe the tremulous throes and convulsive agitations of the earth, during the passage of its strata from the bottom of the seas, in which they received their origin, to the plains and mountains, in which they find their present place of rest." Chap. 5.

Supposing, then, the Sacred Narrative to begin with the original formation of the earth, and to give us an account of its primeval conditions, it agrees with Geology in every point. They both represent the surface of the ground as being universally overflowed—the waters as being in a very turbid state, and violently agitated; and the period as closing with a tremendous revolution, which gave a new appearance to the face of the earth.

CHAP. III.

OF THE STATE OF THE EARTH DURING THE ERA OF THE TRANSITION SERIES, AND OF THE MANNER IN WHICH THAT ERA TERMINATED.

§ 1. The waters having been drained from the dry land into the bed of the ocean, both received such organized and

living forms as were respectively adapted to them. That the waters had deposited their sediment and become clear, is evident from this, that some animals, whose remains have been preserved in the transition rocks, and in them only, have their eyes constructed on the same principles with those of other animals, of the same family, which are still in existence. As they seem not to have survived the transition period, we may suppose them to have been peculiarly intended for and adapted to it, for it is an established law of nature, that the organs of every animal are suited to its peculiar functions and sphere of activity; and we may therefore believe that those races, whose existence was limited to that age, would have been prepared for any peculiarity in the state of its elements, had there been any; and as we meet with no indication of the kind, we may conclude that the waters had become transparent. It was formerly stated that there could have been no terrestrial animals in existence during the era of the primary formations, because the earth was not then in a state to receive them, being universally submerged; and what has just been stated will prove that the waters must also have been uninhabited during the same period, because while so overloaded with sediment they were uninhabitable—there having been no races of animals adapted to such a condition.

§ 2. In the greywacke formation, or silurian system, which is the first of the transition series, and commences the order of fossiliferous strata, the organic remains are few in number, and consist chiefly of marine plants,—a clear proof that organized existence was yet in its infancy, and that animal life had either not commenced at all, or had made very little progress. Before the close of the series, however, animals had begun to multiply, and vegetation had attained a degree of exuberance which has not been equalled in any subsequent age.

§ 3. If any of the plants of the transition era be still in existence, they have been so much altered in the course of time as not to be identified with any existing species; but they have generally the appearance of tropical plants, or

such as prefer a salutary, humid, and dusky atmosphere; and from this it is inferred that a high temperature was then prevalent, and that the land consisted more of islands, with lofty peaks, than of extensive continents, as at the present time. Islands have been thrown up from the bottom of the deep in our times, and again submerged; and it may be taken for granted that some tracts of primeval land have been swept away, or subsided below the level of the sea, in the course of the mutations which the earth has undergone; but there is reason to believe that the higher regions of some of our great mountains chains were raised up in the first convulsion, and that they have not only preserved their position, but have from time to time been receiving additions to their height and magnitude, till they have attained to the state in which they remain. Many of the strata which lean against their flanks, and rise to a considerable height on their declivities, are fossiliferous, and have been formed after the waters became inhabited.

§ 4. The vast masses of vegetable matter accumulated in the great coal formation, are evidences of a vigour and luxuriance of vegetation which is altogether unexampled in any subsequent age of the earth. Such of the fossil plants as can be disengaged from the mass, or as may be found separate, far exceed, in respect of dimensions, those of their representatives in the present times. Arborescent ferns do not at present, in the most favourable situations, exceed 25 feet in height, while those of the carboniferous system attained to 50. Lycopodes, or club-mosses, grew to twice their present size, and many others in the same proportion.

Such was the superior fertility of the earth during the period in question, that M. Ad. Brongniart has invented a theory on purpose to account for it, with which geologists are generally pleased. He supposes the atmosphere to have been unusually loaded with carbonic acid gas, which forms an important element of vegetation. According to M. Fournet, free carbonic acid gas is constantly rising from the ground, in copious volumes, in the volcanic district in the neighbourhood of Clermont; and it is exceedingly probable

that the same may have happened in the carboniferous age, which was evidently a time of very intense volcanic action. Professor Phillips makes the following observations on this interesting speculation:—"What then were the circumstances of the dry land, favourable to the growth of the enormous mass of vegetable substance buried in the coal formation? That the atmosphere was warmer, and by consequence moister, may be easily admitted, and in fact what is known of the structure of plants goes to confirm this opinion, for the most abundant forms are at least analagous to tropical vegetation. But in addition, it is conjectured that the atmosphere might, in those early periods, have had an unusual doze of carbonic acid gas, and thus be more fit to supply the carbon requisite for the growth of such vast forests as must then have encumbered the limited surface of the land. This speculation of Brongniart appears worthy of attention; nothing known to the chemist, or natural philosopher, is opposed to the notion that the quantity of carbonic acid gas contained in the atmosphere may not be extremely variable; it would not indeed be favourable to the life of animals, but what proof have we of the globe being then inhabited by terrestrial animals? Moreover, speculation apart, let any one calculate the quantity of carbon contained in a single English coal-field, once a part of the other living structure of plants, and the equivalent of carbonic acid gas to that small quantity which it holds, the consequence will be an atmosphere charged with the pabulum of vegetable life, to a degree perhaps very favourable to vegetable life, but certainly detrimental to the life of animals breathing with lungs. Now surely it is worthy of attention, that, after the coal was deposited, reptile life began to be manifested and finally to predominate; while on the other hand, vegetable life, though the land was much more extensive, and apparently not much lowered in temperature, never again yielded such thick and extensive carbonaceous deposits."

But, allowing the atmosphere to have been in the state supposed, the non-existence of terrestrial animals would not have been a necessary consequence. Coal does not occur

everywhere—it is found only in particular localities, and the supposed state of the atmosphere may have been peculiar to them. In the volcanic district of Clermont, and probably in other volcanic districts, the supply of carbonic acid gas is much more abundant than in most other places; and in the carboniferous age there may have been localities similarly situated, and where the abundance of the supply and rapidity of the consumption kept pace with one another, while other places were in a different state. Mr. Logan discovered the footsteps of a quadruped in a carboniferous deposit in this Province; and if this be an isolated fact, it should be remembered that animal life was in its infancy—that the temperature of the earth was very high—that the complete decomposition of organic substances, when near the surface, was more rapid and frequent, and consequently that the preservation of specimens must have been rare, and are therefore seldom to be expected. This conclusion is strengthened by the circumstance, that the only proof yet discovered of the existence of quadrupeds at the time in question, consists in the footmarks of an individual, and not in a part of the animal itself.

§ 5. Speaking of the animals of the transition period, Dr. Buckland says, "We find the four great existing divisions of VERTEBRATA, MOLLUSCA, ARTICULATA, and RADIATA, to have been coeval with the commencement of animal life upon our globe." His meaning is not that existing genera and species have been preserved in the more ancient strata of the earth, but that they contain the remains of animals belonging to each of these great divisions. There were then animals in the transition age that were formed on the same general principles with those on which existing races have been formed, and which must therefore have been intended for modes of life not materially different from the present; and this shows that if the world, for which they were created, was different from the present, it must have differed not in kind but in degree.

§ 6. We are here also without any certain or positive data for determining the length of this period; but if we could

suppose it possible, under any circumstances, for such vast masses of vegetable matter, as have been accumulated in some coal formations, to have been produced within a short time, we would have reason to believe that it was not of very long duration. The animals whose remains have been preserved in the strata of that age, do not appear to have made much progress during any of its stages, and were nearly as numerous at the beginning as at the end; and they could not have been both few and stationary without a cause. But they had not yet attained to their maximum numbers, when the waste or destruction must have corresponded with the supply, for such of them as were continued to the next era became far more numerous than they were in this. Neither could it have been from any deficiency of the means of subsistence, which always checks the multiplication of animals and limits their numbers, for the means of subsistence for the herbivorous races were then more abundant than they have ever been since. As little could it be imputed to any excess of the predaceous races, for their numbers were proportionally limited. "In the waters of the transition period," says Dr. Buckland, "the sauroids and sharks constituted the chief voracious forms destined to fulfil the important office of checking the excessive increase of the inferior families." Again, those races which were common to that and the later periods, though fewer in their numbers, were as fully developed in their forms and dimensions in the one period as in any of the others; and their increase therefore could not have been restrained by any inadaptation of their natures to the one period more than to the rest. If these be facts, to what other cause can we attribute their want of progress during the transition period but to their want of time, or the shortness of that period?

§ 7. But, whether it was long or short, it appears to have terminated in a second revolution. There are particular countries in which the age of the porphyries may be regarded as doubtful, but they can generally be traced to the close of this period. They were posterior to the deposition of the carboniferous system, because it is often disturbed by

them, and anterior to the new red sandstone which immediately follows, and which they have not disturbed. About the same time, also, many dykes of trap were thrown up, and by the protrusion of these and other crystalline masses the carboniferous system is everywhere ruptured, and less or more displaced. Whatever rises to the surface must come from the interior, and in every great enlargement of the mountains, there must have been a corresponding depression in the lower regions; and this double movement has increased the agitation, and made its effects more striking. "After the deposition of the carboniferous system," says Professor Phillips, "and before at least any considerable proportion of the superjacent rocks was formed, very extensive displacements happened, in most quarters of the globe, where carboniferous rocks had been deposited. Not that such displacements were limited in geographical extent to the area of this system: on the contrary, from there hardly being a known coal tract exempt from this influence, it would appear that convulsive movements took place, of a very general description, so as to affect very large tracts of the surface of the globe." Page 112.

Geology, then, leads us to the following conclusions respecting this period:—1st, That it was the epoch of the commencement both of animal and vegetable life upon the earth; 2d, That it was adapted to similar modes of existence with the present; 3d, That the atmosphere was warmer, and proportionally more humid and dusky than it is now; 4th, That the fertility of the ground was incomparably greater; 5th, That the period was not of very long duration; and 6th, That it terminated in a great revolution.

§ 3. There is, again, a very striking agreement between Geology and the Scriptures, in regard to the second periods of their respective accounts. The Scriptures state that no sooner had the earth become divided into sea and land than the latter was clothed with a luxuriant vegetation, in full maturity, and the different races of animals were formed; and if the animals which are now in existence were then created, the earth must have been adapted to existing modes

of life. If it differed from the present state of things, it must have differed rather in degree than in kind.

§ 9. It appears again from the Sacred Narrative, that the atmosphere must have been exceedingly humid and sultry, and otherwise favourable to such plants as abound in the carboniferous system. Gen. ii. 5, 6, "The Lord God had not caused it to rain on the earth, but there went up a mist from the earth and watered the whole face of the ground." This notice is short, but important. It shows that there was an active and most abundant evaporation in process during the period referred to, and if the temperature of the atmosphere was such as to raise from the earth such clouds of vapour, it must have been exceedingly close, humid, and dusky, or such as the carboniferous vegetation required. The inhabitants of the temperate regions have no experience of any thing like an approach to such a climate, but those of the equatorial districts can comprehend it. The following account of a morning at San Blas, on the coast of Mexico, after a heavy fall of rain, is given by Captain Hall. "There was a dead calm, with the air so sultry that it was impossible to breath in it. Though the sky remained overcast, the sun had power to raise up from the drenched ground clouds of dense steam, which covered the whole plain as far as the base of the mountains." Such is the view which Moses gives us in the above quotation, of the primeval atmosphere; and it is precisely such as may be inferred from the plants of the carboniferous system. I shall hereafter have occasion to show, that there were in all probability heavy periodical rains in that age; but as some time may have elapsed before the commencement of the first raining season, there will be no disagreement between the supposition and the text.

§ 10. That the fertility of the earth was greater during the period in question, than in any subsequent age of the world, may be inferred from the denunciation pronounced on the ground on account of the first offence of man. Gen. iii. 17, 19, "Cursed is the ground for thy sake; in sorrow shalt thou eat of it all the days of thy life. In the sweat of

thy face thou shalt eat bread, &c." This certainly means that the earth should become less productive than formerly, and that a much greater amount of labour would be thenceforth necessary, in order to extract from it the means of subsistence. The same thing is clear from chap. v. 29, of which the meaning may be thus expressed: "This same shall comfort us, in regard to the work and toil of our hands, to which we have been subjected by the cursing of the ground." While it expresses a hope that the ground was about to be ameliorated, it refers to the drudgery which had been rendered indispensable by the cursing of the ground.

§ 11. The deterioration of the ground, on the occasion of the fall, must have been produced by a revolution in the crust of the earth. The Parents of our race were expelled from Paradise by a volcanic eruption. "So he drove out the man; and placed at the east end of the Garden of Eden a cherubim (that is, lightnings, compare Ps. xviii. 10, 13,) and a devouring flame, rolling about, to bar the way of the tree of life," Gen. iii. 24. Consistency requires that the change in the ground be attributed to causes of this kind. Had the soil been altered by some chemical agent, so as to be injurious to one kind of vegetation, we may believe that it would have been injurious to all, which was not the case. "Thorns also and thistles shall it bring forth unto thee; and thou shalt eat the herb of the field." "Thorns and thistles" is a common Hebraism for plants that are noxious, or comparatively useless; and the "herb of the field" means vegetables of an inferior value. (Is. v. 6, & vii. 23—25, Hos. x. 8, Matt. vii. 16, Heb. vi. 8.) The curse appears to have operated by rendering the ground unfit for cultivation. While extensive regions were overwhelmed with oceans of drift sand, others were converted into swamps and morasses; and in not a few the angular edges of ruptured and dislocated rocks were laid completely bare.

§ 12. It may be supposed that the time which appears to have elapsed between the creation of man and his expulsion from Paradise was evidently too short for the transition era; but in the first place, as has been already shown, the

transition era may have been much shorter than many believe; and in the second place, the expulsion of man from Paradise may have been later than what is commonly apprehended. There are two points on which the settlement of the latter depends, and they are both to a certain extent doubtful. The first is the starting point of the Sacred Chronology. Whether is time reckoned from the creation of man, or his expulsion from Paradise? The Sacred History is properly the history of our fallen state, and of the developement of the great plan of redemption; and as it merely glances at our primary condition, by way of introduction to the main design, it may be supposed to reckon from the epoch of the fall, without including the antecedent period; and were this admitted, the difficulty would be removed. The second point is, allowing the Sacred Chronology to reckon from the creation, at what time did the curse take effect? Was it immediately executed in all its extent, or did it happen by degrees? Or was there some time allowed, as in the case of the deluge and other threatened visitations? Or again, how long did the Parents of our race preserve their innocence? It would not be easy to settle all these points; but till that be done the difficulty is more apparent than real.

The Scriptures and Geology, then, appear to coincide as fully and minutely in regard to the second period of the earth's existence as in regard to the first.

CHAP. IV.

OF THE CONDITION OF THE EARTH DURING THE ERA OF THE SECONDARY STRATA, AND OF THE MANNER IN WHICH THAT ERA TERMINATED.

§ 1. The deposition of the secondary strata appears to have commenced either immediately, or very soon after the great revolution with which the transition period closed; for if the organic remains deposited near the surface of the carboniferous system had continued to be exposed for any length of time to the action of the elements, with the high temperature which still prevailed, they would have certainly been

decomposed; whereas they are in many instances in a very high state of preservation. They must have been very soon covered and protected from the elements of decay, after being deposited in the places where they still respectively continue.

§ 2. The saliferous, or new red sandstone formation, is the first of the secondary series; and it is chiefly remarkable, for the vast quantities of rock salt and gypsum which it contains. There are at least two ways in which common salt may be formed. It is formed by sublimation, in the craters of volcanoes, and also by evaporation from the heat of the sun; and its presence in such quantities among the secondary strata, is a proof of the great heat which prevailed over the earth at the time; and also that it was a time of very intense volcanic action. Gypsum is a sulphate of lime, or lime in combination with sulphuric acid; and as the latter is a volcanic production, with which the atmosphere becomes more or less charged in the time of an eruption, and of which it is again deprived by its combination with lime, when they become gypsum, the thick and extensive beds of that rock which occur in the new red sandstone is another evidence of the great volcanic activity of that time. Many of the sandstone beds of that period bear such a resemblance to drifted snow, as to make it appear that they were deposited by means of the wind; and they give us reason to believe that the atmosphere was as unsettled as the earth.

§ 3. All the strata of the secondary series are fossiliferous; and some of them, but especially the shell limestone, are almost wholly composed of fossils, belonging to different tribes of mollusca, with which the waters of the period abounded. The series contains a very great proportion of limestone, though variously formed,—a clear proof that the condition of the waters was peculiarly favourable to its formation.

As the remains of terrestrial quadrupeds occur but rarely in the secondary strata, their numbers must have either been limited at the time, or they must have kept at a distance from the disturbed districts, where their remains were more

likely to have been preserved; but any deficiency in this form of animal life was more than compensated by the number, variety and dimensions, of the reptiles. They appear to have been adapted to every element and mode of life, and every department of nature was overrun by them. Some had paddles instead of feet, and were inhabitants of the sea; others had feet, and occupied the marshes, ponds, and lakes, occasionally repairing to the land for a change; and others again were provided with wings, and could take the air, the land, and the water, by turns.

Many of these reptiles were not larger than numbers of the same order at present, but others were of a gigantic size, extending to 40, 50, or even 60 feet in length, and being otherwise proportioned. Such were the dimensions of the Megalosaurus and the Iguanodon, reptiles of the lizard and crocodile tribes. The hinder foot of the Cheirotherium, a species of frog, measured from 10 to 12 inches in length, and from 5 to 6 in breadth. Dr. Lyell has given it the name of the Labyrinthodon, from the extremely complicated structure of its teeth; but others call it the Cheirotherium, from the resemblance of its foot to the human hand.

The footmarks of different species of birds, but all belonging to the wader tribe, have been discovered in some secondary strata; and the feet of some of them were so formed as to enable them to walk on the softest mud without sinking, although they were birds of a gigantic size. As they measured five or six feet at every step, we may form an idea of the length both of their legs and necks, for the necks of waders are always proportioned to the length of their legs, that they may be able to fish wherever they can wade; and from this data, we may reasonably suppose that, when standing erect, they could not have been much less than twenty feet in height. All these tribes, whether larger or smaller, derived their subsistence from the marshes and ponds, and probably fed upon the reptiles by which they were so plentifully stocked.

When these different facts are compared, they throw much light on the physical condition of the greater part of the

surface of the earth in that early age. Volcanic eruptions had either very recently been, or still were frequent and violent. Extensive regions were buried under deep beds of sand, interspersed with salt lakes and ponds; and others had been converted into noisome marshes and stagnant pools, whose putrid waters were never agitated but by gigantic saurians, or monstrous frogs. This state of the earth will account, in a very satisfactory manner, for the reduction of its fertility after the close of the transition era; and if that could be identified with the date of man's expulsion from Paradise, it would also show us the manner in which the curse operated so as to produce its physical effects.

§ 4. Though the earth was ill adapted, at this time, for the support of a dense and flourishing population, the elements of future comfort and prosperity were actively preparing on a large scale. The soil is generally of an inferior quality, wherever the primary or transition strata rise to the surface; and it is only by the influence of adventitious circumstances that any large assemblages of men are congregated near them. It is otherwise with secondary and tertiary formations. This is no doubt attributable in part to the height to which these formations rise above the level of the sea, but it is chiefly owing to the circumstance that they are less refractory, and more easily reduced to a friable state; and that, when so reduced, the different earths of which they are composed are found to be in the proportions that are best adapted to agricultural purposes, and more easily fertilized.

§ 5. The close of the secondary era is much less marked by any clear and decisive vestiges of a general revolution than that of any of the other epochs in the physical history of the earth. "Throughout England," says Professor Phillips, "there is no proof of any considerable disturbing movements following upon the deposition of the chalk: yet, from the character of the lower tertiary strata of England, which rest upon the chalk, it appears undoubted that considerable agitation of water occurred, for the surface of the chalk is wasted, and conglomerate or pebble beds formed of the

trital deposits." The chief indications of the termination of an old, and commencement of a new era, consequent upon the deposition of the cretaceous system, are the unequivocal appearances of an amelioration of the physical condition of the earth, in the improvement of animal and vegetable life. The temperature of the atmosphere, which had hitherto been high, was considerably reduced; propably from the greater degree of tranquillity to which the earth had attained, through a decline in the intensity of the disturbing forces.

§ 6. We have no certain means of determining the length of the secondary era. Some of its formations are still very thick, though much inferior in that respect to those of the primary and transition periods; and geologists, reasoning from the time required for the accumulation of vast masses of sediment near the mouths of rivers at the present time, have concluded that the time must have been protracted to many thousands of years; but there are facts connected with some of the formations of the series which seem to warrant a different conclusion.

It has been already stated, that the footmarks of different races of animals have been discovered in some of the strata of this series, and these must have been imprinted when the strata were in a condition to receive and retain them; and their transition from a soft to a solid condition must have been very rapid, for they do not only appear on the surface, but on a considerable number of beds below it. The track of an animal passing through snow will continue to be more or less distinct, through a considerable number of superjacent layers, provided the latter have been deposited in a time when the air was still; but they gradually become less and less distinct, till they are no more discernible. This is often witnessed in the dense forests of this Province, where the wind has no influence near the ground; and the footmarks in question may be supposed to have been continued in the same way, through a series of layers of sand and mud, successively deposited in still water; but how could the water, if perfectly still, have received the necessary supplies of these materials, which it must have contained? They have been

deposited, not in still water, but by a powerful current, loaded with the materials, and this must have instantly obliterated the footmarks in the superjacent layers, as footmarks very soon disappear in drifting snow. Besides, footmarks made in snow become less and less distinct in every succeeding layer, however much sheltered the locality may be, till they completely disappear. But the footmarks in question, instead of being continued upwards, are continued downwards through the inferior layers, becoming less and less distinct, till they are no longer discernible. From this it is clear that they were made on the upper part of the formation, and that the layers beneath were affected from above; and if so, the whole mass must have been deposited and consolidated in a very short time. Unless the whole mass had been soft and yielding, from top to bottom, the impressions could not have been made to such a depth; and unless it had been very speedily consolidated it would not have retained them. Had the series of layers been slowly deposited, the lower ones would have been rendered so compact by the superincumbent pressure as not to have been susceptible of impressions from the feet of tortoises and cranes, waiking on beds at some distances above them.

Neither can the Oolites have been slowly formed. They are limestones, and consist of a congeries of balls, sometimes larger, and at other times smaller, but strongly cemented; and they derive their name from this circumstance. They bear a striking resemblance, in point of structure, to the roes of some fishes. In some instances the balls are as large as buck-shot, and in others as small as the eggs contained in the roe of the herring. They have been concreted in water, around some very minute objects, also present in it, which served as nucleuses, till they became too heavy to float, and then sunk to the bottom. The increase of the larger balls must have been very rapid, as they must have began to sink long before they attained to their full size, and as their dimensions increased their descent towards the bottom must have been accelerated. If the smaller ones were precipitated by their weight, the larger ones must have

been sinking when at the same size, and so rapid was their increase, that before reaching the bottom they became many times bigger than when they began to descend.

The only difficulty here is, to account for the presence of such an abundance of lime in the waters, as such a process evidently required. With regard to this, certainty is unattainable; but there have been different other occasions, in which the waters in particular localities have been rapidly and abundantly supplied with lime in a state of solution. They may have come from some subterranean reservoir, and passed through a magazine of calcium, and become loaded with lime, which, coming into contact with an atmosphere charged with carbonic acid gas, rapidly combined with it, and formed the Oolites; or they may have dissolved, and carried off a bed of chalk on their way to their destination.

The secondary series consists chiefly of different kinds of sandstone and limestone; and if some of each have been formed in a short space of time, positive evidence that the formation of the rest occupied many thousands of years may be reasonably demanded.

§ 7. The Scriptures contain no direct evidence of any change in the physical state of the earth from the cursing of the ground till the era of the deluge, which could not have been less than 1200 years, and most probably more; but they are nearly silent upon the events of that period, and when all are passed over no conclusion can be drawn respecting any particular, because it has been omitted along with others. Had a full account of the events of that period been given, and no reference made to any change in the condition of the earth, the presumption would have been that no such change had happened; but, as matters stand, we are not warranted to draw this conclusion. Besides, there are certain facts stated, from which some indirect information may be gleaned, and, so far as it goes, it coincides with what has been already said respecting the condition of the earth during the secondary era.

The cursing of the ground impaired its fertility, and made it more difficult to procure the means of subsistence than

would otherwise have been the case; and this could not have failed to operate as a check upon the progress of the population. Accordingly, it appears from Gen. vi. 1, that men only *began to multiply* after the lapse of some centuries. The great age to which they lived must have contributed much to the increase of the numbers at one time upon the earth, and yet they seem to have made little progress. This is a highly important fact, and must have had an adequate cause. It is little more than two centuries and a half since Britain began to colonize America, and, with the term of life reduced to its present standard, the population already amounts to many millions; and if the present rate of increase be continued for an equal time to come, the numbers will be immense. Till the time of Enos, in 235 according to the Hebrew computation, or 625 according to the Septuagint, the human race appear to have been rather improving in manners, Gen. iv. 26; but from the time that they began to multiply they began to degenerate in this respect, and as the degeneracy had made some progress in the days of Enoch, Jude 14, 15, who was born, according to the first computation, in A. M. 687, and in 1387 according to the second, we may place the change in manners somewhere between the times of these two Patriarchs. Now the fact that they continued for a period of five or six hundred years, before they began to multiply, and that without suffering as at the present time by the law of mortality, shows that the means of subsistence were scanty, and that the earth must have been in a state somewhat similar to that of the secondary era, as already described.

Besides, the Scriptures give us reason to believe that it was overrun by reptiles of various forms, among which there were Saurians of a gigantic size. Gen. i. 20—22: "And God said, Let the waters bring forth *abundantly*, the creeping things that hath life.—And God created great Saurians, and all the living creatures that creep, which the waters brought forth *abundantly* after their kind; and God blessed them, saying, Be fruitful and multiply, and fill the

waters in the seas.'" There can be no doubt that this passage refers to reptiles, and the terms used in it represent them as multiplying with a rapidity which was altogether unexampled among other races, and consequently in coming to their maximum numbers in much less time than any of the rest. The numbers of reptiles are not however disproportioned now, neither do they multiply so much faster; and for this reason we may suppose the passage to refer to a state of things that has long since passed. The reference to sizes, as well as numbers, is certainly remarkable; and knowing as we do that such animals predominated in the secondary era, when other forms of animal life had made but little progress, it is not unreasonable to regard that as the era intended.

CHAP. V.

OF THE CONDITION OF THE EARTH DURING THE ERA OF THE TERTIARY FORMATIONS.

§ 1. The tertiary strata are neither equal in thickness nor extent to their predecessors. The hardness of all the older rocks appears to have been increased, and the process of denudation had become proportionally difficult, and the materials for new formations in the same degree less easily obtained.

Besides this, the proofs of succession in the order of the strata are still fainter than in earlier times, and we cannot refer their deposition, at least with the same certainty, to different dates. The actual superposition of different strata within the same area is an infallible evidence of a di[illegible]

* Though the Hebrew [illegible] be sometimes used for the smaller aquatic animals in general, it is the appropriate term for reptiles, as distinguished from fishes, as in verse 23, and Lev. xi. 21—23; and the great *Tanneen* were not whales, as our Translators supposed, but animals that had feet (Ezek. xxxii. 2, and which occasionally frequented old ruins, and formed holes and nests, &c., Is. xiii. 22, Jer. li. 37. They must have belonged to the lizard or crocodile tribes, and were probably the Megalosaurus, and Iguanodon. The Hebrews had no knowledge of the whales, and no term in their language for it.

in their ages, and of the ages of the fossils found in them respectively, for when one bed rests upon another, the lower one must have been first deposited; but in the tertiary formations we meet with one deposit in one place, and with a different one in another; and as different races of animals had in all probability their different haunts and respective ranges, we have no clear proof that they were deposited at different times, and not simultaneously, though particular circumstances may lead us to suppose this to have been the case.

§ 2. But, like the preceding eras, the tertiary has been divided into different periods, called the Eocene, Miocene, and Pliocene, and the last is subdivided into two ages, an older and a newer.

Among the organic remains of the Eocene, or earlier age of the period, those of lacustrine plants and animals predominate, which shows that though the reptiles of the foregoing era were greatly reduced in numbers, the lakes and marshes, in which they had found such ample scope, were not yet completely drained. During the Miocene, or middle period, terrestrial mammalia became more abundant than they had previously been; and from the proportion of the remains of herbivorous quadrupeds preserved in the strata of that period, it may be certainly inferred that the condition of the earth had been much improved. Many of the races of this period are now extinct, and appear to have perished either at or some time before the close of the era; and we can give no other view of their instincts and habits than what may be inferred from their peculiar organization. But from this we may suppose that numbers of them subsisted chiefly on roots, which they must have extracted from the ground, and others on the smaller ligneous plants, to the mastication of which their teeth were adapted. For instance, the teeth of the Megatherium, and Mastodon, appear to have been formed expressly for this purpose; and the supposition is strengthened by the fact that a skeleton of the latter has been found on the banks of Hudson's River, in the state of New York, with some remains of small branches and leaves of trees, mixed with reeds, enclosed among the

bones, and in the place of the stomach. The mastodon was larger than the common elephant, to which it appears to have been related, and its bones are found along with those of the elephant, both in South and North America, but at elevations which must have been subject to the same temperature.

The megatherium was a species of the sloth, but of gigantic dimensions. He measured 12 feet in length, 8 in height, and 5 across the hams; he was clothed in a coat of mail, about an inch in thickness, and formed of horn, and his toes were pointed with tremendous claws, which he probably used in grubbing up roots, or as Mr. Owen supposes, in removing the earth from the roots of trees, which, when seated on his broad hams, and clasping their trunks in his fore paws, he, by the combined action of his hinder legs and powerful tail, shook to and fro till he levelled them with the ground, and then luxuriated on their leaves and branches.

Large and unwieldy as this animal must have been, he was far surpassed by the Dinotherium, which, though its organization and form have not been so fully ascertained, could not have been under 18 or 20 feet in length, and probably more. The strong resemblance of his shoulder blade to that of the mole, shows him to have been made for digging in the ground, and consequently much addicted to it; but whether in the way of extracting from it the means of subsistence, or of excavating a habitation under its surface, with its proper compliment of covered ways and subterraneous galleries, may be regarded as uncertain. He was assisted in his labours, whatever were their object, by a pair of tremendous grubbing hooks, which sprung downwards from the lower edges of his under jaws, and bent inwards towards his feet, and gave him the full advantage of his enormous weight, in addition to his overpowering muscular strength, whenever a strong tug was required. Dr. Buckland supposes him to have been a lacustrine animal, and to have used the hooks just mentioned in raking up the roots of lacustrine plants, and also in mooring himself to the margin, in the time of his siesta, while his vast and sluggish form floated at ease in the tepid waters; but this, though ingenious, hardly accords

either with his organization or the strength of the implements with which he was provided. If the lacustrine roots required such a degree of force to extract them from the earth as the strength of the hooks in question would indicate, the buoyancy of the animal would not have been a sufficient counterpoise to the resistance, and he would of course have been securely anchored on the spot, unless he had confined himself to shallow water. The form of his shoulder blade and strength of his neck are favourable to the supposition that he burrowed in the earth; and his hooks and great strength may have been employed in removing the formidable obstacles to his progress, which he must have frequently had to encounter.

When the organization of the Megalonyx, another extinct animal of this period, has been more fully ascertained, it is probable that he will likewise be found to have subsisted on roots, and to have used his claws in extracting them from the earth. The Palæotherium and Anoplotherium, both of which were allied to the Hog, or belonged to a race between that animal and the Tapir, have also become extinct. Cuvier completed skeletons of both, they were of great size, —the Anoplotherium measuring 12 feet from the extremity of the snout to that of the tail.

§ 3. The number and variety of herbivorous races, whose remains are preserved in the strata of this period, is a clear proof that, though the condition of the earth was still less favourable to the support of a useful vegetation than it has subsequently become, it had been much ameliorated. The lakes and marshes of the secondary era had been partially if not wholly drained, and the beds of mud deposited in them had become filled with roots, or covered with a coarse and rank vegetation, adapted to the use of the peculiar races which then predominated, but have since become extinct; though not so suitable for the ruminating animals and other races, which have been preserved to our times.

§ 4. That the amelioration thus begun was progressive, may be inferred from the appearance, at first in smaller but afterwards in increased and increasing numbers, of the ox,

the sheep, the deer, and the horse, and many other existing races, among those who had then possession of the earth, but afterwards became extinct. Though the remains of existing races of quadrupeds are frequently found buried in the strata, they are chiefly to be met with in diluvian deposits, and ossiferous caves; and being in general so much nearer to the surface, where they have been exposed to the action of the elements, they are seldom in the same state of preservation with fossils of a more ancient date,—a decisive evidence that the rate of deposition has been much greater in ancient than in more recent times; for if it had always proceeded at the same rate, why should the organic remains of one period have been better preserved than those of another? The appearance of existing among extinct races, shows that the condition of the earth was improving, while the continuance of the latter, though in diminished and gradually decreasing numbers, makes it equally clear that the improvement was but partial.

In all the formations posterior to the chalk, fossil plants become more numerous than in any formation of the secondary series, and vegetation had again become so abundant as to provide materials for the formation of coal of an inferior quality, and in beds of comparatively limited extent. They occur in different parts of Europe, as at Brora in Scotland, and Bonn in Germany, and have been lately discovered in the Delta of the Ganges, and probably also on the higher Indus, near the base of the lofty mountain chain of Central Asia. The plants however of the brown coal are more allied to existing races than to those of the coal of the carboniferous period. Poplars, willows, and maples, are common; and the linden, the elm, and walnut are found, but they all bear a nearer resemblance to American trees of the same kind than to those of Europe. The grasses, however, with other vegetables more necessary to man, though not unknown, appear to have been few and imperfectly developed.

§ 5. We have no certain information respecting the length of the tertiary era, for though a tree has been discovered in

the brown coal of Bonn, with nearly 800 concentric rings, each of which is probably the growth of one year, it cannot be ascertained to what time of the era it belonged. M. Brongniart refers it to the first, or eocene; Dr. Lyell to the middle, or pliocene; and Dr. Buckland either to the middle or last; and with such a diversity of opinion upon the subject, nothing conclusive can be inferred from it. The tree however itself belonging as it does to the tertiary era, will prove that era to have lasted upwards of 800 years. It was nearly that time in growing; and, from its position in the formation where it has been preserved, it appears certain that it must have been deposited there a considerable time before the close of the era. The whole of the tertiary era could not therefore have been less than 1000 years, and was probably more. The Pachydermata, or the thick-skinned quadrupeds, having incisive teeth both in the upper and lower jaw, which are frequently met in the gypsum quarries in the neighbourhood of Paris, are supposed to have lived in a different age from that of the bears, whose remains are so common in some of the caves of Germany; but that point requires proof, and cannot be allowed to decide any other doubtful matter.

§ 6. But whatever uncertainty may rest upon other points, there is none upon this, that the era terminated in the last great revolution of the earth. The Boulder formation, which Dr. Lyell calls the Drift, is very extensive, and covers many regions of the earth which had been dry land immediately before; and it could not have been deposited in places where it rests, unless they had been submerged into deep water, after having given support both to vegetable and animal life for many centuries. This formation contains the remains of many extinct races, mixed with those of races that are still in existence. The former continued up to the date of the great catastrophe, and the latter survived it; but how so many races escaped when others perished, is a problem that Geology cannot solve. To the mere geologist it must remain involved in impenetrable mystery. With this great catastrophe, the ancient state of the earth terminated

and the present began. Since that time there have been local disturbances, but their effects have been as temporary as their extent was limited, and no general change has happened.

§ 7. The few particulars which may be gleaned by way of inference from the Scriptures, respecting the physical condition of the earth during the period that immediately preceded the Deluge, are unimportant in themselves, but are in strict accordance with the view just given of the tertiary era. Till the commencement of the period, the progress of population appears to have been slow, as formerly stated, which can hardly be attributed to any other cause than the difficulty of procuring the means of subsistence. Few of the arts, whether useful or ornamental, had till then been cultivated, and the greatest simplicity of manners had prevailed; but if the posterity of Cain enjoyed the same term of life with the descendants of Seth, a great improvement in this respect commenced about the time of the translation of Enoch, when the family of Lamech distinguished themselves by their useful inventions. They first introduced the use of the tent as a covering,—the first habitation which man erects; and even carried their improvements so far as to add some of the finer arts to other inventions of a more advantageous kind, Gen. iv. 20—22.

One step in the way of improvement leads to another, both by awakening a taste for it, and creating the means of indulging such a taste; and it is probable that it was after the invention of tents that Cain, being desirous in the evening of his days of a more settled life, and seeing himself surrounded by a numerous and still increasing offspring, built a city and called it Enoch, after his oldest son. The natural tendency of the human mind is to aspire to higher degrees of enjoyment, and to make use of such means as are adapted to that end, when they are easily obtained; and wherever men live like the beasts of the field, and seek no other covering when they lie down to rest than the canopy of heaven, we may infer that the means of subsistence are scarce, and that there is little time for any thing more than to procure a supply for the most urgent necessities.

When we see then that after a lapse of several centuries, during which population had made but little progress, it began to manifest new activity, and to assume an energy which it had not previously possessed, we may suppose that a greater abundance is enjoyed, and that there is not the same necessity for unremitting toil. There cannot be a surer sign of increasing comfort than an increase of population, attended by a corresponding improvement in the arts.

The enjoyment of plenty will in general ultimately lead to improvement in civilization, but it not unfrequently has the contrary effect in the first instance, especially when it comes suddenly, and before the recipients are prepared for the change; and such appears to have been its effect on the antediluvians. When they began to multiply they also began to degenerate; and while many became addicted to rapacious habits, all indulged in sensual gratifications. "They did eat, they drank, they married wives, and were given in marriage, till the day that Noah entered into the ark, and the flood came and destroyed them all," Luke xvii. 27. This change of manners indicates an improvement in the condition of the earth, before men were duly prepared for it, and to a degree which exercised an injurious influence over their minds. The degeneracy had begun some time before, and had consequently originated in other causes; but its progress was accelerated by the greater plenty which resulted from the improvement in the condition of the earth.

CHAP. VI.

ON THE AGREEMENT BETWEEN THE SCRIPTURES AND GEOLOGY, IN REGARD TO THE CIRCUMSTANCES CONNECTED WITH THE LAST REVOLUTION OF THE EARTH.

The last great revolution of the earth merits particular attention from the geologist,—inasmuch as many of the circumstances by which it was accompanied can be more fully ascertained than those which attended any of the previous catastrophes of the kind. Many of the vestiges of former revolutions have been either effaced or so much altered by

subsequent changes that we can only draw very general conclusions from them, and even these but very limited in number; whereas many of the effects of this remain unaltered to the present day, and many important circumstances connected with it may be collected from them. For these reasons, I have made it the subject of a separate discussion; and, instead of giving first the whole of the information which we may derive from Geology respecting it, and afterwards what may be obtained from the Scriptures, I shall, as I proceed, compare the particulars collected from the one source with those collected from the other.

§ 1. It is very generally if not universally admitted by geologists, that the last great revolution of the earth was attended by a great and extensive Deluge. Dr. Buckland says, in a foot note, vol. 1, page 94: "The evidence which I have collected in my *Reliquiæ Diluvianæ* 1823, shows that one of the last great physical events which have affected the surface of our globe was a vast inundation, which overwhelmed a great part of the Northern Hemisphere, and that this event was followed by the sudden disappearance of a large number of the species of terrestrial animals, which had inhabited these regions in the period immediately preceding." The qualified manner in which he speaks of the extent of the inundation shows that his opinions on that particular have undergone a change, for in the work referred to he conceives himself to have proved the occurrence of "a transient deluge, affecting *universally, simultaneously* and at no distant period, *the entire surface* of our planet." Page 146.

The extent of the inundation, and the height to which it rose, may be inferred—1st, From the fact that beds containing fragments of all the preceding formations, from the earliest primary to the latest tertiary, have been deposited in very many and distant countries; and not only near the level of the sea, but as far as man has yet ascended above it. 2d, Large blocks of stone have been transported by its agency from one great eminence to another, as from the Central Alps to both sides of the Jura chain. 3d, There

are many places in which the current must have run so rapidly over high mountains that stood in its way as to meet with no obstruction from them. A small obstruction will divide and ruffle a shallow stream, while a majestic river rolls its waters over large masses, without having even their surface disturbed. The detritus of one mountain has in many instances been transported in a straight course over the tops of other mountains, as if they had presented no impediment to the current. The Jura chain is separated from the Alps by one of the deepest and largest valleys in the world; and though it rises to the height of 5000 feet, immense boulders and erratic blocks, removed from the Alps, have been carried over it into the plains of France; and similar transportations have occurred over a great part of the Northern Hemisphere, both in the new and old worlds. Again, diluvian deposits were found by Humboldt at a great height in the Cordilleras of the Andes, and they are found at a similar height on the lofty mountains of Central Asia.

That the inundation prevailed to the same degree in the Southern Hemisphere may however be questioned. There are different races of animals in Australia that are now peculiar to it, and which are very unlikely to have been carried to it by human agency; and their presence there can be accounted for only on the supposition of their having been created since the Deluge, or of its not having extended to them, or of their having reached it miraculously. The second is on many accounts the most probable. Not more than six genera of quadrupeds, comprehending about forty different species, have yet been discovered in New Holland; and out of these forty upwards of thirty belong to one order, namely, the Marsupial; and there is nothing analogous to them among the existing fauna of other regions, excepting the Opossum of South America. This has not been always the case, for the Marsupial order existed in Europe, during the era of the secondary strata, and their fossil remains have been preserved in these strata. They were not therefore limited to Australia at first; and we cannot assign any other reason for their disappearance in other countries, and their

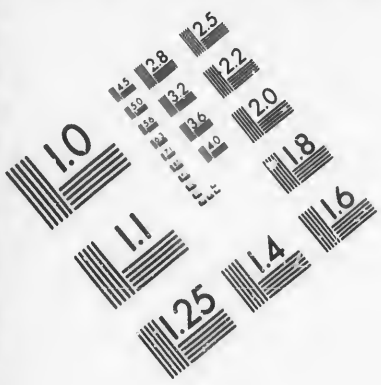
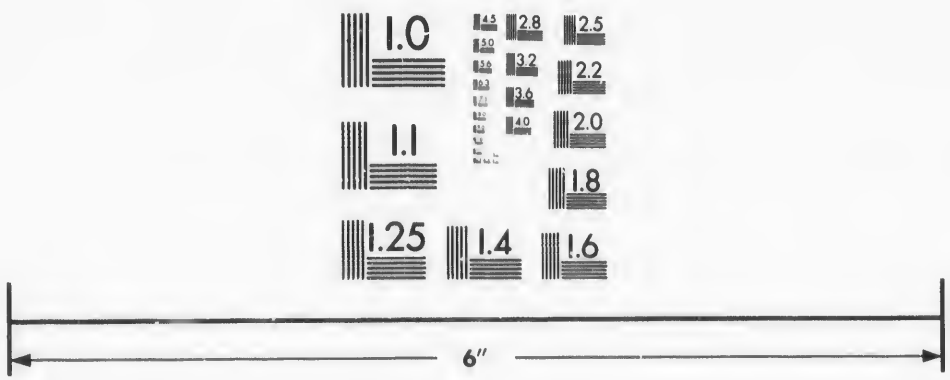
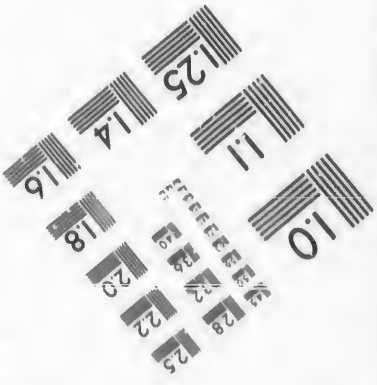


IMAGE EVALUATION TEST TARGET (MT-3)





Photographic Sciences Corporation

23 WEST MAIN STREET
WEBSTER, N.Y. 14580
(716) 872-4503

continuance there, than that the catastrophes in which they were involved in other countries did not reach them there.

This is corroborated by the fact that the gigantic races of birds, that were contemporary with the reptiles in other countries, have been continued in Australia to a very recent period, and are probably not yet wholly extinct. Though they have not been seen alive, their bones have been found in very recent fluviatile deposits, and even an empty nest has been seen. Add to all this that the remains of the reptiles which predominated so generally during the secondary era, appear to have been preserved in places adapted to them near the Equator. Mr. Darwin gives the following account of the Gallapagos:—"It seldom rains, and though the climate is mild the soil is generally dry and harsh, and the vegetation scanty and of little value. The animals and plants are for the most part peculiar to the Archipelago, although they all partake in their general form of an American character. They abound in reptiles, among which the saurians appear to predominate,—many of them being three and some of them extending to four feet in length. Some of them live chiefly in the sea, and others on the land, which is everywhere overrun with them,—so that the Archipelago may be called the Land of Reptiles. It is a volcanic country, and the coast is formed by rough and broken masses of lava." This accords, in every particular, with the state of the earth during the age of the secondary rocks. The soil was equally dry and harsh, and the vegetation equally coarse and scanty. There is the same prevalence of disgusting reptiles, and the same symptoms of volcanic action. The flying reptiles alone are wanting to make the picture perfect in every respect.

There is, moreover, a much closer connection between the existing vegetation of the Southern and that of the Northern Hemisphere in ancient times, than between the latter and what now exists in the same regions. "Professor Lindley justly remarks," says Dr. Buckland, "that it is an important fact, that at the period of the deposit of the Lias, the vegetation was similar to that of the Southern Hemisphere, not alone in the single fact of the presence of Cyca-

deæ, but the pines were also of the nature of species now found only to the south of the Equator. Of the four recent species of Araucaria at present known, one is found on the east coast of New Holland, another in Norfolk Island, a third in Brazil, and the fourth in Chili." Vol. i., p. 488.

"These facts seem to show that there are at least parts of the Southern Hemisphere to which the Deluge either did not extend at all, or which were not completely overwhelmed by its waters. The probability is that some of these places were at the time higher than the waters rose in that quarter. Humboldt met with vestiges of that catastrophe near the sources of the Orinoco, and Captain Hall discovered them in the valley of Coquimbo, nearly 30 degrees to the south of the Gallapagos, but little above the level of the sea.

This may be thought irreconcilable with the Sacred Narrative, where the Deluge is represented as universal. Gen. vii., 19, 20: "And the waters prevailed exceedingly upon the earth, and all the high hills that were under the whole heaven were covered. Fifteen cubits upwards did the waters prevail, and the mountains were covered." There is no doubt that this may be understood in an unlimited sense; and it ought to be so understood, provided it could be shown to be so used in the passage; but it is equally certain that the expressions will admit of a restricted sense, and may be understood to refer only to that part of the earth that was then inhabited, or which was known to man in the days of Moses. The whole world, and the whole earth, are repeatedly spoken of when a part of the earth only is referred to. One great object of the Deluge was the reduction of the human race a second time to one family, that they might commence anew, and under more propitious circumstances than they had ever been since the expulsion from Paradise; and though there were certainly other important ends to be accomplished by it, besides this, there was not one of them that required the universal submersion of the land; and the Sacred Narrative does not, therefore, require the expression to be so understood. At the same time it is clear from it, that the extent of the Deluge must have been very great.

§ 2. The rising of the waters to such a height cannot be accounted for on any other supposition than that of such an upheaval of the ocean bed, or such a depression of the dry land, as to bring them nearer to the same level. The area of the ocean being more than twice that of the dry land, and the mean depth of its waters twice that of the highest mountains, a proportionately small uprising of the ocean bed would submerge the whole of the dry land; and as we know not any other natural cause, by which a universal inundation could have been occasioned, we must suppose it to have originated in this way, till the contrary be shown. This we may do the more readily, that we have undoubted proofs of the ocean having partially shifted its bed, again and again.

The depression of the land appears to have been greater in the Northern than in the Southern Hemisphere. It has been already shown that the latter must have been only partially submerged, but the submersion of the former appears to have been complete; and when it afterwards regained its former position, or rose again to its present state, it occasioned a mighty rush of waters towards the South, which has left indelible effects near the surface. The current which deposited the boulder formation has evidently rushed, with an overwhelming force, from the Arctic regions towards the Equator, and rolled along with it an immense mass of mud and gravel, intermixed with blocks of all dimensions, as far as the forty-third or forty-second parallel, where the blocks in a great measure disappear. As the direction of the current has been nearly the same, and its effects the same, round the whole of the Northern Hemisphere, and as it could not have taken that direction, unless that the water had either accumulated to such a degree around the Pole as to force it towards the South in quest of a level, or had been suddenly and violently thrown off by the upheaval of its bed in that quarter, we may readily adopt the latter supposition, as being on many accounts the most probable. The waters could not have accumulated in the Polar regions, unless they had been previously repelled from the South; and

they would not have oscillated again toward the South, unless that the equilibrium had been by some means disturbed. Either the Southern Hemisphere must have subsided, or the Northern must have risen so as to repel the waters from it. As the current rolled towards the South it would gradually find its level, and become less impetuous, and the larger bodies borne along with it would sooner come to a state of rest; while those that were more easily suspended in the waters would continue to float, and be deposited in a more advanced position. This is the actual state of the Drift, and it confirms the supposition with which it accords.

The Sacred Scriptures attribute the Deluge to the combined influence of three causes, the breaking up of the fountains of the great deep, the opening of the windows of heaven, and the incessant falling of torrents of rain, till it attained its height, Gen. vii. 11, & viii. 2. In giving an account of natural phenomena, they generally speak according to the common appearance of things, without considering whether this be philosophically correct, or only sufficient to give a popular view of the occurrences referred to; and in this way they impute the rise of the waters of the ocean, to a degree beyond what the influx of rivers and the falling of rain would satisfactorily account for, to the openings of copious submarine springs. The great deep means the ocean, and its fountains must have meant springs by which it was at times supposed to have been fed. All that can be inferred from this part of the account is, that the waters rose with such rapidity as to make it evident that they had some other origin than either the winds or rains. To all appearance a heavy rain, continued unremittingly for six weeks, must have had a considerable effect in raising the waters; but a very slight acquaintance with the composition of the atmosphere, and the proportion of water which it is capable of containing, would satisfy us of the contrary. It never contains above a small proportion of water at a time, and no sooner is that separated from it than it is again restored by means of evaporation. It only returns to the earth what it has previously taken from it, and the copiousness of the

evaporation during the whole time must have kept pace with the abundance of the fall.

It may not be so easy to determine what is meant by the windows of heaven. The term in the passage answering to windows, is not the one that is commonly used for such conveniences. It means an aperture of any kind, and particularly a chimney, or opening made for the escape of smoke, Hos. xiii. 3. The only other passages of Scripture in which the windows of heaven are mentioned, are 2 Kings vii. 19, & Mal. iii. 10; and in both the expression means a signal, if not miraculous display of the divine bounty. In Is. xxiv. 18 "The windows from on high" are mentioned, which the Greek Translator, with no little appearance of reason, understood to be the same with "the windows of heaven," and they can hardly refer to anything else than a volcanic eruption, or some other usual concomitant of earthquakes. "The windows from on high are opened, and the foundations of the earth do shake. The earth is utterly broken down, the earth is clean developed, the earth is moved exceedingly, the earth shall reel to and fro like a drunkard, and shall be removed like a cottage." If fire and smoke be for the most part emitted in volcanic eruptions, there are instances in which water is copiously thrown out, and it is probably to something of this kind that the passage under consideration refers.

The Deluge is repeatedly referred to in the Scriptures, and it is represented as originating in the bursting of the barriers of the sea. Job xxxviii. 8, "Who shut up the sea within doors when it burst forth from the womb?" And the prophet Amos says, in reference to the same catastrophe, chap. ix. 6, "He calleth for the waters of the sea, and poureth them over the face of the earth, the Lord of Hosts is his name." These passages show clearly that the sacred writers understood the Deluge to have originated in the rising of the waters of the sea to such a height as to overflow the land.

§ 3. The temperature of the earth appears to have undergone a great reduction at an early stage of this catastrophe,

and it is proper to bring it into view at present, for the sake of other important facts which it serves to explain. The bodies of some animals that perished at the time have been preserved in the arctic ice, without any material change since the moment of their death. Among these there is a specimen of the Siberian elephant, and another of the rhinoceros. Vast numbers of the bones of these animals are found embedded in a fluviatile deposit, on the banks of the Lena, and in an island at its mouth; and in 1772, Professor Pallas obtained from the banks of one of its tributary streams the body of a rhinoceros, which has evidently been preserved in the frozen mud since the time of its death; and again in 1804, an entire mammoth was discovered in a high bank of ice in the same region. The carcases of both retained the thick covering of hair, by which the arctic races appear to have been distinguished from their tropical congeners still in existence. Now, though vast numbers of these and other races inhabited Siberia immediately before the catastrophe in question, they evidently perished in it; and these two specimens cannot be referred to a later period. Again, the climate of the country must have been milder up to the time of their death than it soon after became, or it would not have produced the means of subsistence for them. Allowing them to have been capable of enduring the rigour of an arctic climate at the present day, which is not probable, they must have found in the country the means of subsistence, and that in abundance, or they would not have prospered in it as they appear to have done. But in any climate in which this was possible, their dead bodies could not have been preserved from beginning to putrify more that a very few days. Even in water, though it be very cold, dead animals very soon lose their hair, and become otherwise altered; and the fact that these retain their hair, is a proof that they became immediately enclosed in ice after being drowned. It is probable that the elephant may have floated in an iceberg, but the rhinoceros was found in a bed of frozen mud, a little below the surface, and though frozen bodies will remain unthawed in cold water at a low temperature,

no body will ever freeze in that situation. The rhinoceros must therefore have been deposited in the mud, and the mass must have been congealed at the commencement of the inundation, or before the waters had risen above the level of the bed.

The formation of vast masses of ice at such an early stage of the catastrophe, solves a difficulty which has occasioned much perplexity to geologists. As far south as the forty-second parallel, there are blocks of stone of different dimensions, which in numberless instances have been transported to a great distance from their original beds, by an agent which has left their sharpest angles as perfect and entire as when they were split and detached from their parent masses. Ice will do this, and it is the only agent that is known to do it. Blocks of immense size and weight, being loosened by the frost, and falling from their native cliffs, are frequently carried to a great distance on rafts of ice, without being subjected to any rounding or polishing process. Every inhabitant of this Province has had repeated opportunities of seeing this exemplified either on a smaller or larger scale. The blocks sometimes fall from the banks of our rivers when the ground begins to thaw in the spring, and at other times they are lifted up from their beds by becoming firmly attached to the masses of ice that are formed around them, which raise them to the surface when the waters are swollen.

It is a remarkable circumstance that the freezing of the ocean is mentioned in the Book of Job, in a passage where the Deluge is also referred to. Chap. xxxviii. 30: "Out of whose womb came the ice, and the hoary frost of heaven, who gendered it; when the waters became compact as a stone, and the face of the deep was frozen?"* The country of Job, called the land of Uz, was a district of Arabia, (Lam. iv. 21,) where frost is little known, and the freezing of the sea would be regarded as incredible; and the great age to which he lived, which could not have been less than 200 years,

* The Hebrew word *Heba* means to hide, conceal, close up, make impenetrable, or compact.

would make him contemporary with Serug, when Noah and his sons were still alive, and the circumstances of the Deluge could not have been forgotten. There are repeated references to that catastrophe in the Book, Chap. xxii. 15—17, and xxxviii. 8—11, and the freezing of the ocean is mentioned as a singular fact that was known to those to whom the sublime address was presented, and as a fact which could have resulted only from the interposition of the divine power. The friends of the patriarch could not have been acquainted with the arctic climate, or indeed with any region in which the sea freezes; and the passage must refer to some memorable and well authenticated occasion, when such a singular phenomenon occurred.

It would now be impossible to assign with any degree of certainty, such an event to its proper cause; but as heat is very rapidly absorbed by the conversion of water into steam, we may suppose this to have been effected on a great scale by the action of innumerable submarine volcanoes, which would also account for the torrents of rain that fell from the heavens, without any intermission for a period of six weeks in succession.

§ 4. The waters rose by an intermittent motion, and neither all at once nor by one gradual and combined movement. Not only have many blocks been transported from one place to another, on the same or nearly the same level, but there are many instances in which they have been raised from lower to much higher situations, and that without being either rolled by an impetuous current, or tossed up by a powerful surge. Fragments of greenstone, from Salisbury Crags, in the neighbourhood of Edinburgh, have been lifted over a deep ravine, and up the face of a rugged precipice, to the top of Arthur's Seat, which is some hundreds of feet higher; and in the parish of Benholm, between Montrose and Bervie, there is a hill of considerable height, called the Clonch Hill, which rises abruptly from the water's edge, and on the very top of which there are a number of stones, of equally different kinds and dimensions, lying without any order, and all within a very limited space, every one of

which must have come from a distance,—being not only different from one another, but also from the hill, which is a mass of greenstone, very lightly covered with soil. The largest stone is a slab of grit, about a foot thick, 10 or 12 feet wide, and apparently much longer. It stands on its edge, in an inclined position, with 10 or 12 feet above the ground, and as much below it as is sufficient to preserve it from falling over on its side. It is supposed by antiquarians to have been a Druidical altar, and to afford one proof, among many others, that the aborigines of the country had a knowledge of some mechanical power, which has long been lost. But the principal stone is not in contact with any of the rest, and neither derives nor appears to have derived any support from them. Had it ever been intended for an altar, or used as such, it would have been placed in some other position; and if ever it had been in a more suitable position, it would be difficult to assign a reason for its present. Had it slipped by accident from the stones on which it rested, one edge might have gone to the ground, but the other would have continued to rest upon its supports; or if it had launched from them all, it would have come flat upon the ground.

Again, if it had been thrown off designedly, those who did it must have subjected themselves to immense labour, without any conceivable object, in raising it up to an inclined position, and settling it so firmly and deeply in the earth as to preserve it in that position for ever; when it might have easily been made vertical, and consequently to stand, with much less cost. If we suppose it to have been dropped, with the other stones laying around it, from a mass of ice, every difficulty will be removed. It has evidently come from a bed of grit, of the same appearance, which reclines against the base of the hill, and where all the other stones in its neighbourhood could have been taken up at the same time. Some of these are large rounded blocks of granite and gneiss, which the tides bring South, from the butt of the Grampians; but others are small and shapeless, and altogether unlikely to have been carried there by artificial means.

An inhabitant of Nova Scotia can have no difficulty in understanding how stones, gravel, and mud, may be raised from a lower to a higher situation, by means of ice. In severe winters the frost does not only penetrate to the bottoms of our rivers, but often to a considerable depth into their beds, converting the water, gravel and mud, as far as it goes, into a solid mass; and when the melting of the snow produces a flood, the buoyancy of the ice lifts the whole mass to the surface, which sometimes drifts, from the course of the river, into shallow water, where, stranding on some rising ground, it leaves all the insoluble materials, like a heap of rubbish, when the water falls and the ice dissolves. Collections of stones are frequently met in this new country, in localities where it is difficult to account for their presence, and where they are calculated to tempt the curious to suppose that they must have been brought together by artificial means, and intentionally deposited where they still remain; but the existence of icebergs on the occasion referred to solves the difficulty.

In order to have effected such transportations, the icebergs must have settled some time in the lower situations, in order to become attached to the stones which they afterwards lifted up to the higher; and when the water rose to a greater height, they carried the stones along with them in their ascent. This frequently happens in the bay which lies between Nova Scotia and Cape Breton. Icebergs from the coast of Labrador often drift in and strand near the shore, where they soon become immovable; but when a strong gale from the same quarter beats in a heavy sea into the bay, they are driven from their moorings and dashed to pieces; and their scattered fragments are thrown up upon the beach, with large stones sometimes adhering to them. An iceberg, resting for some time on Salisbury Crags, or on the coast of Kincardineshire, might raise up blocks to Arthur's Seat, or the Cloach Hill, and drop them in passing over these eminences; but the mighty inundation which effected this, must have attained its height by an intermittent movement.

Such is the view presented to us, in the Sacred History, of

the progress of the Deluge. Gen. vii. 17—20: "And the waters increased and bare up the ark, and it was lifted up above the earth. And the waters prevailed and increased greatly upon the earth; and the ark went upon the face of the waters. And the waters prevailed exceedingly upon the earth; and all the high hills that were under the whole heavens were covered. Fifteen cubits upward did the waters prevail, and the mountains were covered." The expressions here are repeatedly varied; and they are varied for the purpose of marking more distinctly the different stages of the rise of the waters, before they attained to their greatest height; and when we consider the genius of the Hebrew language, we may infer from the account that there were pauses in the movement,—that having suddenly risen to one height, they remained there either for a longer or shorter time, and again suddenly rose to another. The catastrophe was effected by a series of paroxysms, which gave deceitful hopes to those who occupied the higher ground, till the last faint expectation was destroyed.

§ 5. Towards the close of the inundation, the waters appear to have been tossed by a tempest. In many places the surface of the rocks has been marked by the passing over them, in a forcible manner, of some rough and ponderous body. They are not only polished by the rolling of gravel, but grooves have been cut in them, apparently by the rubbing of some rough and immensely heavy body over them. Similar effects are produced by the extension of the glaciers in Switzerland; and M. Agassiz, who is familiar with these, has supposed that in some former age the greater part of the Northern Hemisphere has been under ice, which, commencing like Alpine glaciers at certain points, gradually extended on the side that was open, and in the course of its progress produced these impressions. This is ingenious, and to a certain extent plausible; but the scratches in question are found in situations where they must have had a different origin, and it is probable that their origin has been everywhere the same.

Icebergs, driven by a mighty wind, and having a mass of

gravel firmly adhering to their lower sides, are much better adapted to the purpose. They sometimes rise to the height of 200 or 300 feet above the water, and must descend to as many thousands below it, and be otherwise proportioned, in order to keep the same position. On floating masses of such magnitude the wind must act with an inconceivable power; and when once put in motion, and brought to their speed, they acquire an impetus that would carry them into shallow water, where the ground was favourable, and where they would consequently press with inconceivably greater effect upon it. Scarcely a winter passes in which this is not exemplified in the bay already mentioned. Icebergs are often thrown into situations where more than one half of them are above the waters. This must have happened to the grooving agent, when it passed over the Hill of Corstorphine, in the neighbourhood of Edinburgh, for the grooves commence on its western declivity, and, running up over the top of the hill, appear again on Ravelstone Hill, on the opposite side, but 200 feet lower. By whatever agent the effect was produced, it must have struck with such force against the western slope of Corstorphine Hill as to carry it up over its summit, and launch it again into deeper water on the opposite side, where it came in contact with the Hill of Ravelstone. Icebergs, ballasted with stones and gravel, and driven before a furious tempest, would act in this way, and produce such effects as those we are considering; and with the undoubted evidence we have of the existence of such agents at the time, we are justified in imputing these events to them.

We have here another remarkable coincidence with the Sacred Narrative: Gen. viii. 1, "And God made a wind to pass over the earth, and the waters asswaged." Had the grooves been cut at an early stage of the inundation, they could not have been so very distinct and entire as they generally are; and we may therefore suppose them to have been made near its close.

§ 6. The waters of the inundation fell as they rose—by an intermittent movement. This is clear from the beaches which still remain in different parts of the world, and which

were evidently formed at the different levels at which the waters stood, before retiring within their permanent boundaries. In the valley of the Orinoco, near its confluence with the Meta, Humboldt discovered what he considered as undoubted proofs of the vast magnitude of that mighty river in ancient times, as compared with its modern state. He first found black bands and erosions, at a level of 45 feet above its greatest rise at the present time, again at that of 106, and lastly at that of 138; and he says, "Is the present Orinoco then, which appears so imposing and majestic, no more than the scanty remains of those mighty currents of fresh water which, swelled by the melting of Alpine snows or more abundant rains, deeply shaded along its course by dense forests, and without those beaches which promote evaporation, formerly traversed the extensive regions to the East of the Andes, like arms of an inland sea? If so, what must have been the state of the low countries of Guiana, which are now subject to annual inundations? What a prodigious number of crocodiles, lamantines, and boas, must have infested those vast regions, alternately in the condition of extensive lakes and plains? The peaceful world in which we live has succeeded to one of tumultuous agitation. The remains of the mastodon and American elephant are found embedded in the platforms of the Andes, and the megatherium inhabited the plains of Uruguay. Beneath the surface of the elevated valleys, which at the present day are not adapted to the palm and arborescent fern, we discover seams of coal, containing the remains of gigantic monocotyledons. There was therefore a remote period, when the vegetable tribes were distributed otherwise than they are at present; when the animals were large, and the rivers proportionally more broad and deep." Had that distinguished traveller been then acquainted with the more recent discoveries and advanced state of geological science, he would in all probability have referred the change which the Orinoco has undergone to a different origin. It has evidently fallen, not by a gradual and continued decrease, but by fits, renewed after intermittent pauses. It appears to have stood for some time

at the height of 138 feet above the level of its greatest rise in modern times, then to have fallen 32 feet at once, and after another pause 61 feet, and ultimately to its present standard.

Were this the only instance of the kind, it would be rash and unphilosophical to draw any general conclusion from it, for a single fact should be very decisive before being made the basis of a general principle, but there are similar instances in every part of the world, and some of them far more decisive than this. Humboldt believes that the Lake Valentia, in the same region, must have once been large, and that the level of its waters was proportionally higher than either the one or the other is now. It is surrounded by beaches at different distances from its present shores, which appear to have been deserted one after another, as the area of its surface became less and less; yet there are no remains of any ancient barrier that has been broken down, or partially swept away; and the contraction of its area, and reduction of its level, can only be accounted for on the supposition that it once formed an estuary, when the waters it discharged were dammed up by the height of the ocean.

But the parallel roads of Glen Roy in Scotland, afford an instance still more clear than either of these. The Glen is 10 miles long, and bounded on the opposite sides by lofty and precipitous mountains, which meet and close it in at the upper end, leaving the lower end open for the escape of the river, which tumbles over the rocky bed that stretches along the bottom. On the opposite sides of the valley, and facing one another, there are different sets of terraces, which, commencing at the lower end of the Glen, run horizontally, at corresponding levels, till each pair meets at the upper end, and thus preserves its continuity, excepting at the lower end where they begin. Each set or pair is thus shown to be but one line, continued round the greater part of the Glen at the same level. The upper one is found to be 1250 feet above the level of the sea; the second is 200 feet lower; and the third is 50 below the second, and 1000 above the level of the sea. The upper and second ter-

races terminate abruptly on both sides of the Glen, at the lower end; but the third is continued round the face of the hill, and along Glen Spean, which communicates with Glen Roy at that point. There are also corresponding terraces in Glen Gloy, in the immediate neighbourhood, but not so perfect and discernible along their whole line.

These terraces are formed of depositions of gravel and mud, and are evidently beaches of an ancient lake, estuary, or firth; and are formed of substances washed down from the higher grounds to the edge of the waters, when they stood at their respective levels; and the reason why they terminate at the lower end of the Glen is, that the tides in sweeping past them in that place, removed the materials as fast as they were deposited, while they were permitted to rest along the shores of the firth, where the current did not enter.

There are two sets of terraces extending to the length of 60 miles, at Altonfiord, on the N.W. Coast of the Scandinavian Peninsula, but they differ from those of Glen Roy in this respect, that instead of being horizontal they both form inclined planes, and the upper one dips at a higher angle than that of the other.

I shall return again to South America, and give another instance from that quarter. The account of it is taken from Captain Hall's "Journal on the Coast of Chili, &c." Vol. 1, page 308: "On the 18th Sept'r," says he, "our friendly host accompanied one of the officers of the Conway and me in a ride of about 25 miles, up the valley of the Coquimbo; during which the most remarkable thing we saw was a distinct series of what are usually called parallel roads, or shelves, lying in horizontal planes along the sides of the valley. They are so disposed as to present exact counterparts of one another, at the same level on the opposite sides of the valley, being formed entirely of loose materials, principally water-worn rounded stones, from the size of a nut to that of a man's head. Each of these roads or shelves resembles a shingle beach, and there is every indication of the stones having been deposited at the margin of a lake, which has filled the valley up to these levels. These gigantic

roads are at some places half a mile wide, but their general breadth is from twenty to fifty yards. There are three distinctly characterised sets, and a lower one which is indistinct when approached, but when viewed from a distance it is evidently of the same character with the others."

"In the centre of the valley, which is seven miles wide, there stood an extensive plain, narrow at the upper end and widening out towards the sea, thus dividing the valley into two parts. The surface of this insulated place was to all appearance quite flat and horizontal, and as far as the eye could determine, exactly on a level with the above mentioned roads; so that, if a lake ever stood in the valley at the level of the upper road, the present surface must have been barely covered, or as seamen term it, just lipping with the water's edge. It is several miles wide, and shaped like a delta; its sides are in many places deeply indented with ravines, which enable us to see that it is composed exclusively of the same waterworn materials as the roads, which, on both sides, are exactly traced at the same levels, and in perfect conformity with those on the opposite banks of the valley."

"Since the above description of the Coquimbo roads was written, I have had an opportunity of examining the analogous phenomena in Glen Roy, in the Highlands of Scotland. The resemblance between the two cases is not so great as I had been led to suppose from description. In principle, however, there is not the slightest difference; and the identity of origin seems unquestionable." There are several points, of great importance, which have either escaped the notice of this very respectable and intelligent officer, or which he has forgotten to mention: such as the height of the highest road above the level of the sea, the distance of the three sets from one another, and whether the deposits are stratified or not. It is remarkable that there are three distinct sets, and an indistinct one below, which is also the case in Glen Roy. If the Deluge was occasioned by the depression of the Northern Hemisphere, from which it subsequently recovered, the fall of the sea, as compared with the level of the land, when the latter had regained its former position,

would appear greater than its fall in the Southern Hemisphere.

The terraces just described must have been all formed during the retreat of the waters, for, consisting as they do of loose and light materials, they could not have resisted the action of the current and survived the catastrophe, had they been deposited at any earlier period. They are supposed by many to have been beaches of ancient lakes which have burst their barriers and discharged their water, but they are much more likely to have been beaches of the sea when its waters stood at their respective levels.

Most of the great mountain chains appear to have been enlarged when the waters were retreating. Their higher regions are generally intersected by deep rents, and frightful chasms, which have neither been filled up by diluvian deposits nor polished and enlarged by diluvian currents, as those that have been opened in the lower grounds. Were any considerable mass of new matter to be injected into the interior of a mountain, so as to increase its dimension, its exterior parts must either expand, or be ruptured; and in the latter case, deep and rugged chasms would be opened across it; and when we see that deep ravines have been opened, we may refer them at once to such an origin. In many instances chasms opened in this way have been filled up by the rushing in of melted minerals thrown up from the interior, and which have become veins in the masses in which they are enclosed, but in many instances they remain open.

Chasms of a date anterior to the last revolution of the earth, have in general been more or less widened by the action of powerful currents, of which they have been the channels in the time of some more recent catastrophes, but those that were opened at the close of the last great catastrophe have either been little affected by such currents, or not affected by them at all. Their opposite sides are rough and precipitous, and correspond so exactly with one another as to show that they have undergone little alteration since the time they were ruptured and forced apart. Wherever there is a projection on the one side, there is a corresponding

recess on the opposite, and were it possible to bring them again together they would completely fit. There are many chasms of this kind in the Cordilleras of the Andes, in the Indian Caucasus, in the Alps, and in the Pyrenees. In all these countries they have been occasionally converted into lines of communication between one district and another; and though in some places they are quite practicable, there are others in which they are passed with great difficulty. The pass of Quindiu, between Santa Fe and Popayan, is bounded by lofty walls of porphyry on either hand, and in some places so near to one another, that a single ox, the only beast of burden used in it, can squeeze himself through with some difficulty. According to Sir Alexander Burnes, the main road from India to Bokhara, or from the valley of the Indus to that of the Oxus, which was at one time the great route of commerce between India and Europe, runs along a number of deep and narrow defiles, generally the beds of mountain torrents, one of which he believes to be 3000 feet in depth, and so dark and dismal as never to be visited by the light of day; and where the harsh screaming of nocturnal birds responds to the roar of raging torrents, invisible to the eye, but appalling to the ear.

There are many such defiles in the Alps of Switzerland, but the valley of Chamouni is one of the most splendid. It is from seven to eight miles in length, and about half a mile wide, and is bounded on either side by walls reared by the hand of nature, and so very lofty, that little more than the lower stories can be seen by a person passing along it.

Though the sides of many of these chasms are unpolished, and have consequently never been subjected to the action of any powerful current, some of them retain the most decisive marks of having been the beds of inferior running streams for a limited period. Of this the celebrated pass of Bolnun, become better known by the late disasters of our arms in Affghanistan, may be given as an example. "At first," says the ill-fated Conolly, "there was but breadth for a dozen of horsemen between the rocks, which rose like walls on either side to a great height. Afterwards the road

lay broadly between the mountains, occasionally opening out. It was like the beach of the sea, formed of loose pebbly stones and sand, and turning at sharp angles, from one to a hundred yards apart from one another. This was the style of the pass for ten miles to Ser-e-Khujour. At Ser-e-Khujour, the hill broke off from the road, but they still commanded it for other nine miles, and the same beach-like road lay between steep banks, as if it were the bed of a deep but dried river." Journey to India, vol. ii., p. 219.

Chasms, which like the Bolaun Pass lie at such a height above the level of the sea, and were at some time the beds of ancient currents, but for too limited a period to have the projecting angles of their banks rounded, must have been opened about the time when the waters had already begun to retreat, but were still standing at their respective levels. Had they been opened sooner, when the waters rose to a much greater height their sides would have been waterworn, and their sharp and projecting angles broken off, by the force of the current, assisted by the masses of rock and gravel which it rolled along with it. On the other hand, had they not been opened till the waters had subsided below their level, they could not have become the beds of currents, nor could gravel and sand have been deposited along their courses, "like the beach of the sea." The opening of such chasms, when the waters had just begun to retreat, shows that the mountains by which they are intersected were then enlarged—that additional matter had been injected into their interior, and their crust expanded to a greater extent than the elasticity of the strata could admit; and that, as a matter of course, these had been rent in different directions, and either to a greater or less depth, according to circumstances.

It was formerly observed that every addition to the height and other dimensions of the mountains must be attended with loss to the same extent in some other quarter, because it is only a transference of matter from place to place; and there are two ways in which such transferences may contribute to the depression of the level of the sea. They may either open subterraneous caverns into which the waters of

the sea have access, or they may deprive some part of the bed of the ocean of its wonted support, and permit it to fall in. In either case the surface of the waters would subside to the same extent, to which new accommodation for them had been provided.

The parallel roads already mentioned, show that the waters stood for a longer or shorter time at their respective levels; and consequently that they retreated step by step, till they fell to their prescribed and permanent level. In some instances, the relative position of the land and sea appears to have been altered by a depression of the latter; and in others, by an uprising of the former; and in others again, by both combined. As the terraces of Glen Roy have completely preserved their parallelism and horizontality, they must have been left one after another by the sea, while the land remained in the same position; but the fact that they are neither horizontal nor parallel, at Altonfiord, shows that the sea was left by them—that they rose above it, and that, at the rising of both, the upheaval was greater at the one end than at the other.

But, whether it was by a depression of the one or an uplifting of the other, it must have happened occasionally, and not by one continued movement. The waters must have stood at the level of one of the terraces, for a time, to allow the materials of which it is composed to be collected; and then have fallen suddenly to the level of the next. Those of Altonfiord, after being discontinued for some distance, again become visible, and very distinct, in Vaerdel, and Helgedal, in the vicinity of Drontheim. "It is impossible," says Mr. Laing, "to see these valleys, without being struck with the conviction, that they have been chains of fresh-water lakes which, have burst their barriers and been suddenly laid dry. On ascending the steeps which bound the flat alluvial bottoms of the valleys on each side, and which consist generally of banks of gravelly soil, one is surprised to find an upper terrace of excellent land, cultivated and inhabited like the bottom, and consisting of the same soil of friable loam. The terrace rests against the primary rocks of

the Fjelde, and has evidently been the bottom of an ancient lake, which was bounded by these Fjelde ridges. The lake has probably been drained by some sudden convulsion, for the slopes to the level below are steep and sharp, which they would not have been if exposed to the long-continued action of waves and currents." Journal of a residence in Norway, p. 307.

Mr. Laing's opinion, that these terraces are the remains of ancient fresh-water lakes, would have been more probable, had the barriers remained, excepting where they have been broken down and swept away; but while they are bounded in the rear by the base of the Fjelde, they are open in front towards the sea, and appear rather to have been ancient fiords, or firths, such as those by which the coast is still indented, when the waters of the sea rose to their level.

But terraces are not the only phenomena which indicate the sudden upheaval of the land in various places. It may be inferred also from the forcible dispersion of erratic blocks, in opposite directions, from a common centre, and at the same time. Wherever a submarine volcanoe breaks out for the first time, or a new and violent eruption takes place, it will produce a simultaneous rush of waters in all directions from the centre of movement; and whenever we see that impetuous currents have rushed away in different directions, from a common centre, about the same time, we may conclude that it originated in a sudden convulsion, or rising of the land, at or near that centre. Now, if this be correct, there must have been violent agitations and risings of the land in different quarters, towards the close of the last inundation. There can be no doubt that in the Northern Hemisphere the general course of the current was southerly, but there are many localities in which it has for a time taken other directions. It has been already stated that large blocks from the central Alps have been carried westward across the valley of Neufchatel, and even over the Jura chain into the plains of France; others have been rolled down in a northerly direction, from the mountains of Cumberland and Westmorland, into the valley of the Solway; and though fragments of all

the rocks lying between Antigonish and the gulf of St. Lawrence, including a mass of amygdaloidal trap which just appears at Arisaig Point, are scattered about the fields in this neighbourhood, immense boulders of granite have come from the mouth of St. Mary's River, a distance of forty or fifty miles in the opposite direction. In their passage northward, they have followed the long chain of lakes, which connect St. Mary's with Antigonish, and are more numerous and less water-worn as we approach their original locality, behind the village of Sherbrook, where the ground is almost wholly covered with them.

On the subject of such dispersions, Professor Phillips makes the following observations:—"If following the indications of the phenomena, we refer, in every case, the dispersion of the blocks to the uplifting of particular mountain groups, and this is almost a certain inference, we may perhaps admit, in the neighbourhood of such groups, temporary variations, or undulations of the land, like those which accompany earthquakes, sufficiently extensive when combined with the agitation of the sea, to permit the water to take, for a short period, directions previously and subsequently impossible. That the whole was the effect of a very short period, is the universal impression of all observers." Page 210.

If the land thus rose in different places, and at different times; and if, in addition to this, the bed of the ocean became deeper and larger, by a series of convulsions, the waters must have retired by an intermittent fall within their established and permanent limits. Such is the conclusion to which Geology conducts us, and it may be also inferred from the peculiar phraseology in which the close of the Deluge is recorded in the Scriptures. Gen. viii. 3, 5: "The waters returned from off the earth, *going and returning*;" and again, "The waters decreased, *going and decreasing*." This form of expression is used in regard to motion that is renewed after repeated interruptions, and it shows that the Deluge terminated thus.* It is perhaps in reference to this fact,

* When it is said, Gen. xii. 9, that Abraham journeyed, *going and journeying*, towards the South," it means that he renewed

that the Apostle represents the earth as alternately rising above the water, and being again submerged, at the time of the Deluge, 2 Pet. iii. 5, 6.

§ 7. It appears, both from Geology and the Scriptures, that torrents of rain fell from the heavens while the waters were abating. Though some of the terraces already described may have been formed by the impetuous rushing of the waters from a higher to a lower level, in consequence of a change in the relative position between the dry land and the ocean bed, some of them have been formed by other means. The parallel roads of Glen Roy are stratified. They consist of a regular series of beds, distinctly marked, and deposited over one another; and Dr. Lyell supposes the materials to have been rolled down by mountain streams, occasioned by the melting of snow above them, and distributed by the tides along the shore. This might have been the origin of the roads which run along the sides of the mountains which bound the Glen, but there are isolated hills that rise between them, and there are roads round them at the same levels with those on the mountains. This is also the case in the valley of Coquimbo. Now the materials of the roads on these ancient islands, could not have been washed down by mountain streams, because no mountain streams had access to them, but they might have been rolled down as far as the waters fell by heavy rains. In heavy rains, though the water ultimately collects into channels, it flows at first over the whole ground, and will continue to do so on an even surface. Had the terraces in Glen Roy been formed by the agency of mountain torrents, the materials brought down by them would have accumulated about the

his journey from time to time, after repeated pauses. Chap. xxvi. 13: "And the man waxed great, *going and waxing*, till he became very great." He rose step by step, to wealth and influence. Esther ix. 4: "For this man Mordecai *went and increased*,"—he obtained promotion after promotion, till he attained the highest rank to which a subject could aspire. In Gen. viii. 7, a similar construction intimates that the raven hovered about the ark, taking longer and longer excursions from it, till the earth became dry. Compare also Exod. xix. 19, Prov. iv. 18, Jonah i. 11, 13.

entrance of these torrents into the lake; and if distributed along the shores at all, they would have been deposited far more sparingly in the intervening spaces, which does not appear to have been the case; but heavy rains forming a broad sheet of water over the whole surface of the earth, when it had been loosened by the waters and more easily denuded, would wash down materials for the construction of these terraces, both on the mountains and isolated hills, just appearing above water; and would deposit these materials in regular beds, where their farther descent was stopped by the sea.

It appears from the Scriptures that the rains were continued till very near the termination of the Deluge. Gen. viii. 1: "And God made a wind to pass over the earth, and the waters asswaged." This was anterior to the stopping of the rain, which is mentioned as coming next in order, along with the shutting of the windows of heaven, and closing of the fountains of the great deep. "The fountains also of the great deep, and the windows of heaven were stopped, and the rain from heaven was restrained." It failed, or fell off till it entirely ceased.

The Scriptures and Geology agree then in regard to the leading particulars of the Deluge:—that it was general—that it originated either in the depression of the land or the rising of the ocean bed, or both combined—that the temperature of the earth was so much reduced at the time as to occasion the freezing of the ocean—that the waters rose by an intermittent motion—that they were driven by a tempest, towards the close—that they fell as they had risen, by an intermittent motion, and that the catastrophe was accompanied by heavy rains; and while Geology and the Scriptures agree in respect to these points, there is no point on which they differ.

CHAP. VII.

OF THE AGREEMENT BETWEEN GEOLOGY AND THE SACRED SCRIPTURES, RESPECTING SOME IMPORTANT EFFECTS WHICH HAVE FOLLOWED THE LAST REVOLUTION OF THE EARTH.

Every revolution which the earth has undergone has proved beneficial, either in its immediate or remote consequences; but some of them have been rather injurious at first, and have ultimately produced good, by immediately doing harm. There are particular arrangements in the economy of nature, as well as in the moral government of the world, in which transient evil leads to the introduction of permanent good; and on some occasions good and evil are so equally balanced that it would be hard to determine which of them predominates. During the formation of the carboniferous strata, the means of supporting animal life were most abundant; but the peculiar state of the atmosphere, on which this depended, was unfavourable to the existence of terrestrial animals, and they could not have prospered while it continued. The vast masses of vegetable matter that were then produced, were however not useless. The peculiar state of the earth that produced them, also brought agents into operation by which they were collected in particular localities, and there converted into an invaluable mineral, which is now contributing in various ways to the individual and social benefit of man. During the time which immediately succeeded the carboniferous period, animal life was in less danger from azotic gases, but kept in check from want of sustenance; but this state of things had also its use, and we are now deriving important benefits from it. In the tertiary era, a number of important changes were introduced, and the earth was approaching its present state, but had not attained to it; and the revolution in which that era terminated was still necessary to complete its transition, and it appears to have contributed to it in different ways.

§ 1. The last great revolution of the earth appears, both from Geology and from the Scriptures, to have increased its

fertility. The crust of the globe is chiefly composed of siliceous, argillaceous, and calcareous earths,—sometimes in a petrified, and sometimes in a friable state; and none of these earths, if taken by themselves, are well adapted to the support of vegetation. They require to be blended with one another in certain proportions; and, when so blended, they form the most valuable and improvable soils, or soils that are susceptible of the highest improvement, and at the least expense. Now the fact is certain, in whatever way we may attempt to account for it, that, in the great majority of the older formations, these different earths have been kept in a great measure by themselves; and though beds of limestone, shale, and sandstone, often alternate, they are seldom compounded in a way to be useful for agricultural purposes. The agency of a vast and active inundation was necessary to this. The previous revolutions which the earth had undergone, by rupturing the strata, and disposing them in an inclined or vertical position, had exposed them all, more or less, to the action of such an agent; and the great inundation, in which the revolutionary times of the earth terminated, acting upon their fractured, dislocated, and exposed edges, with the greatest intensity, has reduced vast masses to a friable state, blended these masses in all proportions, and deposited them in places where they are the most available for the use of man.

Lofty mountain chains serve many important purposes in the economy of nature, but above a certain height, which depends upon their latitude, they are unfit for cultivation. Their climate is too low to bring the more useful plants to maturity. They are too much exposed to the influence of the weather to be chosen by agriculturists, and too remote and difficult of access for the manufacturer or the merchant. Had they, therefore, been covered with a rich soil, it would have been in a great measure useless; but they have in general been swept by the Deluge; and while their bare summits pierce the clouds, and attract their watery treasures to the earth, perhaps with an influence beyond what they would otherwise have possessed, their soil has been removed to

places where it forms an important element of improvement in the world.

These observations are equally applicable to the Polar regions. They are either within or bordering on the line of perpetual congellation; and their vegetation bears an Alpine character, and graduates into the mosses which fringe the glaciers of the lofty mountains. They have also in general been stripped of their soil. The Aretic regions of North America, according to Dr. Richardson, present a bare and rugged surface, from which every particle of soil has been removed, and where only a few scattered patches of moss form the whole vegetation of the country. The corresponding parallels of Europe and Asia are in a similar condition. The occurrence of coal in Melville Island, and the masses of bones accumulated on the Northern coast of Siberia, show that these bleak and sterile regions were formerly under a milder climate, and that when the climate was congenial they had also a soil adapted to the support of a plentiful vegetation; but when the climate became unfavourable the soil was transported to more genial climes.

It was formerly stated, that, towards the close of the inundation, the waters must have rushed from North to South, with an irresistible impetuosity, as appears from the immense masses of rock which they rolled before them, across deep and extensive valleys, and over hills and mountains beyond them; and that this was probably occasioned by the circumstance, that the dry land having been more depressed in the Northern Hemisphere, had been suddenly raised to its former level, and had, in the course of this movement, thrown the waters violently off towards the South; or the rush might have originated in some other change, which had suddenly disturbed the equilibrium of the waters, and left them to find a new level. That they were loaded with sediment of different kinds, when they fell to the level of the alluvial lands, on the banks of our rivers, appears from the order in which these deposits are frequently found. In many places, what we call intervale lands, are regularly stratified. They consist of a distinct series of beds, in which

gravel, mud, and sand, alternate; but there are many situations in which we meet with one thick bed of gravel, in which the size of the pebbles increases downward, till they become boulders, or waterworn stones of considerable dimensions; while the superjacent mass is one bed of pure mud, which has evidently been deposited at one time, and not by a series of river floods, in which the alternating beds have originated. When the gravel was deposited in one bed, and the mud in another, the materials of both must have been in motion at the same time; and they have been put in motion by the sudden and impetuous fall of the waters from a higher to a lower level; but when the latter was attained, the heavier materials would come first to rest, and the gravel and mud would be separately deposited. In the lower part of the bed of gravel, there are many trees, chiefly maple, but not exactly the maple of our present forests, which shows that the current must have brought the gravel and mud along with it at the same time, for the trees must have been deposited before, as they never move in running water with the same rapidity as the other materials.

Whether the extent of the dry land has been increased or otherwise, by such changes, there can be no doubt that it has been rendered more productive. A deeper and better compounded soil has been deposited over those parts of its surface, which are in other respects better adapted to the support of the more valuable kinds of plants, and the means of subsistence for man and beast can be obtained from it in greater abundance, and at less expense.

In this we have another point of agreement between Geology and the Scriptures. The latter show us, that the cursing of the ground had diminished its fertility, and that at the birth of Noah, his father, moved by the spirit of prophecy, foretold an amelioration in his days. The human race was again reduced to a single family, that the whole might be comprehended under a new arrangement, by which they were to be reinstated in the enjoyment of a number of their forfeited privileges, and, among others, in the possession of greater plenty; and it was intimated in the pro-

mulgation of that arrangement, that they would soon be enabled to recruit their numbers, and repair all the losses they had sustained. Accordingly, we find that before a single century had elapsed, they were in a condition to embark in a great enterprise, apparently with little other view than that of having an object in which they had a common interest, which might serve as a centre point of attraction, and counteract the tendency to branch off into separate divisions; and such an idea could only have originated in the necessity they were already beginning to feel of dispersing themselves over the face of the earth, Gen. xi. 4.* Be this as it may, they had evidently increased with great rapidity; and in the course of a century or two more, they had spread over a great part of Asia—made settlements both in Europe and Africa, and laid the foundations of many great and populous kingdoms. No more decisive evidence can be required, of the great improvement which the earth had undergone. The term of human life was reduced to one-fourth of what it had been anterior to the Deluge, and, with the drain occasioned by the quadrupled activity of the law of mortality, the human race increased with a rapidity apparently unexampled before the Flood.

§ 2. Again, the last revolution of the earth appears, both from Geology and the Scriptures, to have been immediately followed by greater regularity in the course of the seasons than had been previously introduced. Gen. viii. 21, 22: "And the Lord said in his heart, I will not curse the ground any more for man's sake, though the imagination of man's heart should be evil from his youth; neither will I again smite any more every living thing as I have done. While the earth remaineth, seed time and harvest, and cold and heat, and summer and winter, and day and night shall not cease." From this it appears, that the curse formerly pronounced on the ground, had been either wholly or partially

* The confusion of tongues, and consequent division of the human race into different nations, happened about the time of the birth of Peleg, 1 Chron. i. 19, which was in the year 101, after the Flood, Gen. xi. 10—16.

removed, and was never again to be repeated; and that while it lasted, it had, among its other consequences, interrupted the regular course of the seasons, or counteracted their influence, destroyed the distinction between day and night, and prevented the benefits which these natural vicissitudes are intended to secure to us. Had summer and winter, seed-time and harvest, and day and night, followed each other in their proper order, there would have been no occasion for such a promise; and Noah and his family could not have been sensible of any privileges it conferred upon them. The promises given to them and their descendants to the latest generations, have respect to blessings which had been forfeited by their ancestors, and either wholly or partially withheld; and in this view the promise under consideration intimates, that the existing order of the times and seasons was either then introduced anew, or restored after a long discontinuance.

Geology leads, and perhaps more directly, to the same conclusion. Many races, both of plants and animals, which once flourished on the face of the earth, have been long extinct; and but for their remains still preserved in the strata, we should not have known that they ever existed. Under these circumstances, we may be supposed to be unacquainted with their instincts and habits, and consequently unable to reason from their instincts and habits, respecting the condition in which they must have lived. But this is to a certain extent a mistake. The organization of any plant, or animal, may be regarded as a sure, though general indication, of what its instincts and habits have been, and for what peculiar circumstances it was formed. Nature endows her different productions with all that is necessary, and with nothing more; and an animal or plant with a useless organ, or useless property, would be an anomaly among her works. The cat is formed upon the very best construction to enable it to steal silently on its prey, to make a sudden spring, without risk or inconvenience to itself, and to take an instantaneous and firm hold of its victim; and its modes of life may be inferred from its mechanism. Keeping this in view, and

reasoning from analogy, we come to the conclusion, that the greater part of the plants and animals of a former world, were tropical races, and that a tropical, if not more than a tropical heat, prevailed in the parallels that are now called temperate, and extended even into the polar circles. There can be no doubt that the elephant and rhinoceros, as well as the buffalo, abounded in Siberia, to the very shores of the Arctic seas, for there is not a river in that country, on whose banks their remains are not common; and there are some islands near the mouth of the Lena, in which vast masses of them are embedded. From this again we may certainly infer, that the vegetation of these regions has been abundant; for animal life could not have prospered in them as it appears to have done, and that in some of its boldest types, unless they had provided the means of subsistence.

Again there are indications of an opposite character, from which we may infer, that the temperature of these regions was much lower than the above-mentioned fact would lead us to suppose. They contain the remains of the Ovibos Pallantis, a species or variety of the Musk-Ox, a purely Arctic animal; and which is not known to be able to submit even to a temperate climate; and Arctic shells have been found in different parts of the more recent strata. To this we may add that the Siberian elephant and Siberian rhinoceros, were both thickly covered with hair, which is not the case with their existing congeners, which seem to be formed for a warmer climate. It has been inferred from this that they were of a different species; but there are many animals which change their external appearance in this respect, when they remove from a warm to a cold climate, and *vice versa*. In this Province the hog acquires a covering of coarse wool among his bristles; and in warm countries the sheep assumes the covering of the goat, and the dog very often becomes naked; and the fact that the elephant and rhinoceros became warmly clothed, when domiciled in Siberia, will prove decidedly that its temperature was lower than even its vegetation would have warranted us to suppose.

We have thus conflicting evidence respecting the tempe-

rature of the higher latitudes in early times, and as neither of the proofs can be set aside, there must be a way of reconciling them. We are probably not acquainted with all the conditions to which it is possible either for plants or animals to submit, and how much they may be affected by what may seem to us a most unimportant difference. We have reason to believe that different races of plants and animals, which rather prefer a warm climate, can accommodate themselves to a cold one, provided they were exempted from all sudden and great variations. Sudden transitions from heat to cold, and from cold to heat, are more inimical both to animal and vegetable life, than a regular continuance of either extreme. In the Tierra del Fuego, Captains King and Fitzroy observed a variety of tender plants, such as Veronicas and Fuchsias, blooming in a climate where the Thermometer seldom rises much above 36°, or experiences any great fall below it; and in that region of unceasing storms, the woods are inhabited by parrots and parroquets; and the humming bird, which seldom appears in Nova Scotia till the warm weather sets in, flutters there among the shrubs and flowers during the transient fits of sunshine which interpose between the squalls of sleet and snow. This has been attributed, and apparently with reason, to the equability of the climate of that dreary region.

In no other way can we account for the presence of such opposite races as the elephant and musk-ox in the same vicinity, than by supposing them to have been capable of accommodating themselves to different temperatures from those which they prefer, provided they were free from all sudden and great variations; and that such was the climate of Siberia at the time. Its equability fitted it for different races of plants and animals, which could not have endured it had it been changeable. The musk-ox did not altogether consort with the elephant and rhinoceros. While the rivers flow through mountainous districts, no remains of the latter are found along their banks; but they seldom or never fail to be met with, when their course is through low and level grounds. While the elephant rose to the height of 10,000 feet

above the level of the sea in South America, it appears to have been confined to the lowest grounds in the Arctic regions. Yet their presence within the same area, along with purely Arctic races, shows that nature had adopted some arrangement by which all the insurmountable obstacles to their communion had been removed; and a uniform, or nearly uniform temperature, was the most likely for this purpose. It may have been variable, but its range must have been limited, for had it risen much above the medium, it would have been insupportable to one race, or had it fallen much below it, it would have proved equally insupportable to another. We may therefore conclude, that there was something in the state of the earth at the time, which counteracted the regular course of the seasons, and prevented the vicissitudes of cold and heat by which they are distinguished.

Again, if the larger animals frequented the higher latitudes in numbers, they must have found there the means of subsistence; and as all animals require a more liberal supply of food in a cold, than they require in a warm country, the vegetation of these latitudes must have been far more abundant than it is now, and must also have comprehended a much greater variety of plants. This suggests another very serious difficulty; for a due proportion of light is just as indispensable to the plants which the elephant and rhinoceros required, as a suitable climate; and though the Polar regions have more than the necessary compliment of light at one time, they have just as much less at another; and there must have been some means by which this deficiency was supplied. In times more remote than those which immediately preceded the last great revolution of the earth, vegetation was so abundant in still higher latitudes than Siberia, as to furnish materials for the formation of coal, which is known to exist in Melville Island, and the requisite degree of light must have been supplied by some other means than the luminaries of heaven. The laws to which they are subject have been the same from the earliest time to the present day. There are many plants which can accommodate themselves to an artificial existence, and return again to a natural

state, with little inconvenience. They can dispense with the natural light of the day, and accept of an artificial light as a substitute; but they must have enough either of the one or the other; and that the plants of the warmer and brighter regions could have submitted to darkness, for three or four months in succession, without being injured by it, is altogether improbable.

The light and heat, which promoted vegetation in the higher latitudes, had most probably a common origin. Incandescent lava, when it issues from the crater, frequently emits a very brilliant and intense light, as well as a scorching heat; and vast columns of the brightest flame often ascend from volcanoes to the clouds, and illuminate the horizon to a great distance. Now if during the earlier periods of the earth, active volcanoes were as numerous, and their eruptions as frequent and violent as the crust of the earth very clearly indicates, they must have preserved a greater equability of temperature over the face of the earth in general, than would otherwise have existed; and often converted the night into day. The flames of Mount Erebus, lately discovered in the Antarctic regions, are represented by Captain Ross as ascending to the height of 2000 feet; and they cannot fail to shed a glare of light to a great extent over its neighbourhood.

§ 3. Besides, we have reason to conclude, both from Scripture and Geology, that the last great revolution of the earth was speedily followed by a sensible reduction in the size of many terrestrial animals. During the earlier ages of the earth, organized bodies appear in general to have been formed on a larger scale than at present. The arborescent ferns of the carboniferous system were twice the size of their existing representatives. There were also a variety of gigantic races, both of land and water animals. But it would not be fair to compare races, which have left no representatives behind them, with existing races, because we know not what they might have been, had they been continued till this time. But among the fossil remains of a former world, many existing races have been discovered; and when the races can

be identified, the fossil specimens greatly surpass the living in size. The ancient hyenas, whose remains are found in so many ossiferous caves in Europe, exhibit the very same organization as the living species—the same prodigious strength of jaw—the same instincts, and the same habits. They were in all other respects the same kind of animals, but nearly twice the size. The horns of the fossil elk of Ireland are twice the size of those of the modern elk, or moose; and the deer of Scania, and buffalo of Siberia, have been judged to belong to species that are extinct, chiefly on account of their great superiority in this respect. The same thing has been said, and on the same account, of other fossil races. Large and unwieldy as the elephant is, he was far surpassed by the ancient mammoth; and neither the African lion nor Bengal tiger will bear a comparison with their ancestors of the tertiary era.

The resources of man are much superior to those of any inferior race; and he can, in consequence of this, accommodate himself with less inconvenience, and more facility, to a greater variety of physical changes than any other race can submit to, and is much less affected by their influence. If we can then show that he has been affected by the influence of the last revolution of the earth—that his stature has been reduced since the antediluvian age, we may the more readily admit that other races have suffered a reduction. The Sacred Scriptures are chiefly occupied with the moral character and condition of man—with his history as an intelligent, immortal and accountable being; and when his physical condition is adverted to at all, it is only when it happens to be connected directly or indirectly with his higher interests. It is, however, very concisely stated, in Gen. vi. 4, that the antediluvians were of a gigantic stature. Our Common Version represents the passage as stating that there were then giants in the world; but the passage may as well be understood to mean, that the men of those times were giants, or that they were in general men of great stature. The sacred historian could not have intended to have represented the existence of giants in the former world either as a sin-

gular or uncommon fact; for he expressly tells us that there were nations of giants in his own time, Deut. ii. 10, 11, 20, 21, and their existence had a very unhappy effect on the fortunes of the Israelites. Although Egypt was one of the first of the nations, and had assumed a settled form of government in the days of Abraham, the father of the Anakims had founded Kirjath-arba, or Hebron in Palestine, before Zoan, the ancient capital of that country, Josh. xxi. 11, Num. xiii. 22; so that the race can be traced back till within a century or two after the Flood, and they continued in existence till the times of David; and it is not unworthy of notice, that the Hebrew term *Rephaim*, by which they are for the most part designated, represents them as a wasting or dwindling relic of former times.

The statements of Pliny among the ancients, of St. Augustine in the middle ages, and of Kircher, &c., among the moderns, of the discovery of human bones, which must have belonged to men of 20, 40, and even 400 feet high, are to be regarded only as amusing instances of human credulity; yet still they are not to be altogether despised, and may point to the recovery of an ancient and long-forgotten fact. Poets may be regarded as the historians of opinion, in as much as they record the opinions of their respective ages; and Virgil, in predicting the astonishment which the future ploughman should experience at the size of the human bones which he might turn out of their graves, shows a belief that the race was gradually diminishing in stature, and consequently that those who flourished in still more ancient times had surpassed his cotemporaries, as much as he expected the latter to surpass those who might succeed them in a remote period of futurity.

> Aut gravibus rastris galeas pulsabit inanes,
> Grandiaque effossis mirabitur ossa sepulchris.
>
> G. i. v. 496.

"Then after length of time, the labouring swains,
"Who turn the turfs of those unhappy plains,
"Shall rusty piles from the plow'd furrows take,
"And over empty helmets pass the rake,
"Amazed at antique titles on the stones
"And mighty relics of gigantic bones." DRYDEN.

Every country in which ancient traditions have been preserved, has a legendary history, and every legendary history goes back to an age in which the country was possessed by giants, who are invariably represented as voracious and ruthless cannibals. A belief so generally diffused as this, must have had some foundation of a more solid and tangible nature than is commonly supposed. Accordingly we find that the antediluvian age was one of giants, and also that "the earth was corrupted before God, and filled with VIOLENCE," Gen. vi. 11.

Qua terra patet fera regnat Erinnys. OVID.

"So far as the earth extends the fell Erinnys reigns."

§ 4. It is clear from the Scriptures, that the term of animal life has been greatly shortened since the era of the Deluge, and this is at least rendered probable from geological facts. On this subject, the testimony of the Scriptures is full and decisive. Passing Enoch, who was translated when comparatively a young man, the mean term of human life, before the Flood, was nearly 916 years, while that of an equal number of Postdiluvians, beginning with Shem, did not exceed 257, which is not equal to one third; and from the days of Abraham, the last on the list, the term rapidly fell to the standard at which it still remains. The account of the period of human life in the 90th Psalm, which is ascribed to Moses, is as applicable at the present day as at the time when it was written. "The days of our years are three score years and ten; and if by reason of strength they be fourscore years, yet is the overplus but labour and sorrow, and it is soon terminated, and we fly away."

The attention of geologists has scarcely been directed to this point, and it appears rather a hopeless subject of enquiry. So far as I know, Dr. Buckland is the only writer who seems to have bestowed on it a passing thought, and if he has come to any conclusion respecting it, it is directly opposed to the following.

There are in different countries ossiferous caves, containing the remains of antediluvian animals, and he has selected that of Kuloch, in Germany, as the best adapted to his pur-

pose, and most likely to throw light upon the subject. It contains, according to his calculation, 5000 solid feet of black mould, which he supposes to be composed of animal dust, or the residual earth of animal matter, in a state of decomposition. In this mass are embedded considerable numbers of bears' teeth, from which he infers that the cave has been a bear's den; and supposing the residual earth of a full grown bear to be equal to 2 solid feet, and that the cave must have been occupied for 1000 years, he reckons the whole number of bears that died in it to have been 2500, or one for two years and a half.

This reasoning is ingenious but hypothetical, and could not support a solid conclusion. In the first place, it is by no means certain that the black mould is either wholly or even chiefly composed of animal earth. Its colour is at least no proof of it. The cave appears to be singular in this respect, that the teeth contained in it are as black as the mould, and as they have retained their natural colour in other ossiferous caves, the change here must be owing to something that is peculiar to it, and which would of course tinge the mould as well as the teeth. Neither can the other properties of the mould decidedly prove it to be wholly composed of animal dust, especially as the decomposition of a considerable proportion of animal matter in a mass of fine friable earth will altar the appearance of the latter greatly, and give it a striking resemblance to animal dust.

Gypseous and limestone districts are very often cavernous, and contain basons of greater or less dimensions, in which water is seldom retained for any considerable length of time, even while bounded on all sides, so as to prevent its escape above ground. Water, however, will flow into them in rainy seasons, and when it has no visible outlet, it must have some subterraneous passage near the bottom, the entrance to which is so superficially closed as to allow the passage of fine sediment into the interior. Some of these passages have once been open, and formed the entrances to caves and grottoes of different descriptions, and many of them appear to have been anciently the retreats of such predacious animals as the

bear, in the dry seasons. In other instances dead animals have been drawn into them, by the force of the currents which escaped in that direction in the rainy seasons. There are many such caverns still in Greece, and the basons in which they occur are occasionally filled with water, and become lakes in rainy seasons, but are quite dry at other times, when the caverns are inhabited by foxes and jackalls, and other wild beasts of the country. When the water flows into them, it necessarily carries in a quantity of sediment, and sometimes the carcases of dead animals, and other putrescent matter; and in this way may the contents of the cave of Kuloch have been accumulated. As some sets of teeth have been preserved in it, we cannot assign any good reason for the disappearance of others placed exactly in the same circumstances; but a very great number must have disappeared, if 2500 sets have been left in it, as Dr. Buckland supposes. Besides, for any thing that appears to the contrary, the cave may have been occupied by a number of bears at one time, and a considerable proportion of the black mould may consist of the residue of excrementitious matter.

The cave of Kirkdale, in the North of Englaad, is in many respects better fitted to assist us in this difficult enquiry. It is generally supposed to have been a hyena's den for some time before the last general revolution of the earth, and was only discovered in 1821, when the scientific world had become fully alive to the great importance of its curious contents, and when they were carefully examined before being dispersed. It contains the remains of the elephant and rhinoceros, among the larger animals, and of those of the mouse and rat among the smaller, and presents a variety of undoubted proofs of having for a long time been occupied by hyenas.

The floor of the cave is covered with stalagmite, over which there is a stratum of fine mud, about a foot in thickness, and then a second encrustation of stalagmite, of a later date than the deposition of the mud. Stalagmite consists of the carbonate of lime, with which water in filtering through the earth becomes impregnated, and which it car-

ries along with it till it is exposed to the air, when it is deposited as an encrustation. Its formation is generally slow, and it may not unfrequently be regarded as a kind of natural chronometer. The bones preserved in the cave are embedded in the mud, and partly encased in the lower stalagmite, which shows that part of them at least were there while it was in the course of formation; and as none of them are found above the mud, we may conclude that the cave has not been inhabited since the time of its deposition. Some of the bones embedded in the lower encrustation, as well as the stalagmite itself, appear to have been partially worn and polished, by the passing to and fro of the inhabitants of the cave; and taking all these circumstances together, a thousand years does not appear to be an over-estimate of the length of time that the cave was occupied.

Now the whole number of the tenants of the cave, during this period, cannot be rated at more than 200. Its contents have been very carefully examined, and the sets of teeth found among them amount to nearly 300. A considerable proportion of these, however, are milk teeth, and consequently not to be included in the number. It is known, moreover, that the hyena, like the wolf, devours his own species; and as many of the bones of that animal, which have been preserved in the cave, are fractured and partially devoured, in the same manner as those of other animals, it is reasonable to suppose that they belonged to individuals which had become a prey to the inhabitants, and that having been dragged into the cave by the latter, their teeth are also to be deducted from the 300 sets. After these reductions, the number of sets belonging to the regular inhabitants of the cave cannot be reckoned above 200, and if we divide 1000 or 1200 by this number, it will allow at an average six years to every individual, supposing the cave to have been in the exclusive possession of one at a time.

But hyenas, though savage, are not solitary animals. Like the wolf, they often hunt in packs—live in society where their domicile affords sufficient accommodation, and make common cause when a camel or other large animal is to be

attacked. In the cave of Kirkdale, the bones of the elephant, rhinoceros, and hippopotamus, occur in such numbers as to show that these gigantic animals have either become the prey of its tenants, or that their dead carcases were dragged into it, to be there devoured. Now this must have required the united efforts of a considerable number, especially as the cave is in the face of a bank, and at a considerable height above its base.

But besides the bones of the larger animals already mentioned, there are also bones of the partridge, the lark, the rat, and the mouse; and some have alleged that the hyena is not likely to have preyed upon such diminutive animals, and that therefore we may suppose the whole of the bones to have been deposited there by some other means. But this supposition betrays either ignorance of, or inattention to, the habits of predacious animals. They have been sometimes thought to be noble, generous, and high-minded; but they are strangers to every feeling of this kind: the gratification of their appetites is their main object, and their only consideration is to do it most effectually, and at the least trouble and the least danger. Our bear does not hesitate, when circumstances are favourable, to attack the ox, and he rejoices in the capture of a sheep or a hog; but in default of such game, does not disdain to hunt for mice, and rather than be reduced altogether to a vegetable diet, will put up for a time with locusts and grass-hoppers.

The smaller animals, whose bones have been preserved in the cave of Kirkdale, were not meant for its adult inhabitants, but for the use of the junior members of the community. Had the case been otherwise, few of them would have remained to afford scope for the speculations of the geologist. The animal that devours the bones of the ox, will not waste much of his time in picking those of the lark and the mouse, although they may be very well for the first experiments of those who were but just entering on the stage. Beasts of Prey are not less attentive than others to their young, and not less considerate in providing sustenance adapted to their years; and when it happens to be abundant,

they provide more plentifully than their necessities require, and the surplus is allowed to rot in their den. A neighbour of mine lately discovered the den of a fox, by the offensive effluvia emitted by the putrid carcases of mice, which she had collected for her cubs, beyond what they were able to consume.

The fact that some of the bones in the cave are embedded in the under layer of stalagmite, shows that it had been inhabited from the time that the encrustation began to be formed, and consequently at an early period; and the number of inhabitants must at different times have been equal to the task of dragging into it, the carcase of an elephant, a rhinoceros, or a hippopotamos, and that at no small disadvantage, and can hardly be reckoned below 16 or 20. Now, if the whole number of inhabitants, from first to last, did not exceed 200, and if there were 20 of them contemporary, there must have been no more than ten generations, which gives 100 years to each, which is a much longer term of life than the hyena enjoys at the present time.

This reasoning may be regarded as more specious than solid; and it is no doubt partly hypothetical. Too much is assumed, and too little proved; but it is one of those points in regard to which nothing more than probability is attainable, and I leave it to the candid and discerning to determine whether this has not been attained.

CHAP. VIII.

OBJECTIONS CONSIDERED.

PRELIMINARY OBSERVATIONS.

In running the parallel between the discoveries of Geology, and the brief notices contained in the Scriptures, of the early condition and revolutions of the earth, I have endeavoured to do justice to the Pre-adamite theory, by selecting the statements of its leading advocates, and presenting them in general in their own words, without knowingly suppressing any fact of importance to that theory, or exhibiting it in a different light from what is usual. As little can it be justly

alleged, that I have put a forced construction on those passages of the Sacred Scriptures, which have been compared with the statements of Geology; and, without any straining on either side, I have pointed out a very striking agreement between them,—an agreement which is not limited to one or two points, but which has been traced through a considerable number and variety. Geology and the Scriptures give us respectively the very same accounts of the number and extent of the revolutions of the earth—of the order in which they have occurred—of the principal agents by which they have been effected—of their influence on vegetable and animal life, and of a number of important consequences which have followed them.

If this will not identify the period when the sedimentary rocks were formed, with the antediluvian age of the Sacred Scriptures, it would be difficult to determine what kind or amount of proof would be sufficient for that purpose. It is morally impossible that such a number of striking coincidences as have been pointed out could have been accidental; and if not, they will identify the one period with the other, as fully, and clearly, as it is possible for any thing of the kind to be done.

Were we to examine two separate and independent accounts of the same country, the one giving dates and the other none, if they not only gave a similar outline of events, arranging them in precisely the same order, and referring them to the same causes, but corresponded exactly in regard to such details as were given in each, while neither of them contained any statement that was at variance with the other, although the one gave particulars which the other omitted, or the one was more full on this particular, and the other on that, would we hesitate to pronounce them separate accounts of the same period, and series of events?

Geology and the Scriptures are so far from disagreeing, that they reciprocally confirm and illustrate each other. The discoveries of Geology explain and give importance to statements of the Scriptures, which are otherwise misunderstood, or regarded as uninteresting; and the light thus shed by the

one upon the other, is reflected back upon its own source, and illuminates points in it that would have been otherwise obscure. Geology makes known the different revolutions which the earth has undergone, and speculates in regard to their physical causes, or the agents by which they have been effected; but from the consideration of their primary and final causes it cautiously abstains, as if these had been illegitimate subjects of enquiry, or at least beyond the limits of its province. The Scriptures, on the contrary, point out to us at once, the first cause, and unfold the reasons of the divine procedure; and in this way some of the most difficult problems are solved, and some of the most perplexing questions are answered. Geology, for instance, shows us that in the last great revolution of the earth different races of animals perished, while others, with which they appear to have been intermixed, survived, and have been continued till the present time; but how to reconcile the preservation of one race, with the destruction of another, placed in the same circumstances, and apparently exposed to the same catastrophe, is beyond its province; and those who rely upon it as their only guide, have no other alternative than the unphilosophical hypothesis, that the whole were destroyed and a part restored by a new creation.

But can we discover in nature any actual analogy to this, to which we may refer in support of its probability? Every type of organization, that we know, perpetuates its existence by means of reproduction; and in every instance of reproduction, that we know, the offspring derives its existence from the parent, without any immediate or direct interposition of the creative energy. Could the opposite be shown to have once occurred—could it be undoubtedly proved that the creative power has, in a single instance, been interposed for the restoration of a lost genus, or species, we might refer to the fact, for the solution of a difficulty that does not seem to admit of any other solution, but not otherwise. The Scriptures extricate us from this dilemma, by making known to us the means by which existing races escaped the catastrophe, have repaired their losses, and continued down to our times.

I mean not, however, to allege that every difficulty is completely removed, and that no room for objection remains. The many, and sometimes contradictory ways, which have been taken for the reconciliation of the Scriptures with Geology, show, in the clearest and most convincing light, that the subject is beset with difficulties, and that there are objections to be answered of a very formidable kind. To affirm the opposite, would be to treat a number of our most eminent Geologists with a want of respect which they do not merit; and from which their distinguished talents—their great industry, and the important services they have rendered to science, should for ever protect them

OBJECTION I.

The Sacred Chronology does not allow a sufficiency of time for the great changes which the earth has undergone.

§ 1. The great majority of stratified rocks are universally allowed to be aqueous deposits; and the different materials of which they are composed must have been either rolled or suspended in water for some time before being deposited where they now rest. Again, coal consists of vegetable matter; and as immense quantities have been accumulated in coal fields, a much longer time must have been required for its production, than could have been appropriated to it from the antediluvian age. Moreover, there are vast masses of coralline rocks which have been formed by the labours of marine insects, and they can hardly be supposed to have been all constructed during the time which elapsed between the Mosaic creation and the Deluge. Finally, whatever classification of rocks we adopt, there must have been repeated dislocations, denudations, and readjustments, and all these could not have happened in the limited time admitted in the Scriptures.

§ 2. Such are the arguments of those who adopt the Preadamite theory. The question to be answered is not purely one of time, but whether such changes as the earth has un-

dergone could have been either accelerated or retarded by circumstances. The objection is evidently founded on the assumption, that, during the early ages of the earth, there were no other elements of change in operation than such as are in operation still—that they acted with no greater intensity, and that they consequently required the same time, in order to produce the same effects. Were these postulates granted, the objection would be unanswerable, but otherwise it is not.

When the agents, the subjects, and all the conditions, are precisely the same, in two cases, the same results may be expected in both, and that in the very same time; but a change even in some of the conditions may either retard or accelerate the process, or even derange it altogether; and should there be a difference in something more than the conditions, a corresponding difference in the effect may be anticipated. Two currents of water, of the same volume, and the same rapidity, possess the same amount of power, but if either the volume or velocity of the one be greater than that of the other, its power will be greater in the same proportion. Again, should they be precisely the same, both in regard to volume and velocity—if the one act upon substances less or more refractory than those on which the other acts, the effects produced by them will differ accordingly. Should the one flow over a bed of mud, and the other over a mass of granite, the amount of excavation performed by the one would be very different from that of the other. We cannot, therefore, reason from the present to the past state of things, till we first show that they have been in all respects precisely similar.

§ 3. Dr. Lyell, who is entitled to stand at the head of geologists, labours with consummate industry and ability, not wholly unmixed with art, to prove the uniformity with which the elements of change have operated from the earliest times to the present day. But we have both geological and historical evidence of the occurrence of catastrophes in ancient times, to which there has been nothing similar for thousands of years. There have been, and there are still, local dis-

turbances—partial upliftings and depressions of the land, in particular regions, and petty cones are occasionally thrown up in volcanic eruptions; but no change in the crust of the earth can be compared either in extent or in grandeur with that in which the primary era terminated, when the granites and syenites ruptured and dislocated the new-formed strata, and rose into lofty mountain chains, dividing the earth into sea and land—into mountain and valley; or to what more recent change can we point, of equal magnitude with that which closed the transition period? That the tertiary era ended with an inundation, which rose to the height of the highest mountains in the Northern Hemisphere—rolled over them with irresistible violence—widened out dark and rugged defiles into beautiful and winding valleys—rounded the precipitous brows of mountains, and gave a more polished and agreeable aspect to the face of nature, is universally admitted; but this was the last catastrophe of the kind. Since that time no mountain chains have risen, and no capacious valley has been opened. In some localities, the sea may be encroaching slowly on the land, and in others the land may be gaining on the sea; but not only is the superficial extent of both stationary, but their tendency to exchange places is so small that the general confidence of mankind, resting on the uniform experience of ages, is fully established in their permanent retention of their respective positions, in regard to each other.

§ 4. The condition of the earth during the carboniferous period was certainly different in various respects from what it has ever since been. Not only was the vegetation more abundant during that than it has been during any later period, but the geographical distribution of plants has been different; and though we may not be able to ascertain fully the reason of this, it will prove in general that the condition of the earth must have been different from what it is now. Nothing is more certain, than that its temperature was higher than it is at present; and heat, although it may have operated indirectly, has in all probability had a powerful influence on the formation of the strata. Warm countries are gene-

rally subject to heavy and long-continued rains; and in early times, when the strata may have been less compact, and more easily broken up than at present, the rains may have produced far greater changes on the surface of the earth than would appear probable from the present state of things. "One tropical shower," says Captain Grey, (Discoveries in Australia,) "of only a few hours continuance, deposited over a field of barley a bed of sand nearly five inches deep, which the succeeding showers again swept off, carrying it farther on its way to the ocean." And Dr. Lyell has shown, as was formerly stated, in his Principles of Geology, that in the course of one rainy season the Ganges carries down an amount of sediment sufficient to form a bed of earth of 621 acres in extent, and 500 feet in depth. If then, in ancient times, the temperate, and even the Polar regions, enjoyed a mild, if not a tropical climate, we may reasonably suppose that heavy and long-continued rains extended much farther than at present, and that their excavating, transporting, and reconstructing influence, was not less than at the present time.

Besides, in all countries subject to such phenomena, there are extensive deserts, the sands of which are as liable to be moved by the action of the wind, in the dry seasons, as by currents of water, when they are overflowed; and by these means a high temperature is indirectly favourable to extensive changes.

§ 5. It appears also, from various facts, that the generality of the strata were at first softer, and consequently more easily abraded than they subsequently became. Their induration may have been promoted by exposure and desiccation, but it has been chiefly owing to heat and compression. Wherever the crystalline masses have penetrated, the strata have become harder and more compact, and the more frequently and violently they have been disturbed, the more have they been altered, and the nearer have they approached a crystalline form. A high and long-continued pressure will, independent of every thing else, jam the particles so closely together, and lock them so tightly into one another,

as to give them a considerable degree of adhesion; but when a powerful heat has been superadded, the effect has been very much increased. Many of the strata have been partially fused, and converted into a solid mass; and in all such cases their disintegration has been rendered much more difficult.

That many of them were at first in a pasty condition, and continued so for some time, is evident from this, that they have been bent, and twisted, and even turned over, without being broken, which would be impossible in their present state. They have, besides, received the impression of footsteps, and when any solid body has been embedded in them, it has imparted its form more or less distinctly to a number of the laminæ, both above and below. Now, when the strata were either wholly or partially in this state, there cannot be the slightest doubt that they were far more liable to be affected and broken up by currents than after they had been converted into solid rock. The materials for the formation of new deposits were therefore proportionally more easily obtained, and that in much greater abundance than at the present time; and on this account we cannot with propriety reason from the present to the former changes of the crust of the earth. Agreeably to this view of the matter, we find, by commencing with the oldest strata, and continuing our examination down to the latest, there is a regular decrease in the thickness of the formations, till the one bears no proportion to the other.

§ 6. At the same time that the strata were becoming less and less subject to the action of the denuding agents, the latter were both losing a portion of their intensity and becoming more limited in their sphere of operation. As the area of the dry land increased, that of the ocean became circumscribed; and as both became stationary, and the latter ceased to change its bed, it acted no more upon the land as it had previously done, on different occasions.

§ 7. Dr. Buckland believes that a high temperature promotes the consolidation of the strata, and that the kind of rock in the island of Gaudaloupe, which contains fossil hu-

man remains, "is frequently formed in a few years, from sandbanks composed of similar materials on the shores of tropical seas," vol. i. p. 105, and he supposes it probable that these remains are those of men who fell in a battle in 1710. This shows how liable we are to be swayed by the influence of preconceived opinions, or the great tendency of the love of theory to warp the judgment. The battle was fought by Europeans, who bury the slain in collective bodies, and not in an isolated manner, as the remains referred to occur in the rock. Besides, the principal of the remains discovered was a mutilated skeleton of a female, who doubtless may have fallen in battle, but is more likely to have died otherwise. But be this as it may, I have no doubt that rocks of different kinds may be formed in a very short time in warm countries,—having repeatedly witnessed it in the temperate climate of the South of Scotland;* and if so, why may we not suppose the strata to have been formed in much less time than would now be possible? We have Geological evidence of the most decisive kind, that rocks have been very rapidly formed in different places, and on different occasions. Of the fossil fishes of Monte Bolco, Dr. Buckland

* This was on a mountain stream in Lauderdale, called the East Water, on the banks of which I spent many of my younger years. It falls into the Leader, directly opposite to Thirlestane Castle, and at the foot of the bank whereon it stands. The old red conglomerate, which skirts the base of the Lammermoor ridge, appears at different places on the banks of the stream. It first juts out, and forms a promontory on the eastern bank, a little above the northern road, which crosses the stream in that quarter, and is seen last on the western side, at the entrance of a gorge, about half a mile above the first. At the very foot of the promontory, and about 40 or 50 rods below the gorge, at which places the current is impetuous when the stream is swollen, there are often laminated slabs formed, of considerable extent and thickness; and which remain for a longer or shorter period, according to circumstances. They consist of fine-grained sandstone, with pebbles embedded in it; and having more or less of a ferruginous colour. The extent of the formation at both places, depends on the height and duration of the flood. The stone is soft and easily demolished at first, but when left dry, and exposed to the air, it soon hardens. The bed will sometimes remain for a few years, and at other times it is broken up, and swept away, in as many months.

very justly observes: "They must have all died on the fatal spot, and been *speedily* buried in the calcareous sediment, then in the course of deposition. From the fact that certain individuals have even preserved traces of colour on their skin, we are certain that they *were entombed before the decomposition of their softer parts took place.*" Again: "Evidence of the fact of vast numbers of fishes and saurians having met with sudden death and *immediate burial*, is afforded by the state of entire preservation in which the bodies of hundreds of them are found in the Lias. It sometimes happens that scarcely a bone or a scale has been removed from the place it occupied during life. This condition could not possibly have been retained, had the uncovered bodies been left for a few hours, exposed to putrefaction and the attacks of fishes and other small animals at the bottom of the sea." And again he says, of the fossil fishes at Mansfieldt and Eisleben, "As they maintain the attitude of the rigid state immediately after death, it follows, *that they were buried before putrefaction had commenced*, and apparently in some bituminous mud, the influx of which had caused their destruction." Vol. i. pp. 123—125. To the same purpose he observes, that the fossil Loligo at Lyme Regis has been suddenly caught by some sudden catastrophe, which overtook them by surprise, and prevented them from discharging the contents of their ink-bags, which they instinctively do on the least alarm, as a means of preservation. "I might register the proof of instantaneous death," says he, "detected in these ink-bags, for they contain the fluid which the living Sepia emits in the moment of alarm; and might detail further evidence of their *immediate burial*, in the retention of the forms of their distended membranes: since they would speedily have decayed, and have spilt their ink, had they been exposed but a few hours to decomposition in the waters. The animals *have died suddenly, and been quickly buried* in the sediment that formed the strata, in which their petrified ink and ink-bags are preserved." Page 307. Fossil animals have been discovered in different places and different formations, which appear to have died so very sud-

denly that their death might have been imputed to an electric shock, had they not retained unequivocal symptoms of the spasmodic action which usually accompany a violent death by other means. Their death must have been occasioned by a sudden and overwhelming rush of mud into that part of the sea which they were in at the time, and in the heart of that mud they were all entombed.

There are different ways of accounting for such an event. It might have originated, for instance, in an intense thaw. It has been already stated, that the vast masses of ice and snow which had been accumulating for years on the volcano of Cotopaxi, were suddenly dissolved, a very short time before the great eruption of 1803; and the valleys below were instantaneously inundated with water heavily charged with sediment. When the frost has penetrated deeply into the ground, as it always does within the limits of perpetual congelation, and happens to be suddenly expelled, the ground is loosened to a great degree, and far more exposed than at other times to the excavating power of impetuous currents; and we know, to our cost in this Province, that an inundation, under such circumstances, is far more destructive to the land than an inundation occasioned by heavy rains.

But there are other causes in which such phenomena may originate. When the volcano of Carguairago burst and fell down, in 1698, the water which had been pent up in its interior, and was then liberated, covered an area of 18 square miles, to a great depth, with the sediment which it carried along with it; and the tide of mud which descended from Tunguragua, during the earthquake in February 1797, filled some of the valleys at its base, to the depth of 600 feet. The waters which fall into lakes and ponds, as well as those which make their way to the sea, for the most part, hold a proportion of the carbonate of lime in a state of solution, which they deposit in beds of marl when they come to rest. A great part of this may be easily raised again, and made to float, by the violent agitation created by an earthquake, and the breaking down of the barriers of such lakes and ponds.

Again, an overwhelming deluge of mud may originate in

the attendants on a volcanic eruption. In 1835, Cosequina threw out such a quantity of ashes as to cover the ground to the depth of 10 feet, to the distance of 20 miles in a southerly direction, when great numbers of land animals, both wild and tame, were buried under them. Now, if such a fall of ashes should be immediately followed by heavy rains, they would be swept into some part of the sea, and every animal contained in it would be suffocated. It was by such a fall of ashes and scoriæ, that Herculaneum and Pompeii were buried so deeply that their very sites remained uncertain for seventeen centuries.

§ 8. Facts like the foregoing show very clearly that some strata have been formed in a very short time; and if some have been so formed, why not others? Why not all? Beds that have been suddenly deposited are not limited to one or two classes only, but extend to many: such as limestone, sandstone, lias, marlstone, &c.; or all the kinds of rock contained either in the secondary or tertiary series,—so that there is nothing in the composition or structure of any of them, opposed to the idea of their rapid formation.

§ 9. There are, however, certain arrangements which geologists regard as natural chronometers, and which, if rightly interpreted, assign a much higher antiquity to the existence of the earth than the Scriptures allow. In the bason of Paris, for instance, salt and fresh water deposits alternate with one another for a considerable number of times; and it is inferred from this fact, that the district had been as often raised above the level of the sea, and again depressed below it, and that the completion of these alternate risings and fallings must have required many thousands of years. But it has been already mentioned, that the Run of Cutch, which is 2000 square miles in extent, suddenly subsided in 1819, and was overflowed by the Indus; while the Ullah Bund, in its immediate neighbourhood, rose to the height of 10 feet above its former level. The same district is confidently believed to have been under water at no distant period before; and in 1838 it again emerged and became dry. Between 1819, when the disturbance occurred, and 1826, the

course of the Indus in that place had been continually shifting, but in the latter year it forced a passage through the Ullah Bund, into the depressed district, which had then been filled with salt water from the sea, and converted it into a fresh water lake for a time; but during the southerly monsoon in 1827, when the wind drove in the waters of the sea, it not only recovered its former saltness, but in time became salter than the sea itself,—no doubt by means of evaporation, which, while it carried off the water, left the salt behind. Here then is an instance of salt and fresh water alternating in the same bason, and that in the space of a single year, and not only so, but of forming deposits of sufficient importance to preserve undoubted evidence of the fact to future ages. The passage cut through the Ullah Bund, in 1826, was 18 feet in depth, 120 in breadth, and 16 miles in length; and the mass of rubbish which was removed from this channel, and of course deposited in the bed of the lake, would cover an area of considerable extent to the depth of a number of feet. In 1827 the salt water again predominated, and would of course deposit a salt water bed on the surface of the other; but in 1828 an unusual rise in the Phurraun branch of the river, cut away the banks of the above-mentioned passage to a great extent, and consequently formed another bed of freshwater sediment, where the others had been deposited. In the same, or in some similar way, may the alternating beds in the bason of Paris have been anciently deposited, and that in a comparatively short time.

Another argument for the very great age of the earth, is drawn from the form and extent of many of those valleys by which the surface of the earth is diversified, and down which rivers flow on their way to the sea. On this point Dr. Lyell reasons thus:—On the coast of Calabria, for instance, there are many beds of marine deposits, which are at present hundreds and even thousands of feet above the level of the sea, and which must have been raised to that height at a comparatively recent period, as they contain many fossil shells belonging to races which are still in existence in the neighbouring seas; and yet these beds are intersected by val-

leys varying in depth from 50 to 600 feet, and are sometimes a number of miles wide; and as these valleys must have been excavated by the streams which flow through them, and that, at their present rate of progress, the whole operation, from the beginning till now, must have occupied an incomparably longer period than the Scriptures allow. "Some speculators, indeed," he says, "who disregard the analogy of existing NATURE, and who are always ready to assume that her forces were more energetic in by-gone days, may dispense with a long series of movements, and suppose that Calabria 'rose like an exhalation' from the deep, after the manner of Milton's Pandemonium. But such an hypothesis would deprive them of that peculiar removing force required to form a regular system of deep and wide valleys; for time, which they are so unwilling to assume, is essential to the operation. Time must be allowed in the intervals between distinct convulsions, for running water to clear away the ruins caused by landslips, otherwise the fallen masses will serve as buttresses, and prevent the succeeding earthquake from exerting its full force. The sides of the valley must be again cut away by the stream, and made to form precipices and overhanging cliffs, before the next shock can take effect in the same manner." Princ. of Geol., vol. ii. p. 353. In this reasoning two things are assumed, which require to be proved. 1st. That all strata containing fossils belonging to existing races are therefore of recent date; and 2dly, That all valleys have been not only originally opened but subsequently enlarged by internal convulsions. That many existing races of animals were in being for some time at least before the last general revolution, will not be denied, and though that may be accounted a recent event, it may have been the origin of many of the valleys referred to, and the means of enlarging and modifying others. The current which deposited the drift, and which rolled before it, in a straight course over mountain and valley for hundreds of miles, masses of stone of many tons weight, must have acted with incalculable energy, in cutting away the strata and scooping out capacious valleys and basons, wherever chasms or ravines had existed,

or wherever the land had been previously depressed; and if we admit this, it is unnecessary to suppose a series of convulsions, precipitating landslips from the brows of mountains, to be slowly removed by ordinary currents, acting imperceptibly during the lapse of intervening periods, which separated them from one another, and made them "like angel visits, short and far between."

The excavation of the deep bed of the St. Lawrence, for a number of miles below the celebrated Falls of Niagara, has been referred to as an operation which must have required many thousands of years at its present rate. Had nothing ever occurred to accelerate the process, it would have been perfectly fair to have estimated its past by its present rate; but if times have occurred which were attended by circumstances that dispatched the work of centuries in a day, it would be unfair in the highest degree, and could not fail to lead to the most erroneous conclusions. Now, though the general features and aspect of the country have undergone no material change since the era of the boulder formation commenced, the excavation of the trough has been evidently going on since that time, and must therefore have been accelerated in no small degree by the great catastrophe, in the course of which that formation originated. The shale which underlies the calcareous rock, from the top of which the river is precipitated, is soft and very easily abraded; but the fall, by converting the water into foam, renders it in a great measure powerless, and the shale is slowly wasted away by the influence of the weather. The water has little or no effect upon it, but when the mountains were overflowed by a current, which rolled vast masses of solid rock over their summits, it must have acted with tremeduous energy in such ravines as the bed of the river below the falls. The force of a current is always greater at the bottom than at the surface, in proportion to its depth, because it has the weight of the superincumbent volume to give it impetus; and its excavating power is immeasurably increased when it falls from a precipice without being broken, as it must have done when the mountains were covered.

The strongest argument in support of a very high antiquity, is furnished by the Great Coal Formation. Coal is chiefly composed of vegetable matter, but the way in which such vast masses have happened to be accumulated in particular localities, is only a matter of speculation as yet, and cannot therefore be adopted as the basis of any theory of the age of the earth. So far as is known, all the plants in the coal formation have been long extinct, but they belong to orders which are still in existence; and they serve to show, that though the state of the earth has undergone a very great change, it has been in many respects the very same from the earliest times, and that some of the actual phenomena of nature may be safely referred to in our speculations about the past.

The coal lies in distinct beds, which are separated from one another by intervening strata of sandstone, limestone, shale, or conglomerate. The number of the beds is not everywhere the same, but differs considerably in different fields; and they differ from one another in the same field, in respect of thickness, quality, and some other particulars. In the great coal formation in the North of England, the whole number of the beds is upwards of 90, of which one third are coal, and the rest limestone, sandstone, &c. In Scotland the seams of coal amount to 80, and in Wales to nearly 100.

The origin of this important formation is enveloped in mystery, and very little has yet been done towards its elucidation. The theory of Mr. Logan is most in vogue at present, and he supposes every coal-field to be the site of an ancient lake, or estuary, in which was produced a plentiful crop of the *stigmaria ficoides*, an aquatic plant that abounds in the coal, and whose long and slender branches and leaves, floating in the water, became so intertwined and closely matted as to form a groundwork for other plants: such as gigantic club-mosses, tree-ferns, flags, &c., which continued to accumulate till materials were produced for a coal seam, when the whole subsided below its customary level, and being overspread by beds of sand and mud, was followed by a

fresh crop of the stigmaria and its usual attendants, till another depression occurred; and that this process continued to be repeated till the number of beds in the field was completed.

This theory is original and ingenious, but liable to some formidable objections. Coal is usually found in basons, sometimes of smaller and at other times of larger dimensions; and the different seams or beds in the formation may be compared in some respects to an equal number of basons placed the one within the other, and diminishing so regularly in their size and form, that their edges or brims are upon the same level. Now the original bason, with all its contents, must either have repeatedly subsided in a body, or the area of the subsidence must have been gradually diminished, always leaving the rim of the last formed bason unbroken. Generally speaking no disturbance has occurred in the coal formation till after it was completed, for the faults so common in it for the most part descend from the highest to the lowest bed in the system, and on the opposite sides of a fault the beds correspond in number and thickness, though they may be depressed on the one side or uplifted on the other. If the whole bason had subsided at any stage of the formation, before it was completed, the next bed deposited in it must have been just as extensive as the first; the area of both must have been the same, and if the subsidence was partial, if a section of the field only sank down, there would not have been a correspondence between the beds previously and subsequently formed.

Others, rejecting Mr. Logan's theory, suppose the materials of the coal to have been collected from different quarters, and deposited in the places where they now rest, in the same manner as a vast collection of vegetable matter, mixed with mud and other substances, is at present accumulating in the delta of the Mississippi. This was most probably the origin of the coal of the tertiary series, which evidently consists of a collection of trees, and other plants of inferior dimensions, intermixed with mud, and all huddled and jammed together, as if by the action of some powerful current. "A

Pietzberg, near Bonn," says Dr. Buckland, "six or seven beds of brown coal alternate with beds of sandy clay and plaster. The trees in the coal are not all parallel to the planes of the strata, but cross one another in all directions, like the drifted trees now accumulating in the alluvial plain and delta of the Mississppi. Some of them are occasionally forced into a vertical position."

But that some of the plants embedded in the coal have been produced on the spot which they still occupy, appears to be certain: as the roots of the stigmaria are still found inserted in their natural order, in the bed of clay which underlies every seam of coal; and there are plants, of which the leaves and other tender and delicate parts are in such a complete state of preservation, and deposited with so much regularity, as to exclude the idea of their having been drifted to the spot by any current of sufficient power to have transported such a mass. The long and slender arms of the stigmaria, and its proportionally long and slender leaves, must have been produced in water that was generally at rest, for in no other element could they have spread around the trunk to such a distance in a horizontal position. It is equally clear that part of the materials were brought from a greater or less distance, and by an agent that only acted periodically, or was at least subject to frequent interruptions; and moreover that the materials thus collected were not always equally abundant, for the seams of coal generally alternate with beds of something else,—a proof that they were formed at different times; and they are neither of equal thickness nor of the same quality.

A large lake or inland sea, having no tides, and lying at the base of some mountain range, from which the vegetation might have been easily swept, must have been favourably situated for a coal formation. Tropical countries are in general subject to periodical rains, when extensive tracts of land are overflowed, and stripped not only of their luxuriant vegetation, but in many instances of a portion of their soil; and when the rainy season terminates, and the rivers retreat to their customary beds, vegetation is forced on with a vi-

gour unknown in temperate climes; and another abundant crop is produced to follow its predecessors in due time. Now, when a tropical or more than a tropical heat prevailed over the greater part of the earth, it is probable that it was accompanied with periodical rains, and that the inundations which they occasioned collected the masses of vegetable matter which has been converted into coal. During every intervening period, between one rainy season and another, a fresh crop of the stigmaria, sigillaria, and other plants of the coal formation, would be produced in the lake and surrounding country, and when the rainy season again returned, and the land became inundated, this would be first swept down by the current, and afterwards masses of other substances, to complete the deposit for one season.

The seams of coal, with the intervening beds with which they alternate, generally dip towards the centre of the basou in which they rest, and are wedge-shaped, both at their exterior and interior edges, which is the usual form in which all such materials as are not for a time held in suspension are deposited in bodies of deep water, into which they are carried by running streams. "It is well known," says Dr. Lyell, "that torrents and streams, which now descend from Alpine declivities to the shores, bring down annually, when the snow melts, vast quantities of shingle and sand, and then as they subside, fine mud, while in summer they are nearly, or entirely dry; so that it may be safely assumed, that deposits like those of the valley of Magnan, consisting of course gravel alternating with fine sediment, are still in progress at many points, as for instance, at the mouth of the Var. They must advance on the Mediterranean in form of great shoals terminating in a steep talus, such being the original mode of accumulation of all coarse materials conveyed into deep water, especially when they are composed in a great part of pebbles, which cannot be transported to indefinite distances by currents of moderate velocity." In the deposition of a coal formation, the vegetable matter being more easily removed from its native place, would be first swept from the land into the basou, and after it the shingle, sand, and mud,

when the ground had been loosened by the influence of the water, and the finer sediment being longer held in suspension than the pebbles and other grosser substances, would be deposited last, and consequently form the bed of clay on which the coal generally rests, and in which the roots of the stigmaria were fastened.

In Nova Scotia the coal measures sometimes rest on the Silurean, and at other times on the Devonian strata; and these are supported by primary schists, which in their turn recline against a mass of granite that runs from end to end of the Province, and defends it on the west from the encroachment of the Atlantic. This mass appears to be the remains of some ancient mountain chain, which being undermined when the porphyries of the Andes rose up, or when some other great convulsion occurred, sunk down to its present level for want of support, and rent the strata in different directions, and opened the Gulf of St. Lawrence in the rear. The appearance of the rocks in sections along the Gulf Shore, accords well with this speculation, and supposing it to be correct, the materials of the coal which abounds in some districts of the Province, may have been produced on the eastern declivity of the chain, and collected in a lake which stretched along its base.

Assuming this to have been the origin of the Great Coal Formation, we may form a general estimate of the time that elapsed while it was accumulating. Supposing one seam of coal, with its accompanying beds of other substances, to have been formed every rainy season, and that there was a rainy season once in the year, the number of seams in a coal field would indicate the time occupied in its formation. Now the greatest number of seams yet discovered in any field, does not exceed, and probably does not amount to a hundred.

It may be objected to this, that some seams are so thick, and at the same time so widely extended, as to make it altogether improbable that the mass of materials of which they are composed could have been produced in such a limited time; but it is universally admitted, that the fertility of the

earth during the carboniferous era was incomparably greater than it has ever been since; and there cannot be a doubt that there may have been tracts of land possessing this fertility, and of sufficient extent for such a purpose; and it can only seem improbable to those who reason from existing circumstances to a state of things that has passed away.

I have supposed the close of the carboniferous era to correspond with the epoch of the cursing of the ground for the sin of man, when it was deprived of much of its original fertility; but the precise date of this is uncertain; and we are therefore at liberty to refer it to the time which, taking all things into consideration, appears most likely. When the retributive dispensations of Providence have been foretold, and referred to particular offences as their occasions, there has generally been some time allowed for preparation for them, and if we suppose this course to have been followed when the ground was cursed, the chief difficulty will be removed. The birth of Seth, which, according to the Greek version of the Sacred Chronology, which is preferred by many, was 230 years after the creation; and this will allow sufficient time, provided we admit of competent agency, for the formation of the whole of the transition series.

Dr. Lyell seems to admit that 150 feet in thickness, of coal formation, might have been deposited in an equal number of years, provided the beds had been horizontal, and not wedge-shaped at the edges, but of an equal thickness from edge to edge; (Elem. Geol. vol. ii. p. 142;) but because the seams are wedge-shaped, and less or more inclined, he thinks we cannot come to the same conclusion. But a stream descending from higher grounds into a lake below, and rolling different substances along with it will fill up the bason just as soon, by beginning at one side and advancing towards the other, as by spreading the materials over the whole area in horizontal beds of equal thickness, and depositing one bed above another, till the whole be completed; and if the beds be distinguishable from one another, their number can be obtained in either form, with equal certainty. The time required for the accumulation of any given amount is not

affected by the form in which the additions are made to it from time to time, but by their magnitude.

Though there is an established order among the different formations, it does not follow that they were always deposited at different times. In point of order, the lias precedes the oolites, and the oolites the chalk; yet some of these might have been formed simultaneously with one another, and there may even have been instances, in which a later in point of order, was earlier in point of time. Though the order is seldom violated, they are very rarely all present in one place, and still more rarely do they all lie in the same planes. One occurs in one place and another in a different one, and both may be present in a third, where others are wanting, with which they are sometimes conjoined. Again, the different formations may not only be distinguished from one another by their mineral characters, but likewise by the fossil remains preserved in them. One formation contains fossils of one type, and another those of a different one; and these are supposed to have belonged to different ages of the earth, but for what reason is not always clear. Different formations may have been simultaneously deposited in different localities, and these localities may have been occupied by different but contemporary races. There is in this respect a striking similarity between different depths of the sea, and different elevations on the land; and both may be compared with the different zones into which the face of the earth is divided. According as we ascend above the level of the sea, or descend below it, we pass through different degrees of temperature, and something that affects animal life in the same way as it is affected in passing from the Equator to the Poles. Like the different parallels, different altitudes are adapted to different living forms, and it appears, from the researches of Professor Forbes, to be the same in regard to degrees of depth in the sea. They are inhabited by different races of shell-fish, which graduate into one another, as they approach the limits of their respective ranges. Now, as a great proportion of the fossiliferous strata, and indeed of the sedimentary rocks in general, have been formed in

the sea, might not the deposition of different orders, with their respective fossils, have been going on at the same time? Had they been deposited within the same area, and extended alike to all its boundaries, no two of them could have had the same date. But where one occurs in one place, and another in a different one, it is quite possible for them to have been formed simultaneously.

Different races of terrestrial animals prefer very different localities, sometimes for obvious reasons, and at other times for reasons which are not easily ascertained; and we have no decisive evidence that it was in different ages that the pachydermata inhabited the valley of the Seine, the bears and hyenas the Hercynian forest, and the elephant and rhinoceros the banks of the Lena. Were a general revolution to occur at present, and affect every region of the world, would future geologists be warranted to conclude, from the diversity of forms found embedded in different regions, that they must have all lived in different ages, and that the earth must have existed a sufficient time to have admitted of this? Now, if different races, which have been referred to different periods, may have been cotemporaries, the geological evidence, that the earth must have existed for millions of years before the date of the Mosaic creation, will be exceedingly impaired, if not completely overturned.

Considering then that the early condition of the earth was different from the present—that many of the strata consisted originally of mud and sand, and were consequently easily demolished and re-constructed—that the agents of such changes were more numerous and energetic than at the present day—that the different formations may have been contemporaneously deposited, and that we have undoubted evidence of the formation of rocks in different places in a very short time, the objection we have been examining cannot be valid. We have three versions of the Sacred Chronology: the Hebrew, the Samaritan, and the Alexandrian Greek, which differ widely from one another; and though it may be impossible to determine, under such circumstances, which of the three is to be preferred, our most approved chronolo-

gists, for reasons which they assign, and which are at least plausible, prefer the last: according to which, the Deluge happened in the year of the world 2242; and though that period will bear no comparison with the millions of years which geologists claim for the revolutions of the earth, it is a period in which mighty changes may have happened, provided that competent agents were in operation.*

OBJECTION II.

The absence of human remains from the strata, shows that man was not in existence at the time of their formation.

The non-existence of man during the period in question, has been confidently but very inconsiderately assumed, because it rests entirely on negative grounds. There are cases in which negative proof is decisive, but this is not one of them, for even though we grant that human remains have not yet been discovered in the strata, we cannot say that they will never be discovered, till every place where they may possibly be preserved has been thoroughly examined. Not a year passes but fossils are discovered which were not previously known to be in existence, and what geologist would venture to affirm that we have at last arrived at the ultimate limits of such discoveries, and that nothing more of the kind is to be expected.

Admitting the total absence of human remains among the

* The following Table exhibits the three different versions referred to in the text:

	Heb.	Sam.	Greek.
Adam,	130	136	230
Seth,	105	105	205
Enos,	90	90	190
Cainan,	70	70	170
Mahalaleel,	65	65	165
Jared,	162	62	162
Enoch,	65	65	165
Methusaleh,	187	67	167
Lamech,	182	53	188
Noah,	600	600	600
	1656	1307	2242

undoubted relics of a former world, it may be accounted for in different ways, without supposing the non-existence of man, as one of its inhabitants. We cannot tell in what region the human race may have then been located, and where human remains have been preserved. It may have been in a region that is yet unexplored, or which now forms a part of the bed of the ocean, and is consequently inaccessible to our researches. If the ocean has repeatedly changed its bed, as geologists maintain, and if it cover two thirds of the surface of the globe, this is by no means improbable; and, if admitted, it will account for the fact that human remains have not been discovered. We will not in that case have access to the places where they are chiefly to be found.

But, independent of this, it must have been in the regions that were most frequently disturbed, that the inferior races were most liable to be involved in the revolutions of the earth, and to have their existence registered in its archives; and it is in such regions that their remains are found in the greatest numbers. But for the very reason that they were subject to such events, they would be shunned by man, the more especially as the earth must have then been but thinly inhabited, and as more eligible situations must have been easily found. The danger of approaching the disturbed regions would have its own influence, and independent of this, their sultry atmosphere would render them intolerable. If, in the lower grounds, a tropical heat prevailed even as far as the Polar circles, man, and many of the inferior races which have shared his fortunes, would in general be confined to the higher ranges of the great mountain chains, where the climate would be more temperate and salubrious. The climate and productions of every parallel from the Equator to the Poles, may be found in different degrees of elevation, within the limits of the same area under the line. At the level of the sea, nothing but tropical productions can be seen; at a greater height the forms of the temperate regions appear; these are succeeded by Alpine forests, above which those that are peculiar to the Polar regions maintain a doubtful struggle for existence, on the margin of the Glaciers.

which surmount the whole. Now, provided that the temperature of the higher regions, in ancient times, bare the same relation to that of the lower which it bears now, the Peak of Chimborazo, and loftier summits of Dhawalaghiri and Jewaker, must have enjoyed a mild and agreeable climate; and it was in all probability in some such extreme elevations that the cradle of the human race was placed.

Some races have evidently been prepared for entering on the stage before they actually made their appearance; for instead of appearing in the first instance in small numbers, they entered in such force as to make it evident that they had been previously in existence for some time, but remained concealed behind some cover, till they were in a condition to compete successfully with those races which they ultimately supplanted. In their original habitations, little had occurred to preserve their memory, and they have left no vestiges behind them, till either invited or expelled from their retreats, and drawn into scenes where their memorials have been preserved.

To such a conclusion the Scriptures as well as Geology would lead us. The topographical account which they give us of Paradise, shows that it must have been situated in some elevated ground; for besides that gold and jewels were found in it, which are chiefly confined to lofty regions, it gave rise to four large rivers, which appear to have flowed in different directions,—a circumstance that would have been uncommon in a low or even a level country. Accordingly we find it repeatedly called *The Mountain of God*, which is a common Hebraism for a high mountain. "Thou hast been in Eden, the garden of God; every precious stone was thy covering, the sardius, the topaz, and the diamond, the beryl, the onyx, and the jasper, the sapphire, the emerald, the carbuncle, and gold.—Thou wast upon the holy mountain of God.—By the abundance of thy merchandise they have filled thee with violence, and thou hast sinned: therefore I will cast thee as a profane thing out of the mountain of God." Ezek. xxviii. 13—16. In its literal sense the passage does not relate to Eden; but it refers to it, and whatever is here

represented as belonging Tyre, must have been supposed to be true of it; and it is not only called the garden, but the mountain of God, or in other words the great mountain.

Supposing our present races of animals to have existed in the early ages of the earth, and to have been confined for a time to its higher regions, this must have operated as a check upon their increase, and limited their numbers. The more useful productions do not come to the same perfection in the higher regions, even when the climate is very favourable, as they attain in temperate latitudes. Wheat does not prosper in South America, at 10,000 feet above the level of the sea, where the mean temperature of Europe prevails. The climate of the table lands of Mexico corresponds with that of the North of Italy, and South of France, but vegetation there is in general less healthy and vigorous than in the latter countries, and the productions of Europe do not prosper equally well as in their native soil. The reason of this is supposed to be, that the rays of the sun appear to be affected by the rarified medium through which they are transmitted, and do not act with the same energy on the powers of vegetation. This being the case at present, must have also been the case anciently under similar circumstances; and we may therefore take it for granted, that in the higher regions the means of subsistence were less plentiful, and that the numbers of the races by which they were inhabited were limited in proportion. The great longevity of the antediluvian patriarchs naturally leads to this conclusion. It seems to be an established law of nature, that the most ephemeral races are the most prolific, and that their fecundity diminishes according to their allotted period of life; and it is by such compensations that the balance is preserved, and that in the competition for enjoyment each has its own peculiar advantages. There were but ten generations of the human race between the Creation and the Deluge; and though, in consequence of being nearly all cotemporaries, their whole numbers may have appeared to be considerable, yet they will become insignificant when compared with the numbers which pass through life within an equal period in later times; and if

their numbers were limited, the chances must have also been proportionally few of their being involved in the ancient revolutions of the earth, and preserved in the ruins occasioned by them.

Be this as it may, we have decisive proof that different races inhabited much higher regions than they can live in now. The horse and the deer have been found at the height of 16,000 feet in the Himmaleh-range, which is within the line of perpetual congelation, and too severe for these animals at the present time. And Burnes informs us, in his Travels to Bokhara, that he had seen petrified Tortoises which had been brought from the same elevated regions. Vol. ii. p. 273. "In my search," says he, "for such curiosities, I have heard of some petrified stones shaped like birds, and about the size of a swallow, found in the hill of Budukshan. I did not see a specimen, as the owner was absent from Bokhara. I am the more disposed to give credit to such things, since I have innumerable stones in the shape of small turtles or tortoises, which were brought from the higher ranges of the Himmaleh." Again, the remains of the elephant and mastodon were found by Humboldt in the lofty plains of Mexico and Quito,—heights to which the elephant never ascends in our day. That animals chose their respective habitations in ancient times, on the same principles that they choose them still, appears from the fact, that though in South America the mastodon ascended to the height of 10,000 feet above the level of the sea, he never went beyond 1500 feet in the Central States of North America.

Moreover, the only terrestrial quadrupeds, whose remains have been found in the secondary rocks, are marsupials, which are able to endure a greater heat, and might therefore have frequented the more disturbed regions, but are also notorious for their want of sagacity, and liability to be involved in dangers which other races would shun; and many of the rocks have been originally deep beds of mud, of such a consistency as to have proved a snare to such races.

The great majority of fossil animals yet discovered, belong to marine and lacustrine orders, whose instincts and habits

exposed them to dangers, from which man was exempted; and this will account for the greater abundance of the remains of such races in the sedimentary strata. A sudden change in the temperature of their native element—the mixture of salt water with fresh, or of a certain proportion of mud or quick-lime with either, and other changes to which water is subject, all prove fatal to innumerable multitudes of aquatic animals, which have not in such cases the same resources with such animals as breath with lungs; and as for reptiles, they generally sleep in mud, and in an age when revolutions were so frequent and sudden, their bed must have often become their graves. In South America, the large saurians bury themselves in the mud and sand, on the margins of rivers, when the waters are low, and sleep till the return of the rainy seasons; and if in the mean time a revolution were to occur, innumerable multitudes would be entombed where they lay.

We have undoubted proofs of the existence of animals during the earlier ages of the earth, of which no other memorial has been preserved, or at least discovered, than a few foot-marks imprinted on strata, over which they had walked; and we may reasonably suppose other animals to have existed, though no such evidence of the fact has been discovered.

There are presumptions as strong as positive evidence, of the existence of races of which not the slightest vestiges has been discovered. The prevalence of certain predaceous races in particular regions, during part of the tertiary era, proves beyond a doubt that the herbivorous races were proportionally numerous in the same regions, for the one cannot subsist without the other; but this conclusion is not warranted by the proportion in which their fossil remains have been discovered. The whole extent of the Hircynean forest, comprehending a district of not less than two hundred leagues, appears to have been almost in the exclusive possession of the Bear and Hyena, during a great part of the tertiary era: but their vast numbers prove decidedly that their means of subsistence were equally abundant, for no

race can ever prosper in a state of famine. The predaceous races occupied caves, where many of them died and became fossilized; while the herbivora lived above ground, where their remains, being exposed to the action of the elements, were soon reduced to their respective elements.

The practice of burying the dead, which can be traced to very ancient times, would have favoured the preservation of human remains, had it been general in the revolutionary times of the earth; but there have been countries where it was the custom to burn the dead, and there are countries where it is the custom still; and unless we can say that the practice of burying is coeval with man, it cannot be referred to in support of any theory whatever.

There have been different races in early times, of which only a very few imperfect remains have yet been discovered. The foot-marks of the cheirotherium have only been found in two places; and though it is exceedingly probable, it is no more than probable, that a few fragments of his bones have been obtained, and from these few mutilated relics it has been confidently inferred that there was more than one species of the animal. There have been other races, of whose past existence the proofs obtained are equally scanty, though quite satisfactory; and they warrant the supposition that races have become extinct, of whose existence no proof remains.

Had the fossil remains of every extinct race been abundant—had complete skeletons of every one of them been found in numbers, the total absence of human remains during the period in question, would have afforded a very strong presumption that man was not then in existence; but of a great number of the extinct races no other remains have been discovered than a few decayed and mutilated fragments: such as a part of the skull of one, or shoulder-blade of another, a jaw-bone of a third, a tooth of a fourth, and so on of others; and as the preservation of not a few of these may be regarded more as an accident than a common occurrence, no inference can be drawn from it, against the existence of man, as a cotemporary of the races to which they belong.

The non-existence of man, during the period in question, cannot therefore be taken for granted, and cannot be admitted as a valid objection to the alleged identity of the revolutionary times of Geology, with the antediluvian age of the Sacred Narrative, especially as that identity is supported by the agreement already pointed out between these periods,—an agreement which is too minute and circumstantial, and extends to too many particulars, to be merely apparent or accidental.

But have no human remains been discovered in the strata? This has been hitherto taken for granted,—not because it is a fact, but for the purpose of meeting the objection on its own merits, and showing its invalidity even if established. But it is not the fact. Human remains have been discovered in different places, intermixed with those of extinct races, and no other reason has been assigned for referring them to a later age than the non-existence of man, as a cotemporary of those races. In the neighbourhood of Bize, of Pondres, of Souvgnarque, and of Liege, there are caves which contain human bones among other fossils; and in the island of Guadaloupe, and at Waterford Haven in Ireland, human skeletons, nearly entire, and in a high state of preservation, have been found entombed in the strata. Geologists, however, allege that these strata are recent deposits, and will not therefore prove the existence of man in ancient times. They first assume the non-existence of man in the times in question, from the supposed absence of his remains in the strata, and then they pronounce those strata in which his remains are discovered recent deposits, because his remains are contained in them. This is clearly reasoning in a circle, and cannot be admitted. Let them first prove the non-existence of man during the period in question, by some other evidence than that of the absence of his remains in the strata; and then the presence of his remains in a bed, will prove it to be a recent deposit; or let them prove by some other evidence that the beds are recent, and then the presence of human remains in them will give no support to the existence of man in times more ancient. The bed in Waterford Ha-

ven is a marine deposit of sand and clay, and extends eight miles into the country, where it rises to the height of 45 feet above its level in the haven, where the skeleton was found. the bed in Guadaloupe is a hard limestone, and contains, besides human bones, arrow-heads, and fragments of pottery; but wherever man existed in life, some vestiges of his skill and industry may be expected. The age of the bed in Guadaloupe may be doubtful, but the presumption is that all hard rocks are ancient; and its antiquity should be taken for granted, till its recentness be proved; and the extent of the bed at Waterford Haven, and the height to which it rises in the interior of the country, prove its antiquity, unless we can show that there has been an uplifting in that locality in more recent times.

Though the existence of man in the times in question be generally denied, it is admitted by some geologists of high standing, and for reasons of no small importance. "To what point of the supercretaceous period," says Professor Phillips, "shall we refer the creation of man? To this important question impartiality must allow that Geology gives no clear and certain answer. It has no evidence upon the subject that is at all of a positive character. We believe that the older stratified rocks were Pre-adamite, for the following reasons: because no remains of plants or animals occur in them, the same, or very similar to the existing forms of life—because land quadrupeds are about utterly unknown to them, and because the physical conditions of the globe were utterly different from what we now behold."

"Let us apply these tests to the supercretaceous deposits. In none of those, which have been formed in the sea, have we yet found the remains of man or his works; but remains of animals and plants, identical or very similar to existing kinds, are found even in the oldest of them; land quadrupeds occur both in fresh-water and marine strata, which are among the earliest eocene tertiary deposits; and finally, the physical conditions of the globe were, at the beginning of the period, very similar to the present, and this similarity continually augmented." Pages 191, 192.

For these reasons he believes that the creation of man could not have been earlier than the chalk formation, but that it probably occurred during some part of the tertiary era. The appearance on the stage of those races which are still in existence, or of races very similar to them, shows that the earth had come nearly, if not entirely into its present state; and we cannot assign a satisfactory reason why the creation of man should have been delayed, after the earth was prepared for his reception. Man is more capable than any other terrestrial animal of accommodating himself to a great variety of external conditions, and if many of those races which have shared his fortunes, and which appear to have been formed principally for his use, were then in existence, the Professor asks, "What is to prevent our receiving, as the *most probable indirect inference*, that the era of the creation of man had arrived while the tertiary strata were in the course of deposition?"

We have no proof whatever, from Geology, that the earth was prepared for the reception of man prior to the deposition of the chalk formation, but we have as little proof to the contrary. The fossil animals of the earlier formations are chiefly marine or lacustrine races; but it does not follow that there were no terrestrial animals in existence, as the absence of their remains in the strata may be otherwise accounted for than by supposing them not to have been created till afterwards.

OBJECTION III.

Though the great majority of existing races of plants and animals are generically the same with fossil races, they are specifically different from them, and may therefore be regarded as a distinct and later creation.

It appears from the Scriptures, that many at least, if not the whole of existing races, are to be referred to the Mosaic creation as their origin; but it is alleged by geologists, that while many races that were formerly in existence have been utterly lost, and have no representatives among living forms,

those that appear to be represented, such as the ox, the horse, the dog, the lion, the tiger, the elephant, the rhinoceros, and many others, differ in so many respects from their representatives as to show that the latter are not their descendants, but have had a different origin.

A difference of some importance may exist between a living and a fossil race, without amounting to what is properly a specific difference. Every species may be divided into accidental varieties without number, and with our limited acquaintance with the extent of the plastic powers of nature, it would be impossible for us to decide how far the subdivisions of a species may, in the course of time, diverge from one another, and from the parent stock. The shape, colour, and general appearance of the greater part of known animals, may be less or more modified by their habits, and their habits are often controlled by circumstances, and rendered in a great measure artificial, or different from what their natural instincts would form. Habits which originate in any particular combination of circumstances, may be perpetuated by its continued operation, and will in the course of time affect the form, and in some respects the organization of the individuals which have been compelled to adopt them. The more full and perfect developement of one organ may be promoted by its sustained and more intense action, while the developement of others is checked by their disuse. By the combined influence of such causes, a peculiar conformation may be produced, and not only produced, but transmitted through a series of generations, till it ultimately becomes constitutional, and it will then be retained till reduced by some counteracting influence.

These facts are known to all who are conversant with the improvement either of plants or animals, and it is on them that their experiments are generally founded; and in many instances their experiments have been attended with great success. The greater part of our valuable grains were originally grasses, and have been brought to their present improved condition by means of cultivation; and some of our finest fruits are known to have had a poor and worthless ori-

gin. The common sloe, or black thorn, which bears a small and worthless berry, is understood to be the parent from which all our varieties of the plum are descended; and the red cabbage and cauliflower, which do not differ more from one another than from their common stock, are both sprung from the wild *Brassica Oleracea*, a marine plant, which is in its native state of no value; and I shall only add, that the opinion of Linnæus has been fully confirmed, that notwithstanding of the striking difference in form and appearance, between the primrose, the polyanthus, the cowslip, &c., they are but accidental varieties of the same plant.

This tendency to diversify under the influence of circumstances, extends to the animal as well as the vegetable kingdom. The varieties of the dog, the horse, the ox, and the hog, for instance, are much more numerous than those of any species of plant that is known. The varieties or different breeds of the ox, do not only differ from one another in regard to configuration, size, and colour, but some of them are long horned, others short horned, and others again are hornless; and what is curious, the other characteristics of particular breeds seem to be connected with these circumstances. A few individuals of hornless cattle have been accidentally obtained in my own neighbourhood, without any intercourse with the Galloway breed, and such is their general resemblance to that breed, that a Gallovidean would take them for Humble Duns from his native hills. Even the human race, which has far more resources than any one of the lower animals, and is better qualified to resist the modifying influence of external circumstances, has in this respect partially shared the fate of the rest. It consists of four or five general divisions, which are easily distinguished from one another by certain peculiarities, and each of which is broken into smaller subdivisions, between which there are minuter points of difference.

Now, those who allow the differences which exist between accidental varieties to be the effect of physical causes, operating through a long succession of ages, will find it a hard matter to prove that physical causes still more powerful may

never have existed, or that they would not produce, in the course of time, those wider divergences which are supposed to constitute a difference of species. We have not yet ascertained the limits within which accidental variations are confined, and till we know the points where they terminate, and original and specific differences begin, we are not in a condition to speak with certainty on this subject.

We are only acquainted with two certain or infallible tests of a specific difference. The one is the impossibility by crossing to produce a permanent hybrid race. There are instances in which a hybrid individual may be obtained by the union of one species with another,—as of the horse with the ass, or the lion with the tiger; but the individual is incapable of transmitting its own mixed nature, in its full integrity, through a series of generations. A mule may in some cases have progeny, but not by union with a mule, or in any other way than by connexion with an individual of one or other of the parent stocks; and this necessarily destroys the equilibrium between the two natures, and brings back the progeny so many degrees nearer to the race with which it has been crossed a second time. The other test is, that accidental varieties, being freed from the influence of those circumstances in which they originated, and of all others which are capable of producing them, or on being restored to their original state, gradually lose their acquired peculiarities, and revert again to their original form.

But we cannot subject existing races to either of these tests, so as to ascertain whether or not there is a specific difference between existing and the fossil races represented by them. We can neither cross an existing with a fossil individual, nor, supposing existing to be descended from fossil races, can we relieve them from the influence of the physical causes which have produced the change, nor replace them in the precise condition of their progenitors, to see if they would revert to the fossil types.

In the changes which living forms have undergone, it is remarkable that the carnivora and pachydermata have suffered much more than the ruminatia, though the latter were

contemporary with the former orders, and exposed to the same dangers and catastrophes. Among the ruminating animals, the deer, the ox, and the buffalo, have perhaps undergone the least change. It must be admitted, however, that the fossil remains of this numerous family present peculiar difficulties to the naturalist; for though the characteristics of the ruminantia are so strongly marked as to distinguish them from every other family, the distinctive attributes of the genera, and still more of the species, are much less discernible. In ascertaining the species, the horns are of essential importance, and as these differ both in form and size, in accidental varieties of the same species, the conclusions drawn from them with respect to the diversity or even identity of one species with another, are always to be received with much hesitation. Keeping this in view, and looking to the probable, more than to what is absolutely certain, Cuvier, the chief of comparative anatomists, after a careful and laborious examination, and comparison of the fossil with existing races, decides in favour of their identity. The same accurate and minute resemblance subsists between the fossil and the living horse, and various other races not belonging to the ruminating family.

Differences between the fossil and existing races are no doubt discernible, but they are in many instances not greater than are to be found between varieties of the same existing species. Into how many varieties, for instance, have the horse and the dog become divided? and how far have some of these diverged from each other, both in regard to size and configuration? Numbers of them even appear to be possessed of different instincts. The pointer no doubt requires training, but what other variety of the species can be trained to the same habits? Some of the varieties of the species seem even to be possessed of properties that have been bestowed in compensation for the want of others. While the fleet grey-hound is destitute of scent, and not endowed with any superior degree of sagacity, but has to depend on his sight and power of action, which are sufficient to counterbalance these deficiencies, some of his more clum-

silk-formed congeners have an acuteness of scent, tenacity of purpose, and power of endurance, from which it is difficult ultimately to escape.

The causes of change, whether in plants or animals, are not in all cases easily ascertained. A change is sometimes purely accidental, or depends on causes that appear to be occasional, and of rare occurrence, while at other times it is the effect of causes that are permanent, whatever they may be. Both in Britain and in British America, where the climate and other physical conditions are widely different from those of Africa, Negroes in general retain the distinctive peculiarities of their race, at least through a considerable number of generations; while individuals lose them in a very short time, and at the same time become handsome Mulattoes in the course of one or two generations, in the country of Sennar, which differs little from their native country, either in climate or any thing else. When Poncet visited that country, in 1696, the inhabitants were Negroes, who had some time before expelled their predecessors, and taken forcible possession of it. When visited by Bruce, seventy years later, they had lost much of the Negro features, while they retained a considerable share of their complexion; and when recently visited a third time, by Caillaud, the transition appears to have been still greater. Their features are now regular and agreeable, and their complexion has become a copper-brown. Again, though the natives of Nova-Scotia are in general healthy and well-proportioned, and capable of enduring both privation and fatigue, they would be thought in Britain to have a sickly complexion; and emigrants from Britain become climatized in less than a year after their arrival. The change which the inferior races undergo is for obvious reasons not very soon visible, but equally certain, and of still more importance. All the domestic animals degenerate in the course of a very few generations,—the young in general appear to me to have comparatively little of the buoyancy of youth, and full-grown dogs often lose themselves within a few miles of their homes, which rarely or never happens in the mother country.

Plants are as liable to transmutation as animals; and there are both particular localities and races, in which the tendency to it is greater than in others. I have obtained a variety of oats in this country, which has degenerated little in twenty years; but have repeatedly imported the Potatoe, Hopetone, Blainslie, Zealand, Early Angus, and Kildrummie varieties, and could not preserve them genuine for three crops. The bald wheat readily runs into the bearded, and the white-bearded into a small reddish-coloured variety, of a superior quality, but deficient in bulk; and there are some districts in this neighbourhood in which potatoes for the most part improve, and others in which they commonly degenerate. Keeping all these facts in view, the objection we have been considering cannot be sustained.

OBJECTION IV.

The Geographical distribution of plants and animals is irreconcilable with their dispersion from a common centre.

The Geographical distribution of organized forms opens an important field of enquiry, and presents for solution some highly interesting but difficult problems. It would perhaps be impossible, in the present state of our acquaintance with the subject, to assign a satisfactory reason for the preference given to particular localities, by particular races. Distance from the Equator, and elevation above the level of the sea, have in general a marked and powerful influence; but it may be partly counteracted by the features of a country, or some peculiarities not easily detected. What is most curious, and hard to be explained, is, the want of uniformity in regard to the preferences manifested in different localities, by the very same races. In Scotland for instance, the hazel grows in a higher latitude than either the Scotch fir or the spruce, while in Norway, which is at no great distance, the case is reversed. Again, in the latter country, the birch extends one degree nearer to the Pole than the Scotch fir, and that in its turn three degrees nearer than the spruce. While in Siberia the spruce extends farther in the same direction than

the Scotch fir, and the Scotch fir farther than the Birch. Other instances might be given equally contradictory, and how they have originated, or to what they are owing, it may be impossible to determine.

It is however a well-known fact, that, generally speaking, different countries are preferred by different races; and the questions now to be considered are: if they have been dispersed from a common centre, as the Scriptures affirm, by what means have they arrived at their respective destinations? and, how has it happened that they have continued in the countries which they must have in many instances reached with difficulty, while they have left no trace behind them in that from which they have all taken their departure? To either of these questions it may be impossible to give a satisfactory answer; but if there are actual phenomena, as has just been shown, in the distribution of plants, for which it may be difficult if not impossible to account, there may be other phenomena, equally inexplicable, though not exactly of the same nature; and when a theory accounts in a satisfactory manner for a great number and variety of facts, it is not to be rejected, though it should leave some difficulties unsolved.

We may give instances of a particular species of animals which has spread from one locality to another, in a way for which it would be difficult to account. The *mydaus meliceps*, an intermediate link in the chain of being between the polecat and the badger, is an inhabitant of the higher lands of Java, and is not known to descend to a lower elevation than 7000 feet above the level of the sea; and yet it has found its way from one lofty peak to another, though many of them are isolated, and separated from one another by intervening plains, where it is unknown, and has never been seen. A circumstance which is in some respects similar, is at present exciting no little interest, and occasioning no little speculation in this Province. The wolf has been long an inhabitant of the Canadas, and also of the neighbouring Province of New Brunswick; but has not till within a year or two made a descent on Nova Scotia. But he has at last made

his appearance, and that too in considerable force; and what is still more remarkable, and to the point in question, in the very place where he was least of all to have been expected, and where his arrival appears the most unaccountable: namely, in Musquodoboit, to the eastward of Halifax. Had he landed in any part of the Province bordering on the Gulf of St. Lawrence, or washed by its waters, he might have been supposed to have come from Canada or Labrador, on a raft of ice; and this has doubtless been his mode of conveyance; but he must have passed through the Gut of Canseau, doubled the Cape of that name, and after getting out to open sea, and sailing along the shore of the Atlantic, had the rare fortune of arriving safe on terra firma, near the place where his depredations are now creating so much alarm. It is nearly thirty years since an individual, following this route, came ashore in the Gut of Canseau, and was shot in Guysborough, and not more than half that time since another landed at Cape George, near the entrance of the Gut, and soon after met with the same fate; and these occurrences point out the course that must have been followed by the more fortunate adventurer, who, after escaping the most formidable dangers, has planted a colony in the heart of the Province, before the possibility of such an occurrence was even dreamed of by the most credulous and apprehensive. The geographical distribution of many races may have been effected in the same, or in a similar way.

The human race has been more extensively disseminated over the face of the earth than any other; and if we can account for their dispersion in a satisfactory manner, it will assist us in solving a number of the difficulties by which the subject is beset. Mankind are divided into four or five varieties, but there is no specific difference between them. The Mulatto is no more a hybrid than the White. A hybrid race cannot be continued through a series of generations pure and unaltered, but any two varieties of the human family may easily be blended, and under proper conditions the mixed progeny may be preserved entire, and transmitted through an indefinite number of generations, without the

aid of either of the stocks from which it sprung. Neither do they manifest a tendency to revert to the original type, after having been changed by the influence of circumstances. This shows the whole race to be of one species—to have had a common origin, and therefore to have diverged from a common centre.

Keeping this in view, it is easy to account for the very general diffusion of the race. Man, relying on his superior resources, trusts himself on the water as well as on the land, and there are many well-authenticated instances, in which individuals, and even numbers, have been drifted at sea to a great distance from the different points from which they respectively started. Captain Cook met, in the island of Wateoo, with three natives of Otaheite, who, having lost themselves at sea, had arrived there, though the islands are 550 miles apart, and they had not seen land between them. In 1696, thirty persons, who had left Ancorso, in two canoes, were thrown upon Samar, one of the Phillippines, at the distance of 800 miles; and Kotzebue found, in one of the Caroline islands, an individual, the only remnant of a party, who had come from Ulea, a distance of 1500 miles, which is equal to half the breadth of the Atlantic. Other instances might be given if necessary. Now, as no inhabited land, yet discovered, is 1500 miles distant from all other inhabited lands, we see at once from these facts in what way one continent or one island may have first received its inhabitants from another.

In the same way may we account for the dissemination of some at least of the inferior animals. To whatever regions man has wandered, the faithful dog has been his companion, and though divided into an endless number of varieties, their specific identity can be easily ascertained. The crossing of almost any two varieties produces a third, and whenever the animal becomes wild it speedily loses its acquired habits, and reverts to something like a common standard. The larger domesticated animals have for obvious reasons been less extensively dispersed, wherever a conveyance by water is indispensable. When there was no other means of trans-

portation by water than the frail canoe, constructed of bark, reed, or skin, or even of the hollow trunk of a tree, the removal from one island to another of the larger animals, unless for the most important reasons, was out of the question; and accordingly we find that they are seldom met with in countries which have depended on such means of mutual intercourse, when first discovered,—a strong presumption that the smaller animals have been conveyed to such countries by human agency.

Were the actions of men always dictated and guided by reason, or could they be all accounted for on rational principles, it would be difficult to assign to human agency many occurrences that can be distinctly traced to that origin. There are few of the animals by which the earth is inhabited, whether savage or tame, whether wild or domesticated, that have not been deified in some country, or in some age; and to whatever quarter man emigrates, he carries with him the symbols of his faith. Whether the Egyptians emigrated from Hindostan, or the Hindoos from Egypt, the perfect identity of their ancient superstitions shows them to be descended from a common origin; and wherever they have gone they have carried their gods and rites of worship. The Phenicians did the same. In all their wide-spread colonies, the altar was duly erected to Baal, its precincts streamed with human blood, and its fires smoked with the living bodies of hapless infants, immolated by the ignorant devotion of their parents. Every nation, and every tribe of the human family, acts on this principle, and the Poet only expresses a common feeling of our nature, in making the shade of Hector address Æneas to this effect:

> Sacra, suosque tibi commendat Troja Penates:
> Hos cape fatorum comites, his moenia quaere,
> Magna pererrata statues quae denique ponto.
> [ÆNEID xi. v. 293.
>
> Troy now commends to thee her future state,
> And gives her gods companions of thy fate:
> Under their umbrage hope for happier walls,
> And follow where thy various fortune calls.

When men had "changed the glory of the incorruptible

God into an image made like to corruptible man, and to birds, and quadrupeds, and reptiles," which they did at a very early date, it is not surprising if they carried the objects of their worship along with them in their different migrations.

This will account for the dispersion of at least a number of races, but not for the fact that different races have their respective localities. If Noah and all his companions in the ark disembarked at a particular point in Asia, whether it was on Mount Ararat in Armenia, or on some part of the Indian Caucasus, which is the most likely, how does it happen, that, while some have not emigrated at all, but continued stationary in their original seats to the present day, others have long since bid a final adieu to it, and repaired to Africa, America, or Australia, where they have respectively become stationary, and are only to be found? There are certain races that cannot continue in the vicinity of man, and which must retreat as he advances. The lion was an inhabitant of Western Asia, and even of Europe, posterior to the commencement of the historical age; but, with all his muscular power and activity, he is unable to contend with the ingenuity of man, and deserts his habitation when it is invaded by his enemy. The forests of Britain were, till a recent date, infested by the wild boar, the wolf, and the bear, and the times at which they were respectively exterminated are known.

There are various other causes which may occasion the extirpation of some races from particular localities. The animal economy of every country depends either directly or indirectly upon its vegetation, and vegetation depends on meteorological phenomena, and other elements which are liable to change. A succession of unusually dry seasons may give to some particular race such a preponderance over another as to enable it ultimately to expel it from its habitation, or to destroy it utterly. Should a herbivorous race be reduced by famine, brought on by a series of dry seasons, it may be in time exterminated by the predaceous races, which depend upon it, from the simple fact that its diminish-

ed numbers cannot supply the usual demand, without suffering a farther reduction; and the stock is diminished with an accelerating rapidity, in proportion as the increase becomes more and more inadequate to the combined demand. And the loss does not terminate here, for the race that encroaches upon its capital dries up the sources of its regular income, and must sooner or later become the victim of its imprudence. The musk-ox has for some cause or other deserted Newfoundland, since the era of its discovery; and the Dodo appears to have become entirely extinct within the same period. I may add that the range of the musk-ox is less extensive now than it has evidently been at no very distant period; and as it is retreating from the lower to the higher latitudes, on the continent of America, the buffalo is extending in the same direction.

It must be admitted, however, that what has been stated will only apply to a number of cases, and that there are others which must be accounted for in a different way,—for it is altogether improbable that such animals as the Jaguar, and Puma, and some other races, should have been transported by human agency to the American continent, without leaving any trace of their existence in the Old World; and, admitting even this to have been the case, is it likely that the New Hollanders would have selected such a variety of marsupials, and left every other species of quadruped, with the exception of the dog, the rat, the bat, and the ornithorynchus? It was formerly stated, that parts of the Southern Hemisphere was most probably not overflowed at the Deluge—that some parts of the dry land in that quarter might not have been depressed to the same degree as in the Northern Hemisphere, and if so, the original inhabitants of these countries may have been preserved to the present time.

Should this be admitted, the whole difficulty suggested by the geographical distribution of animals will be easily removed. Though it would appear that the same races were very generally diffused over the face of the earth during the earlier periods of its existence, it had, from whatever cause, become different in the tertiary era. Different races had se-

parated from one another, and chosen different localities for their habitations. In the gypseous formation in the Basin of Paris, which extends over an area of twenty leagues, almost the only fossil animals discovered belong to one family. The Hircynian forest was occupied by a completely different family; and the lower grounds of Siberia were in possession of a family different from either. At the creation of all things, different races would be found near the localities to which their natures were respectively adapted; and wherever they have survived the repeated catastrophes which the earth has undergone, and their original habitations have not been too much altered for their peculiar habits, they will still remain.

The distribution of plants is not attended with the same difficulty. Many roots and seeds retain their vitality for a very considerable time in water, and for a much longer time in the ground. In some instances seeds have been drifted across the Atlantic, from America, and the West Indies, to Europe, and deposited on the coasts of the latter country, in a state sufficiently sound to germinate; and plants have been actually raised from them. Now if this be the fact, it solves the main difficulty respecting the geographical distribution of vegetables. Supposing all the existing races of plants to have been anterior to the Deluge, and that out of the vast numbers of seeds which must have floated on the waters, some of one kind and some of another escaped destruction, and were left in places where they subsequently prospered, recruited, and spread from so many centres, the actual state of the vegetable kingdom would in due time become the result.

I have thus examined the main objections to the identity of the ancient times of Geology, with the antediluvian age of the Sacred Scriptures, and shown them to be more specious than solid, and consequently insufficient to disprove that identity, or render doubtful the decisive evidences on which it rests.

BOOK IV.

OF THE BENEFITS WHICH THE PRESENT INHABITANTS OF THE EARTH DERIVE FROM THE PHYSICAL CHANGES IT HAS UNDERGONE.

CHAP. I.

PRELIMINARY OBSERVATIONS.

§ 1. From the foregoing discussions, it appears that the earth was in ancient times in a very unsettled and disturbed condition—that it was ever and anon pouring streams of molten minerals from its boiling entrails, while its heaving surface rose and fell like the vast undulations of a tempestuous sea; and that there were particular occasions when the disturbing forces acted with far more intensity than usual, and produced the most violent and extensive changes. But every natural phenomenon, whatever may be its more immediate effects, is ultimately attended with beneficial consequences, and these of such importance as to do more than compensate for all its evils. If the earth has undergone a series of great and violent changes, before attaining to its present state of rest, and if these revolutions proved destructive to innumerable races of animated beings, they have at the same time prepared it for the accommodation of far more important races, and for the full developement of the designs of Providence in regard to their destinies.

§ 2. To some, it may seem a reflection on the Creator, to allege that his work was imperfect at first, and has been subsequently improved by physical agency; but this is his usual mode of procedure, and it is no reflection to say that he has not departed from it in bringing the earth to its present state. We generally prefer approaching our ends by the shortest

and most direct course, especially when their attainment in this way affords an opportunity for the display of our abilities; and we too readily suppose the Creator to be influenced by the same motives with ourselves; but though the divine power is the moving principle in all the diversified phenomena of nature, it is generally masked by second causes, and there is unspeakably more, both of wisdom and power, manifested in the direction of the conflicting elements which Providence employs in the accomplishment of its purposes, than if these were attained by supernatural interpositions. To an enlightened mind, which delights in searching into the mysteries of nature, and tracing the relation between cause and effect, it affords the highest and purest pleasure, to contemplate the sure, but gradual and imperceptible manner in which Providence accomplishes its ends—the unerring precision with which its elements are adapted to one another, and the whole to the particular object in view—the perfect regularity with which the movement arrives at its intended destination at the time appointed, and the unfailing certainty with which anticipated results are obtained: and because it purifies, enlarges, and elevates the mind, it is the way which Providence generally prefers. The great majority of its works appear in the first place in embryo, and are gradually and imperceptibly developed and matured by physical agency. Indeed it is only for special purposes, and on rare occasions, that any other mode of procedure is adopted. Did ever we know an instance of a plant or animal coming into the world in a state of maturity? or can we point to any arrangement of Providence, that stands unconnected with every other, or that appears wholly independent of previous changes.

§ 3. In all our attempts to trace the influence of final causes, an exercise which is not more difficult than fascinating, it is necessary to observe the greatest degree of vigilance and circumspection,—for, though the proofs of design are manifest and unequivocal, in a vast majority of the phenomena of nature, we are very liable to err, in imparting to them objects which are purely imaginary; and when a mis-

take of this kind has been detected, it does an injury to science which is not easily repaired.

§ 4. It is moreover proper, in tracing the objects of Providential arrangements, to beware of defining their limits too precisely, or of representing them as intended only for the attainment of single ends,—for though we may completely succeed in tracing a connection between a previous and a subsequent movement, there is very often a chain of sequences, every one of which is subsidiary to a common and ultimate design; and the importance of every link of the chain can only be perceived by being viewed in connection, both with its immediate and remote consequences. In some respects the machinery of Providence may appear exceedingly plain and simple, but it is complicated and involved in the highest degree; and though particular operations may have a special regard to certain things, which we distinctly perceive, they may not be restricted to these, but have a reference to other objects besides, which may be imperceptible for a time; and even when they come distinctly into view, they may be preliminary to other objects, which we cannot for a time perceive. Now this complexity and variety of design must affect the adjustment of the elements, by whose combined operation it is to be progressively accomplished.

§ 5. It has evidently not been originally intended, that the earth should receive, at the very first, or even soon after its creation, the full number of human beings for whom it may yield the means of subsistence, or that they should attain to their maximum numbers, before they had made a certain progress in improvement. Had it become densely inhabited by a race of savages, without skill and enterprise to explore and develope its hidden resources, nothing but misery and crime would have been the result. The strong would have tyrannized over and oppressed the weak—every generous feeling of our nature would have been chilled and extirpated, and insurmountable obstacles placed in the way of all improvement. The numbers of the human race, though rapidly increasing, are still few, in comparison of what they may hereafter amount to; and while extensive regions are

yet unreclaimed from a state of nature, there are but few districts improved to the utmost extent of their capabilities, or which have been made to yield all the means of subsistence, that may be extracted from them by the most skilful modes of cultivation that may be adopted. Now, so long as this continues, it is in perfect accordance with the divine benevolence, that every spot which man is not in a condition to reclaim, and convert into an abode of rational enjoyment, should be in the mean time conditionally occupied by inferior races, and rendered the scenes of such kinds and degrees of happiness as are best adapted to their respective natures. The arctic regions have long been, and in all probability will continue to be, the undisputed domain of such animals as the musk-ox and the Polar bear. The hardy frame and close covering of the musk-ox enable him to withstand the rigours of the climate, while the vegetation which is peculiar to that dreary region, is more to his taste than that of more genial climes; and wherever herbivorous races are stationed, there must also be predaceous animals, to prevent their increase from overrunning their resources, which would be the very worst thing that could befal them; and also to terminate, by a speedy death, the sufferings of old age and disease, which might otherwise be protracted, and aggravated by want.

§ 6. On the same principle, we may reasonably suppose a great proportion of the surface of the earth to have been anciently occupied by such races, as were adapted, by their peculiar instincts and habits, to its less advanced condition, but which have one after another disappeared from its surface, as they became incapable of accommodating themselves to the successive mutations by which it was prepared for the convenience of man. I shall endeavour to show in the sequel, that these mutations had ultimately this effect: that they improved the condition of the earth in a variety of ways, as the habitation of man, and prepared it for those great transactions of which it has become, and was intended to be, the theatre. At the same time it must be admitted, that, in so far as man was concerned, their immediate tendency was

of a deteriorating nature. "When earthquakes are frequent," says Dr. Lyell, "there can never be perfect security of property under the best government; industry cannot be assured of reaping the fruits of its labour; and the most daring acts of outrage may occasionally be perpetrated with impunity, when the arm of the law is paralysed by the general consternation. It is hardly necessary to add, that the progress of civilization and natural wealth must be retarded by convulsions which level cities to the ground, destroy habitations, render roads impassable, and cause the most cultivated valley-plains to be covered with lakes, or the ruins of adjoining hills." Prin. of Geol. vol. ii. p. 359. And for these reasons, namely—that the state of the earth in ancient times was unfavourable to the progress of society—to the intellectual and moral improvement of man—a great proportion of it was occupied by inferior races, till the greatest obstacles to this were removed.

This opens an extensive and diversified field of enquiry, where matters of the highest importance crowd upon our notice, and invite our attention; but where brevity is required it is necessary to make a selection, and if the particulars hereafter to be discussed be properly examined, they will show, that the revolutions which the earth has undergone have been productive of benefits, which do far more than compensate for all the temporary evils which attended them.

CHAP. II.

OF THE USEFUL MINERALS WHICH THE REVOLUTIONS OF THE EARTH HAVE BEEN THE MEANS OF PREPARING AND RENDERING ACCESSIBLE.

If we penetrate below the surface of the earth, and examine the stores of mineral wealth deposited there, we will find them to be both varied and rich in the highest degree; and also that they have either been prepared or rendered available by the revolutions of the earth.

§ 1. I shall begin with limestone. Being extensively used in architecture, and agriculture, as a flux in the reduction of

some valuable ores, and in other branches of industry, its value is generally known and admitted. Lime, which is one of the earths, is an oxide of calcium, and it combines readily with a number of acids, and forms substances possessing different properties accordingly. In combination with carbonic acid gas, it forms limestone, and chalk, or the hard and soft carbonates of lime, the great majority of sea shells, and other bodies of less importance: combined with sulphuric acid, it forms plaster of paris, alabaster, &c.: with fluoric acid, the fluate of lime, which is used in the reduction of copper ores; and with phosphoric acid, the phosphate of lime, of which the bones of animals are chiefly composed. It is of vast importance, therefore in the economy of nature, and many interesting phenomena depend upon it. It enters into the composition of a very great proportion of plants; and no coral insect, no shell-fish, and no vertebrated animal whatever, could exist without a regular supply of it. It is necessary to repair the waste of bone which is continually going on in the animal economy. Were lime, therefore, wanting in the earth, or did it exist in a very small proportion, there is probably not another substance that would supply its place, or answer all the purposes for which it is intended; and it is impossible to calculate what would be the consequences, or how many alterations in the system of nature would become indispensable.

Lime, in some one or other of its combinations, is very common, and is supposed to constitute an eighth part of the crust of the earth. It is present in all, or at least the greater part of the strata, but generally so mixed up with other earths, or so combined with other substances, as not to be available for many of the purposes to which it is applied by man. This evil is obviated by its formation into limestone, which is so very common among the sedimentary rocks, but especially among the secondary and tertiary systems; and for this we are indebted to the early condition of the earth.

It is probable that vast magazines of calcium exist in its interior, and that coming into contact with currents of water, it combined with the oxygen of the latter, and formed

lime, which was again deposited among the other materials of which the crust of the earth is composed. Be this as it may, water filtering through the earth becomes less or more charged with lime, which it holds in solution till it becomes stagnant, when it absorbs carbonic acid from the atmosphere, and forms laminæ of the carbonate of lime. At the bottom of a majority of lakes and ponds, there is a bed of marl, which if taken away will again be restored in the course of time,—which shows that it is deposited by the waters that flow into it, and that it will continue to increase till the sources from which it is derived are exhausted.

The waters of thermal springs generally contain a larger proportion of lime than other water, and from this it may be inferred that heat promotes its solution, and separation from the other earths with which it may be blended; and if so, the high temperature of the primeval earth, combined with the excess of carbonic acid contained in the atmosphere, must have been peculiarly favourable to the formation of limestone.

Besides the stratified limestones which are so common, there are large masses of coralline rock, possessing the same mineral properties, and which have been constructed by the united labours of innumerable multitudes of marine insects; and others again, which consist in a great measure of shells, cemented and compressed into a solid mass. But these are not exceptions to the general rule, for the early condition of the earth was equally favourable to their formation. The coral insect is chiefly confined to warm regions; and repeated and successful depressions of the ocean bed are undoubtedly favourable to its operations. It cannot rise above low-water mark; and though it may carry on its labours in deeper water than Mr. Darwin supposes, it is reasonable to believe, from the reduction of the temperature in deep water, that it must decidedly prefer shallow water. If the mass should therefore subside for one or two hundred feet, after having been raised nearly to the surface, the superstructure would go on with renewed activity, and the unsettled state of the earth contributed to the occurrence of such depres-

IMAGE EVALUATION TEST TARGET (MT-3)

6"

sions. The abundance of lime in the ancient waters was no less favourable than the other circumstances already mentioned. The coralline insect has not the power of making lime; it merely secretes or separates it from the water, and forms it into rock; and the more abundant the material, the more rapid must be the progress of the work. We may therefore conclude that the formation of all the varieties of limestone, whether sedimentary or coralline, was much promoted by the ancient condition and changes of the earth.

§ 2. Coal is another mineral substance of great importance, which owes its origin to the early condition and changes of the earth. Nobody doubts that it had a vegetable origin, and has been formed of a vast collection of plants,—for besides that it resembles charred wood, the different parts of the plants contained in it are often very perceptible; and as its formation was confined to one period, it is generally believed that the earth was in a peculiarly favourable state for the production of those plants, of which it is chiefly composed. Beds of an inferior kind of coal have been occasionally discovered in the tertiary series, but never since the carboniferous era does the earth appear to have been in a proper state to support vegetation to the requisite extent for the formation of the coal of that time.

Coal has been long and extensively used as a fuel, and that in situations where a substitute could not be easily procured; and in this way alone it has contributed immensely to the convenience of man; but in future ages, when present forests shall have given way to fruitful fields, and become densely planted with populous towns, many of the temperate regions of the earth would be in a miserable state without this mineral. But this is not the only use of coal, nor even the use of it which contributes most to the progress of civilization. It is equally, if not more beneficial to man, as the most important element in the production of steam, and its application to various branches of industry. By means of it, the manufacturer can not only extend his operations, and answer orders to any amount, but is enabled to submit to a very great reduction of prices, without any loss of profit on

his capital; and its application to navigation has the same effect, as the bringing distant nations to each others shores. It facilitates their mutual intercourse—the exchange of their respective productions—of their discoveries in the arts and sciences, and improvements in manners, customs, and laws. The discoveries and inventions of one country—the lights that are struck out, and the new paths that are opened up to wealth and power, are speedily diffused through steam navigation, and become the common property of our race; and while every nation is compensated for what it gives, the happiness of all is simultaneously increased, and the power of each to fulfil its obligations, and repay the favours it has received, is extended and brought into more intense activity.

§ 3. Iron occupies a prominent place among the useful minerals contained in the earth. We have no mineral substance whatever which is applied to so many different purposes, or which is of more essential service to man. It is also of very great importance both in animal and vegetable Phisiology, as it enters less or more into the composition of a very great number and variety both of plants and animals, and is essential not only to their health but their existence.

Iron is very generally diffused, but not in a state to be available for a number of the most important purposes to which it is applied. It tinges a great proportion of the reddish and ferruginous coloured rocks and soils. Chalybeate springs are strongly impregnated with it; and there is a proportion of it in the waters of the greater part of running streams. But it is necessary to be put into a different state before it can be applied by the ingenuity of man to the various ends for which it is used; and great masses were put into that state through the influence of the early condition of the earth.

Wherever decayed organized matter, whether animal or vegetable, is deposited in stagnant water of a certain temperature, the surface of the water is soon covered over with a coating of some greenish or ferruginous coloured matter, which is a hydrate of iron; and when it is deposited in masses, as frequently happens, in the vicinity of ponds, it is dis-

tinguished by the different names of *marsh ochre, bog ore, and meadow earth*, &c. This has been discovered by Professor Ehrenberg to be secreted by *infusoria*, or very minute microscopic insects, which multiply with incredible rapidity in stagnant water, in a tepid state, and loaded with animal or vegetable matter in a state of decomposition. The iron secreted is formed into tiny shields, which continue to attract more of the metal, till they assume the form of small nodules, when they are deposited in some convenient place, and ultimately become beds of iron ore. Bog ore, of which there are several varieties, is very common about the margins of old and extensive morasses, and it continues to accumulate till the locality be changed.

Iron, in some one or other of its combinations, is usually found in more or less abundance in the vicinity of coal; and it was probably formed in a similar way with the bog ore of the present time. The high temperature of the carboniferous era, acting on the vast masses of vegetable matter collected from time to time in the coal basons, contributed to its active secretion and rapid accumulation in such localities.

§ 4. In this way have limestone, coal, and iron-stone, been formed, and placed in juxta-position with one another; and their contiguity is of very great importance to the progress of the arts. Coal is necessary to produce the heat required in the reduction of iron ore, and lime is one of the best fluxes for assisting in the operation. The Rev. Mr. Conybeare says, in reference to this subject, "The occurrence of this most useful mineral in the immediate connection with the fuel necessary to its reduction, and of the limestone which facilitates that reduction, is an instance of arrangement so happily suited to the purposes of human industry, that it can hardly be considered as recurring unnecessarily to final causes, if we conceive that this distribution of the rude materials of the earth was determined with a view to the convenience of its inhabitants." As proofs of design have not unfrequently been pointed out in the phenomena of nature, which are by no means obvious to

common capacities, some degree of caution in referring to final causes may be proper; but the arrangement in question affords such a clear and striking instance of the provision made for the convenience of man, in the distribution of the rude materials of the earth, that we cannot but admire the wisdom and goodness, of placing the infant globe for a time, in that peculiar condition which led to such an arrangement, and which placed the minerals, when so distributed, in a situation to preserve them for our benefit.

§ 5. The muriate of soda, or common salt, is another mineral of great utility, for which we are indebted in a great measure to the early condition and revolutions of the earth. It is necessary to man in a state of civilization, and has been used in all countries and in all ages, as a means of preserving and seasoning food. The waters of the ocean contain a large proportion of it in a state of solution, and it is easily separated from them by means of evaporation. But inland countries have not sea water to evaporate, and salt is too heavy, and though necessary, is of too little value to be transported to a distance by an overland conveyance, and at a cost that would admit of its general use. Nature has made provision for this, in the immense masses of rock salt which occur so often in the early part of the secondary strata, and which only require to be extracted from the earth, and reduced to powder, in order to be fit for use. In many localities springs arise from beds of salt, and it can be obtained by evaporating the water, without the trouble and expense of mining.

There are different ways in which beds of salt may have been originally formed. In the great desert of Zahara, in Africa, there are extensive basons which are filled with water during the rainy season, but either partially or wholly dry at other times; and as the sand of the desert is impregnated with salt, and the water of most of the springs brackish, salt is annually carried down into the basons by the currents which flow in the rainy season, and left there when the waters are dried up; and from this the interior of Northern Africa is supplied with the article. The deposition of

beds of salt in these localities, sometimes to a very great thickness, may suggest to us the way in which rock salt was often formed in the early times of the earth. Though the strata of the new red sandstone system are commonly regarded as aqueous deposits, some of them may have been formed of drifted sand, like those of Zahara, and the Lybian deserts; and salt may have been formed among them in the same manner as above mentioned. It may also have been formed in lakes and ponds, into which the sea flowed at high water, and where the water was evaporated during the recess of the tides. It may also in some instances have had a volcanic origin, as it is one of the most common saline substances, formed by sublimation in the craters of volcanoes; and Messrs. Smythe and Lowe give an instance in which it effloresces from the ground, and covers it like a fall of snow. Journey from Lima to Para, p. 145. When compost heaps containing salt have become heated, the salt sometimes rises to the surface and forms an encrustation. In an age when so many regions of the globe were subject to intense volcanic action, masses of salt may have been formed by its influence. But in whatever way it was formed, it originated in the peculiar condition of the earth, and is therefore to be numbered among the benefits which we now derive from that condition.

§ 6. There are many other metals besides iron, which are of very great use to ma and there are numbers of them at least which have been rendered accessible to us by the revolutions of the earth. They generally occur in veins, and these veins have evidently been formed subsequently to the strata in which they are found, and they appear to have been filled from the interior of the earth. They do not lie between the strata, or on the same planes with them, but intersect them at higher or lower angles; and commencing at greater or less depths below the surface, they descend in a vertical or inclined direction, through all the underlying strata, and even through the crystalline masses beneath, to an interminable depth in the interior. Small veins are occasionally discovered, which are wider above and narrower below, till their opposite sides meet, and they consequently run out:

and from this fact, taken in connection with another, namely, that they sometimes contain water-worn pebbles, it has been inferred that they have been formed in chasms occasioned by the drying of the ground, and filled from above, rather than from below.

But though the minor branches sometimes become thinner as they descend, till they ultimately run out, this never happens with the large veins, from the sides of which these branches start off. Wherever metallic veins have been formed, the rocks which they intersect, whether crystalline or stratified, present the most unequivocal evidences of having been ruptured and dislocated about the time of their formation; and if a main rent were formed in the surface, by an expansion beneath, so as to admit the rushing upwards of melted minerals, it could hardly fail to produce some branches running transversely, and becoming narrower downwards, till they terminate in an angle,—for if we take a pile of clay, or any other substance adapted to the experiment, and force a body of some magnitude upwards through its centre, till it reaches the surface, it will rend the mass in different directions, and the lateral branches from the main opening will be wider above, and narrower as they descend, till they at last terminate; and if any liquid were forced upwards through the main opening, it would fill every one of the branches. Again, while this process was going on, some of the loose materials might drop from the upper part of the sides of the chasms, and be found embedded in the vein.

That veins have been filled from the interior, may be inferred from the fact, that no great one is known to run out, or even to become thinner as it descends into the earth; and also, that the materials with which they are filled, have been under an intense heat at the time of their repletion. They have been forced into every crack and fissure along their course; but what is of still more importance to the point at issue, is, they are in general highly crystallized, and very often compactly united with the rock which they intersect. On both sides, the contiguous part of the rock, to a greater or less distance in proportion to the thickness of the vein,

has been partially fused, and in the process of cooling they have become firmly united. Now, as there can be no doubt that veins of granite, porphyry, trap, greenstone, &c., have come from the interior, and as metallic veins agree with them in many particulars, we may confidently infer that they have had a similar origin. Like veins of granite, they frequently intersect one another, and very often the strata on one of their sides have been raised up, and those on the opposite side depressed. On one side they lie on one plane, and on the other on a different one, and show by their position that they have been both violently and repeatedly disturbed, on the different occasions on which the different sets of veins were filled.

Metallic veins occur more frequently in the older than in the more recent formations. "Not one case," says Professor Phillips, "is known, of a mineral vein being at any time worked, in any part of the British Islands, above the new red sandstone. In the new red sandstone, and magnesian limestone, hardly more than slight traces of such products appear; they are rare in our coal tracts, but become abundant in the mountain limestone, and the older strata."

It is moreover admitted, that the richness of such veins does not depend on the kind of rocks in which they occur, but on their vicinity to the axis of the disturbing force by which the rocks have been affected. While they abound in some districts that have been repeatedly and violently disturbed, they occur but rarely or not at all in other districts, that have been but little disturbed, although the rocks are precisely the same. "The most general point of view in which mineral veins present themselves," says the same writer, "is that of dependance on proximity to the sources of subterranean heat. In the rocks nearest these sources, they are most numerous and varied; they abound nearest the disturbances which are consequences of variation of internal heat; and in certain cases (Pyrenees, &c.) they are not rare among newer strata, where the subterranean igneous rocks have exerted a remarkable influence." Whether we suppose them to have been filled by the injection of matter from

the interior, or by sublimation, or in some other way different from either of these, their repletion appears very clearly to have been connected with and dependent upon subterraneous disturbances; and, in so far as their contents are useful to man, we are indebted to these disturbances for the access we have to them.

By far the greater part of the metals contained in these veins are useful to man, either in one form or another. Many of them are useful in a very high degree; and numbers of them are almost indispensable to his interests in a state of society. And it is a circumstance well entitled to notice, that they appear to be more or less abundant, in proportion as they are more or less useful; and also according to the peculiar form in which they contribute to our welfare. In some instances the metals found in the bowels of the earth, have a conventional as well as an intrinsic value; and in such cases an overabundance would do far more harm than good. Iron, lead, and several others, such as tin and copper, &c., possess only an intrinsic value, and therefore the more abundant they are the better,—provided the supply do not exceed the consumption, and a useful branch of industry be ruined. But were the precious metals, such as gold and silver, to be increased beyond a certain proportion, their value would be diminished, and their utility destroyed. In the proportions in which they have hitherto been obtained, they are useful in a very high degree, but were they to become as common as iron or lead they would be good for nothing.

It is of the utmost importance to the progress of civilization, that we possess an article which may be universally adopted as a representative of value, and an instrument of exchange; as a standard by which we can compare all other commodities, and that will facilitate the exchange of what we have to dispose of for what we need. But an article of this kind should possess an intrinsic as well as a conventional value, in order that the supply may not exceed the demand. Under proper regulations, a paper currency possesses many advantages. It is easily handled, and easily transmitted from place to place,—its cost is trifling, and when ac-

cidentally lost or destroyed, the community at large does not suffer by the event; but unless it be convertible into specie at pleasure, an over-issue cannot be prevented, and its value cannot possibly be sustained. Besides, it cannot, by any regulations whatever, be prepared to meet the exigencies of a crisis, or made capable of resisting the influence of a panic, and preventing its consequences on commercial credit; and not only is it ineffectual under such circumstances, but it is calculated, from its very nature, to produce alarm, and to aggravate its evils,—for no sooner is a crisis apprehended, than the issuer who possesses peculiar facilities in foreseeing its approach, begins to limit his accommodations, and to withdraw a portion of his paper from circulation; and this in itself, when markets are glutted, and sales dull, may lead to a crash, which might have otherwise been avoided.

The precious metals are not liable to any sudden or sensible depreciation from a superabundance,—for the moment they begin to exceed the demand for them in any one country, and consequently to sink in value, they find a vent to other countries, and the equilibrium is restored. Neither are they so likely to be withdrawn from circulation, as a paper currency,—for this reason, that being real, and not fictitious property, and the capitalist having given value for them, he cannot so well afford to lock them up in his coffers, and when he can obtain security for them, he will let them still continue in circulation. They sustain their credit at the very height of a paroxysm of commercial suspicion; and though their circulation may suffer a momentary check, it is easily restored. They are like every other commodity,—no one wishes to hoard them, and those who are in possession of them are anxious to invest them in something that promises to yield a profit.

Moreover, the precious metals may be easily coined, and have their integrity guaranteed by public authority. They are not easily counterfeited, and they can never become more abundant than is sufficient to meet the general demand for them. While copper, lead, tin, &c., occur in districts where they can be procured at an expense which admits of their

application to all the purposes for which they are adapted, it is a wise provision of nature, that the richest gold and silver mines which have yet been discovered, namely, those of Potosi, Pasco, and Chota, are placed in regions where the means of subsistence cannot be raised, and must be brought from a distance, and that at a very heavy cost, on account of the natural features of the country; and where all the operations of the miner are necessarily performed with such difficulty, that the produce of the mines could not be made to pay, were the supply to become greater than the demand.

It may perhaps be supposed, that though a supply beyond a given amount might operate injuriously, a deficiency could have no bad effect: as a smaller weight would possess a value equal to a greater one, and as the quantity obtained might be divided into smaller portions, and answer the purposes of an instrument of exchange equally well as if they had been more abundant; but this is a mistake. The smaller the portions into which gold and silver are divided, the greater will be their surface, and the more the waste. For in order to prevent them from being counterfeited, they must have room on their surface for the devices of the mint; and, independent of this, whatever is scarce is more easily monopolized, and when money, or whatever may be a substitute for it, is in the hands of a few, it becomes an instrument of oppression, rather than of advantage to the community at large. The circulating medium should always bear a certain proportion to the commerce of a country, but an excess does less harm than a deficiency. When it exceeds, it produces a corresponding depreciation, but that is not generally perceived at first. It is rather supposed that a general rise of prices has taken place; and when the markets in general continue to rise, or are supposed to do so, although the rise should be only apparent, every branch of industry is stimulated, and all the elements of improvement are set in operation. Accordingly we find, that the sudden and great influx of the precious metals into Europe, consequent upon the discovery of America, exercised a most powerful and beneficial influence on the progress of all the useful arts, and

gave a spring to industry which continues to be felt at the present day.

§ 7. When the useful minerals had been rendered accessible, it was a matter of no small importance to the main object of the change, to have them properly secured from waste and destruction. Had they been exposed on the surface of the earth, many of them would have suffered from the action of the elements, and others would have been wasted in thoughtless prodigality. What is easily obtained, however valuable, is for the most part freely spent; and had the mineral stores which are treasured up in the bowels of the earth, for the benefit of all ages till the end of time, been less protected by the arrangements of nature than they happen to be, they might have been exhausted by improvidence, before the time comes when they shall cease to be necessary. The labour and skill necessary to the successful operations of the miner, together with the amount of capital which they require, ensure a greater degree of economy in the use of the different products of the mines, than would have been thought requisite, had the expense of working them been much less.

§ 8. Moreover, had the crust of the earth consisted chiefly of loose and friable earths, instead of solid and compact rocks, it would have been everywhere permeable to water; and all the water that fell on its surface, together with a great proportion of that of the sea, would circulate through it in all directions, and there would be no springs, running streams, lakes, or ponds, above the level of the sea; or any other means for performing their functions in the economy of nature. This evil is prevented by the disposition and general compactness of the strata. If there are some beds through which water permeates, others are impervious to it; and when it reaches these, it accumulates on their surface, till it runs into troughs, which conduct it again in the form of springs to the surface, where it is collected into rills, brooks, and rivers, and conveyed to the sea, to be returned again to the heavens by evaporation; and spread anew over the face of the earth.

The usual state of coal fields may be here referred to, as a striking instance of the beneficial effects of the revolutions of the earth on the disposition of the strata. They have been everywhere more or less disturbed since the coal was deposited; and though their dislocations have in some respects been hurtful, they have been far more beneficial than injurious. Coal is naturally a porous substance, and readily admits the entrance of water, and its free circulation through the whole mass; and resting as it generally does in capacious basons, that retain the water which finds its way into them, it would in many instances have been an insurmountable obstacle to the progress of the miner, had the formation continued in its original state. But coal fields are generally divided into sections, sometimes of greater, and at other times of less extent; and these sections are separated on all sides from one another by natural partitions, usually called "faults" in mining phraseology, which run through the bason in different directions, from side to side, and from top to bottom; and being in a great measure impervious to water, they prevent its passage from one section to another. The strata of the formation have been violently agitated, ruptured, and displaced. Sometimes one part has been raised up above its original level, and another adjoining has sunk below it; and everywhere rents and chasms have been opened, intersecting one another in all directions; and these having been subsequently filled with mud, which has in course of time become solid and compact, the sections are separated by massy walls, through which the water does not penetrate. By means of this arrangement, one section may be wrought at a time, which would have been otherwise impossible: as the most powerful machinery that ever was constructed, would have been wholly inadequate to the draining of the pit, or the preventing of it from being filled with water. Of this all miners are sensible, and leaving the faults entire, they generally confine their operations to one section at a time.

CHAP. III.

OF THE BENEFITS WHICH RESULT TO THE INHABITANTS OF THE EARTH FROM ITS EXTERNAL CONDITION.

§ 1. The geographical divisions of the surface of the earth contribute in various ways to the interests of its inhabitants. The most general division of the surface of the earth, is into land and sea,—the latter extending over fully more than two-thirds of it, and the former of course consisting of the remainder. This division might appear, to one who is wholly unacquainted with the art of navigation, to be calculated to prevent an intercourse between the inhabitants of different countries, and the exchange of their productions; but its real tendency is to facilitate both. Between distant countries, no other mode of conveyance is equally convenient and economical, as that by water; and for all the more bulky and ponderous commodities, it is the only one that is practicable. The ocean is the high way for the commerce of the world; and trade by sea has done more for the interests of civilization in general, than has been done by any other element of improvement. In all ages maritime countries have taken the lead in all the useful arts and sciences; and from them these arts have slowly penetrated into inland regions; and we may therefore conclude, that, tardy as the progress of improvement has been, it would have been still more so, had the surface of the earth been placed under a different arrangement.

Besides, were it not for the influence of the sea, the heat would accumulate to a ruinous degree within the tropics, while the higher latitudes would be left in a deficiency; but it takes off part of the excess in the former, and by conveying it to the latter, tends to bring it nearer to an equilibrium; and consequently contributes to the production of a greater amount of the conveniencies of life, than would be obtained otherwise.

Moreover, as the great sink of the world, the ocean receives all the waters that are drained from the land, with all the impurities, and other substances with which they have

become impregnated in their course; and while it retains every thing that is noxious, or useless, and renders them innocuous, it returns the purified water to the heavens, to perform the same circuit anew.

§ 2. And if the division of the earth into land and sea be a beneficial arrangement, that of the land into mountain and valley is equally advantageous, though in a different way. Besides giving a pleasing variety to the face of nature, it is directly conducive to a variety of objects, both physical and moral, of vast importance to the inhabitants of the earth, and for which substitutes would not easily be found. Were the surface of the land as uniform and level as that of the sea, it would be very hurtful, if not destructive, both to animal and vegetable life.

Rain is indispensable to the health and nourishment of all the more useful kinds of plants, and it promotes their growth in different ways,—sometimes directly, and at other times indirectly. The atmosphere is a compound of different gases, some of which are more adapted to the support of animal, and others to that of vegetable life. Carbonic acid gas, and ammonia, are among the latter; and as large quantities of these are continually disengaged, and set afloat in the air, in consequence of the decomposition of organic substances, in which they are contained, it would in course of time become over-charged with them, and become injurious to animals, were it not that rain carries off the excess, and communicates it to the soil, which they tend to fertilize, and where they cease to be injurious either to man or beast. A great deal of rain falls in the sea, where it probably performs no other service than that of purifying and rendering the atmosphere more salubrious; but a great deal more would have the same destination, were not the clouds which are formed in the higher regions attracted to the earth by the influence of the mountains. It is always around the tops of the mountains that the clouds first come in contact with the earth, and from these they descend to the lower grounds. It is on the higher lands that rain is both most frequent and abundant; while on some low, level, and extensive regions,

such as Egypt and the Lybian deserts, it seldom or never rains at all.

Mountains are also a great protection to the lower grounds, from the injurious influence of atmospheric currents, in their sweeping course from the Pole to the Equator. Cold air is always more condensed, and consequently heavier than what is heated; and in consequence of this, there is a regular current from the colder to the warmer regions, which is more or less rapid according to circumstances. In the equatorial regions it is heated and rarified, and pushed upwards to a great height above the earth, by the pressure of an unceasing current from the Poles, and from the higher regions of the atmosphere it falls back again towards the Poles, to run the same course again. This is a highly important arrangement, but were it not for the shelter which the mountains afford to the lower grounds, it would be attended with very pernicious effects.

The great Plains of Central Asia, and Northern Africa, where the winds meet with no effectual obstruction, have been converted into oceans of drifting sand, and unless reclaimed by means of some great physical change, they have been rendered uninhabitable till the end of time. "The sands of Lybia," says DeNon, "driven by the west winds, have left no land capable of tillage on any part of the western bank of the hill, not sheltered by the mountains." And Burnes gives the following account of the great Plain of the Oxus:—"The heat of the sand rose to 150°, and that of the atmosphere to 100°; but the wind blows steadily, nor do I believe it would be possible to traverse this tract in the summer, if it ceased to blow. The steady manner in which it comes in one direction in this inland country is remarkable. It is true that, in every direction except the North, we have mountains, but they are too distant to affect the winds." Every one knows that, all other things being equal, vegetation prospers most in sheltered situations, but comparatively few are sufficiently aware of the degree to which proper shelter is beneficial, or how much it increases the productiveness of the ground. At the celebrated falls of Tequen-

dama, where the Rio de Bogata is precipitated from a height of 574 feet, there is a complete change in the character of the vegetation at the two levels. Above, there are fine crops of wheat, surrounded by rows of the oak and the el , and other plants of the temperate circles; but from this terrace, where the traveller is reminded of the vegetation of Europe, and North America, he looks down upon a scene that is peculiar to the tropics, where the lofty palm, and other plants of a kindred character, flourish in his view. This difference cannot be owing to the difference of elevation at the two levels, for what are 574 feet in an equatorial region? M. Humboldt merely hints at the shelter afforded by the higher to the lower ground. The falls are upon the verge of the lofty and extensive Plain of Bogata, where the winds meet with no obstruction; and the current sweeps over the ground below at too great a height above it to injure the banana and the sugar cane which flourish in the shelter.

But, independent of this, the ground is much better adapted to agricultural purposes, in consequence of its inequalities, than if its surface had been even. Had there been no descent, there had neither been natural nor artificial draining; and a great part of the face of the earth must have been a morass. In consequence of the undulating state of the ground, the waters which fall upon it from the clouds, after having moistened, and imparted to it the elements of fertility which they hold in solution, are collected into streams, and conveyed to the sea; and besides this, artificial draining, which is of the very highest importance to agriculture, is both rendered less expensive and more efficient by the same means.

§ 3. Again, the geographical situation of different countries, which have exercised a very powerful and beneficial influence on the progress of civilization, has contributed much to the preservation of their independence—their own improvement, and the extent of their influence in promoting the improvement of other lands. Britain, for instance, owes much to her insular situation. It has on different occasions saved her from the calamities of a hostile invasion, which are

always great, even when the invasion is repelled. It has favoured the progressive improvement of her institutions, which has been slowly but steadily and surely advancing for many generations; and is, along with her inexhaustible mineral resources, the origin of that commercial greatness on which her vast power depends, and by which she has been enabled to disseminate the elements of social improvement over many extensive and populous regions, situated in distant quarters of the globe. Had she formed a part of Continental Europe, she could hardly have escaped from the blasting influence of despotism which so long predominated there; and had her civil liberty been crushed in the bud, the human race must have suffered to an extent of which it would be difficult to form an estimate.

The division of mankind into families, all speaking different languages, and observing different customs and laws, may appear at first sight as an injurious arrangement,—as an arrangement calculated to produce national jealousies and dislikes, and to prevent the free interchange of their discoveries; and to a certain extent this is true; but national jealousies and national emulations have their beneficial as well as their injurious influence, and the one will do more than counterbalance the other. Austria and Italy, Spain and Portugal, have never looked with the same hostility on the growing power of Britain, with which it has been long regarded by France; and France has been the first of the continental nations to adopt her constitution, and to follow in her wake; and this is very easily accounted for. In every contest in which they have been engaged, she has felt the superior power of her opponent, and has after repeated trials become sensible that the only way of attaining to an equality, is to take the same course. The real secret of a rival's power is very often soonest discovered by an unsuccessful trial of strength. National animosities have no doubt been a fruitful source of bloody wars; but even these, with all the frightful consequences that attend them, have not unfrequently a redeeming effect. When civilization has attained to a certain stage, it can dispense with the assistance of violent stimulants; but

whether it would have reached that stage without them, is at least questionable; and that they have accelerated its progress may be easily proved. But, independent of this, different nations, speaking different languages, and observing different customs and laws, necessarily form different tastes, and different habits, and modes of thinking; and by comparing these, and analysing their tendencies, a clearer light is often struck out—practical errors are detected and exposed, and the path of improvement in the arts of life is made more plain and easy.

But had it not been for the lines of demarcation formed by the hand of nature, in the formation of such barriers, as mountain chains, unfordable rivers, and arms of the sea, the national existence of many families of the human race could never have been established; or having been accidentally established, they could not have been preserved. No country can be effectually protected by natural defences, however formidable, unless these defences be manned by a people determined to be free; but they are nevertheless of essential service to such a people, and have often proved of much avail, when the boldest spirits would have failed without them. The Pass of Thermopylæ was turned by the Persians, but the determination with which it was defended by the Greeks, made an impression on the minds of the invaders that was not lost, and contributed materially to the fate of the campaign.

Every region has its peculiar productions, which become objects of desire to the inhabitants of every other; and the effect of this physical diversity is increased by the diversity of taste and habit, which accidentally grows up among different nations. By giving a diversity of soil and climate to different regions, Providence has made arrangements for promoting a mutual intercourse between them, in the beneficial exchange of their respective productions; and were these arrangements not interfered with, by the paltry attempts of statesmen to improve them—were there no restrictions imposed on commerce, by impolitic tariffs—were it allowed to flow in the channels that nature has opened, it

would exercise a far more powerful and beneficial influence on the character and condition of human nature, than it can possibly do under the shackles unwisely imposed upon it.

CHAP. IV.

OF THE BENEFITS WHICH RESULT FROM THE COURSE OF THE SEASONS, AND THE DIFFERENCE OF CLIMATE IN DIFFERENT PARALLELS.

§ 1. The earth has, in consequence of the revolutions it has undergone, become better adapted in various ways, to the constitutions and habits of a great majority of the existing races, both animal and vegetable. The greater part both of plants and animals have their times for activity and their times for repose. A very great proportion of both wake in the day, when all the functions of life are in exercise, and sleep in the night, when the exercise of these functions is suspended for the time. There are both nocturnal plants and animals, with regard to which this order is inverted; but the inversion is not accidental or acquired, it is original and constitutional, and accords with certain peculiarities of their organization. To both classes, therefore, the regular alternations between day and night are not only convenient and agreeable, but even necessary. Rest and sleep are as necessary to health and vigour, as any of the other means of subsistence. An artificial stimulus, judiciously applied, may enable individuals to dispense for a time with the repose and nourishment which nature requires; but the experiment is always attended with risk, and when often repeated seldom fails to impair the constitution, and render it more liable to the attacks of disease. That rest is in all cases indispensable, is universally known; and the regular return of the night, after the fatigues of the day have been borne, is a wise and benevolent provision of nature, and well adapted to the purposes of affording relief and refreshment.

Again, by far the greater number of plants, and not a few animals, hybernate. They sleep in the winter and revive in the spring; and the seasons have a very powerful influence.

even on races whose habits are different. Domesticated animals have, through the force of circumstances, become in a great measure artificial, and we cannot reason from their habits, with regard to the point under consideration; but if we attend to those which are guided by their original and uncontrolled instincts, we will find in general that they change along with the changing year. The lengthening of the shadow, and turning of the leaf, are signals for the melody of the groves to cease; and it is hushed till awakened by the return of the spring. In autumn the trees drop their leaves, and the fields put off their cheerful green—the inferior animals relinquish their gambols, and all nature assumes the aspect of sadness and decay. On the other hand, when the year comes round, the woods resume their wonted dress, in all its varied tints and hues—the fields are overspread with a carpet of flowers—the melody of the groves opens anew, in full chorus, to welcome in the summer months, and every thing again looks fresh and gay. These, and other well-known facts, are decisive proofs of the influence of the seasons on animated nature.

But, whatever effect they may have on animals, they have a still greater influence on vegetation. There are two different seasons of the year, namely, spring and autumn, when the majority of plants undergo a change; but every tree, and shrub, and flower, has its proper season for coming into bloom, and bringing its seed to maturity. There is a class indeed, natives too of the temperate regions, which continue to bloom and bear seed during the whole year, and which have at all times a succession of crops, in all the different stages of their progress towards maturity; but a far greater number bear seed but once in the year, and they prefer very different times for this purpose. The hardy mezereon, and modest snow-drop, bloom in the midst of the snows of February; the dazzling crocus prefers March; and in April "the primroses paint the sweet plain." A vast number bloom in May, many in June, and not a few near the close of summer. Some delay till the approach of harvest; and even a few wait to relieve the sadness of the scene, when

"the sear and yellow leaf of autumn" has tinged the forest with the hue of decay, and as it were signed the passports of the departing year. But whatever particular periods of the year they respectively prefer, they in general require twelve months, and all the alternations of light and shade, and of cold and heat, which usually occur within that space, to perform their cycles.

It may however be supposed, that the ordinary phenomena of vegetation are rather to be regarded as the proper effects of the changes of the seasons, than that the course of the seasons has been adapted to them; and in many instances this may be correct. But though the cycles of plants appear to be regulated by the course of the seasons, and though many plants possess the power of adapting themselves to external circumstances, there are others that do not. The different hemispheres are in respect to climate the exact counterparts of one another. They have respectively, their tropical, their temperate, and their polar circles; and each has the same changes as the other, but they happen to occur in different times. Now we might suppose that it would make little difference to a plant, if it enjoyed the same course of the seasons, whether its changes occurred or not at the same time, yet the vegetation of the two hemispheres is different; and what is more, many of the plants of the one hemisphere do not prosper under the same circumstances in the other. Though all other things are equal, the winter of the one is the summer of the other, and *vice versa;* and they do not readily conform to this arrangement, and some persevere in refusing to conform to it till they die in their obstinacy.

Besides, though there are plants which are capable of adapting themselves to an artificial existence, there are others that are not, and which resist every attempt to subject them to it, till they ultimately become a sacrifice to their own immutability. Some will after a short time grow in the night and sleep in the day, provided the one be artificially illuminated, and the other made dark; but others continue to expand their leaves during the natural day, even though

in darkness, and to shut them during the night, even though placed in a blaze of light.

These facts show, that there is something in the natural constitution of plants, which accords better with the actual arrangements of nature, than it would have done with any different arrangement. And whatever this property may be, the established course of the seasons is adapted to it; and they act in accordance with one another, in producing subsistence for man and beast.

To every thing possessing life, times of repose are indispensable; and though there are both nocturnal plants and animals, whose organization fits them for acting in the night, rather than in the day, all other races, when left to the bias of their natural instincts, retire to rest with the close of the day, and start with the dawn; and this habit is not only the most natural but the most beneficial. It is, all other things being equal, better calculated to promote bodily vigour, and mental activity, than any other arrangement we can follow. Those who possess a robust constitution, may not be sensible of any inconvenience from a different habit, but it is not so with those who are delicate; and all sound medical practitioners, who generally base their prescriptions on experience, recommend a natural regime to their patients. Their experience confirms the homely maxim, in which an important truth is expressed in plain and simple, but not inappropriate or unbefitting language.

> The way to be healthy, wealthy, and wise,
> Is early to bed, and early to rise.

In the earlier stages of the history of the earth, the course of the seasons, as was formerly shown, appears to have been interfered with, and prevented from taking effect, by the frequency and intensity of volcanic action, which gave an unnatural temperature to the earth, and often turned the night into day by its vivid coruscations. Till this state of the earth terminated, the order of nature was held in abeyance; but the tranquility to which it has long since attained, has removed the obstruction out of the way, and we are now enjoying the benefits of the change.

§ 2. The reduction of the temperature of the earth to its present standard, has been of the greatest service to its existing inhabitants. From all that we can learn of the nature and habits of the extinct races which inhabited the earth in ancient times, it does not appear that we have sustained any serious loss by their destruction. Their fossil remains may be regarded as authentic and invaluable memorials of the ancient state of the earth, and of the repeated and mighty revolutions it has undergone; but had they been preserved to our times, they would have been of no use to us; and they must have occupied room which is far more advantageously filled by others.

In consequence of the reduction of the temperature of the earth, there are different elements in different parallels; and a far greater variety has been introduced, both into animal and vegetable life. We have, both in the animal and vegetable kingdoms, equatorial, temperate, and polar races; and each of the divisions is subdivided into an almost endless number of varieties. Now, as the productions that are peculiar to one region of the globe are, from the constitution of our minds, objects of desire to the inhabitants of every other region, a foundation is laid for a free and friendly intercourse between them, for an advantageous exchange of their respective commodities, and a still more beneficial exchange of their discoveries and improvements. The Poet's imagination may be pleased with the prospect of that anticipated state of things, when—

> Cedit et ipse mari vector: nec nautica pinus
> Mutabit merces: omnis feret omnia tellus. VIRGIL.
>
> The greedy sailor shall the seas forego;
> No keel shall cut the waves for foreign ware;
> For every soil shall every product bear. DRYDEN.

But to the philanthropist, the statesman, and the philosopher, it appears in a very different light,—for if "every land produced every thing"—if every man got in his neighbourhood whatever he might expect to obtain from a distance, there would be no motive sufficiently powerful to induce the great majority of mankind "*Tentare Thetim ratibus*,"—to brave the dangers of the ocean; and there would

be no community of interest or opinion among the different families of the human race. Whatever discoveries or improvements might be made, would either be confined within a comparatively narrow circle, or if they penetrated farther, it would be slowly and imperfectly, and the interests of civilization would thus be sacrificed.

§ 3. It is a trite saying, that "man is the creature of circumstances"—that if the basis of his character be founded in nature, it is greatly modified by his external condition. In a tropical country, where his real wants are comparatively few, and the means of supplying them easily obtained, he has not the same incitements to industry, nor the same motives to endeavour to abridge or supersede the necessity of manual labour, by ingenious contrivances, and he therefore seldom or never attempts it, and permits both his physical and mental energies to lie dormant, or become impaired through disease. And independent of the absence of stimulants to action, the enervating influence of a tropical climate relaxes the system, and unfits both body and mind for sustained exertion. Mrs. Wilson, of the Scotch Mission in Hindostan, says, in one of her letters to her friends, "The climate has a depressing influence, and the susceptibilities, which would be awakened and roused to energy in England, are here permitted to lie dormant. Most of us live like the natives, creatures of mere sensation, and scarcely conscious of the existence of intellectual life." It would be folly to expect that any decided improvement could originate in such a situation, and under such circumstances. It must be in colder climates, where the system is braced by physical agency—where the wants are both more numerous and urgent—where a man must be comfortably clothed and fed—where he can neither go naked, nor subsist on a handful of rice for a day, and where consequently his imagination is taxed and exerted, to supply what is deficient in the bounties of nature, that all the resources of the human mind are put in requisition and gradually developed.

If in the warmer regions, where the inhabitants can afford to spend their days in voluptuous ease, any thing should oc-

cur of sufficient influence to agitate the stagnant waters of life, and produce some temporary symptoms of energy, the attention is directed to the arts which only serve to embellish, and not to those that really improve; and while the higher and sterner attributes of mind are wholly neglected, the reveries of a heated imagination are indulged; and the results are, a fervid species of fiction, and glowing style of poetic representation, which having no actual types in nature, possesses no practical influence, and though it interests and excites for a moment, the excitation speedily terminates in exhaustion, and leaves no other fruit behind. Those who are independent of the useful arts, will not trouble themselves with framing laws and institutions for their encouragement; and without useful laws and customs, men are either barbarians or slaves. If they have not sufficient energy of mind to attempt the improvement of their social system, they will pay little attention to their personal improvement; and though they may yield for a time to an unnatural excitement, and be impelled into an artificial and misdirected activity, they speedily relapse into their former apathy, and even become more hopeless than before.

With the single exception of the Saracen movement, which originated in no permanent principle, and swept over the East with all the rapidity and violence of a hurricane, till it spent its force, and terminated in a dead and fatal calm, no agitation of any importance, and bearing along with it the elements of improvement, ever proceeded from South to North; but on many occasions have such movements taken an opposite direction, and either directly or indirectly ameliorated the condition of the countries which they visited. One of the most memorable and important of these, was that which overthrew the western empire in the Middle Ages. Under the influence of a system that was radically vicious and defective, the South had sunk into a completely rotten and demoralizing species of social existence, and nothing but a violent dismemberment of the system, and reconstruction of its elements on an improved principle, could have produced an amelioration. This was accomplish-

ed by the overwhelming irruption of the Barbarians of the North, the most fitting agents for such an achievement. The Reformation originated in the same quarter, and took the same direction. The general current of human improvement is like the course of the wind from North to South—from the Pole to the Equator. The prospect of finding a more genial climate, fairer skies, and a brighter sun, invites the hardy sons of the North to try their fortunes in that direction. Surge after surge, and wave after wave, have followed one another with longer or shorter intervals between them, but whatever may have been their respective destinations, or wherever they fell to pieces, none has returned towards its starting point. Cyrus and Napoleon, the greatest men of their respective times, and who have few rivals on the page of history, both tried to stem the torrent, and roll it back on its own source, and both fell victims to the vain attempt. After the flow had settled into a smooth and placid state, and been imperceptible for several centuries, it has been again agitated in our own times; the Scythian hordes have once more made a descent on the South—placed their banners at the foot of the Alps, and on the banks of the Seine, and acted a very prominent part in the overthrow and dismemberment of one of the most powerful and warlike despotisms ever erected by the ambition of man.

The elements of improvement have become too deeply rooted in the social system of Western Europe, either to require or even to admit of a total dissolution of that system, and it is impossible for the North to produce more than a temporary agitation in that quarter. That has been done on the occasion just referred to,—the elements of improvement have been agitated and they are now fermenting, and preparing to enter into new combinations, and to assume a new and ameliorated form; and it is highly probable, that while Western Europe is engaged with its own internal arrangements, Russia may perform an important service to the interests of civilization in Eastern Europe, and Western Asia. Turkey and Persia have ceased to perform the functions of nations, and can hardly be regarded in any other light than

as cancers in the social system of the world; and the sooner they are extirpated, so much the better for the good of the whole. The operation may be painful, and the more so if performed by an unskilful hand; but if it restore health and soundness to the system, the enlightened mind will regret it the less.

The necessity for skilful and sustained exertion imposed on the inhabitants of the higher latitudes, combined with the bracing influence of their climate, first opened to them the path of improvement; and the success which attended their first attempts, operated as a stimulus to increased exertions. Though the elements of intellectual and moral improvement are thus prepared in the temperate circles, their influence is not limited to these, but extends to regions nearer the Line,—for though the indolent and enervated inhabitants of the latter may not possess the requisite energy to make discoveries, and originate and mature important changes, they have capacity to receive these when presented to them; and even the very indolence of their temper, prepares them the more to act the part of passive recipients, when foreign improvements are imposed upon them, by those who have an interest in pursuing such a course.

Moreover, the arrangement under consideration is productive of a number of physical benefits of great importance to the welfare of our race. Although there are electrical changes in the atmosphere, which, in consequence of being local and limited in their influence, produce currents in any direction, there are, as has been stated already, general and unceasing atmospheric currents from the Poles towards the Equator; and these meeting together within the tropics, produce the trade winds, which are known to be of vast importance to commerce. But this is neither the only nor the greatest benefit we derive from them. They purify the air and render it salubrious, and fit it for performing its various functions in the economy of nature. Wherever organized bodies are in existence, there are always some of them in a state of decay. The process of decomposition is continually going on, either on a larger or more limited

scale; and the consequence is, that gases, injurious to animal life, though necessary to plants, are freely disengaged; and if allowed to accumulate in any locality would poison the atmosphere, and render it destructive to animal life. It is absolutely necessary that these should be dissipated—that they should be dispersed over the face of the earth, or put into a state to enter into new and useful combinations; and this, with other interesting phenomena, is effected by the wind. In the earlier ages, the temperature of the earth was not subject to the same arrangement as at the present time, and the consequence was, that in the carboniferous era, azotic gases accumulated in the atmosphere in particular localities, to an amount that proved highly conducive to the progress of vegetation, but destructive to animals breathing with lungs. In the succeeding age, which is that of the new red sandstone, a large proportion of the surface of the land was overwhelmed with an ocean of drifting sand; and though the frequent changes in the direction of the strata, show that the winds by which they were broken up and reconstructed must have been extremely variable, they must also have been more under local influences, than under the general law by which they are now regulated. If they did not stagnate, as in the carboniferous age, their action was insalubrious; and during both periods, man and all the more useful animals were confined to the more elevated regions of the earth, where their means of subsistence must have been less plentiful, and where serious checks were imposed on their increase.

Were the atmosphere everywhere of an equal temperature, it would be without motion of any kind; but it is the natural tendency of cold air to displace what is heated, because the latter, being also made lighter, cannot present an equal resistance to it; and it therefore continues to recede before it, till it arrives within the tropical regions, where it is met by a current from the opposite Pole, and mounts up to the higher regions, from whence it falls down again towards the Poles. This continued and healthful circulation of the atmospheric fluid, depends chiefly on the unequal distribution of heat to the different parallels.

There are oceanic currents which have a similar origin; and if they perform no other function in the economy of nature, they serve to carry off some portion of the excess of heat from the equatorial regions, where it has a tendency to accumulate, and to impart it to the temperate and polar regions, where it has a tendency to become deficient; and it is partly by this means that their relative proportions are continually preserved.

CHAP. V.

OF THE BENEFITS WHICH RESULT FROM THE REDUCTION OF THE SIZE OF ANIMALS, AND THE ABBREVIATION OF THE TERM OF HUMAN LIFE.

The reduction of the size of animals, and abbreviation of the term of human life, since the earth came into its present state, are interesting facts; and must form points of less or more importance in the general economy of nature. They are evidently conducive to the main object of the different revolutions which the earth has undergone, namely, to render it an abode of the greatest amount of happiness, consistent with the nature of things; and also a nursery for raising the greatest number of human beings, consistent with their due preparation for a future and higher state of existence. The changes referred to in the economy of animals were formerly pointed out; and they have no doubt resulted from the mutations of the earth. Had they been occasioned by supernatural, and not by physical agency, they would have in all probability been completed at once; whereas they appear to have been progressive, and even slower in some instances than in others. The mean ages of the antediluvian patriarchs, omitting Enoch, was something more than 912 years; and Noah, the last of them, lived to the age of 950; which shows that, till the Deluge, no material change had occurred. The age of Shem was reduced more than one third, and his son's again was nearly one third shorter than his own. For three generations after Shem, the term of life remained stationary; when in the next following, it fell again

one half, and then continued nearly stationary for other four or five generations, when it sunk rapidly to its present standard.

Since the days of Moses, "three score years and ten" have been the measure of our days; but it may be lengthened or shortened by the influence of circumstances; and in some countries it overruns, and in others does not reach that standard, which may no doubt be traced to a difference in regard to modes of life. Herodotus represents the Ethiopians of his time as "the tallest, the handsomest, and longest lived of the human race,"—a description which, with very little abatement, may be applied to the *Tuaricks*, a nomad race of Northern Africa, supposed to be descended from the ancient Ethiopians; (Captain Lyons' Narrative, pp. 108—112;) and the Macrobians, or Sabeans, to whom Herodotus particularly refers, lived to the age of 120, which they imputed to the influence of a generous diet. This was 500 years before the commencement of the Christian Era, or 1800 after the Flood.

In the same gradual manner was the stature of man reduced, from its ancient to its present state. There was still a race of giants in the days of Moses; (Numb. xiii. 32, 33;) they had been much more numerous in former times; (Deut. ii. 10, 11, 20, 21;) and they were not even extinct, although few in number, in the reign of David. According to Herodotus, in the passage already quoted, the Macrobians were "the tallest, as well as the handsomest, and longest lived of the human race." Isaiah represents their persons as majestic, Chap. xlv. 14; and Agatharchides, as quoted by Bochart, Phaleg. ii. 26, speaks of them in similar terms.

The fact, that the age and stature of man were both reduced in a gradual manner, and also that they fell more slowly in some instances than in others, proves beyond a doubt that the change originated in physical causes, and that it was brought about by physical agency. It is well known that a change in the condition of the inferior animals will in the course of time produce a very sensible effect on their general appearance, or that they can be either deteriorated

or improved by treatment; but they can neither be brought all at once to the highest pitch of improvement of which they are susceptible, nor do they sink all at once to the *ne plus ultra* of deterioration. They come progressively to both. One generation gains or loses to a smaller extent, another does the same, and so on, till the full effect is ultimately produced; and the process in either direction may be accelerated, or it may be retarded by the influence of circumstances.

Now, considering the present state of existence as introductory to another, and the earth as a nursery, intended for raising the greatest number of human beings that is consistent with their due preparation for that other, the removal of every thing that might operate as a check upon the increase of their numbers must be favourable to the attainment of that end; and there cannot be the slightest doubt that such is the tendency, both of the reduction of the stature of man and of the abbreviation of his allotted term of life. The larger the size of any animal, the more in general will it require of the means of subsistence; and as the fertility of the earth has its impassable limits, beyond which the most skilful modes of cultivation could not stimulate its powers, it must be a wise arrangement to reduce the amount of bone and muscle to be kept in repair, as far as may be done consistently with the due performance of their functions. There are Pigmy races in different quarters of the globe, but to whatever it may be owing, or however we are to account for it, their mental capacities appear in general to be as deficient as their stature; and it may be laid down as a general rule, in every country, that diminutive races have inferior intellects, though if taken individually there are many striking exceptions to it. On the other hand, a gigantic stature is no proof of superior intellect, but rather of the contrary, at least any credit be due to the universal opinion of mankind on the point,—for the fabulous giants of all ages and every nation have been equally marked by brutality of disposition and mental incapacity; and three nations of them, then esteemed numerous and power-

ful, were simultaneously defeated by a roving band, which was pursued and routed by Abraham, at the head of the trained servants of his own establishment, amounting only to 318, Gen. xiv. 5.

We may then conclude that the present stature of man is, upon the whole, the best adapted to the end of his being—that it could not admit of any greater reduction, consistent with that end, and that an increase would have the effect of reducing our numbers, without being compensated by any positive gain, if not attended with loss.

With respect to the inferior animals, there are some cases in which weight is a benefit, as it may enable a single team to perform a piece of work for which it would be otherwise unfit, and where the employment of a double team would be necessarily attended with a waste of harness, time, and power, beyond what might have been sufficient. But in all other cases, if we can reconcile our minds to it, what is wanting in weight may be compensated by numbers; and as every animal of the same species, in the same condition, and under the same circumstances, must enjoy an equal amount of happiness with each of its fellows, whether its size be a little less or a little more, it is clear that a greater number of animals, of dimensions sufficient for the end of their existence, must have an aggregate of enjoyment superior to that of a smaller number of the same race; and if the smaller number have no more weight and no more value than the greater number, there is a loss of enjoyment without any adequate compensation. The Dinotherium may have consumed the vegetation of a lake, and consequently expelled from it all the happy herbivorous forms that would have sported in its waters; and the consequence would have been that all the happiness which that scene afforded, would have been compressed into that measure of passive enjoyment, of which his sluggish form was susceptible. Three oxen, of 500 lbs. each, are of the same value as two of 750; but, supposing the circumstances of each to be the same, and that they have all the same capacity for enjoyment, the difference in regard to the latter will amount to 33⅓ per cent. Add to

this, that gigantic animals do not in general appear to have an equal capacity for enjoyment with those of inferior dimensions, even when they belong to the same species. All our different races of dogs are but accidental varieties of the same species,—they have all sprung from one stock, and are reducible to a common type; but though the larger varieties generally possess more sagacity, and are therefore more useful, the smaller ones as commonly exhibit a greater flow of spirits—a greater propensity to frisk and to gambol, and enter with a keener zest into all the forms of canine amusement; and there are various other animals besides the dog, to which these observations are applicable. If such facts are forced upon our attention, our selfishness leads us to overlook their importance; but we may rest assured that they enter into the primary calculations of the great and infinitely benevolent Being, without whom even a sparrow falleth not to the ground, and whose chief delight is to multiply, to diversify, and extend enjoyment—to contemplate the endless variety of its forms—to provide for their permanence, and to watch over and protect them from injury.

This is, however, to be kept in mind, that as the inferior animals were not wholly made for themselves, their capacity for enjoyment must be combined with their usefulness; and though a still greater reduction in size might have increased the gross amount of happiness, it might have been attended with a corresponding loss of efficiency, which would have acted unfavourably in some instances even on the very object it was intended to promote. Predaceous animals, for instance, are indispensable in the system of nature. They are its scavengers, and its police. They prevent an excess of numbers, and consequently a famine among the herbivora; and they often prevent, by a speedy destruction, the lingering miseries of sickness and of age; but that they may not create unnecessary suffering—that they may despatch their victims as speedily as possible, they must have size and strength adequate to the work.

That the reduction of the size of animals, as far as attention to their efficiency would admit, is a wise arrangement,

and that it admits of an increase of numbers, and especially of the numbers of the human race, cannot admit of a doubt; and it is one of the innumerable benefits which have resulted from the ancient mutations of the earth.

§. 2. The abbreviation of their term of life is another. So long as the earth was but thinly inhabited, and so long as it was incapable of affording subsistence to a dense population, the longevity of man was an evident benefit, rather than an evil. It must have been the effect of a more hardy and durable constitution than has been transmitted down to the present time; and such a constitution was in all probability indispensable in the state in which man was then placed. But were the term of life again restored to 900 years, it could not fail, at least in all the older and more densely inhabited countries, to occasion the most extensive misery, unless the ancient system in all its parts was completely restored at the same time; and even then, the consequence would necessarily be. that at the end of 1000 years there would not have been more than one in thirteen, or even less, that would have passed through life under the existing arrangements.

This is a consideration of the greatest importance. The mineral treasures of the earth are vast, but still they have their limits. They are far from being inexhaustible; and the higher the degree of civilization we attain to, the greater is their consumption, and the sooner must they be spent. From this it is clear that the earth is not intended to last for ever. It is coming to an end, and cannot even exist under the present arrangement for a very long time. Supposing it then to be designed, as we have every reason to believe, for raising and preparing human beings for a future and higher state of existence, it is of the utmost importance that the term of life be as short as is consistent with the attainment of this end, that the number thus raised and prepared may be as great as possible. The earth can only contain a given number at one time; and as that number must go out before another enters, the sooner they can dispatch their business and depart, the more will their numbers amount to in the end

As a certain amount of information and experience necessarily dies with every generation, and indeed with every individual, and has to be acquired anew by the next in succession, and as much of this must, from its very nature, be acquired by means of instruction and example, and that too in a slow and progressive manner, it cannot be transmitted from race to race, unless they go out and come in by divisions--numbers being at all times in all the different stages of the progress. Now this cannot be done in a very few years. We come very slowly to a state of maturity; and a considerable number of years are spent before we can even begin to learn the useful arts, a number more are spent in the learning, and all this preparation would be useless, were there no time allowed, after the acquisition, to practice the arts thus slowly acquired. All things considered, the present standard of the term of life could not suffer any farther reduction.

But the question is, Has it not been reduced too much already? It is certainly possible, if not more than possible, that a greater progress in improvement might have been made, had the life of man still extended to hundreds of years; but we have no great reason for thinking that a greater improvement would have actually taken place. It is for the most part before we enter on the decline of life, when all our powers of body and mind begin to flag, that we embark with the greatest ardour and success in the busy scenes of active life; and though a man who lived to the age of 900 years may have made greater progress than another who lived only 70, the progress made by thirteen successive generations of the latter, might have been much greater than that of the former. It was not before the eighth generation, which was about 900, or if we prefer the Greek version of the Sacred Chronology, 1450 years from the creation, that some of the most necessary and easily-invented improvements were adopted, which is no great evidence that long life is favourable to improvement, Gen. iv. 20—22. Constituted as we are, the prospect of a lengthened period before us might operate very unfavourably upon our activity,

while the certainty that we have not very long to live, may prove a stimulus. It is certain that moralists, in recommending diligence to their fellow men, have in all ages represented the shortness of human life as a powerful motive to diligence and perseverance, and it is reasonable to suppose that it should be a stimulus.

But even supposing that something might have been gained in the way of improvement, had the antediluvian term of life been continued, what loss must have been sustained in respect of numbers by such an arrangement? What was gained in one way would have been no compensation for what was lost in another.

CONCLUSION.

§ 1. In these researches into the physical history of the earth, we have seen that it has undergone a number of violent and extensive revolutions before attaining to its present state of rest; and though these revolutions may appear to us at first sight to have been the effects of accident—to have been based on no general principle, and to have possessed no unity of design, the very reverse is found, upon an attentive enquiry, to be the case. That they may be all traced to physical agency is readily admitted, but this is only moving the enquiry one step farther back; for whatever links we may be able to number in the chain of sequences, we must come at last to a first cause. The revolutions of the earth, without one exception, contribute directly, though in different ways, to a common object; and in doing this, they present to us the most clear and decisive proofs of unity of design. Now design implies intelligence, which physical agency cannot possibly possess. Matter may act in different ways upon matter—one class of substances may have the property of attracting and another that of repelling one another—one may condense and another may expand; but when we observe a number of conflicting elements, apparently working confusion and disorder, but terminating in

the establishment of an improved state of things—when we see this perplexing process repeated, and that for a considerable number of times, with longer or shorter intervals between each—when we see that every succeeding repetition is attended with some variation in the phenomena, but that notwithstanding of the diversity in the length of the intervening periods, of the change of circumstances, and difference of the more immediate results, they all bear upon one object, and promote that object more effectually by their partial disagreement, than they could have done by the most perfect uniformity, we may rest assured that the whole is arranged by a presiding intelligence, and directed by a skilful and omnipotent hand; or in other words that it is the work of Him who has "prepared his throne in the heavens, and whose kingdom ruleth over all."

The intelligence which directed the revolutions of the earth has been skilfully masked, but not so as to be concealed from those who are open to conviction, and are willing to behold the perfections of their Maker, in the works of His hands; and they do not only see the most interesting displays of intelligence in them, but intelligence and power, working in the most perfect unison with goodness. All these revolutions have been useful, and that in a very high degree; and it is worthy of observation, that they occurred in the order in which they were calculated to do the most good—at the times when they were calculated to do the least possible harm, and that they respectively stopped at the precise points at which they were calculated to do the most extensive and lasting good, and beyond which they would have unavoidably done the greatest mischief. Some of them have been more and others less violent and extensive; and there cannot be the slightest doubt that they might have been still more diversified than they have actually been—that some difference in the proportions or combinations of their elements was within the range of possibility, and that they might, by a different arrangement, have either accomplished much less good, or occasioned the most tremendous evils: they might have neutralized each other's influence, and con-

sequently left the earth in an unfinished state; or they might have blown it into atoms, and dispersed them among different sections of the universe; or without imagining such a catastrophe, no great addition to the disturbing forces would have been required, to convert all the limestones either into marble or calcareous spar—the coal into coke, and the sandstones into schists; and it would be impossible to estimate the amount of loss we should have sustained from such a change.

There cannot be the slightest doubt, that the heat which fused the crystalline masses, and ejected them from the interior, in incandescent floods, might have been increased to such a degree as to melt the sedimentary strata, and convert them likewise into refractory masses. The primary strata have all been partially crystallized since their deposition, and had they been subjected to an additional heat, the change produced must have been proportionally greater: or the more useful formations may have been buried to such a depth in the bowels of the earth, as to have been rendered completely inaccessible to man. The different geological periods appear to have been continued just as long as they could be rendered subsidiary to the great object towards which they all converged, and no sooner were their respective parts performed, than they terminated respectively in revolutions, which still contributed, though in different ways, to the same great and ultimate object. Had the carboniferous period been much prolonged beyond its actual duration, it would no doubt have produced a greater amount of coal, lime, and other minerals; but while these would have been accumulated to a greater amount than will probably be required, other important objects would have been sacrificed. The same, or at least a similar observation, may be made in regard to every other geological era. Had they been abbreviated, they would not have done the good they have done; and had they continued longer than their appointed times, they would have accomplished more than was required, and prevented the accomplishment of other and more important objects that were required, and from which we derive the most important benefits.

Now, had there been only one or two changes, their beneficial tendency, or even their agreement in promoting one great object, might have been accidental, or at all events it would not have amounted to a full and satisfying evidence of design; but in the calculation of probabilities, the uniform agreement, in regard to tendency, of such a number of changes as the earth has undergone, and of changes which, while they agreed in tendency, differed in many other respects, cannot be set down as accidental. They differed from one another in too many ways, and to such an extent, as to show that they could on no account be regarded as similar effects of similar causes—that they were not dependent, like the rising and setting of the orbs of heaven, on some uniform and permanent law; and yet they acted in such a manner, as to indicate a common relation to a common object, and subjection to one presiding power. The combination and adjustment of so many different and conflicting elements—the balancing and directing of such tremendous forces, and the adapting of their intensity to the ends intended, are all evidences of the most decisive nature, that the presiding Intelligence unites in his character, unbounded wisdom, power, and goodness.

§ 2. And besides establishing the fundamental doctrines of tural Theology, the discoveries of Geology serve to confirm the truth of the Scriptures, and consequently give their support to Revealed Religion. They corroborate the truth of some of the most difficult passages of the Sacred Narrative, and illustrate some of the most obscure.

But there is no way in which they give more efficient support to the Scriptures, as a Divine Revelation, than by affording the most conclusive and satisfactory evidence of the truth of miracles. The truth of miracles is one of the main pillars of Revealed Religion, and for this very reason it has been more fiercely assailed, and warmly defended, than any other point in which religion is concerned. If the miracles recorded in the Scriptures were genuine, they prove the Scriptures to be beyond all doubt the Word of God; but if they were an imposition practised on the credulity of man-

kind, the Scriptures are not divinely inspired books, however sublime their composition and sentiments, or however pure and excellent their morality.

The truth of miracles has often been exposed, rather than confirmed, by the indiscreet zeal of its well-meaning but injudicious friends. The evidence of miracles has little in common with human testimony. The latter is strengthened by the numbers who concur in it, because it is at all times less likely, that a multitude of men of common sense should either be mistaken or conspire to impose a falsehood on the world, than that this should be done by a very few. Whereas the more common that miracles become, they become the more suspicious; for we have no right to suppose that the Divine Being will either condescend to overcome our obstinacy by the performance of a long series of miracles in support of one point, or that there can be many points that require such proof. Moses performed a long series of miracles in Egypt; but the design was not to convince, but to harden, and it was calculated to produce this effect. And many of our Lord's miracles were rather designed to show the extent and variety of his power than the divinity of his mission. One or two genuine or well-attested miracles, are better than a thousand; because when miracles become common occurrences, they cease to be regarded as miracles, whether we be able to trace them to secondary causes or not. There are many events recorded in the Scriptures, which, though by no means common, may easily be referred to natural agency; and yet it has been customary to represent them as miracles, either from a natural fondness for the marvellous, or from a mistaken idea that the more miracles we can produce the better. This is unwise, and attended with no small degree of danger. The multiplication of positions which must be defended, serves to fritter away our strength, and the more especially if the points be untenable; and when any such point must be surrendered, it invariably produces an unfavourable impression. It would be well, therefore, for the friends of religion, to surrender at once all that is doubtful, and to reserve their unbroken strength for the de-

fence of what must be defended; and to act in general upon the maxim of Horace, which was originally intended for a very different purpose:

> Nec Deus intersit, nisi dignus vindice nodus,
> Incideret. DE ARTE POET., v. 191.
>
> Never presume to make a God appear,
> But for a business worthy of a God. ROSCOMMON.

Had the friends of truth always acted upon this principle, they would have strengthened their position; but they have in many instances acted differently, and their opponents have made dexterous use of their blunders. Had the latter been contented with the detection and exposure of fraud and folly, their conduct would have been unobjectionable, if not praiseworthy; but their object was not to improve, but to destroy—not to prune and dress, but to extirpate; and having torn off some excrescences, they laid the axe to the root of the tree, with the full intention of levelling it with the ground. They have denied even the possibility of proving a miracle, to the satisfaction of any rational mind,—partly because, as they allege, a miracle is from its nature unsusceptible of proof, and partly because it is contrary to the constitution of our nature to admit of it, however strong the proof may seem.

In support of this objection, they lay down the general principle, that like causes invariably produce like effects; and that we instinctively take this uniformity for granted—that we have no experience of any thing else, and that we cannot believe in any deviation from it. It is true in general that we rely upon the undeviating uniformity of causation, and instinctively anticipate like effects from like causes; and that we also reason backwards, as well as forwards, from this point; and take it for granted that like effects have always had like causes. But as nothing is impossible but what implies a contradiction, we never doubt that the train of sequences may be interrupted by the interposition of a new cause, different from any cause, of the effects of which we have yet had experience; and we can as little doubt that it may have been interrupted by such an interposition in

time past, and either temporarily suspended or permanently changed. When we see a complicated machine in operation, and observe the perfect regularity of its movements, and the skilful adaptation of its various parts to their respective functions, we can no more doubt of the competency of the skill displayed in its construction, to alter or suspend its movements entirely, than we can doubt that its speed may be increased or diminished, by an increase or diminution of the moving power. The power to alter cannot be different from the power to make; or if it differ from it in any thing, it must be in degree, and not in kind; and if we allow the existence of a God at all—if we allow him to be the Creator of the universe—to have adjusted its innumerable and infinitely diversified parts, and to have subjected the whole to a system of laws, necessarily complicated in the highest degree, but never interfering with one another, it would be absurd to question his power to interfere with these laws, provided he has a sufficient reason for doing so; and to allege that such a reason cannot exist, is to assume the right to judge of matters of which we are not competent to decide.

There is nothing in the constitution of human nature against the truth of miracles, but an evident predisposition to admit of it. All nations and all ages have had their prodigies; and children, and all ignorant people, who are more completely under the original principles of their nature, are far more easily imposed upon than philosophers. We are naturally disposed to be credulous, and even to carry our credulity to excess; and experience alone corrects this habit, and renders us distrustful.

The point then to be considered is, neither whether it is possible for the laws of nature to be interrupted or dispensed with on a proper occasion, nor whether we are capable, according to the constitution of our nature, to admit the reality of an interruption or suspension of them, but, whether or not, in the nature of things, there can be such an occasion as this supposes. Now this is one of those problems which can only be solved by a reference to facts. It is rea-

sonable to suppose that there may be such occasions. That every emergency must have been foreseen, and that it might have been provided for by the divine prescience, so as to have rendered any direct interposition of the divine power unnecessary, is readily admitted; but the question is not, what might have been done, but what would have been proper; and as we have been created by the divine power, and are wholly dependent upon the divine bounty, it may be useful to us, from time to time, to be reminded of this; and nothing can make us more sensible of our dependence on God, than to see distinctly that the laws of nature themselves are in his power; and this is placed beyond all doubt by the discoveries of Geology.

In the composition and structure of the crust of the earth, we meet with frequent and decisive proofs, either that the laws of nature have been different from what they are at present, or that if they were the same, they were at times counteracted by influences which are not now in operation. The uniform tendency of the laws of nature, so far as we have the ability and means of ascertaining it, is to preserve every thing in the same state, or at least from any permanent change. There are many established cycles in nature, but they are regular and uniform in their respective courses. They are exact repetitions of one another, without any real deviation; and we can tell at the commencement of any one of them, how long it will move in a certain direction, and when it will return to the starting point; and it is from our experience of this undeviating uniformity in the operations of nature, that we have come to the conclusion that like causes will always produce like effects, and that like effects have always been produced by like causes—that the chain of sequences has always been, and will always continue to be uninterrupted. But when we examine the past history of the earth, our confidence in the soundness of this conclusion must be shaken, for in ancient times the operations of nature have tended as much to important changes, as they now tend to prevent all such changes. "Amid all the revolutions of nature," says Professor Playfair, "the econo-

ry of nature has been uniform, and her laws are the only things that have resisted the general movement. The rivers and the rocks, the seas and the continents, have been changed in all their parts; but the laws which direct these changes, and the rules to which they are subject, have remained invariably the same." Again, "The inhabitants of the globe, like all other parts of it, are subject to change. It is not only the individual that perishes, but the whole species."

"A change in the animal kingdom seems to be a part of the order of nature, and is visible in instances to which human power cannot have extended." Illustrations of the Huttonian Theory, § 374, & § 413. And Dr. Lyell, to mark his cordial concurrence in these statements, has placed them on the title pages of his "Principles of Geology."

Now, if this be true, if all things have been changed but the laws of nature, the operation of these laws has not always been sufficient to preserve every thing in the same state; and whatever confidence we may have in the uniformity of causation, there have been times when it failed. Day and night, and summer and winter, with their respective phenomena, are uniform in their courses; but the carboniferous period having once passed has never returned—it has had no representative in any subsequent age of the earth, and there has been no repetition of any of the other geological epochs,—no one of them can be regarded as a return of any one that has gone before it. But it may perhaps be alleged, that they are only the stages of a larger cycle, which requires millions of ages to run its round; and that when the iron and coal have been exhausted, past changes will again commence: that there will be a new series of all the formations, with their respective revolutions, disruptions, and reconstructions—that another deluge shall overwhelm the earth, and that—

> Alter erit tum Tiphys, et altera quæ vehat Argo,
> Delectos heroas: erunt altera bella;
> Atque iterum ad Trojam magnus mittetur Achilles.
> Another Tiphys shall new seas explore,
> Another Argos land the chiefs upon th' Iberian shore.
> Another Helen other wars create,
> And great Achilles urge anew Troy's fate. DRYDEN.

But this speculation is purely hypothetical, and far more congenial to the taste of the Poet, who delights in the construction of new creations, and fabrics of the brain, than to the sober judgement of the inductive Philosopher, who reasons from well-authenticated facts.

But the ancient revolutions of the earth, it may be said, have already been referred to physical agency, and though not agreeable to the existing order of things, are not to be regarded in the light of miracles. But if they prove that the laws of nature have either been changed, or if they have been always the same, that they have been repeatedly counteracted by other influences, they disprove the doctrine of their undeviating uniformity. They show that reasons for their interruptions and suspensions have existed; and if so, reasons for their interruption may have occurred again.

But the discoveries of Geology go further than this, they show that events have actually occurred which were strictly miraculous, and which, if they were now to be repeated, would be regarded as miracles of the highest order. No event could be more truly miraculous than the creation of a man, or indeed of any one of the inferior animals; and if Geology proves any thing at all, it proves undoubtedly that all organized beings whatever, whether animal or vegetable, have been created. Whatever theory of the earth we adopt, we come, in tracing back its history, to a period that was antecedent to the existence of any of them; and they must therefore have all had a beginning. Dr. Lyell, who dissents from this view of the matter, and alleges that the primary strata might have been originally fossiliferous, and that the organic remains embedded in them have been obliterated by their partial crystallization, readily admits that the earth undoubtedly existed before either the creation of man or any other existing race. "If we have found it impossible," says he, "to assign a limit to that time, throughout which it has pleased an Omnipotent and Eternal Being to manifest his creative power, we have at least succeeded beyond all hope, (Did he not mean "beyond all question?") in carrying back our researches to times antecedent to the ex-

istence of man. We can prove that man had a beginning, and that all the species now contemporary with man, and many others which preceded, had also a beginning, and that consequently the present state of the organic world has not gone on from all eternity as some philosophers had maintained." Elements of Geology, vol. ii. p. 85. He goes farther than this, he says also, "It appears, that from the remotest periods there has been for ever a coming in of new organic forms, and an extinction of those which pre-existed on the earth; some species have endured for a longer, others for a shorter time; while none have ever reappeared after once dying out. The law which has governed the creation and extinction of species seems to be expressed in the verse of the Poet:

> Natura il fece, e poi ruppe la stampa. Ariosto.
> Nature made it, and then broke the die.

And this circumstance it is, which confers on fossils their highest value as chronological tests, giving to each of them, in the eyes of the Geologist, that authority which belongs to contemporary medals in history," vol. i. p. 200.

There have then, without all controversy, been repeated instances in which the Divine Power has acted directly, or without the use of means, when there was a proper occasion for it. And if for the purpose of giving existence to man, and of giving existence to such plants and animals as may be directly or even indirectly useful to man, that Power has been directly exerted, would it be improper to exert it directly again, for the purpose of promoting the great end of his creation, when it was exposed to danger, and could not be so effectually promoted otherwise? If religion be necessary, or even useful, in preparing us for a higher state of existence, and if we are in danger of adopting a false religion, as is clear from the frequency with which this has been done, we cannot conceive a more suitable occasion for the performance of a miracle, than that of attesting a divine commission, and putting an end to all doubt about what is truth. If plants and animals have been created, partly for the supply of our temporal wants, and partly for our instruction, by

presenting us with more varied and interesting exhibitions of the divine wisdom, and the divine power, may not miracles have been performed in confirmation of the divine inspiration of the Scriptures, which give us far more clear and precise information with regard to the perfections of the Divine Character—the duties we owe to our maker, and to one another, and the importance of attending to these duties, than we can possibly obtain from any other source, or by any other means?

But while we adhere to this as a reasonable supposition, and one that is borne out by science, let us beware of rendering the miracles recorded in the Scriptures suspicious, by bringing them down to the level of events, which, though memorable and instructive in a high degree, were not intended for the same purpose, and which may be accounted for by a reference to physical agency. There is a sufficient number of genuine miracles recorded in the Scriptures, which can be accounted for in no other way than by a direct reference to the divine power; and nothing can be gained by increasing their number. Anxiety to do this rather betrays a suspicion of their sufficiency, or a doubt that something farther is necessary; and it may be the means of creating doubts where none would have existed, and will certainly be taken advantage of by those who deny the truth of the Scriptures.

§ 3. Again, Geology corroborates the view presented in the Scriptures, respecting the future destiny of the earth. The Apostle seems, in Rom. viii. 21, to refer to some great and beneficial change, which the frame of nature is yet to undergo, and that change, and the manner in which it is to be accomplished, is distinctly foretold in 2 Pet. iii. 10—13: "The day of the Lord will come as a thief in the night; in which the heavens shall pass away with a great noise, and the elements shall melt with fervent heat, the earth also and all the works that are therein shall be burnt up. Seeing then that all these things shall be dissolved, what manner of persons ought ye to be in all holy conversation and godliness, looking for and hasting unto the coming of the day of

God, wherein the heavens being on fire shall be dissolved, and the elements shall melt with fervent heat? Nevertheless we, according to his promise, look for new heavens and a new earth, wherein dwelleth righteousness." This is evidently not to be regarded as a poetical or figurative representation, but as a plain matter of fact statement, made with a view to affect our minds and influence our conduct; and it clearly foretells another general revolution, in which the mass of the globe is to be melted, and its elements are to be reconstructed on a new principle, and adapted to a new and different mode of existence from the present. We have no right to regard one part of the passage as literal, and another as figurative; and as one part of it undoubtedly refers to the dissolution of the earth, and its attendant atmosphere, the other must refer to the reconstruction of both, upon an improved plan. It is at present infested with vice and crime, and a scene of much privation and suffering, and consequently adapted to the nature of the transactions of which it is the theatre, and the characters of those who are actors upon its stage; but it may be destined to become the abode of purity and of peace, and to be brought into an accordance with that design. Man is intended for a far higher and happier state of existence than the present, and should the earth be hereafter the occasional resort, or stated residence of any part of the human family in their improved condition, it will no doubt be adapted to that end; and it is clear from the passage, that to whatever extent it may be changed, or to whatever future use it may be appropriated, heat is again to be the revolutionizing agent, as it has so often been in times that are past.

For all this our minds are prepared by the discoveries of Geology. Though we may now regard the earth as an emblem of stability, its mutability is indelibly written in its structure. It is the nursery of a race of beings who are formed with aspirations which it cannot satisfy, and who instinctively look forward to another state of existence than the present, and one more adapted to their capacities and powers. It has already undergone a series of vast and im-

portant mutations, by which it has been more and more improved, and better fitted for the accommodation of its inhabitants, and which may all be regarded as so many stages in its gradual progress to its final destination; and as its present state will not warrant the conclusion that that destination has been already attained, we may believe that some farther change is approaching. There are different facts which point to this conclusion. The human race cannot go on increasing to eternity,—for unless the universe be infinite, and all its sections be designed for their reception, which we have no reason to believe, but the contrary, the time must sooner or later come, when their numbers would be greater than the means of their accommodation, and their farther increase would be a serious evil.

But what is more level to our comprehension, the mineral stores laid up in the earth, on which we are in some important respects dependant, are not inexhaustible, as has been already observed,—they are limited, and will certainly be exhausted before the expiration of many thousands of years. There are extensive regions, in which neither coal nor iron have been discovered, and in which we are certain they either do not exist or are wholly inaccessible to human industry; and it is not impossible to calculate the amount of the unexcavated coal in all the known coal fields, and the precise period when they will be exhausted, should the present rate of consumption be continued. That the rate will be reduced, we have no reason to believe,—that it will be increased, may be regarded as certain; but to what amount it is impossible to tell. That the present state of things will continue while the provision which nature has made for it lasts, we may certainly believe,—for no mistake is made in her calculations, and when her purposes have been accomplished there will be no deficiency in that provision, and no excess. We may therefore conclude that the present state of things will not continue beyond a given time; and as the consumption of its means is rapidly increasing, the expected termination will probably come as the Scriptures express it, "as a thief in the night," or sooner than was anticipated,

rather than the reverse. The past history of the earth has been divided into periods, every one of which has been adapted to the accomplishment of a particular object, subordinate to its main and ultimate design; and no sooner was that object attained, than the period terminated in a violent revolution, which introduced a new and improved state of things; and if we may be allowed to reason from the past to the future, we may conclude that there is another revolution approaching, and that the preparations for it are now going on.

In all the past revolutions of the earth, heat has been one of the principal agents, and we are not acquainted with any other equally well adapted to the purpose, or more likely to be called again into action. There are different processes by which it may be generated, and that to any amount required; and when subjected to a high degree of compression, the elements of expansion may be greatly increased. The fires which burnt with so much intensity during the earlier ages of the earth, have greatly abated in later times, but they have not been extinguished. There are thermal springs, and active volcanoes, in every quarter of the globe; and there are few countries which are not occasionally agitated by earthquakes. The elements of disturbance are there still in existence, and may be thrown into a more tremendous paroxysm than ever. It frequently happens that the longer that active volcanoes slumber, the more violent are the eruptions by which their rest is broken; and if the earth has remained for thousands of years in a state of tranquillity, we may believe that the explosion will correspond in magnitude to the time that has been spent in preparing for it. While we are living in peace on its surface, and busily engaged in works which we fondly hope to be lasting, mines are charged under our feet, and ready to be sprung. The elements of the most awful catastrophe with which the earth has yet been visited are silently elaborated in its interior furnaces, and accumulating in its magazines; and when all the preparations have been brought to a close, in the twinkling of an eye, and without any previous warn-

ing given, it will be rent into fragments, and thrown once more into the crucible of Omnipotence, to be fused and recast in a more beautiful mould; and I do not know with what more suitable thoughts and reflections we can contemplate the approach of such an event than those of the Apostle, "Seeing then that all these things shall be dissolved, what manner of persons ought we to be in all holy conversation and godliness, waiting for and hasting unto the coming of the day of God."

THE END.

ERRATA.

Page	3,	line	6,	—For 'epuator,' read, Equator.
"	8,	"	13,	" 'they enter the latter,' read, they enter beneath the latter.
"	25,	"	1,	" 'from,' read; fórm.
"	30,	"	19,	" 'raised,' read, raises.
"	34,	"	22,	" 'means compression,' read, means of compression.
"	47,	"	3,	" 'fully clearly,' read, fully and clearly.
"	54,	"	37,	" 'identified,' read, identifiable.
"	55,	"	1,	" 'salulary,' read, sultry.
"	60,	"	30,	" 'raining,' read, rainy.
"	61,	"	17,	" 'n cherubim,' read, cherubim.
"	64,	"	25,	" 'then,' read, them.
"	66,	"	7,	" 'propably,' read, probably.
"	70,	"	4,	" 'in coming,' read, as coming.
"	84,	"	19,	" 'developed,' read, dissolved.
"	85,	"	30,	" 'that,' read, than,
"	91,	"	28,	" 'events,' read, effects.
"	92,	"	38,	" 'intermittent,' read, intervening.
"	93,	"	11,	" 'large,' read, larger.
"	96,	"	19,	" 'dimension,' read, dimensions.
"	98,	"	27,	" 'by which they are intersected,' read, which they intersect.
"	146,	"	5,	" 'Jewaker,' read, Jewaher.
"	151,	"	19,	" 'Souvguarque,' read, Sovignargues.
"	168,	"	37,	" 'imparting,' read, imputing.