CONSISTENCY

OF THE

DISCOVERIES OF MODERN GEOLOGY,

WITH THE

SACRED HISTORY OF THE CREATION AND THE DELUGE;

BEING A

SUPPLEMENT TO THE SECOND AMERICAN FROM THE FOURTH

ENGLISH EDITION OF

BAKEWELL'S GEOLOGY.

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INTRODUCTORY REMARKS.

An outline of the annual course of geological lectures in Yale College, was annexed to the former American edition of this work, published in 1829, and was designed, primarily, for the use of the students. That short tract, including important additions to facts and some modifications of opinion in regard to theory, would have been revised and annexed to the present edition, had not the principal work been so much augmented by the anthor, as to render it inexpedient to make it materially larger.

An elementary treatise, presenting a copious, but condensed, generalization of the geology of this continent, and sustained by numerous and precise facts, is a desideratum.

Mr. Maclure, many years ago, led the way by a masterly sketch, covering a large part of the United States, and of some of the adjacent provinces and islands.

Professor Eaton has given us many valuable facts, relating, principally, to the state of New York and to New England; and recently, Professor Hitchcock, with the advantage of all the lights held out by his predecessors, has ably detailed, in an octavo volume, the geology of Massachusetts.

We have many good memoirs on particular districts; they are to be found in scientific journals, in books of travels, especially of the scientific expeditions sent out by the American government, in the transactions of learned societies, in detached pulications, and sometimes even in the newspapers. These materials are of great value; but much more must be done before they will be sufficiently copious to enable some master spirit to reduce the whole subject to order, and thus to give a full and digested account of American geology. Foreign geologists will do us the jnstice to remember, that our field is vast, while our laborers are comparatively few, and they are, generally, men occupied by other pursuits; this country is rarely explored by those whom fortune leaves at ease to follow a favorite pursuit. The learned leisure of Europe, and especially of England, is here almost unknown, and our most efficient cultivators of science are also laborers

in other fields. Still, when we remember that geology, as a regular science, is, in every country of Europe, of recent origin; and that, in the United States, most of its early cultivators are still on the stage, we have great reason to take courage and work on.

On the present occasion, we will annex some remarks on the nature of geological evidence, and its consistency with sacred history, making use of some portions of the "*Outline*."

Statement of the subject.

By some, this discussion may perhaps be now regarded as obsolete. In the minds of well instructed geologists, this is probably, to a great extent, true. Still, the Vindiciæ Geologicæ and the Reliquiæ Diluvianæ of Professor Buckland, the Preliminary Discourse to Mantell's first volume on the Geology of Sussex, that of Phillips in his Geology of Yorkshire, that of Conybeare and Phillips in their Outline of the Geology of England and Wales, some of the lectures of Cuvier, and of late, the Geology of Dr. Ure, the Mosaic and Mineral Geology of Penn and of Higgins, besides the distinct work of Chaubard, "Offrant la concordance des faits historiques avec les faits geologiques," and various others of earlier date, sufficiently prove, that the subject is not quite at rest in Europe.

In this country, the cultivation of scientific geology is of so recent a date, that many of our most intelligent and well educated people are strangers even to its elements; are unacquainted with its amazing store of facts, and are startled, when any other geological epochs are spoken of than the creation and the deluge, recorded in the pentateuch. But, it is beyond a doubt, that there are innumerable and decisive proofs of successive revolutions, and of a gradual progress in the course of geological events, implying, on the whole, a regular order in the formation of the crust of the planet, interrupted by occasional disorder and convulsion. These events necessarily imply much time, and cannot be referred, exclusively, to any course of diluvial action. It is impossible, for instance, upon any sound principles of philosophical reasoning, to refer to this cause, the extensive, various and interesting class of facts, relating chiefly to the consolidated rocks composed of water-worn ruins and fragments, and to those containing organized remains, in a mineralized state, entombed in the firm strata and mountains. This is a vast field of observation and instruction, and it is less known, even to the greater number of intellectual persons, than almost any department of knowledge. None but geologists study it with diligence, and none who have not made themselves

masters of the facts, are qualified to judge of their importance and of their bearing. The subject requires, for full illustration, the study and exhibition of a great mass of facts, either in the fields, mines and mountains, or, as an imperfect substitute, in the cabinet. Persons who are entirely ignorant of this species of information, are destitute of the means of forming a correct judgment on the subject; they can never have acquired the habit of comparing one fact in geology with another, and of thus estimating their relation to each other, and to the entire planet. On the subject of geology, it is, therefore, very difficult to find access, to many minds, otherwise enlightened, and habituated to receive and weigh evidence, with candor and intelligence. The reason obviously is, that they are not in possession of the first elementary conceptions; and when the facts are stated, if they are not denied, they are neglected, because they are inconsistent with previous and habitual impressions; thus they fail to make the impression on the mind which they must always produce, when fully understood and realized.

In this country, where the moral feeling of the people is identified with reverence for the scriptures, the questions are often agitated:—When did the great series of geological events happen? If the six days of the creation were insufficient in time, and the events cannot all be referred to a deluge, to what period and to what state of things shall we assign them? This is a fair topic of enquiry, and demands a satisfactory answer. This answer is given by the whole series of geological facts, and the question will never remain of doubtful issue in the mind of any one who has fully studied and mastered them. The subject of geology is possessed of such high interest, that it will not be permitted to slumber; it will proceed with increasing energy and success; a great number of powerful minds and immense research are now employed upon it, and many collateral branches of science are made tributary to its progress. Its conclusions have been supposed to jar with the scripture history: this is contemplated with alarm and displeasure by some, and with satisfaction by a few; but there is no cause for either state of feeling: the supposed disagreement is not real; it is only apparent. It is founded upon the popular mistake, that, excepting the action of a deluge and of ordinary causes still in operation, this world was formed as we now see it, and that all its immense and various deposits were made in a very short period of time. Both these are fundamental errors, which have misled both the learned and the unlearned, and are still extensively prevalent. Although the materials were created by almighty power, they were evidently left

to the operation of physical laws, which laws also affected, more or less, the fate of the various races of plants and animals that were successively called into existence. But, there is no reason to believe that any part of the crust of the earth, reaching even to a fathomless depth, is now in the condition in which it was originally made; every portion has been worked over and brought into new forms, and these changes have arisen from the action of those physical laws which the Creator established, and which are as truly his work, as the materials upon which they operate. The amount of time is the only difficulty, and this will vanish before an enlarged and reasonable view of the whole subject, taken both in its geological and historical bearings.

Nature of the evidence.

The evidence is the same which is readily admitted as satisfactory in the case of historical antiquities.

Roman coins, weapons, personal ornaments, utensils, baths, roads, camps and military walls, and defences of various kinds, have been frequently discovered in Britain. They are ascertained to be Roman, by their resemblance to, or identity with, the acknowledged productions of that remarkable people, as still existing in Italy and the adjacent countries, the ancient seat of their dominion. Had Julius Cesar and the other Roman historians and writers been silent as to the Roman invasion of Britain, and as to the Roman dominion, which, for more than four centuries, existed in that island; still, could any one, acquainted with the facts, hesitate to believe, that the Romans had not only visited Britain, but also remained there, as conquerors and masters, for a great length of time. Had all historical knowledge of the Romans been lost, would not the antiquary who examined the relics named above, and who also extended his observations to other countries where similar things were found, with perhaps the addition of splendid aqueducts, and temples, and amphitheatres, all evidently originating from one and the same people, would he not, without hesitation, pronounce them to have been highly civilized, warlike and powerful; and would he hesitate to assign to them a considerably high antiquity.

At this moment, the barrows or sepulchral mounds, some of them of stupendous size, which are so frequent in some parts of England, and in various parts of Europe and Asia, besides similar structures in North America, with the stupendous forts, which, in Ohio and Kentucky, and other western states, amaze and confound the observer;

these things enable us to realize the supposition just made respecting the Romans, and oblige us to say, that all these structures were the work of unknown races of men, on whose history even tradition sheds not a ray of light.

It is easy to make the case still stronger. When, in 1738, the workmen, in excavating a well, struck upon the theatre of Herculaneum, which had reposed, for seventeen centuries, beneath the lava of Vesuvius; when, subsequently, (1750,) Pompeii was disencumbered of its volcanic ashes and cinders, and thus two cities were brought to light; had history been quite silent respecting their existence, as it was respecting their destruction;* would not all observers say, and have not all actually said,—here are the works of man, his temples, his forums, his amphitheatres, his tombs, his shops of traffic and of arts, his houses, furniture, pictures, and personal ornaments, his streets, with their pavements and wheel-marks, worn in the solid stone, his coins, his grinding mills, his very wine and food, his dungeons, with skeletons of the prisoners chained in their awful solitudes, and here and there a victim, who, although at liberty, was overtaken by the fiery storm.

Because the soil had formed, and grass and trees had grown, and successive generations of men had unconsciously walked, toiled, or built their houses, over the entombed cities; and because they were covered by lava or cinders, does any one hesitate to admit, that they were once real cities, that they stood upon what was then the upper surface, that their streets once rang with the noise of business, and their halls and theatres with the voice of pleasure; and that, in an evil hour, they were overwhelmed by the eruptions of Vesuvius, and their name and place blotted out from the earth and forgotten.

All this is legibly read by every observer, and all agree in the conclusions to be drawn. When moreover, the traveller of the present day sees the cracks in the walls of the houses of Pompeii, and observes that some of them have been thrown out of the perpendicular and have been pointed, and plastered, and shored up with props, he learns, that the fatal convulsion was not the first, and that the doomed towns, must have been before shaken on their foundations, by the throes of the laboring earth.

To establish all this, it is of no decisive importance that scholars have gleaned, here and there, a fragment from ancient Roman classics,

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* In the histories of those times, it is only said, in general terms, that cities and villages were overwhelmed.

to shew that such cities once existed; and that they were probably overthrown by the eruption of the year 79 of the Christian era, which gave occasion for the interesting letter of the younger Pliny, describing the death of his uncle, while observing the volcanic storm which proved fatal to him. In such cases, the coincidences of historical and other writings and the gleanings of tradition are indeed valuable and gratifying, and are of great utility in fixing not only the order, but the time of the events; but, the nature of the catastrophe, which buried the devoted cities, is perfectly intelligible from the appearances themselves, and needs no historical confirmation. No man ever imagined that Herculaneum and Pompeii, were created where we now find their ruins; no one hazards the conjecture that they are a lusus naturæ, but all unite in giving an explanation consistent, alike, with geology, history and common sense.

Application of the Evidence.

In the same manner then, we reason respecting the physial phenomena of our planet.

It is full of crystals and crystallized rocks; it is replete with the entombed remains of animals and vegetables, from entire trees to lichens, fuci and ferns—from coal beds to mere impressions of plants; it is stored with animals from the minutest shell fish to gigantic reptiles; it is chequered with fragments, from fine sand to enormous blocks of stone; it exhibits in the materials of its solid strata, every degree of attrition, from the slightest abrasion of a sharp edge or angle, to the perfect rounding which produces globes and spheroidal forms of exquisite finish: it abounds with dislocations and fractures; with injections and fillings up of fissures with foreign rocky matter; with elevations and depressions of strata, in every position, from horizontal to vertical; it is covered with the wreck and ruins of its upper surface; and finally, its ancient fires, sometimes for variable periods, dormant and relenting, have never been extinguished, but still struggle for an exit, through its two hundred volcanic mouths. The present crust is only the result of the conflicting energies of physical forces, governed by fixed laws; its changes began, from the dawn of the creation, and they will not cease till its materials and its physical laws are annihilated.

Instances.

They are innumerable, and are every where at hand; every system of geology unfolds them; our author's preceding volume is rich in

such facts and it remains only to illustrate our position by a few examples, in general, not novel, but duly connected, to sustain the argument.

Fossil Fish of Mount Bolca.

The beautiful fossil fish* more than 100 species of which are found in marly limestone, in Mount Bolca, near Verona in Italy, inform us that they were once living and active beings; just before those hills were deposited, and when the waters stood over the place where the fish were entombed, in the bottom of the sea, the rock which contains their skeletons was formed around them, doubtless in the state of a calcareous sediment; this calcareous stratum was then overwhelmed by a submarine eruption of molten rock, and the heat was not communicated through the bad conducting substance of the marl to the destruction of the organic forms; then again, and still on the bottom of the sea, the calcareous rock was formed anew with its enclosed fish; again the molten rock flowed over the calcareous marl and so on in several successions. But this is not all; this remarkable formation is now several miles from the Adriatic, the nearest sea, and it rises 1200 feet above it. It is plain then, not only that the whole was successively formed beneath the ocean, but that the hill, with the country to which it belongs, was raised afterwards by subterranean power, and that the surrounding waters have also retired and have, ages since, left only dry land.

Organic Remains in Early Rocks.

In very early, and often deeply seated rocks, coming immediately after the primitive and usually called the transition, we find the first traces of organized beings; the perfect impresses of plants, with the earliest coal, and both the impresses and the entire mineralized bodies of millions of animals; the deposition of these rocks was therefore cotemporary with or subsequent to, the creation and propagation of the organized beings whose impresses, or whose forms they contain, and it is selfevident, that these rocks could not have been deposited prior to the date of the animals and vegetables included in them.

Both the plants and animals lived and died at or near the places where they are found entombed in the rocks; for in most instances, they present few or no marks of violence, or of accident; their del-

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* Of which there are splendid specimens in the cabinet of Yale College.

icate parts are, often, perfectly preserved; animals, with all their organs entire, and plants with their fibres and leaves in full expansion.

Occasionally, however, we find one stratum with its included mineralized organic bodies entire, and a contiguous one having them more or less broken, mutilated and dispersed.

Both the plants and animals, belong generally to races which are no longer found alive, or if *analogous* races exist, they are related to the ancient ones, rather by generic than by specific characters. These ancient animals, are commonly either zoophytes or, shell fish; always having a simple structure, and in many instances, they are destitute, or nearly so, of the power of locomotion; sometimes, however, they are furnished with organs for that purpose. Madrepores and encrinites, could move very little; the echinus, found abundantly in the chalk, a very recent rock of the secondary class, moved on his spine, which served him for a foot, and some of the early shell fish, had organs to enable them to rise and fall in the water. Sometimes, rocks rich in entombed animals, occupy great districts of country. In the transition marble for instance, animals reposing in the bowels of mountains, miles from day light, often form almost the entire mass, and they are so firmly united to the rock, as to constitute a part of its substance. Many of the architectural marbles owe much of their beauty to imbedded animals, myriads of which lie almost in absolute contact; the matter of the rock between them, only filling up the void occasioned by their angular and confused positions.

The trilobite is one of the early fossilized and imbedded animals; this animal, having in his back, a jointed articulation, could bend his body like a lobster, and we find him sometimes doubled, and sometimes expanded, as he lies in the rocks.*

Possible Mode of Consolidation.

There is little difficulty in understanding how the marine animals, for example, the crinoidea that fill, more or less, the transition limestone of the Peak of Derbyshire, came to be thus entombed. We cannot

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* Grand trilobites, of singular size and perfection, were shown me by the late Mr. John Sherman, at Trenton Falls, near Utica, (New York,) where they were obtained. Dr. Eights, of Albany, in a voyage to New South Shetland, found the trilobite, *still a living animal*. Prof. Green, of Philadelphia, has illustrated this interesting family by a valuable monograph and admirable models, moulded and colored, in exact fac simile, with the originals.

doubt that the animals received their existence, and lived and died in the ocean, and that, at least at the time of their death it was full of calcareous carbonate either in solution or in mechanical suspension, or both.* When they died, they of course subsided to the bottom, and were surrounded, as they lay, by the concreting calcareous matter. Multitudes of them were present, at the same time and place, in all the confusion of accidental position, and therefore were enveloped, just as we find them, in every imaginable posture; the interstices were filled by the calcareous deposit, and this being more or less chemically dissolved, produced a firm sub-crystalline mass, a section of which shews us the animals sawn through, and admitting of a polish, like the rest of the rock.

If we could suppose that our common clams and oysters, that lie in the mud of our harbors and inlets, were to become solidified into one mass, along with the matter which envelopes them, the case would not be dissimilar; only they would be enveloped in earthy, instead of crystalline matter, and the rock formed from it would be referred to the most recent secondary, or to the tertiary, unless its texture were afterwards altered by igneous or other agencies.

It is easily understood, also, how a new stratum, either of the same or of different constitution, may be deposited upon a previous one; and with it, the bodies of the animals that lived and died in the fluid; and these might be the same animals with those of a previous stratum, or of a different species or genus, it being understood that, in the case of marine animals, each successive stratum was, in its turn, the bottom of the then ocean, and also the upper or last consolidated layer of the crust of the earth, as it then was at that place.†

As we have no direct historical evidence to the facts, it is impossible to say, precisely, what circumstances would determine the waters to deposit, different things at different times, for instance at one period, a stratum of limestone, with madrepores and encrinites, and at another, one of breccia or sandstone, with bivalve or univalve shells.

With respect to marine and aquatic animals, the waters appear to have been, at different periods, adapted to the support of different races, and thus their remains became successively solidified; not imply-

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* The eruption of a vast calcareous sediment, by submarine igneous agency, which some have supposed in the case of chalk, is hardly admissible here, as the transition limestones does not corresponds with the usual appearance of mechanical deposits.

† A similar course of reasoning, will apply to fresh water deposits.

ing, however, the entire extinction of all the animals of a particular race; a multitude were entombed, as is proved by their remains, but the species often survived; in the mean time, new races were created and petrified in the forming rocks: again perhaps, the diminished race peopled the waters anew, and their relics were solidified in a new deposition, and so on in succession.

Whether animals and vegetables were deposited in the ocean, or in seas, in lakes, rivers or estuaries, it is easy to imagine, that if all the causes necessary to produce the events, were in successive operation, they might follow each other in the order supposed; and that this was the fact, cannot be reasonably doubted, any more than that an edifice, having granite for its foundation, and sandstone for its basement, and marble for its superstructure, and wood for its roof, and lead, zinc or iron for its covering was actually constructed of these materials, by the architect and connected in that order by his intelligent design.

The great truths of geology are few, simple and intelligible; needing nothing but the application of a sound judgment, enlightened by science, to the accurate observation of facts, which can often be distinctly observed, and the order of their succession ascertained, whether the proximate causes and the immediate circumstances can be discovered or not.

It is a supposition, altogether inadmissible, and unworthy of a serious answer, that the animal and vegetable races, entombed in such profusion, and buried often under entire mountain ranges, or firmly cemented into their very bosom, were created as we find them. On the contrary, there can be no doubt whatever, that they were once living beings, performing the part belonging to their respective races, and that at their death, or soon after, they were consolidated, in the then concreting and forming rocky strata, or that they were, in various instances, overwhelmed by igneous or diluvial catastrophes.

Animal Remains in Secondary and other Rocks.

The older secondary rocks often abound in shells of molluscous animals, principally of extinct genera, and there is a progression through the more recent strata, exhibiting a greater and greater approximation towards the more complicated structure of the most perfect animals; while the newer rocks of this class, and of the strata that lie upon them, including the tertiary, contain reptiles, fish, and even birds, and terrestrial quadrupeds.

Saurians or Lizards.

Within a few years, the skeletons or disjointed bones of some very large oviparous animals of the Saurian family, namely, ancient crocodiles, the ichthyosaurus or fish lizard, the megalosaurus or great lizard, and the plesiosaurus, have been found in the recent secondary rocks, especially of England and France, and some of them in the tertiary.

The Megalosaurus is found in limestones and sandstones lying higher than the lias, and the ichthyosaurus and plesiosaurus are found also in many of the strata above, and in some of those below that rock.

The fossil crocodile appears to have been, anciently, an inhabitant of fresh water, and of rivers, as at present. In the West Indies, according to De La Beche, the crocodiles frequent muddy, and sometimes brackish ponds; and in shallows, they often remain for hours, with the tips of their noses out of water. The organization and habits of crocodiles, do not enable them to contend with the agitations of the sea, which they shun. It would seem, however, that the organization of the ichthyosaurus would enable him to swim in the waves.

The crocodile has been continued, perhaps, from the new red sandstone—certainly from the lias, to the present time—and, as its remains often occur in the interval, it appears to have been a tolerably constant inhabitant of our globe.

With one exception, that of the opossum, found in the Stonesfield slate, near Oxford, (Eng.) no viviparous vertebrated animal has been found below the chalk.* The Stonesfield slate belongs to the oolitic series, and lies below the chalk.

The remains of the Saurians, found, within a few years, in England, France, and other countries, indicate animals of twenty, forty, fifty, and seventy feet or more in length. They were generally amphibious, and there is every reason to believe, that when only portions of England stood out, as islands, above the water, these enormous animals swam and sported about, in the inter-insular waters of primitive Britain, or basked upon the shores of its seas and estuaries.

Mr. Mantell, of Lewes, in Sussex, England, has described another enormous Saurian animal, the Iguanodon, (so called from his resemblance to the Iguana of the West Indies;) it was an herbivorous reptile, and appears to have attained the length of seventy feet or more with a height of nine or ten feet. Still, his remains are interred in

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* Unless it be the East Windsor animal.—Vide Am. Jour. Vol. II.

solid ferruginous sandstone, far below the chalk, and probably more than one thousand feet beneath the upper strata, that were subsequently formed over him, many of which have been swept away by diluvial action, or by other catastrophes.

In July, 1832, another Saurian was discovered in the sandstone of Tilgate Forest. It is described by Mr. Mantell, in his late work on the Geology of the South East of England, and a plate of its bones is annexed. The reptile is named, by Mr. Mantell, the *Hylæosaurus*, or Wealden Lizard. Vertebræ, ribs, coracoids, and other bones, were found, either in connexion or in juxta-position, making an imposing mass, and very firmly cemented into the sandstone. The animal was gigantic, but its exact dimensions are not given; its tail is supposed to have been twenty five feet long.

The vegetable remains, as well as the fishes and shells, and rolled stones, that are found entombed in the same strata, show that they were once the upper surface and formed part of a vast estuary, which was subsequently buried by the marine formation of the chalk and its attendant strata.

Organized Remains in very recent rocks.

It is easily understood, why no land quadrupeds are found in formations earlier than the tertiary. Until this period, there was not dry land enough for terrestrial quadrupeds. When they were created, it was evidently a period more advanced, than that which produced the ancient crocodiles; more land was uncovered, but a multitude of natural basins, forming lakes, were still full of water, and as the strata which they now present, were in the course of being deposited, various quadrupeds, fortuitously conveyed into the water, or perhaps drowned by accident or by partial inundations, became buried and solidified, and their remains are now found in the basins of Paris and London, and of the Isle of Wight. They are much less frequent, than the marine animal remains of the earlier strata, probably, both because the animals were much less numerous, and because the circumstances attending their existence and death, were far less favorable to their inhumation and preservation.

It is worthy of remark, also, that in the very strata in which they are contained, the relics of water-born animals are very numerous. It is believed, by Cuvier and Brongniart, whose elaborate investigation of the Paris strata, has been several years before the world, that there were successive periods, in which marine and fresh-water shells were, alternately and successively, produced in the waters.

Trees and their members, and even entire forests are found in similar situations.

In general, the bones and trees are not mineralized, but are rather, for the most part, in the condition of grave bones or ancient wood.

The bones could not be found in the older strata, as the animals were evidently not in existence when those strata were deposited. Much less could we expect to find human bones in them, for man was not created till the earth was reduced to order, and many generations of animals and plants, had lived and died; depositing their remains in the rocks, whose formation was contemporaneous or immediately subsequent, or whose materials were accumulated, by catastrophes that also overwhelmed the organized beings.

The relics of plants, (the coal formations excepted,) are far less numerous than those of animals. It is in no way surprising that their creation should have been successive, and associated with different rock formations, and when the same plants occur in repetitions of the same or of different formations, their seeds or roots might have been preserved, and transported from other places, by the waters or other causes.

That state of things which attended a particular rocky deposition, may have been such, when the same kind of rock came to be deposited again, as to favor the production of the same animal or vegetable races from the germs, seeds, roots or individuals that had been preserved.

In the same latitudes, there is now, on the earth, a great regularity in the vegetable species, and in a less rigorous degree, in the animal races.

There is every reason to believe, that the creation of animals and plants was successive; not by equivocal generation—not by atomic action, but by the fiat of the Almighty.

Early animals—wood—trees—coal.

Among the primitive rocks there are no traces of vegetation, any more than of animal life. But we repeat in this connexion, that we no sooner reach the transition rocks, than both animals and plants begin to appear; the animals, however, are marine, and are vastly more numerous than the plants. There is no reason to believe that plants appeared until there were shores, and even marine plants must have, in general, points of attachment in shallow waters.

According to Mr. De La Beche, wood and terrestrial plants are found in most rocks, from the old red sandstone upwards, and, in fact, in the order of rocks immediately beneath, i. e. the transition; proving that dry land must have existed, more or less, previous to, or at the time of the formation of most of these rocks. We may suppose, therefore, that ponds, lakes and rivers, existed also.

Arborescent plants, and their branches and roots, are often found in the coal formations, and in their sandstones, &c. which proves that the gigantic vegetables were sometimes embraced in those depositions.

It would appear, from the relics of the periods immediately succeeding the transition rocks, that vegetation had increased prodigiously upon the earth, and that there were even trees and forests upon those parts of the surface that had become sufficiently dry.

Bituminous coal, belonging to the era of the earlier secondary, or, as now agreed, to the transition, seems to have been formed, as there is great reason to believe, from submerged and inhumed vegetables, chiefly of cryptogamous plants, whose vestiges are so numerous in the coal mines.

Coal, being peculiarly limited in its relations, and often contained in basins, it seems probable, that it generally arose from local circumstances, with all its alternating and attendant strata of shales, sandstones, limestones, clays, iron ores, pudding-stones, &c.; and, as these depositions are often repeated several times, in the same coal basin, and the mines are occasionally worked to a great depth, (even to twelve hundred feet, in some places in England,) it is plain that no sudden and transient event, like a deluge, could have produced such deposits, although it might bury wood and trees, which, in the course of time, might approximate to the condition of lignite or bituminized, or partially mineralized wood, which is often found under circumstances indicating a diluvial origin.*

Early existence of trees.

It has been supposed, that the plants which have contributed to the formation of coal were generally succulent, with little or no firm woody fibre. It appears, however, from two memoirs by H. Witham, Esq. of Edinburgh, that large trees, strongly resembling the Norway fir and the yew tree, existed, even anterior to the deposition of the great bituminous coal-field of the Lothians, around Edinburgh. Near that city, in 1826, a fossil tree was discovered, three feet in diameter at its

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* See Am. Jour. Vol. XXV, p. 101.

base and thirty six feet long, lying nearly horizontally between the strata of sandstone. Its composition was carbonate of lime 60, oxide of iron 18, carbon 9, alumine 10.

Another fossil tree has been recently discovered in the quarry of Craigleith, near Edinburgh, whose geological position is in the mountain limestone, and considerably below the great coal basin of the Lothians. Its elevation is seventy five feet above the level of the sea, and its roots were in the bottom of the quarry. The length of the stem was forty seven feet—a large branchless trunk—in some parts much flattened, so as to afford an elliptical section. At the largest place, its diameter was five feet by two, and at the smallest, nineteen inches by sixteen. Its branches, and many feet of its top, are gone; it was probably sixty feet long, and the incumbent mass of sandstone appears to have been one hundred feet thick; the bark is converted into coal. The composition of this tree is, carbonate of lime 62, carbonate of iron 33, carbon 5, with the sp. gr. 2.87. It was a conifera.

In the great coal-field of the North, in Britain, fossil plants are usually found lying parallel to the strata, but much broken and compressed, and their parts scattered; but some vigorous plants, generally Sigillariæ, appear to have been so strong as to resist the torrents and to remain in their natural position.

It results from Mr. Witham's discoveries, that plants with their organs of fructification apparent, (gymnospermous phanerogamic,) are much more frequent in the coal formations than has been imagined, and that proper trees, of true ligneous fibre and of great size, existed even earlier than the bituminous coal.*

More recent fossil trees and plants.

Among the more recent secondary rocks, vegetables increase in quantity and variety, as we approach the tertiary, in which we find inhumed wood in the form of lignite, or bituminized wood, or wood slightly mineralized; eventually we find wood unchanged; and thus we trace the vegetable families, from their commencement on the borders of the primitive, quite down to our own times. In the loose sand, gravel, and detritus, we often find trees, at every depth, between the surface of the ground and the fixed rocks below; the surface is often covered by bowlders of travelled stones, and the deposition is evidently diluvial.

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* Am. Jour. Vol. XXV. p. 109.

Organized Remains deposited from Water, but not from a Transient Deluge.

It is scarcely possible to doubt, that the process of animal and vegetable deposition in a mineralized state described above, was that which really happened. Whatever may have been the operations of fire, at preceding or subsequent periods, it is impossible that it should have been concerned in the first formation of the mineral strata, which contain numerous organized remains. Animal or vegetable life could never be produced or sustained in the midst of fire; and indeed, it is quite incredible, that strata, containing distinct organized remains, were ever melted; nor is it easy to imagine, that they could be even softened, in any great degree, without destroying or materially deranging the organized structure.*

It appears evident also that the mineralized plants and animals of the solid strata have not been collected in these situations, by any sudden and local, or even general catastrophe, for as an author remarks, "among the immense number of fossil shells, many are remarkable for their extreme thinness, delicacy and minuteness, of parts, none of which have been injured, but on the contrary are most perfectly preserved." Among the plants of the coal formation situated sometimes hundreds and thousands of feet below the surface, and covered by many beds of solid rocks, their leaves, many of which are of the most tender and delicate structure, are often found fully expanded, in their natural position, in regard to the rest of the plant, and laid out, with as much precision as in the *hortus siccus* of a botanist. It is often true that the minutest parts do not appear to have suffered attrition or injury of any kind.

Fragmentary Rocks.

The rocks composed of fragments and rounded water worn pebbles afford us the strongest evidence of progressive destruction, deposition and consolidation.

Among the transition rocks, we find (in general) for the first time, fragments both rounded and angular of all the previous rocks; some-

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* *October* 21, 1833.—A day or two since, I observed a common hard baked brick, lying in the pavement of a street in this town, (New Haven, Conn.) bearing a distinct and beautiful impression of a scallop shell (pecten); the shell was gone, being doubtless destroyed by the fire, while its impress remained. Strata that have been ignited may therefore retain the forms of organic bodies, which would of course be destroyed by the heat.

times, these fragments are united by crystalline matter of a different nature, forming the paste or cement, which holds them together; at other times, the paste is composed of nearly or quite the same materials with the fragments, but in a state of much finer division, and at other times there is little interposed cement.

But many of the rocks of this class are most palpably fragmentary, and the fragments are of all sizes, from those that are scarcely visible to the naked eye, to those whose dimensions are measured by inches and even by feet.

Instances.

The brecciated marble of the Potomac, employed in the public buildings at Washington, is a remarkably firm rock, composed of angular and ovoidal pebbles, the latter of which have evidently, received their shape from friction in water. The cement is a more minutely divided substance of the same kind, but calcareous matter is not exclusively the material either of the pebbles or of the cement.

The fragmentary rocks of Rhode Island, extending by Providence to Boston, and which are very conspicuous in Dorchester, Roxbury, Brooklyn, and other neighboring towns, are fine examples of early formations of this kind. They are very interesting five miles east of Newport, at a place called Purgatory, where a large mass of the rock separated by the natural seams which are found in it, running parallel for a great distance, and cutting the pebbles in two, has fallen out, having been undermined by the sea, whose waves, when impelled by storms, break and roar frightfully in this deep chasm.

The pebbles are here chiefly quartz—they are ovoidal in form and of every size from that of a birds egg to that of a common keg, and they lie generally with their transverse diameters parallel.

The pebbles of the fragmentary rocks about Boston are very various in their composition, obviously however the ruins chiefly of primitive rocks. The pebbles, which there lie in the roads and fields have proceeded from the disintegration of this pudding stone.

The great sandstone deposit of the valley of the Connecticut presents every variety in the size and form of the parts that have been broken up from previous rocks,—transported—more or less rolled, and cemented into rock again.

In East Haven, near New Haven, the rocks often contain massy pebbles of granite, gneiss—mica slate and clay slate, and of the individual minerals of which they are composed. Water worn-pebbles are in some places as common in these rocks as on the sea shore:

they form mighty strata, which have been tilted out of the horizontal position, into an inclination of 15 or 20 degrees from the horizon.

The Cattskills, are conspicuous monuments of geological revolutions. Not only at the base, but at the summit, from two to four thousand feet above the level of the Hudson river, we find these mountains composed extensively of fragmentary rocks, rounded and angular, and their rude piles inform us, that the materials of which they are built were once loose and rolling about, in the waves of an early ocean, encountering friction and violence in their various modes of action, and we see not how to avoid the conclusion that these mountains, after consolidation, have been raised from the depths of the sea.

Origin.

If we enquire whence arose the mighty masses of ruins of every shape and variety, composing not merely accidental fragments, or here or there a stratum or a hill, but covering myriads of square miles, which are sometimes the basis of countries, and rise occasionally even into high mountains, we must look for an adequate cause.

Such are the effects and proofs of crystallization, as exhibited in the early primitive rocks, that the contrast afforded by the fragmentary rocks, must appear very striking; and connected with their relative position, can leave no doubt on the mind, that they arose from a subsequent and totally different state of things.

What were the causes that broke up portions of the primitive rocks and left their ruins the sport of the waves, destined in the progress of time, to be cemented again into firm masses?

Besides the wearing effects of the weather and the seasons, powers still constantly in action, and of the vicissitudes of temperature, we can add the convulsions of earthquake, tempest, flood and fire, by which our planet is still occasionally agitated. Beyond these, facts do not enable us to go, but the causes that have been named would in the course of ages, perform the work, great as the results may now appear.

The breaking up of primitive and other rocks by violent convulsions, and the transportation of their ruins, often to distant places: the frequently rounded form of the fragments, presenting pebbles of every size, from that of a pea, to that of a hen's egg,—a human head, or a barrel,—quartz being not unfrequently the material; the reconsolidation of these masses into firm rocks,—their stratification at first horizontal and then rising, at various angles of inclination; the alternation of such strata with slate and coal and other deposits, their ex-

traneous contents of innumerable organized beings, and the elevation of the whole, sometimes hundreds or thousands of feet above the ocean level; all these facts leave not a doubt that the fragmentary rocks, required much time for their formation, consolidation and elevation, and could never have been the work of a short period, or of a transient deluge.

Diluvial Deposits.

As regards the wreck and ruin, with which the surface of our planet is every where covered; their extraordinary position, and, to some extent, their production, are justly and generally attributed to diluvial agency; to mighty floods and rushing torrents of water.

The effects of a deluge are not forming, but destroying; they are chiefly mechanical, and very little if at all chemical. 'There is not the least reason to believe, that any solid rock was produced by the general deluge, nor that any firmly imbedded and petrified organized remains belong to such a catastrophe; to the action of waters, agitated by a mighty moving force; turbid in the extreme, and filled with moving rocks, stones, gravel, and coarse and fine sediment—and with extirpated and floating vegetables, and drowned animals.

Diluvium is found every where. The almost universal deposits of rolled pebbles, and bowlders of rock, not only on the margin of the oceans, seas, lakes, and rivers; but their existence, often in enormous quantities, in situations quite removed from large waters; inland,—imbedded in high banks, or scattered, occasionally, in profusion, on the face of almost every region, and sometimes on the tops and declivities of mountains, as well as in the valleys between them; their entire difference, in many cases, from the rocks in the country where they lie—rounded masses, and pebbles of primitive rocks, being deposited in secondary and tertiary regions, and vice versa; these, and a multitude of similar facts, are among the most interesting of geological occurrences. Curvilinear stones may, possibly, in given instances, be formed, by decomposition of the angular portions—by various chemical agencies, aiding those of a mechanical nature; but pebbles, present unquestionable evidence of having been brought to their rounded form by friction, and they can scarcely be confounded with those produced in any other way.

The attrition of the common waters of the earth, and even that exerted during the short period, of the prevalence of the deluge described in Genesis, would do very little towards producing so mighty a result; and we must assign this operation to an earlier and much

more extended course of mechanical agencies, produced by long agitated waters.

We must charge to moving waters the undulating appearance of stratified sand and gravel, often observed in many places, and very conspicuously in the plain of New Haven, and in other regions of Connecticut and New England; exhibiting frequently, a delicacy of flexion, in the layers of gravel and sand, which makes them appear as if they had, but a moment before, received their impulse and position from undulating water, and as if they had copied the very eddies and gyrations of the wave.*

Bowlder stones, consisting of fragments of primitive rocks, probably from the regions north of the great lakes, are found abundantly on the secondary regions of Ohio, New York and other states; the fragments of the primitive Alps, on the Jura chain, (the lake of Geneva intervening;) the ruins of the Scandinavian mountains on the secondary and diluvial plains of Prussia and Northern Germany, (the Baltic being between,) and the fragments of the northern counties of England, cover the southern and middle regions.

In many cases, bowlders and pebbles can be traced to their native beds, and frequently they are strangers to the regions where they are found.

Deserts of sand, covering tracts more or less extensive, such as those in South Africa, and in the Zahara, stretching in a vast belt, from the Atlantic ocean to the desert of Lybia; the sandy plains of Arabia, Germany, and Russia; the great desert at the foot of the Rocky mountains, and all similar deposits, in situations where no existing causes could leave them, are, with great propriety, referred to diluvial agency.

Diluvial torrents—lakes—valleys.

That diluvial torrents had sufficient power to roll even bowlder stones and disjointed columns† to great distances, or to precipitate them into the valleys, is sufficiently evident, from what we know of the energy of torrents in our own time.

Beds of sand, gravel, clay, loam, pebbles, and bowlders, are found, as already stated, to compose the loose materials of every country,

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* These strata would probably now be arranged with the tertiary.

† Such as the columns of trap, sometimes of enormous size, which are found scattered, up and down, through the great Connecticut valley, often at a great distance from their parent ridges. The most remarkable case in this range, is ten miles west of Hartford, on the Albany turnpike.—*See Tour to Quebec.*

and they invariably exhibit the appearance of deposition from water, sometimes tranquil, sometimes more or less agitated.

Diluvial waters appear to have first transported, and then, in a state of comparative quietude, to have arranged these masses by sedimentary deposition.

The effects of diluvial devastation are in a considerable degree veiled, by the gradual depositions of sedimentary matter, during the decline of the waters.

Granting that the earth has been, from any cause, covered by water, and that it has been in any way withdrawn, there must evidently have been a multitude of local lakes, determined, by the basin shape, so often traced by contiguous hills and high grounds; in these, separate and independent deposits were doubtless going on, for a length of time, perhaps even after the earth began to be peopled at the creation, or repeopled after the deluge; for this view will apply equally to the waters which covered the earth originally, and to those that returned upon it by an universal deluge. Those lakes that had no permanent supply of water, would, of course, be exhausted by soakage and by evaporation: others would burst their barriers, or gradually wear them down, and during their escape, renew the diluvial ravages; while those only would be perennial, which were fed by streams or springs.

Many valleys of denudation, as they are called by Prof. Buckland, were probably produced by diluvial action. Such valleys are conspicuously seen in the South of England: similar strata are found capping contiguous hills, projecting at their sides, and running beneath their foundations; a curve or hollow having been scooped out between, thus indicating the effects of great rushing torrents, attended perhaps by convulsions, that more or less, broke up the superficial strata.*

It is not intended that all valleys were produced in this manner; many doubtless were thus formed, and many more were thus deepened and modified, but a multitude of them were probably among the original features of the planet, or produced by early convulsions.

Extraneous contents of the diluvium.

Single bones, parts of skeletons, and entire skeletons of the larger animals, often of extinct species, but mostly of known genera, are

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* See this subject ably investigated and illustrated in the Reliquiæ Diluvianæ.

found abundantly in the diluvium of all countries, where curiosity and intelligence exist.

Whales, sharks, and other fishes; crocodiles, and other amphibia; the mammoth or the extinct elephant; species of elephants, nearly or quite like those of modern times; the rhinoceros, the hippopotamus; hyenas, tigers, deer, horses; various species of the bovine family, and a multitude more, are found buried in the diluvium, at a greater or less depth; and in most instances, under circumstances indicating that they were buried by the same catastrophe which destroyed them; namely, a sudden and violent deluge.

It appears, from Dr. H. H. Hayden's Geological Essays, that under the diluvium of the Atlantic portion of the middle and southern states, there lie buried a great quantity of the bones of whales, sharks, porpoises, mammoths, Asiatic elephants, and other large animals, along with numerous trees, sometimes with their fruit. Layers of marine mud are also found deep beneath the diluvium, below the present low water mark.

There are also vast quantities of shells, and especially of a gigantic oyster, in many parts of the southern states. They are found, not only in digging for wells, but they form vast beds in various places.

Near Tours, in France, is a bed of oyster shells twenty seven miles long and twenty feet thick.

But the beds of the southern states far exceed this. A stratum, on the whole continuous, although mixed, more or less, with the general diluvium, and other materials of the country, has been traced from the Eutaw springs, in South Carolina, to the Chickasaw country; six hundred miles in length, by ten, or from that to one hundred, in breadth.*

There can be little doubt that many of the beds of oyster shells, which have been attributed to the aboriginal Indians of this country are diluvial deposits.

The bones and skeletons of large animals, especially of the mammoth, are found in wide dispersion, and in very remote countries; in both Americas, in Europe and in Asia. In northern Asia, the tusks of the extinct elephant, are discovered in the diluvial banks of almost every river, and the ivory is found in such abundance, as to be a regular article of commerce. An enormous carcase of the northern or Asiatic elephant, a few years since, by the gradual thawing of the frozen bank, in which it was imbedded, high above the water, fell down and exhibited the flesh in full preservation; the long bristly

* Mr, Finch.

hair and vast massy hide, requiring a large number of men to carry it, afforded proof irrefragable, of the existence of the animal in those rigorous climates, and of his sudden extinction, inhumation and congelation, with so little interval of time, that putrefaction had not commenced, and has not since taken place, during a long succession of ages.

Indeed, there is but one view which appears to carry with it the least probability, as to the cause of the wide dispersion and sepulture of the gigantic races; especially of extinct animals in the various quarters of the world. It seems evidently to have been the work of a deluge, which at once drowned, and in many instances extinguished, whole races of animals, and buried their bodies in the wreck of the planet with which those waters were evidently filled. Such a scene of awful devastation, was as well fitted to produce these effects, as it was ill adapted, to the comparatively tranquil life and death of the successive generations of marine and aqueous animals, that peopled the earlier oceans.

As organized remains are found at very high levels, not only mineralized, but loose or in diluvium, the prevalence of the ocean at different periods and under very different circumstances, is thus proved.

It is said that the skeleton of a whale lies on the top of the mountain Sandhorn, on the coast of the northern sea. The mountain is three thousand feet high, and there is no cause that could have conveyed the whale to that elevation, except a deluge rising to that height.

So late as June, 1824, the remains of a whale were found on the westernmost Stappen, a mountain in Finmarck, at an elevation of eight hundred feet above the ocean. The specimens, which were reported to be vertebræ, were lost by shipwreck on their passage to England. Similar remains are said to exist also in North Fugeloe, another mountain in those regions.—*Penn.*

It is common to find trees and their members, not only in the diluvium, but also in the known alluvium of rivers, &c. In general, they are not much altered; sometimes they are partially bituminized or verge towards lignite, or perhaps are really lignite; at other times, they are penetrated by acids and saline substances, and metallic minerals, as pyrites, are occasionally formed upon or in them.

As there is no difference in the nature of the operations by which diluvium and alluvium are produced, we must resort to an induction of particulars, in order to enable us to distinguish between them; but in most situations, especially those that are remote from rivers and moving waters, there is very little occasion for hesitation, in forming an opinion.

Beautiful Arrangement of Loose Materials.

Nothing in geology strikes the observer, with more interest, than the beautiful arrangement, in strata, of the beds of sand, gravel, clay, loam and pebbles, which may be observed in every country.* A section of a bank of any of these deposits—or better still, an avulsion or fall, which leaves the stratification exposed, without being obscured by the rubbish, produced by digging, or by the sliding of loose sand—never fails to exhibit the effects of sedimentary deposit; sometimes horizontal—sometimes inclined at various angles, great or small—sometimes undulatory, and recording, in a language that cannot be misunderstood, the effects of subsiding water. The beds are not always in the order of the magnitude of the parts. Sometimes coarser gravel, or even pebbles, will form a layer, above fine sand, and then perhaps the order will be reversed, indicating that there were currents; and these, relenting and increasing, alternately, as they were impelled probably by tides or storms, so that coarser or finer materials were transported and deposited, as the waters were more or less agitated; for currents must have existed to the last. Could these sedimentary deposits be now all removed, we should see the naked, scarred and devasted skeleton of the planet, exhibiting the most decisive proof that it had been swept by violence, of which we find evident marks in the scratches and furrows, found in the fixed rocks, that are covered by diluvium.

If a section of the deepest diluvium could be made quite down to the solid rock, there can be little doubt, that, on the whole the magnitude of the parts would correspond with the depth, and the larger fragments of these materials would often be found at the bottom. This does not render it improbable, that bowlder stones should be occasionally deposited on the surface, especially when they are found on the firmer materials, or on rocky ledges.

Contrast between Diluvial, and Tranquil Aqueous Agency.

The agency of water, whether fresh or salt, in sustaining, depositing and burying organized bodies, (except the effects of occasional convulsions) was, evidently, tranquil and long continued; giving time for many generations of the same or of different races; and for all the alternations and successions of different strata with different organized bodies.

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* For our present purpose it is immaterial whether these depositions be referred to tertiary deposits, or to those that are strictly diluvial.

The occasional intervention of igneous irruption, whether submarine or subterrene, below or among the strata of aqueous origin, or upon them, only increases the necessity of time, and when these coincidences occur, they add to the evidence of grand geological cycles.

But diluvial agency is, usually violent, sudden, and of short duration.

If the universal deluge recorded in Genesis, be taken as the type of diluvial action and the time and the elevation stated in the history be taken into the account, nothing could be more violent, destructive, overwhelming; and certainly upon the face of the earth are every where recorded, in legible characters, the necessary physical effects of such a debacle.

It has entered but little into the views of any except geologists to discriminate between these two classes of effects. They are as wide apart as possible, and nothing in science is more unskilful or more unhappy than to confound them.

The surface of our planet has been swept by violent, agitated torrents of water, which covered the earth every where with its own ruins, but probably this catachlysm did not form any of the firm strata filled with organized remains.

*Miscellaneous Illustrations, from Mantell's Geology of the South East of England.**

From this volume, the most recent in time, and not surpassed in authority by any work on Geology, we now cite some miscellaneous facts and conclusions, principally in the words of the respected author.

His labors, ably seconded and illustrated by the talent and taste of Mrs. Mantell, have shed a most unexpected light on the geology of the South East of England; and with the efforts in the same region, of Webster, Murchison, Fitton, Buckland, and other eminent men, have amassed materials upon which are erected general conclusions of the greatest importance. Mr. Mantell's publications on local geology entitle him to rank with Cuvier and Brongniart, whose grand work on the environs of Paris, led the way in this species of research, which, has since, been so ably and successfully followed in many places, and in several countries.

Chapter XI of Mr. Mantell's late work, from which our citations will now be made, forms the conclusion of the volume, and presents

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* The preface of which is dated in April, 1833.

the "Results" of a course of detailed and exact induction, involving extensive and precise knowledge of several collateral sciences, and especially of conchology, botany, and comparative anatomy.

The chapter, although detached from its documents, is mainly intelligible without them, and presents a fine example of the course of induction now pursued by the most able geologists and is precisely in point in support of our present argument. Mr. Mantell, remarks:—

Happily, the evidence of the great physical mutations, and important changes in organic life, which have taken place in this part of the earth during the geological periods to which our researches refer, is so clear and satisfactory, that even the general reader will perceive that our deductions, extraordinary as they may appear, naturally result from the facts themselves.

The several formations or groups of strata, previously described, may be regarded as geological chronometers, marking certain distinct epochs or periods; the lowermost or most ancient of which (as we have already noticed) is of fluviatile origin, and reposes on the *Oolite*, a marine formation of great extent, that forms an important feature in the physical structure, not only of England, but also of the Continent. The *Portland Limestone* constitutes the uppermost division of the Oolite, and contains marine remains only; it is succeeded by the *fresh-water strata of the Isle of Purbeck*, which may be considered as the lowermost deposits of the Wealden.

But there is a fact connected with the history of the Portland and Purbeck beds, so highly interesting, and which illustrates in so striking a manner the nature of one of those grand geological mutations which have taken place in the south of England, that it will be necessary to notice it here, although it occurs without the limits of the district, which it is the professed object of this work to describe.

In the island of Portland, the oolitic limestone is extensively quarried for architectural purposes, and supplies most of the cities and towns in the south-east of England. On these oolitic strata are placed deposits of a totally different character. Immediately on the uppermost marine stratum (which abounds in *ammonites*, *terebræ*, *trigonia*, &c.) is a bed of limestone, much resembling, in appearance, some of the tertiary lacustrine limestones. Upon this stratum is a layer of what appears to have been an *ancient vegetable soil; it is of a dark brown colour, contains a large proportion of earthly lignite, and, like the modern soil on the surface of the island, many water-worn stones.* This layer is called the *dirt-bed* by the quarrymen; and in, and upon it, are a great number of silicified trunks of coniferous trees, and plants allied to the recent *cycas* and *zamia*. Many of the stems of the trees, as well as the plants, are still erect, as if petrified while growing undisturbed in their native forest; the former, having their roots in the soil, and their trunks extending into the superincumbent strata of limestone. On a late visit to the quarries, a large area of the surface of the *dirt-bed* having been cleared, preparatory to its removal for the purpose of extracting the building-stone from beneath, several stems, from two to three feet in height, were

exposed, each standing erect in the centre of a mound or dome of earth, which had evidently accumulated around the base and roots of the trees: presenting an appearance as if the trees had been broken, or torn off, at a short distance from the ground. Portions of trunks and branches were seen, some lying on the surface, and others imbedded in the dirt-bed; many of these were nearly two feet in diameter, and the united fragments of one tree measured upwards of thirty feet in length. The silicified plants allied to the *cycas* are found in the intervals between the trees; and I dug up from the dirt-bed several that were standing erect, evidently upon the very spot on which they grew, and where they had remained undisturbed amidst all the revolutions which had subsequently swept over the surface of the earth. 'The dirt-bed extends through the north of the Isle of Portland, and traces of it have been observed in the coves at the west end of Purbeck; and a stratum, with bituminous matter and silicified wood, occurs in the cliffs of the Boulonnois, on the opposite coast of France, occupying the same relative situation with respect to the Purbeck and Portland formations. A similar bed has also been discovered in Buckinghamshire, and in the Vale of Wardour, proving that the presence of this remarkable stratum is coextensive with the junction of the Portland and Purbeck strata, so far as they have hitherto been examined.'*

Above the *dirt-bed* are thin layers of limestone, the total thickness being about eight feet, into which the erect trunks extend, but no other traces of organic remains have been noticed in them. These limestone beds are covered by the modern vegetable soil, which scarcely exceeds in depth the ancient one above described; and instead of giving support, like the latter, to a tropical forest, can barely maintain a scanty vegetation, there being scarcely a tree or shrub on the whole island.†

Here, then, we have recorded in characters which cannot be mistaken the nature of the changes which took place in this part of the globe, after the sea of the oolite had deposited the marine strata of Portland. A portion of the bed of that sea was elevated above the surface of the waters, and became clothed with a vegetation, which, reasoning from the close resemblance of the fossil plants to the recent *Cycadeæ*, must have enjoyed a climate of a much higher temperature than is known in these latitudes at the present day. How long this island, or continent, (for of its extent no correct estimate can be formed,) remained above the level of the ocean, cannot be conjectured; but that it was dry land for a considerable period, is manifest from

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* Vide Geology of Hastings, p. 76. *et seq.*

† The appearance of the large quarry on the northern brow of the Island of Portland was, at the time of my visit (in July, 1832), peculiarly interesting; and although prepared by a perusal of the excellent Memoirs of Mr. Webster, and Dr. Buckland, (Geol. Trans. 2d series, vol. ii.) for the phenomena presented to my view, I was struck with astonishment at the extraordinary scene; the floor of the quarry was literally strewed with fossil wood, and before me were the remains of a petrified tropical forest, the trees and the plants, like the inhabitants of the city in Arabian story, being converted into stone, yet still maintaining the places which they occupied when alive.

the number and magnitude of the petrified trees which remain. It is equally evident, that it was submerged before the Purbeck and Wealden strata began to be deposited; for the dirt-bed, and its contents, are covered by the freshwater limestone of the former. The tropical forest of Portland must, therefore, have gradually and tranquilly subsided (like many subterranean forests of the modern epoch) beneath a body of fresh water, sufficiently profound to admit of the accumulation of the limestone and fluviatile strata that compose the Wealden. What contemporaneous changes took place in other parts of Europe, it would be foreign to our purpose, and perhaps, in the present state of our knowledge, in vain to enquire; but we may remark, that the submergence of so extensive a tract of country, probably produced in other regions important mutations in the relative level of the land and water. At this epoch, then, the land and its tropical forest sank to the depth of many hundred feet, and became the bed of a vast lake or estuary, into which we have the clearest evidence that a river flowed, and formed a delta, made up of the debris of the rocks which composed its bed, intermixed with the remains of the animals and vegetables of the country from whence its waters were derived; for, as Mr. Bakewell has sagaciously remarked, a river that could form a delta of such extent as the Wealden, it must have required the drainage of a vast continent to supply.*

The proofs of the Wealden having been the delta of some ancient river, are so fully stated in the preceding chapter, that it is unnecessary to dwell upon the subject. Of its original extent, our conjectures must necessarily be extremely vague: Dr. Fitton has, however, ingeniously instituted a comparison between the known superficial surface of the Wealden, and the deltas of some modern rivers. Assuming that the occurrence of the Wealden strata at Beauvais is established, this eminent geologist computes that the remains of the delta of the Iguanodon period, are from west to east, or from Lulworth Cove, to the boundaries of the Lower Boulonnois, about 200 miles; and from north-west to south-east, or from Whitchurch to Beauvais, 220 miles; the total depth or thickness being about 2000 feet.† This but little exceeds the modern deltas of the Ganges, and the Mississippi; and is not equal to that of the Quorra, or Niger, which forms a surface of 25,000 square miles, being equal in extent to one half of England.

We have no data from which to calculate the probable duration of the Iguanodon epoch; it is, however, manifest that no brief period could have sufficed for that profuse evolution of animal life, of which we have such positive evidence in the organic remains. It may here, too, be remarked, that the vegetables and animals of this era, like the forest of Portland, denote a tropical climate, and belong to species and

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* Had the fossil vegetables of the Wealden been identical with those of the Isle of Portland, it might have been supposed that the latter was dry land at the Iguanodon period: but although the vegetable remains in both deposits indicate the floras of tropical climates, they are totally distinct from each other, and belong to different species and genera.

† Geology of Hastings, p. 58.

genera, wholly unknown: and, as we have elsewhere observed, the fossil bones of the oviparous quadrupeds are so enormous, that it is even difficult to believe the evidence of our senses, when we attempt, from these remains, to restore the forms of the extinct monsters of the ancient world.

The next great change is the subsidence of the Wealden into the abyss of that extensive and profound ocean which deposited the chalk formation. Whether this mutation were effected suddenly, or by slow degrees; whether the Wealden subsided entire, or were broken up previously to its submergence; or whether, like the Isle of Portland, it constituted dry land at some remote period antecedently to its being buried beneath the sea, we have no data to enable us to decide. The principal lines of elevation of the Wealden are clearly referable to those movements which up-heaved the chalk and incumbent strata: but we may observe, that the deeper beds exhibit traces of extensive faults and dislocations, which seem to belong to previous disruptions, for the fissures and chasms are filled up with broken shale, and clay, and sand, the debris of the Wealden, and contain no intermixture whatever of the marine deposits which may be supposed to have once covered them.

The ocean of the chalk appears to have been of vast extent; it buried beneath its waters a considerable part of Europe; and, probably, like the Atlantic, its waves reached the western world, and covered a portion of the continent of North America.* The nature of the strata, and the organic remains which they enclose, prove that the chalk was deposited in the tranquil depths of a profound ocean; the abundance of *Ammonites*, *Nautili*, and other multilocular shells that inhabit the bottom of the deep; the almost entire absence of pebbles and gravel; the perfect state in which the fishes and other perishable organic bodies occur—not as in the Wealden, crushed, and disjointed, but as perfect as if they had been enveloped by a soft paste when living, or even while in a state of progression—all bear evidence in favour of such a conclusion.

There are but few, if any remains of terrestrial animals and plants, to throw light on the nature of the climate during the cretaceous epoch: we may, however, infer from the nautili and other tropical shells, as well as from the presence of the stony *polipidoms*, or corals, that the temperature was not much inferior to that of the Iguanodon period, for this division of zoophytes is not known to exist in low latitudes in our modern seas.† The *cretaceous* strata of the chalk, with

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* The occurrence of the remains of the *Mososaurus*, that extraordinary reptile of the Maestricht beds, in the strata of the United States, previously mentioned, is a remarkable fact in corroboration of such an inference. See Dr. Morton on the *Ferruginous Sand Formation of North America*, 8vo. 1 vol. with plates. Philadelphia. 1833.

† M. Lamouroux observes, that in the colder latitudes the *Cellarias*, and *Sertulariæ* alone are to be found; with a few closely woven sponges, and a small number of alcyonia. The minute *Pentacrinus Europæus*, recently discovered by Mr. Thompson in the Cove of Cork, is an exception; but the recent *Pentacrinus Caput Medusæ*, to which the pentacrinal stems that occur in the chalk bear considerable analogy, is found in the sea off the West India Islands.

their nodules and veins of flint, have more the character of a chemical production, than of a mere mechanical deposit; and may perhaps owe their origin to precipitation from thermal waters. The shells and crustaceous coverings of the echini are invariably changed into calcareous spar; and in many instances the *terebratulæ* are twisted and contorted in every direction, without the shells exhibiting a single fracture; changes which probably resulted from the influence of a high temperature under considerable pressure.

With the exception of the *pentacrinus*, the teeth of fishes resembling those of the shark, the teeth of crocodiles, and perhaps a few shells,* the organic remains of the chalk differ entirely from all known existing species, as well as from the fossils of other formations. The thickness of the chalk, which is estimated at upwards of 1200 feet, and the immense variety and numbers of its organic remains, evince that the agents which produced it were in full activity through a long period of time.† Although we have no satisfactory evidence to determine whether the chalk were deposited over the entire surface of the Wealden (as seems most probable,) or whether the latter were undergoing elevation during the deposition of the chalk, and were but partially covered by the cretaceous strata, yet there can be no doubt that the chalk originally very much exceeded its present limits. It is true that gravel, and partially rolled flints, occur but rarely on the Wealden, the diluvial covering of the latter chiefly consisting of its own debris; yet this fact may have resulted from the action of the sea during the elevation of the strata, or many other causes, and cannot be admitted as affording conclusive evidence that the Wealden was never wholly covered by the chalk. Our limits will not allow us to examine this interesting question in all its bearings, which will be fully elucidated in the 3d volume of Mr. Lyell's "Principles of Geology," now in the press; and we proceed to the consideration of the next geological era—that in which the older *tertiary* strata were deposited.

The epochs we have already noticed are marked by immense mutations in the relative situation of the land and sea; yet these changes appear to have been effected in such a manner as to have occasioned comparatively but little derangement in the strata, and to have been succeeded by periods of repose of long duration. In the tertiary era, on the contrary, it is manifest that the disturbing forces were in frequent and violent action, and produced elevations and subsidences, and enormous dislocations and fissures, throughout the whole mass of the strata of the south-east of England. In the anticlinal axis of the Forest ridge, from whence the strata diverge to the south-east in Sussex and the north-west in Kent, we have evidence of a force having acted from beneath, in a direction from east to west, by which the Wealden beds have been elevated above the chalk formation, and the

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* Even these few exceptions are very equivocal, and probably the species will hereafter prove to be distinct from their supposed analogues.

‡ The fossils of the chalk of Sussex are enumerated in the Catalogue in the Appendix to this work. In the list of the organic remains of the cretaceous strata of Europe, given by M. De la Beche, there are, of Reptiles, 6 or 8; Fishes, 10 or 12; Crustacea, 15; Mollusca, 225; Conchifera, 285; Annulata, 110; Radiaria, 90; Vegetable remains, 20 species, 16 of which are marine.

cretaceous strata broken up, and swept away from the whole central area of Kent and Sussex. On these phenomena Dr. Fitton observes, that, 'whether the fractures and up-heavings took place entirely beneath the sea, or after the strata were in part or wholly raised above its surface, at once or at distant epochs, we have no facts to enable us to decide; it is, indeed, not impossible that the very act of rending the strata may itself have effected their protrusion from beneath the waves.'* If, however, we consider that the chalk was upwards of 1200 feet in thickness, and extended over the whole southern denudation, it seems probable that elevation and destruction were going on simultaneously. So soon as the first ridge of chalk on the anticlinal line protruded above the surface of the ocean, it would become exposed to the action of the waves; and as elevation proceeded, degradation would proceed also, until the whole of the chalk strata were carried away, and the Wealden beds in their turn became exposed to the same destructive agency. The debris of both formations would thus become intermixed and deposited in the hollows of the chalk, giving rise to those accumulations of transported materials of which the tertiary strata are principally composed. During these important and extensive changes, the tertiary ocean which then covered the south-east of England, must have been studded with islands, formed by the most elevated portions of the chalk and Wealden;† the marshes of the then existing continent were peopled with tribes of extinct animals allied to the *Tapir* (the *palæotherians*,) and the lacustrine formations of Hampshire and the Isle of Wight were deposited.

The organic remains of the tertiary epoch differ entirely from those of the chalk upon which in the south-east of England they repose. In the Isle of Wight, in the Paris Basin, and many contemporaneous deposits on the continent, they consist of alternations of marine and freshwater shells, indicating the existence of lakes communicating with the sea. The ammonites, and other ancient pelagian shells, entirely disappear, and a small proportion of recent species occurs in the most ancient, and a much more considerable number in the newer deposits. With these are associated the remains of the Palæotheria, of crocodiles, turtles, birds, and fishes; and the stems and leaves of palms, and other vegetables characteristic of an equatorial climate. In the tertiary strata of the south-east of England, no traces of mammalia have been discovered; the organic remains consisting of shells, the bones and teeth of fishes, and the leaves and stems of vegetables.

The next era is marked by the existence of the fossil elephant, or mammoth, in these latitudes, having for contemporaries a species of deer, ox, and horse; and in other parts of England, the rhinoceros, hippopotamus, &c. The teeth which have been found in Sussex belong to a species nearly allied to the Asiatic elephant, and the deposits in which they occur are decidedly of a more recent date than those

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* Geology of Hastings, p. 83.

† Vide the 'Principles of Geology,' vol. ii. In the map illustrating the extent of the tertiary sea, or seas, it will be seen that Mr. Lyell has delineated a range of chalk islands in the south-eastern part of England, agreeably to this theory of the gradual elevation of the land.

above described, for they contain boulders of tertiary sandstone, and breccia; while, in the older tertiary, the remains of the elephant have not been discovered. The perfect state of the teeth in the deposits at Brighton, forbids the supposition that they were transported from a distance: and we have, too, the remarkable fact, that while the shingle on which the elephant bed reposes, is composed not only of chalk pebbles, but of boulders of granite, porphyry, and other primary rocks which must have been brought from a distant part of the country, and of tertiary sandstone and breccia, and the sand beneath contains the bones of whales, no remains of elephants have been found therein. It would seem, therefore, that the sand, and the shingle, were formed in an estuary, and that when the upper beds were deposited, all communication with the ocean was cut off; for neither the bones, nor the materials of which the bed is composed, appear to have suffered from attrition, nor is there any intermixture of marine exuviæ. These deposits were evidently of considerable extent: there are outlying patches on the chalk along the coasts of Sussex and Kent, and also at Etables, and other points on the opposite shores of France. Similar beds occur on the banks of the Loire, and probably the same series is represented by the *Crag*, overlying the London Clay, on the eastern shores of England; facts which tend to prove that the estuary once extended over a considerable portion of the area now occupied by the British Channel.* The geological relations of this group of deposits are as yet but imperfectly known. The zoological characters which distinguish them from the older tertiary strata, are the absence of the *palæotheria*, and the occurrence of the remains of the mammoth, rhinoceros, and other mammalia, whose bones are so constantly found in the superficial gravel of Europe, intermixed with those of recent species.

To this epoch we may probably refer the existence of hyenas, tigers, and other carnivorous animals, whose skeletons are entombed in such immense numbers in caverns, and fissures, and in beds of superficial gravel, in various parts of England, and the continent. One solitary instance only is known of the occurrence of remains of this kind in the south-east of England. The lower jaw and a few fragments of other bones of a hyena were discovered, a few years since, in a chasm in a stone quarry at Boughton, near Maidstone.

The next era is that during which the *Crag*, and the tertiary strata, and the chalk on which they repose, were lifted up to their present situations; the channel which separates England from France was broken through, and the transverse valleys of the North and South Downs were produced or enlarged; for, although these valleys are now river courses, yet it is obvious that they originated in disruption, for the strata, in every instance which I have observed, diverge from

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* Mr. Samuel Woodward, of Norwich, the author of the 'Synoptical Table of British Organic Remains,' (a work indispensable to the practical geologist) states, that in the crag on the coast of Norfolk, the remains of Mammoths are so abundant, that on the oyster-ground off Harborough, the grinders of these animals which have been found must have belonged to upwards of 500 individuals.

the line of fracture.* We should doubtless err in assigning all these mutations to one and the same period; the phenomena are extremely complicated, and an appearance which may seem to have been produced at the same time, and by a single operation, may have been the result of many and varied changes. There is, however, one fact respecting which there can be no hesitation, namely, that the disturbing forces which have broken up the tertiary deposits came into action *after the elephant epoch*. These elevatory movements and convulsions were manifestly of great intensity, and materially changed the physical geography of the south-east of England, and the contiguous parts of the continent, and occasioned the vertical position of the strata in the Isle of Wight and Hampshire. These alterations in the surface of the country, must, too, have been attended with great changes in the hydrography of Hampshire, Surrey, Kent, and Sussex; the waters resulting from the drainage of the land, and which, before the existence of the transverse fractures, probably flowed through the longitudinal valleys towards the east, would be thrown into different channels, and find their way to the ocean by the existing river courses. Traces of these revolutions remain in the boulders and superficial loam and gravel, which occupy the valleys and low elevations of the south-east of England.

Subsequently to these last mentioned changes, the surface of the country appears to have undergone no material alteration; the ordinary effects of the atmosphere, the degradation of the shores by the action of the sea, the erosion by river currents of the strata over which they flow, and the formation of deltas, and the silting up of valleys, being the only physical changes that have taken place in the south-east of England during the modern epoch, and which are still in active operation.

The existing rivers in this district are producing on a small scale the same effects as the mighty river of the Iguanodon period; bringing down from the interior the debris of the strata over which they flow, mixed with the bones of animals, and the trunks, branches, and leaves of vegetables, and imbedding a portion in the chalk valleys, in a deposit of mud or silt, and transporting the remainder to form deltas at their entrance into the ocean.

The levels near Lewes, described in a former part of this volume, afford so interesting an illustration of the silting up of the disrupted valleys of the chalk, during a comparatively very recent period, that we subjoin the following summary of the sequence of events which they record.† First, there was a salt-water estuary peopled for many years by marine testacea identical with existing species, and into which some of the large cetacea, as the sea-unicorn and porpoise, occasionally entered. Secondly, the inlet grew more shallow, and the water

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* Mr. Woodward arrives at the same conclusion from an examination of the chalk valleys of Norfolk. "These," he observes, "are *valleys of disruption*; that is, they were formed by the elevation of the chalk and its consequent fracture, as is evident from the strata of chalk and flints on each side of the valley being now found to decline from the line of elevation."—*Correspondence with the Author.*

† Principles of Geology, vol. ii. p. 276.

became brackish, or alternately salt and fresh, so that fresh-water and marine shells were mingled in the blue argillaceous sediment at the bottom. Thirdly, the shoaling continued until the river water prevailed, and was no longer habitable by marine testacea, but fitted only for the abode of fluviatile species and aquatic insects. Fourthly, a peaty swamp or morass was formed, into which trees and terrestrial animals, as deer, were occasionally drifted by land floods. Lastly, the soil, being only subject to periodical inundations from the river, became a verdant plain, through which the narrow Ouse now winds its way to the British Channel. It is in alluvial deposits of this kind *that the remains of man first appear:* human skeletons, and the rude instruments of a half-civilized race, are found associated with the bones of animals which still inhabit this country, and in some instances intermixed with the osseous remains of a few species that appear to have been extirpated by man.

Such are the results which a review of the geological phenomena of the south-east of England offers to our consideration. We have evidence of great physical mutations of the surface of the earth—of vast changes in the temperature of the climate; and we perceive that these revolutions were accompanied by a corresponding alteration in the forms of organic life: these are general conclusions, which cannot be disputed, although the laws that governed these co-existing phenomena may be concealed from our view. It is, however, obvious, that the great changes which have taken place in the relative proportion of the land and water, must have materially influenced the temperature of the climate, and consequently the geographical distribution of animals and vegetables. Mr. Lyell has treated this question in a very luminous and admirable manner, and has shown that there is every reason to conclude that since the commencement of the tertiary period, the dry land in the northern hemisphere has been increasing; not only because it is now greatly in excess beyond the average proportion which land generally bears to water on our planet, but because a comparison of the secondary and tertiary strata affords indications throughout the space occupied by Europe, of a transition from the condition of an ocean, interspersed with islands, to that of a large continent: and to this increase of the land in the northern hemisphere we may probably attribute, in a great measure, that gradual diminution of temperature which the organic remains of the different periods denote. "The climate was hottest when the northern hemisphere was for the most part occupied by the ocean; and the refrigeration did not become considerable until a very large proportion of that ocean was converted into land and replaced in some parts by high mountain chains: nor did the cold reach its maximum until these chains attained their greatest elevation, and the land its utmost extension."

The changes that have taken place in the forms of the animal and vegetable kingdoms, are not less striking than those which we have above described in the inorganic world. The animals and plants of the more ancient strata, are not only such as could not now exist in the latitudes which they formerly inhabited, but almost all the species, and very many of the genera, are no longer to be found in any part of the known globe. In the newer deposits, on the contrary,

we perceive an intermixture of existing with extinct species; the proportion of the former increasing according to the more recent formation of the strata, till, in the deposits of the modern era, the remains of existing species alone are discovered, and, as we have already remarked, in these accumulations of débris, the skeletons of man, and traces of the works of art of the early tribes of our race, are sometimes found imbedded.

The extinction of whole genera of animals and plants has, no doubt, depended on various causes. In the earlier revolutions, the vicissitudes of climate, and the mutations of land and water, were, probably, the principal agents of destruction: but since man became the lord of the creation, his necessities and caprice have occasioned the extirpation of many tribes, whose relics are found in the same superficial strata with those of species concerning which all human history and tradition are silent.*

The obliteration of certain forms of animal life (and perhaps the creation of new ones) appears, therefore, to be dependent on a law in the economy of nature, which is still in active operation. Of this we have a remarkable instance in the case of the *Dodo*, which has been annihilated, and become a denizen of the fossil kingdom, almost before our eyes. The Dodo was a bird of the gallinaceous tribe, larger than the turkey, which existed in great numbers in the Mauritius and adjacent islands, when those countries were first colonized by the Dutch, about two centuries ago. This bird was the principal food of the colonists; but it was incapable of domestication, and its numbers soon became sensibly diminished. Stuffed specimens were sent to the museums of Europe, and paintings of the living animal were executed, and copied into the works on natural history. *The Dodo is now extinct:* it is no longer to be found in the isles where it once flourished, and even all the stuffed specimens are destroyed; the only relics that remain being the head and foot of an individual in the Ashmolean museum at Oxford, and the leg of another in the British museum. To render this history complete, the fossilized remains were alone wanting, and these have actually been found beneath a bed of lava in the Isle of France, and are now in the museum of the Jardin des Plantes at Paris; affording the most unexpected and conclusive evidence of the truth of what was formerly considered one of the most startling propositions in modern geology.†

Another highly interesting and important fact is proved by the phenomena that have been presented to our examination, namely, the comparatively recent period at which man became an inhabitant of the earth, and exercised dominion over the animal creation; a fact in

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* In Great Britain, we may instance, as belonging to species which formerly existed in this country, and are still living in other parts of the globe, the *beaver*, *bear*, *wolf*, *hyena*, *&c.*; and, as wholly extinct, the *Irish Elk* and *Mammoth*, with whose bones existing species of shells are sometimes found associated. Consult *Dr. Fleming's British Animals*, 1 vol. 8vo. 1828: also an excellent Memoir, by the same author, in the Edinburgh Philosophical Journal, No. xxii.

† See an excellent paper on the Dodo, by Mr. Duncan, *Zoological Journal for January*, 1828: also, "Contributions towards the History of the Dodo, (*Didus ineptus*,) by J. V. Thompson, Esq., *Mag. Nat. Hist.*, vol. ii. p. 442; and Mr. Lyell's Principles of Geology, vol. ii. p. 151.

strict accordance with those sacred records which reveal the moral obligations and destiny of the human race.

With these observations I conclude this volume; entreating the indulgence of the geologist for much prolixity on subjects with which he was already familiar, but which without such detail would have presented but little interest to many; and assuring the general reader who may feel desirous of further information, that the more he becomes acquainted with the nature and objects of geological enquiries, the more he will find them to possess in an eminent degree the charms and advantages which are so eloquently described by Sir John Herschel, as being inseparably connected with the study of every branch of natural philosophy. "To the natural philosopher there is no natural object unimportant or trifling. From the least of nature's works he may learn the greatest lessons. The fall of an apple to the ground may raise his thoughts to the laws which govern the revolutions of the planets in their orbits; or *the situation of a pebble may afford him evidence of the state of the globe he inhabits, myriads of ages ago, before his species became its denizens.* Accustomed to trace the operation of general causes, and the exemplification of general laws, where the uninformed and unenquiring eye perceives neither novelty nor beauty, he walks in the midst of wonders: every object which falls in his way elucidates some principle, affords some instruction, and impresses him with a sense of harmony and order; while the observation of the calm, energetic regularity of nature, the immense scale of her operations, and the certainty with which her ends are attained, tends, irresistibly, to tranquillize and re-assure the mind, and render it less accessible to repining, selfish and turbulent emotions. And this it does, not by debasing our nature into weak compliances and abject submission to circumstances, but by filling us, as from an inward spring, with a sense of nobleness and power which enables us to rise superior to them; by showing us our strength and innate dignity, and by calling upon us for the exercise of those powers and faculties by which we are susceptible of the comprehension of so much greatness, and which form, as it were, a link between ourselves and the best and noblest benefactors of our species, with whom we hold communion in thoughts, and participate in discoveries, which have raised them above their fellow-mortals, and brought them nearer to their Creator."*

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* Discourse on the Study of Natural Philosophy, p. 14–17.

IGNEOUS FORMATIONS.

1. *Products of Active Volcanos.*

It is sufficient, for the purpose of our present argument, simply to name the products of active volcanos. They are well known; their causes are now in active operation, and lava beds and currents are still frequently forming, in many countries. They often bear, in their very texture and features, palpable marks of the agency of fire, and thus they inform us, in very intelligible language, that they are indeed igneous: even when these features are not distinctly legible, it often happens that the geographical and geological position of the masses does not permit us to entertain a doubt of their volcanic origin. We observe their currents, and we recognize their birth from fire, even when they form beds of solid rock, which have no appearances of scoriæ, cinders, glass, or gaseous inflation, except, perhaps, on their upper surfaces. No one doubts that volcanic currents overflow whatever lies in their way, and therefore we find them covering, occasionally, every geological formation, and every work of man which can withstand the action of heat.

This topic was sufficiently illustrated in the introductory remarks, and every one admits (what is indeed only a single instance of a general truth in geology) that the superincumbent mass is, generally, of more recent origin than that upon which it lies. The evidence presented by the eruptions of active volcanos, and the igneous formations which they produce, goes then to establish the truth of geological succession, but does not necessarily imply that its events are more ancient than the commencement of organic life. This remark is limited to volcanos strictly so called, and is not intended to include the unstratified rocks, concerning the igneous or aqueous origin of which, there has been, heretofore, much discussion and opposition of opinion, although they are now generally attributed to the agency of heat.

2. *Products of Extinct Volcanos.*

Much philosophical scepticism formerly existed with respect to extinct volcanos. They were vaguely referred to, but without decisive proof of their real volcanic origin; and many persons, very imperfectly qualified to judge of such questions, were sufficiently inclined to infer the existence of volcanos of former ages, wherever they saw a conical hill, or almost any hill, with a hollow on its summit; and porous stones, of whatever kind, were referred to a similar origin. It was a very imposing and sublime idea, that volcanic fire, still active

in our planet, and still bursting forth, in many places, with destructive energy, had, in times long past, exerted agencies still more extensive—covering provinces with ruins, and operating, even in the bed of the primeval oceans. The speculation seemed to claim quite as much affinity with poetical, as with philosophical conceptions, and it was not till the middle of the last century, that the subject of extinct volcanos began to be investigated with accuracy and skill.

It will be sufficient to name the much disputed country of Auvergne, Velay, and Vivcrais, in France, which has been often visited and examined by able geologists, and we believe, that within a few years past, no one of them has left that region, without being convinced that it is of volcanic origin. This district lies upon the river Rhone, nearly in the angle formed by it with the Mediterranean, and covers a square area of forty or fifty leagues in diameter.

Craters, regularly formed, often entire, sometimes with the thin and scorified edge of the lip in fine preservation, and occasionally of vast dimensions; here, black, rugged and scathed with fire—there, overgrown with trees, and there, filled with water, forming lakes; currents of lava, lying where they flowed from the crater, or where they burst from the side or foot of the ruptured mountain, extending many miles, and many leagues, traceable directly to their source, winding along the gorges and the sinuosities of the vallies, now and then diverted from their course by rocks, hills, and other obstacles; sometimes damming up rivers, whose beds they have crossed or obstructed, and thus forming lakes of considerable dimensions; exhibiting all the varieties of lithoid lava, from that which is compact and rock-like, to that which, in an incipient, or in a prevailing degree, is porous and vesicular; crowned or mixed with slag, scoriæ, pumice, olivine, and other exuviæ of known and active volcanos; displaying frequently a structure, now spherical, ovoidal and concentric; now prismatic and columnar, and fronting streams, and bounding valleys, with ranges of columns, equalling or rivalling the regularity of the famous colonnades of Fingal's Cave and the Giant's Causeway; these are a few of the most striking features of these countries, which are so affluent in proofs of igneous origin, that there is nothing needed, but to select, carefully and judiciously, those facts which will be the most decisive, especially with respect to minds not familiar with such contemplations.

The volcanos of the Auvergne, &c. are regarded as of different ages; some appear to have been active before the formation of the present valleys, and some since; where the currents of lava have

been cut through, by those causes which formed the present valleys, they are then obviously older than the valleys, and where these currents have flowed into valleys, beds of rivers, &c. they are as evidently of a more recent date.

Although the formation of these volcanic regions was anterior to the records of history, it was, evidently, in the most recent portions, posterior to the existence of organized beings, which are found imbedded in the volcanic tufa.

The recent researches of Humboldt, "have greatly extended our knowledge of the volcanic tracts of our globe; he has shown the whole country round the Caspian to be a vast district of this nature, a "pays cratere," exactly resembling, in its general outlines, the telescopic appearance of the moon; he has also pointed out another great seat of volcanic action, the chain of Thion Chou, south of the Altai, and running about 42° lat. N. and between 70° and 80° long. E. of London. This vast igneous district extends over two thousand five hundred square leagues, and being generally remote from every sea, shows that marine contiguity, although a common, is by no means an indispensable concomitant of volcanic action."*

For our purpose, it is not necessary to go any farther into detail, with respect to this class of rocks. All that is true of modern eruptions from active volcanos, considered as proofs of succession in geological events, is true in the present case. Every thing was occasionally covered by the currents that issued from the ancient volcanos, and there is no reason to doubt, that, as happens in connexion with modern volcanic convulsions, destructive earthquakes preceded and attended their eruptions.

It is not our purpose, on this occasion, to enter into the consideration of the theory of volcanos. It is undoubtedly obscure, and attended with many difficulties, especially in the extent to which the view of igneous action is carried by most of the geologists of the present day. "It is impossible, (says Conybeare,) to propose, as explanatory of volcanic phenomena, any probable theory, which does not, at the same time, embrace the entire structure of the globe, in all its generality."†

3. *Ancient Rocks of Igneous Origin.*

With respect to the extent of this class of rocks, there has been great diversity of opinion.

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* Discourse of Prof. Conybeare on Geology, at Oxford University, 1832.

† Discourse at Oxford, 1832.

Trap, porphyry, and pitchstone, have long been consigned over to an igneous origin, and as there is no longer any difference of opinion on this subject, it is not necessary here to enter into the discussion.* Nor is it important to our argument, to adduce the proofs in favor of the extension of the agency of fire, to the formation even of granite itself, with all its family of rocks. The igneous origin of granite is now generally, although not universally, admitted. It is, however, of no importance to this discussion, whether granite, as well as the other unstratified rocks, is of aqueous or igneous origin, since the proofs of geological succession, which is all that our argument requires, are, in either case, sufficiently decisive.

The intrusion of the rocks supposed to be of igneous origin, among those that are superincumbent, producing dykes and veins, often much ramified; the elevation and disruption of the upper strata; the confusion often induced among them; the chemical changes produced upon the contiguous masses, and the profuse and rich crystallization of many of the primitive rocks, both in the minerals proper to their constitution, and in those foreign ones which they contain imbedded: all these afford decisive proofs of geological order, event, succession, and time sufficient for the phenomena.

Crystallization in Rocks.

No person in the least acquainted with the subject, hesitates to admit that crystallization implies a previous state of corpuscular mobility either in fluid, in fusion, in vapor, or at least in a state of softness and diminished cohesion. Although crystallization is not confined to any one geological period, it is eminently conspicuous in the primitive rocks.

They present to the eye of one who has been accustomed to examine the results of chemical deposition, very decisive proofs that their particles have been in that state of *mobility*, which leaves them at liberty, to unite according to the laws of corpuscular attraction; the heterogeneous particles being connected by chemical, and the homogeneous by mechanical attraction. Thus in feldspar, (if we include both its necessary and occasional constituents) oxygen is an element in all the binary compounds that enter into its constitution; in the silex it is united to silicon; in the potassa to potassium; in

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* For a view of this subject, the reader is referred to Dr. Cooper's lecture, in the fourth volume of the American Journal of Science.

the soda to sodium; in the lime to calcium, and in the usual contaminating oxide, to iron. Supposing these to be the ultimate elements of the mineral, the proximate principles would be produced, first by their uniting, chemically, to form these binary compounds; which would still farther unite, but still chemically, to form the integrant particles of the mineral and these particles united mechanically by cohesion, would form the mineral itself.

The same reasoning may be applied to every variety of rocks and minerals. Limestone, consisting for its immediate principles, of lime carbonic acid and water, contains, for its ultimate elements, according to the present state of our knowledge, calcium, carbon, hydrogen and oxygen; the latter principle being united with each of the former ones, so as to produce the lime, (oxygen and calcium,) the carbonic acid, (carbon and oxygen,) and the water, (oxygen and hydrogen.) If the limestone were a magnesian one, then we must add oxygen and magnesium, and so of other earths, as silex or alumine, if they were present.

How far back, and how near to the isolated, independent state, we are to trace each element, we cannot determine. Whether the elements were created, in the first place, in a state of perfect freedom, and their earliest movement was, not so much, that of elemental war, as of elemental combination; or whether, they were combined in pairs, and those pairs again combined, to form more complex results we can never know with certainty; and all our suggestions on this subject being necessarily hypothetical, ought of course to be concisely stated.

But the discussion of these questions, which might easily be extended to the most complex rocks, and to all their imbedded minerals, however curious and even interesting, is in no way material to our proceeding to reason intelligibly—may we not say even conclusively, upon the act or process, which must, according to physical laws, have preceded the concretion of the materials of the primitive rocks.

Suppose the elements which are to form granite, to have already united, and a previous state of chemical mobility, to have rendered such a result possible, a simultaneous deposition of the different minerals must of course happen; the quartzy particles must find their fellows, those of feldspar will do the same, and those of mica the same, and the three minerals, born at the same moment, will find repose in the same cradle. In the same manner, their ornamental companions, (not essential to the rock, but often studding it, like gems set in royal robes)—the emeralds, the topazes, the garnets, the tourma-

lines and other crystallized minerals which sparkle in the bosom of the primitive rocks declare a common birth.*

True it is, that creative power would call the rocks into being, without any arranging process in their parts, but no analogy countenances the truth of such a supposition, and neither moral nor physical reasons oblige us to admit so improbable a supposition.

Who has contemplated the stupendous garnets of Fahlun—the equally gigantic quartz and felspar crystals of the Alps—the more delicate emeralds of Brazil and Ethiopia—the variously colored tourmalines of Chesterfield, and Goshen, Mass., and of Paris in Maine—the fluor and calcareous spars of Derbyshire and Cumberland—the idocrases of Vesuvius, and the rubies and sapphires of Ceylon and other regions of India, the bubbles of air included with water and other fluids in quartz—the fibres of amianthus—the crystals of titanium—the filaments of native copper and silver shut up in the same mineral—the successive crystallizations of galena—sulphate of barytes—calcareous spar—quartz and fluor spar, often included in the same group—the splendid amethystine and other geodes—little grottoes lined with polished and beautiful geometrical figures—who has seen all these things—the ornaments of our cabinets, and has doubted that they were as truly the results of crystallization, as any of the products of art, which are formed in our laboratories?

Crystallization is indeed not exclusively the attribute of primitive regions; but in such regions it is eminently conspicuous, and if we find crystals in the productions of every geological age, we are thus furnished with proof, that these agencies continued to operate, although with less frequency and energy, through all succeeding periods, and that they have not ceased even in our own times,† for mineral crystals are, every moment forming around us.

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* Prof. Hitchcock, in his geology of Massachusetts, considers the simultaneous and mixed crystallization of the different minerals in granite, as affording decisive proof of its igneous origin, since, as he avers, aqueous solutions of different substances crystallize, always successively, and never in promiscuous confusion.

† I have obtained crystals of calcareous spar—of sulphate of barytes and of sulphate of lime and some of them repeatedly as accidental results in chemical processes: I have seen even quartz crystals form rapidly under my eye, and others have cited them as slowly produced with regularity and beauty, from the fluoric solution of silex. Crystals of pyroxene—specular iron, titanium and other minerals have been produced by volcanic and furnace heat; more than forty species of minerals have been observed in the slags of furnaces, and white pyroxene has been produced by the action of fire upon the constituents of this mineral, and after fusion, it has re-crystallized, in the same form.—*Am. Jour. Vol.* 10. *p.* 190.

Still no one finds in the upper secondary rocks—much less in the tertiary, the numerous and grand crystals that are common in the primitive, and even to a degree in the transition and early secondary formations, nor does any one look for those grand crystal cavities, *fours a cristaux*, as they have been fancifully called,* except in the ancient mountains, and in the veins and beds by which they are intersected.

No person who has been conversant with chemical effects can easily confound them with those of mere mechanical deposition. Take a piece of the most beautiful granite—its quartz is translucent if not transparent—its feldspar is foliated in structure, presenting two regular cleavage planes, united at definite angles—its mica is perfectly foliated, and splits into innumerable thin laminæ, each of which, is perfectly transparent and has a high lustre, and this last property is common (sometimes in a less degree,) to the quartz and the feldspar. Gneiss and mica slate and saccharoidal limestone are distinguished, in a greater or less degree by similar characteristics. Now, translucency—transparency—lustre—cleavage-planes, and regular structure, are known and established results of chemical deposition and are never the effect of mechanical aggregation. Compare the above properties, with those found in a piece of clay, and no person, however unskilled in physical characteristics, can possibly attribute them to a similar origin. The latter has as obviously sprung from mechanical as the former from chemical laws;—mechanical suspension must have preceded the one, and solution, fusion or sublimation the other.

Crystallization is the most exalted agency of the mineral kingdom and it answers to organization in the animal and vegetable. It results in the production of regular solids—often of beautiful figures, bounded almost always, by plane faces, which constitute the outline of beauty in the mineral kingdom, as the curve line does in the organized kingdoms.—*Haüy.*

Proximate Causes of Crystallization in the Earth.

Of the original state of the materials of our planet, as first formed by the Creator, we know nothing. It is, however, in the highest degree improbable, that the innumerable crystals of so many different substances and forms, which we find in the earth were originally crea-

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* Patrin's mineralogical travels.

ted as we now see them. Crystallization by natural laws is constantly going on around us and we can at pleasure, form crystals of many substances; in some cases, we produce those that never have been discovered in nature, and in others we can surpass them in size and beauty. Although, as already remarked, it is possible that crystals might have been the first forms of mineral matter, it is in the highest degree improbable; it is far more reasonable and philosophical to admit that wherever we find a crystal in the earth, it has been formed by the laws of crystallization operating upon the crude materials and there is no reason to doubt that we could always imitate natural crystals, provided we could command the powers and circumstances which operated in the original crystallization of mineral bodies. In all the geological epochs, after the primitive, there is decisive evidence of great mechanical changes,* operating first on the primitive rocks, to produce the materials for the derivative rocks, which often exhibit unquestionable proofs of mechanical destruction and mechanical formation; in a word, of changes from the pristine state of the materials in the primitive rocks, greater than crystallization implies in relation to the constituent or integrant particles, which we may presume to have been originally created.

As to the proximate causes of crystallization among minerals it can be referred only to two agents, heat and solution. The only powers with which we are acquainted, that are at all equal to the effect, are water, and fire, aided by various acid, alkaline, saline, and other energetic chemical agents, which, in large quantities, we now find actually entering into the constitution of the rocks, and which were therefore originally provided in the grand store-house of created materials.

The solution theory, once almost universally prevalent, has now given way to the igneous, which not stopping with actual or extinct volcanos or with trap, porphyry or pitchstone, has taken possession of the granite mountains and of the very centre of the earth. It undoubtedly explains with great felicity, the appearances of granite veins and of many other phenomena, although neither the igneous nor any other theory has explained every feature of the planet.

It is allowed by nearly all geologists, that the ocean has for a long time occupied all countries. It is now evident also, that ignition and fusion have always existed in the earth on a great scale, and this

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* Among the primitive rocks, mechanical force is exhibited in fractures, elevations, &c.

is admitted by all whether they believe in the fusion of the central nucleus or not. Internal fire still prevails to a great extent in the interior of our planet, and its effects appear to have been the greatest, and the most extensive in the earliest periods. Volcanic mountains and islands are known to have risen, even in modern times, from the bosom of the ocean and islands are still existing where in former ages the sea raged uncontrolled. The sub-marine volcanos also occasionally project flames, smoke, and red-hot stones through the ocean, and thus inform us, that water cannot always subdue fire, that even now, there are strata, at the bottom of the sea, where extreme ignition and extreme hydrostatic pressure, operate conjointly, upon the firm materials; and that both, aided by the principal chemical agents which we know to exist in the constitution of our globe, may unite to produce results of which our trifling experiments can give us but a feeble conception. An attempt for instance, to dissolve granite by boiling it in water is just as rational as an attempt to melt it in a common fire; neither experiment can possibly succeed; but the former would not prove that, granite was never dissolved nor the latter, that granite was never melted; because, the circumstances which may have operated in the interior of the earth are not under our control and our experiments are therefore nugatory.

In volcanic countries, silex is certainly dissolved by hot alkaline water under great hydrostatic and steam pressure, and granite is as certainly melted in the intense heat of deep seated fire.*

We should accept with equal readiness the aid of fire or water, or other agents, as they may appear best adapted to explain a given effect, and we should not hesitate to call in all the great natural powers whether mechanical or chemical, as there may be occasion.

There is no doubt that fire and water and other powerful chemical agents have operated in all ages in producing mineral crystallization. Of these however, fire appears to have been by far the most active, and although it is not proved by actual experiment, or even by rigorous observation, there is every reason to admit that even granite has been melted in the bowels of the earth and therefore may crystallize from a state of igneous fusion. If this be true of the proper crystals of granite, it may be also true of the imbedded crystals which it contains, and therefore of all other crystals. Those which

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* It appears now to be generally conceded, agreeably to the conclusions of Cordier, that the temperature of the earth increases as we descend. Sources of error have been indeed pointed out, but they appear to be local and accidental.

contain much water of crystallization may present a serious difficulty, but perhaps pressure may have retained the water and as the parts of the mineral concreted, in cooling, the molecules of water may have taken their place in the regular solid. Still we can see no reason for excluding water and other dissolving agents, acting with intense energy under vast pressure and at the heat of even high ignition, from playing a very important part in crystallization.

If we give granite to igneous fusion it is hardly possible to avoid admitting the conjoined action of water on the crystallized slaty rocks that usually cover it.

Nature and Application of the Argument.

It is we trust obvious that we have been occupied, not in the superfluous labor, of giving a complete system, but in selecting from the great store house of nature, a few facts taken from the principal geological classes and epochs, to evince that our planet, before it was inhabited by man, was subjected to a long course of formation and arrangement, the object of which evidently was, to fit it for the reception, first of plants and animals, and finally of the human race.

In that remote period of which he who recorded the fact probably knew not the date :—*In the beginning* God created the heavens and the earth, and established the physical laws, the ordinances of heaven, by which the material world was to be governed.

The earliest condition of the surface of the planet, appears to have been that of a dark abyss of waters of unknown depth and continuance, which repressed the deep seated forces of internal fires.

The structure of the crust of the planet affords decisive evidence of a long series of events, in relation both to the formation of rocks, and to the creation and succession of organized bodies, of which many of them contain such astonishing quantities.

Time and order of time ; event, succession and revolution are plainly recorded in the earth ; and sacred history expressly states that the events involved both time and order of time.

Geology cannot decide on the amount of time, but it assures us that there was enough to cover all the events connected with the formation of the mineral masses, and with the succession of the generations of living beings, whose remains are found preserved in the strata.

It is obvious that ages must have passed, while the various geological events, which are recorded in the structure of the earth, were happening, and particularly while the innumerable organic forms,

after their creation, were in the course of reproduction, life, death, deposition, consolidation, and preservation.

We will not enquire whether almighty power inserted plants and animals in mineral masses, and was thus exerted in working a long series of useless miracles, without design or end, and therefore incredible. The man who can believe, for example, that the Iguanodon, with his gigantic form, seventy feet in length, ten in height, and fifteen in girth, was created in the midst of consolidated sandstone, and placed down one thousand or twelve hundred feet from the surface of the earth, in a rock composed of ruins and fragments, and containing vegetables, shells, fish, and rolled pebbles; such a man can believe any thing, with or without evidence. If there are any such persons, we must leave them to their own reflections, since they cannot be influenced by reason and sound argument; with them we can sustain no discussion, for there is no common ground upon which we can meet.

The order of the physical events, discovered by geology, is the same as that recorded by the sacred historian; that is, as far as the latter has gone, for it was, evidently, no part of his object to enter any farther into details, than to state that the world was the work of God, and thus he was naturally led to mention the principal divisions of natural things, as they were successively created.

The Bible is not a book of physical science, and its allusions to physical subjects are, in the main, adapted to common apprehensions. Still, the creation and the deluge, although they have a momentous moral bearing, are, *in their nature*, entirely physical. Why should any one refuse to attend to a history of these two stupendous events, merely because that history professes to have proceeded from the same author as the work itself; and why should we suppose that the brief notices of the great *physical* facts, connected with a *physical creation* and a *physical destruction*, are not correctly stated, in this earliest and most venerable of histories?

If all our discoveries regarding the surface and the interior of the planet tend, when properly understood, to confirm the credibility of both these events, and to enable us to discriminate between the circumstances and evidence which belong to them respectively—what moral consideration can, in this case, forbid a happy application of the discoveries of science, and why should science refuse to lend its aid to the support of moral truth!

The question then recurs;—how can the amount of time be found, consistently with the Mosaic history, for the order of time is the same. The solution of this difficulty has been attempted in the following modes.

1. *The present earth was formed from the ruins and fragments of an earlier world, re-arranged and set in order during the six days of the creation.*

This explanation has been given by men of powerful minds—strongly impressed with the overwhelming evidence which the earth presents of innumerable events, and of progressive development through successive ages. It therefore honestly meets the difficulty, and fully grants the necessity of allowing sufficient time for the series of geological formations. It is, however, unsatisfactory; because it does not provide at all for the regular successions of entombed animal and vegetable races, and for the progressive consolidation, often in long continued tranquillity, of the strata which are formed around the organic bodies, and also for the numerous alternations and repetitions of these strata, frequently, as in the coal fields, in a regular order. All this demands time, and seasons of protracted repose, interrupted indeed by occasional elevations, subsidences, and other convulsions and catastrophes. In order that the solution above stated may prove satisfactory, it is necessary that the earth should be, what it actually is not, a confused pile of ruins, not only of loose fragments, such as are now found on its surface, but they must be consolidated, to form all its mountains and strata. Ruins, the mountains and strata do indeed, in many places, contain, but they form only a portion of a vast structure, in which ruins have no part.

The earth is unlike Memphis, Thebes, Persepolis, Babylon, Balbec or Palmyra, which present merely confused and mutilated masses of colossal and beautiful architecture, answering no purpose, except to gratify curiosity, and to awaken a sublime and pathetic moral feeling;—it is, rather, like modern Rome, replete indeed with the ruins of the ancient city, in part rearranged for purposes of utility and ornament, but also covered by the regular and perfect constructions of subsequent centuries.

This theory, if it provide at all for the primitive rocks, must assign their crystallization and consolidation to a period of indefinite geological antiquity, and it must also admit that they have undergone more recent modifications, particularly in being upheaved by subterranean force, and thus elevating, not only themselves, but the superincumbent strata.

The hypothesis has, however, great merit, inasmuch as it admits, in the long-gone-by ages, of just such events and successions as geology has proved to have taken place; but it adds a general catastrophe, which has not happened, and it implies a reconstruction of the crust

of the planet, entirely out of its own ruins, a supposition which is inconsistent with the state of facts.

2. *The present crust of the planet has been regularly formed between the first creation "in the beginning,"* and the commencement of the first day.*

It appears to be admitted by critics, that the period alluded to in the first verse of Genesis, "in the beginning," is not necessarily connected with the first day. It may therefore be regarded as standing by itself, and as it is not limited, it admits of any extension backward in time which the facts may require.†

By asserting that there was a beginning, it is declared that the world is not eternal, and the declaration that God made the heavens and the earth, is a bar, equally, against atheism and materialism. The world was, therefore, made *in time* by the omnipotent Creator.

The creation of the planet was no doubt instantaneous, as regards the materials, but the arrangement, at least of the crust, was gradual. As a subject either of moral or physical contemplation, we can say nothing better, than that it was the good pleasure of God that this world should be called into existence; but, it was also his pleasure, that the arrangement, by which it was to become a fit habitation for man, should be progressive.

This is in strict analogy with the regular course of things in the physical, moral and intellectual world. Every thing, except God, has a beginning, and every thing else is progressive. The human mind,

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* "*Of old*, hast thou laid the foundation of the earth, and the heavens are the work of thy hands." Ps. cii. 25. "And thou, Lord, *in the beginning*, hast laid the foundation of the earth." Heb. i. 10.

† "This statement appears to be entirely distinct from all that follows."—*W. M. Higgins, F. G. S.; the Mosaic and Mineral Geologies: London*, 1833.

"In this view I find no difficulties, either as a divine or a philosopher."—*Private correspondence of the Editor with an eminent biblical critic and divine.*

Dr. Chalmers says—"Does Moses ever say, that when God created the heavens and the earth, he did more, at the time alluded to, than transform them out of previously existing materials? Or does he ever say, that there was not an interval of many ages betwixt the first act of creation, described in the first verse of the book of Genesis, and said to have been performed in the beginning, and those more detailed operations, the account of which commences at the second verse, and which are described to us as having been performed in so many days? Or, finally, does he ever make us understand, that the generations of man went further than to fix the antiquity of the species, and of consequence that they left the antiquity of the globe a free subject for the speculations of philosophers."—*Evid. Christ. Rev. in Edin. Encyc.*

the bodily powers, the inception and growth of the animal and vegetable races, the seasons, seed time and harvest, science and arts, wealth, civilization, national power and character, and a thousand things more, evince, that progression is stamped upon every thing, and that nothing reaches its perfection by a single leap.

The gradual preparation of this planet for its ultimate destination, presents therefore no anomaly, and need not excite our surprise.

It is of no importance to us, whether our home was in a course of preparation, during days or ages, for the moral dispensations of God to man could not begin until his creation.

The abyss of waters which existed at an early unknown period, before the time of the final arrangement of the surface, which preceded the creation of man, and continued, we may suppose, for an unlimited time, is just such a state of things, in coincidence with the operation of internal fire, as is demanded for the formation of the central rocks, and for their elevation, as far as facts may justify us in supposing that it took place so early.

The supposition now before us is equally consistent with both the igneous and the aqueous theory of the earth; and indeed it would be impossible to account for the appearance of things, without the conjoined agency of internal fire, and of an incumbent ocean; the latter repressing the expansive and explosive power of the former, causing its heat greatly to accumulate, even to the fusion of the most refractory materials; preventing the escape of gaseous matter, as, for instance, of carbonic acid gas from the limestones, and by its pressure and slow cooling, from the small conducting power of water, preventing melted rocks from assuming the appearance of volcanic cinders, slags, scoriæ, and other inflated masses.

The incumbent ocean is therefore indispensable to the correct deductions of the theoretical geologist, even if he believe in the igneous origin of the primitive rocks: still more, if he attribute these rocks to dissolving agencies.

With these views, then, the historical record happily agrees, and geology has no quarrel with the sacred history.

During the period when this dark abyss of waters prevailed, the earth was without form, and void, or better, as Hebricians say—"the earth was invisible and unfurnished;" we may presume that then the early operations of geological formation and arrangement began, by producing the fundamental rocks, and thus providing materials for all the derivative strata, which, in the course of their consolidation, were destined to embosom such an endless diversity of extraneous contents.

This theory then is satisfactory as far as it goes: like the one previously discussed, it fairly recognizes and encounters the real difficulty in the case, and it would be quite sufficient to reconcile geology and the Mosaic History, as usually understood, did not the latter assign particular events to each of the successive periods called days; the most important of these events are, the first emergence of the mountains, and the creation of organized and living beings. It seems necessary therefore to embrace the days in the series of geological periods; and the difficulties of our subject will not be removed, unless we can show that there is time enough included in those periods called days, to cover the organic creation, and the formation of the rocks, in which the remains of these bodies are contained.

3. *The days of the creation were periods of time of indefinite length.*

Instead of most of the observations, which we might otherwise have made on this head, we shall substitute a comment on some of the lectures of the late illustrious Cuvier, by a distinguished philosopher, Prof. Jameson, of Edinburgh.* It is not necessary to speak of the eminence of those gentlemen in science, or of their attachment to the sacred writings; both are well known.

We would observe, that while we fully accord with Prof. Jameson in the general course of his argument, we leave his particular criticisms on some minor points, to those who are qualified to judge of their merits, Cuvier remarks:—

"The books of Moses shew us, that he had very perfect ideas respecting several of the highest questions of natural philosophy. His cosmogony especially, considered in a purely scientific view, is extremely remarkable, inasmuch as the order which it assigns to the different epochs of creation, is precisely the same as that which has been deduced from geological considerations."

This, then, is the issue, in the opinion of Baron Cuvier, of that science, which has been held by many persons to teach conclusions at variance with the Book of Genesis,—when at last more matured by a series of careful observations and legitimate induction, it teaches us precisely what Moses had taught more than three thousand years ago.

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The first chapter of Genesis is written in a pure Hebrew. This was the language spoken, and afterwards extensively written, by the people whom Moses conducted to Palestine from the land of Goshen.

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* Am. Jour. vol. xxv. pa. 26.

That it differed greatly from the language of the Egyptians, we have full proof in the Coptic remains of the latter, in the Egyptian proper names preserved in the Hebrew writings, and also in the circumstance that Joseph, when pretending to be an Egyptian, conversed with his brethren by means of an interpreter. Yet, in the chapter in question, we find no foreign terms, no appearance of its being translated from any other tongue; but, on the contrary, it bears every internal mark of being purely original, for the style is condensed and idiomatical in the very highest degree. Had Moses derived his science from Egypt, either by oral communication, or the study of Egyptian writings, it is inconceivable that some of his terms, or the style of his composition, should not, in some point or other, betray the plagiary or copyist.

But the conjecture that Moses borrowed his cosmogony from the Egyptians, must rest, moreover, on a supposition that the order which he assigns for the different epochs of creation, had been determined by a course of observation and induction, and the correct application of many other highly perfected sciences to the illustration of the subject, equal at least in their accuracy and philosophical precision, to those by which our present geological knowledge has been obtained. Nothing less than this can account for Moses' teaching us precisely what the modern geology teaches, if we allow knowledge to be merely human. How comes it to pass, then, that while he has given us the perfect and satisfactory results, he has been enabled so totally to exclude from his record every trace of the steps by which they were obtained? The supposition of such perfection of geological knowledge in ancient Egypt, implies a long series of observation by many individuals, having the same object in view. It implies of necessity, also, the invention and use of many defined terms of science, without which there could have been no mutual understanding among the different observers, and of course no progress in their pursuit. These terms have all totally disappeared in the hands of Moses. He translated, with precision, the whole science of geology into the language of shepherds and husbandmen, leaving no trace whatever of any one of its peculiar terms, any more than of the curious steps in its progress.

But there is a phenomenon in his record still more unaccountable upon any supposition that his science is merely human. His geology, acknowledged by the highest authority in this age of scientific improvement to be thus accurate, dwindles down in his hands to be a merely incidental appendage to an enunciation of the most rational

and sublime theology. This latter he did not learn in Egypt, for it was in the possession of his ancestors while they were yet inhabitants of Canaan.

Shall we, then, conjecture that Moses borrowed theology from the Hebrews on the one hand, and geological science from the Egyptians on the other, to compound out of them that brief, but unique and perfect system of both, which is presented to us in the first chapter of Genesis; or, is it possible that we could adopt any conjecture more absurd, and this, too, in utter destitution of all proof that the Egyptians possessed any knowledge of geology in the sense in which we use the term?

The result of our inquiry is, that the geology of Moses has come down to us out of a period of remote antiquity before the light of human science arose; for, to suppose that it was borrowed from, or possessed by any other people than the remarkable race to which Moses himself belonged, involves us on all hands in the most inextricable difficulties and palpable absurdities.* Of that race, it has been long since justly remarked, that while in religion they were men, in human learning and science they were children; and if we find in their records any perfect system of an extensive and difficult science, we know they have not obtained it by the regular processes of observation and induction, which, in the hands of European philosophers, have led to a high degree of perfection in many sciences.

Let us now, then, inquire into the true value and necessary result of Baron Cuvier's statement, "that the cosmogony of Moses assigns to the epochs of creation precisely the same order as that which has been deduced from geological consideration."

Before we proceed to that detail and comparison of particulars which are necessary in the due prosecution of the inquiry, we purpose to shew that a right understanding of the terms employed by Moses,

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* We believe that the opinion of Calmet may be maintained by very extensive and highly satisfactory internal evidence, that Moses, in the book of Genesis, has transmitted to us the successive writings of the earlier Patriarchs, just as the Prophets, who succeeded him, have transmitted to us that book and his own writings. We believe, likewise, with Bishop Gleig, that the opinion generally entertained of the late invention of alphabetical writing, is no other than a vulgar error, and that such writing must have been practised before the flood of Noah.

Sir William Jones, when he hazarded the conjecture, or rather opinion, that the language of Noah is probably entirely lost, must have quite overlooked the internal evidences, that the original language of Genesis can be no other than the language of both Noah and Adam. But these questions are too important and extensive to be more than thus briefly alluded to in a note.

will lead us to several more agreements between his statements and the results of the modern geology, than are indicated by our common English translation. This will lead us into a critical examination of several of these terms. We do not mean to hinge much of these criticisms on grammatical niceties, but to rest them chiefly on an examination of other passages of Hebrew Scriptures, where the terms are also employed, and where the context throws such light on them, as puts an end to all doubt about their true import. This is a process of criticism which is universally allowed to be quite satisfactory, where we have sources for employing it, as happens to be the case in the present instance.

To make our criticisms intelligible, without the labor of turning to the passages quoted, we shall quote the common English translation to such an extent as may be necessary.

The term, the meaning of which we shall first investigate, is "*day*" (in the Hebrew, yom.) The interpretation of this, in the sense "*epoch*" or "*period*," has been a subject of animadversion, of an unnecessary severity in some cases. A careful examination of the first chapter of Genesis itself, leads unavoidably to the conclusion, that our natural day of one revolution of the sun cannot be meant by it, for we find that no fewer than three of the six days had passed before the measure of our present day was established. It was only on the fourth day, or epoch of the creation, "that God made two great lights to divide the day from the night, and to be for signs, and for seasons, and for days and for years." The very first time that the term occurs in the Hebrew text, after the history of the six days' work, and of the rest of the seventh, as if to furnish us with definite information regarding its true import, we find it employed in a similar manner to that in which we must understand it here; for, in Gen. ii. 4, we have, "These are the generations of the heavens and the earth, *in the day* (beyom) that the Lord God made the earth and heavens." The use of the term in this indefinite sense is so common in the Hebrew writings, that it would be a great labor to quote all the passages in which it is found; and we shall satisfy ourselves by at present referring to Job xviii. 20, where it is put for the whole period of a man's life, "They that come after him shall be astonished at *his day*" (yomu); and Isaiah xxx. 8, where it is put for all future time, "Now go note it in a book, that it may be for the latter *day* (leyom), for ever and ever." It is quite obvious, from these examples, that the Hebrews used the term (yom) to express long periods of time. The very conditions of the history in this chapter, prove that it must be here so understood.

They who object to this interpretation of the term here, immediately quote against it the reason added to the fourth commandment, "For in six days the Lord made heaven and earth, the sea, and all that in them is, and rested the seventh day, wherefore the Lord blessed the Sabbath-day and sanctified it." This is, however, no more than a brief reference, and the terms of it must therefore be strictly interpreted in accordance with those of the detail to which the reference is made.

It has been said that such an interpretation goes to nullify the reasons assigned for the sanctification of every seventh revolution of the sun; but this does not follow. In point of fact, the rest from the work of creation (we use this form of speech from the example before us) did not endure for only one revolution, of the sun, but has continued since the creation of man; and we have no grounds on which to establish even a conjecture of the time of its coming to a close; so that if we were urged to adopt a period of twenty four hours as the meaning of yom, that the six days of creation might literally correspond with our six working days, we should then find the apparent disagreement, which, by this process, we would endeavor to avoid, transferred to our weekly period of rest, and the rest from the work of creation.

It will surely be readily allowed, that the sanctification of the Sabbath has respect to man and his duties; and since his Creator has been made known to him, and the order of the six successive epochs in which the earth was rendered fit for his habitation; if we are to allow what surely no reflecting mind will ever deny, that it is his duty to reflect with gratitude on the blessing he has received, and to maintain in his heart a sense of his dependence upon, and responsibility to him, who made the heavens and the earth, and all that they contain, no method could have been devised better calculated for preserving these feelings in constant activity than appointing some definite portion of time, returning at short intervals, to be devoted to the contemplations that awaken them, nor any interval more appropriate than that which so directly recalls the order of the events of the creation.

Since we have introduced the subject of the measure of our present day, we would offer an observation regarding the work of the fourth day, which includes the sun, moon and stars. Respecting the period of their creation, geology, from its nature, gives us no precisely definite indications. The history regarding them is from the 14th to the 18th verses, and we would observe of it, that the terms employ-

ed are such as do not not absolutely imply that these bodies were at this epoch first created, but admit of the interpretation that their motions were then first made the measures of our present days and seasons. We had found it already stated in the 1st verse, that the heavens and the earth were created *in the beginning*, antecedently to the work of the six days, by which they were reduced to their present order, and the earth was peopled with organized beings. It would seem an unwarrantable interpretation to exclude the sun, moon and stars from among the objects expressed by the general terms, the heavens and the earth. It is the most obvious interpretation, that they were then creat nd were lighted up on the first day, but that it was only during the ourth epoch, that they were made, the greater light to rule over the present day, and the lesser light to rule over the present night, and to be for signs, and for seasons, and for days and for years, according to the measures of time, which we now find established by them. This part of the history, then, when interpreted in consistency with the 1st verse, and without any violence to the terms, implies, (in the common language of men, which, in all nations, refers the diurnal and annual revolutions of the heavenly bodies to the motions of these bodies themselves,) that the earth was during this epoch, finally brought into its present orbit.

The work of the third epoch was the appearance of the dry land, and the creation of the vegetable kingdom. The history of the latter in our common translation, is v. 11, "God said, Let the earth bring forth *grass* (in the margin *tender grass*,) the herb yielding seed, and the fruit-tree yielding fruit after his kind, whose seed is in itself, upon the earth: and it was so." V. 12, "And the earth brought forth grass, and the herb yielding seed after his kind, and the tree yielding fruit, whose seed was in itself, after his kind." The terms grass (in Hebrew, deshe,) herb (Hebrew, oeseb,) and tree (Hebrew etz,) are here all put disjunctively in the Hebrew; there being only one conjunction in the twelfth verse between herb and tree, which does not affect the disjunctive character of the three terms, as it is a common practice in the Hebrew writings to couple, in this manner, the two last of a series of disjunctive terms, as, for example, the names of the four kings in Genesis xiv. 1. In the two last of these terms, herb and tree, we find a recognition of a remarkable natural distinction among the vegetable tribes, and this very circumstance would lead us to infer that the first term, which has obviously presented a difficulty to our translators, since they have given two interpretations of it, is intended to express some class or tribe of the vegetable kingdom, naturally

distinguished from herbs and trees, as they are from one another. The term in question (deshe) is a noun from a verb, which, from Joel ii. 22, we learn the meaning is *to spring*, *to shoot*, *to vegetate*, "Be not afraid, ye beasts of the field, for the pastures of the wilderness *do spring*, (dashcu.") In the 11th verse under consideration, we find both the verb and the noun, for the words translated "*Let the earth bring forth*" are (tadeshe haaretz,) which, in accordance with the obvious sense in Joel, would be better rendered "*Let the earth shoot out.*" From this meaning of the verb, then, the noun, would signify the *springing* or *shooting plant*, and as used here in contradistinction to both herbs and trees bearing seeds, it is surely not recommending any forced interpretation to suggest that it is meant to express that class of vegetables, which all botanists recognise as being naturally distinguished by the obscurity of their means of reproduction.

It tends to support this interpretation, that the Hebrew has a different term for grass, the common food of cattle (chatzir,) which the lexicographers have shewn is derived from its tubular structure. Thus, in Job, xl. 15, we have "he eateth *grass* (chatzir) as an ox;" and, Psalm civ. 14, "He causeth *grass* (chatzir) to grow for the cattle."

In several passages besides this of Genesis, we find *deshe* contradistinguished from both *oeseb* and *chatzir*, as in Deuteronomy xxxii. 2, "As the small rain upon the *tender herb* (deshe), and as the showers upon the *grass* (oeseb);" and Psalm xxxvii. 2, "They shall soon be cut down like the *grass* (chatzir), and wither like the *green herb* (deshe);" and 2d Kings xix. 26, "They were as the *herb* (oeseb) of the field, as the *green herb* (deshe), as the *grass* (chatzir) on the house tops." These quotations shew the want of uniformity with which the English translators have rendered these terms, and go to support the sense we would assign to *deshe*.

But we must not conceal that there are three passages in which this word occurs, that might seem to imply, until closely examined, that we should not be warranted to restrict the sense of it in the manner proposed. One is in the 23d Psalm, "The Lord is my shepherd, I shall not want. He maketh me to lie down in the pastures of *tender grass** (deshe)." On this we have to observe, that the word rendered here *in the pastures*, has been rendered in the Vulgate, in various places where it occurs, and by the Septuagint in some instances, *desirable* or *beautiful places*, and their accuracy in doing this seems confirmed by the circumstance, that the Hebrew has another term for

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* The marginal translation, which is the literal one.

pasture; and if this interpretation of that word be admitted, then *deshe* might signify here plants rather fitted for lying down on, as the mosses and ferns, than for pasture, which would make out a consistent image expressed in this clause or sentence, in opposition to the one derived from the abundance of pasture, which is evidently already sufficiently completed in the terms, "The Lord is my shepherd, I shall not want." This passage, then, when rightly understood, rather serves to confirm the meaning which we have suggested for *deshe*. Another passage is Job vi. 5, "Doth the wild ass bray when he hath *grass* (deshe), or loweth the ox over his fodder?" but no stress can be laid upon this, when we consider that both the ass and the horse eat, of choice, various species of ferns and equiseta, a fact which it is not unreasonable to suppose might be known to the author of a book which contains so much accurate and interesting natural history as this of Job. The plants, whatever they might be, which formed a supply for the wild ass, are at least obviously set in contradistinction to those which formed the fodder of the ox. The third passage is Jeremiah l. 11, "because ye are grown fat as the heifer at *grass* (deshe)." But there is, in a great number of manuscripts, a various reading for *deshe* here, by which the meaning becomes, "ye are grown fat, like a heifer thrashing, or treading, out the corn;" and several circumstances shew the latter reading to be the more probably correct one.

It remains, then, very highly probable, upon the whole, that *deshe*, in the 11th and 12th verses, is intended to express the cryptogamous vegetation.

In our observations on the terms emplyed in the history of the creation of the animals, we shall arrive at some important conclusions that are more absolutely certain.

The first thing that we would observe in regard to this, is, that there are two distinct words, of very different origin, which the English translators have rendered, promiscuously, *creeping creatures* or *thing*, and also *moving creatures*, following, no doubt, the authority of the Septuagint, which has given ἑρπετα for both; thus occasioning a great confusion instead of a clear and perspicuous order of creations exhibited in the Hebrew text. The first of these words is *sheretz*, as in verse 20th, in the history of the fifth day's work, "God said, Let the waters bring forth abundantly the *moving creature* (sheretz);" in the margin, the *creeping creature*. This word is from a verb, which signifies to *bring forth*, or to *increase*, or to *multiply abundantly*, being the very verb which is rendered *bring forth abundantly* in the 20th

verse, "Let the waters bring forth abundantly," (is heretzu hamaim). We find the verb obviously having this meaning in other passages, of which we shall quote examples: Gen. viii. 17, "*That they may breed abundantly* (vesharetzu) in the earth, and be fruitful and multiply in the earth;" Exod. i. 7, "And the children of Israel were fruitful *and increased abundantly* (vaisheretzu), and multiplied, and waxed exceeding mighty, and the land was filled with them;" Exod. viii. 3, "And the river *shall bring forth* frogs *abundantly* (vesharatz), * * * and the frogs shall come up both on thee and on thy people, and upon all thy servants."

From all this it appears that the proper translation of the noun *sheretz* is not *the creeping* but *the rapidly multiplying creature.* The creatures expressed by this noun were part of those which were created during the fifth epoch.

The other word translated *creeping thing* is (remes), and the creatures expressed by the noun were created during the sixth epoch. We shall afterwards shew that it has a very different meaning from *sheretz.*

In the history of the fifth day's work, the translators have rendered the Hebrew word (oph), by fowl. This limits its meaning so as to include only the birds. But the term includes also the winged insects, as is evident from Leviticus xi. 20, "All fowls (haoph) that creep, going upon four." The proper translation of the term is not *fowl*, but *flying thing*, including the tribes of all kinds that can raise themselves up into the air; as is indeed rendered obvious by the expression in the 21st verse of the 1st chapter of Genesis itself (cal oph canaph), "every flying thing that hath wings."

In the 21st verse it is said, "God created (hathananim hagedolim)," which Hebrew words, our translators, following the Septuagint, (which has given for them *τα κητη τα μεγαλα,*) have rendered great whales. We have abundant resources to shew that this translation is erroneous. In fact, neither the Greek nor the English translators have been consistent with themselves in translating the Hebrew word (than) or (thanim), for it occurs in both these forms. We find them in other places translating it severally by the term *δραχων*, and dragon. It would be tedious to quote the passages where they have thus varied from themselves. We shall refer to Ezekiel xxix. 3, for the latter sense, "I am against thee, Pharaoh, king of Egypt, *the great dragon* (hathanim hagadol) that lieth in the midst of his rivers," where the Septuagint has *τον δραχοντα τον μεγαν.* The figure in this passage is evidently borrowed from the crocodile of the Nile, and this circum-

stance of itself would shew that dragon, in place of whale, would be a better translation in Genesis. But (thanin) has a still more comprehensive meaning. We find two words formed from it, one of which (Leviathan) is the specific name of the crocodile, as is obvious from the descriptions of Job chap. xli. and of Isaiah chap. xxvii. 1, in which last passage (thanin) is also used,—and the other (Pethan) is the specific name of some serpent, as is obvious from the reference to its poison, in Job xx. 14, and Deuteronomy xxxii. 33. In this last passage we also find poison ascribed to the thanin; "Their wine is the poison of dragons (thaninim), and the cruel venom of asps (pe'hanim);" so that here it is evidently meant to express a serpent, as in Ezekiel and Isaiah, as we have seen above, it signifies one of the lacertine species.

These references, which we could have greatly extended, were it necessary, are sufficient to prove that (than) or (thanin) was a sort of generic, or rather classical, name, to designate the serpent and lizard tribes; and that instead of *great whales* in the 21st verse, the translators should have given the words *great reptiles.**

The result of our criticism is, that the work of the fifth epoch, as described in Genesis, was the creation of the inhabitants of the waters; of the birds, winged insects, and reptiles; in fact, of the oviparous races named in detail, with some omissions which are to be accounted for by the uniformly condensed and brief form of the whole narration.

We proceed to the work of the sixth epoch, which concluded with the creation of man.

In the English translation we find *creeping things* again included among the beings which were created during this period, and these English terms, in their most commonly received acceptation, imply some of the insect or reptile tribes. We have seen that the Septuagint countenances the interpretation *creeping things;* but the Hebrew term (remes) does not. This is derived from a verb which signifies *to move*, and which is so far from being limited in its application to the insects or the reptiles, that, in Psalm civ. 20, 21, we find it applied to the beast of the forest and the young lions: "Thou makest darkness and it is night, wherein all the beasts of the forest *do creep* (tire-

* There is only one passage in which (than) means, with certainty, any thing else than a serpent or reptile, which is Lamentations iv. 3, where probably a seal is meant; but the passage is highly poetical, and no authority can be given to it to supersede the uniform meaning of the term in all the earlier writers, which we have established in the text.

mos). The young lions roar after their prey." In the 24th and 25th verses, (remes) is grouped with cattle (behemach), and *beast of the earth* (haith haaretz). Proofs are abundant, and too tedious to be all referred to, that by (behemah) the Hebrews generally expressed the larger herbivorous animals, and by (haith haaretz) the larger beasts of prey. (For the former see Genesis xxxiv. 23, and for the latter Leviticus xxvi. 22.) Thus we find races of mammalia expressed by these terms, and to comprehend the whole class we must understand (remes) as referring to its other tribes. It is at least no race of insects that can be meant by the term, for, in point of fact, where any of these are obviously meant in other Hebrew passages, either the name (sheretz) is given to them, as in Leviticus xi. 42, "Whatsoever doth multiply feet among all *creeping things*," (hasheretz), or the name (oph), as we have already seen.

It is true that remes is applied to the oviparous tribes, but not as a noun or name, but as a verb to express their motion, just as in some passages above quoted, we have seen sheretz applied as a verb, but not a name to mammalia.

Previously to setting down the following table of coincidences between the first chapter of Genesis and the results of geological observation, it is necessary to make a remark on one passage in Humboldt's table of geological formations, which possesses a classical celebrity over Europe. In that table, following an earlier authority, he has placed the formations of transition, in the limestones of which are found several species of shells, intermediately between the primitive formations and those containing bituminous coal; and his table would thus indicate that an animal creation had preceded any vegetable one. We shall not need to discuss the question, whether the formations, named transition, are considered in a right point of view, when they are placed between the primitive and pit-coal strata, since it is sufficient for our present purpose to remark, that several observations, among which we may particularly refer to those of Thomas Weaver, Esq. F. R. S., on the geological relations of the south of Ireland, have proved that the anthracite or glance coal of the transition formations, with some of its accompanying strata, are full of impressions of various plants;* so that in the transition strata a vegetable creation is discovered as well as an animal.

In the following table we have taken the geological facts from various authorities. The passages quoted, are selected chiefly on account of their brevity. In the quotation from, and reference to Genesis, the events on which geology can throw no certain light are in italics.

* This is true, on a vast scale and in innumerable instances, in the anthracite mines of Pennsylvania; not to mention that most geologists now include the bituminous coal in the transition class.—*Ed.*

Table of Coincidences between the Order of Events as described in Genesis, and that unfolded by Geological Investigation.

In Genesis.	No.	*Discovered by Geology.*
Gen. 1. 1, 2. In the beginning God created the heavens and the earth. And the earth was without form and void; and darkness was upon the face of the deep; and the Spirit of God moved upon the face of the waters.	1	It is impossible to deny, that the waters of the sea have formerly, and for a long time, covered those masses of matter which now constitute our highest mountains;
3, 4, 5. *Creation of light.* 6, 7, 8. *Creation of the expansion or atmosphere.* 9, 10. Appearance of the dry land.	2	and, further, that these waters, during a long time, did not support any living bodies.—*Cuvier's Theory of the Earth, sect.* 7.
11, 12, 13. Creation of shooting plants, and of seed-bearing herbs and trees.	3	1. Cryptogamous plants in the coal strata.—*Many observers.* 2. Species of the most perfect developed class, the Dicotyledonous, already appear in the period of the secondary formations, and the first traces of them can be shown in the oldest strata of the secondary formation; while they uninterruptedly increase in the successive formations.—*Prof. Jameson's remarks on the Ancient Flora of the Earth.*
14 to 19. *Sun, moon and stars made to be for signs, and for seasons, and for days, and for years.*		
20. Creation of the inhabitants of the waters.	4	Shells in Alpine and Jura limestone.—*Humboldt's tables.* Fish in Jura limstone.—*Do.* Teeth and scales of fish in Tilgate sandstone.—*Mr. Mantell.*
Creation of flying things.	5	Bones of birds in Tilgate sandstone.—*Mr. Mantell, Geological Transactions*, 1826. Elytra* of winged insects in calcareous slate, at Stonesfield.—*Mr. Mantell.*
21. The creation of great reptiles.	6	It will be impossible not to acknowledge as a certain truth, the number, the largeness, and the variety of the reptiles, which inhabited the seas or the land at the epoch in which the strata of Jura were deposited.—*Cuvier's Ossem. Foss.* There was a period when the earth was peopled by oviparous quadrupeds of the most appalling magnitude. Reptiles were the lords of Creation.—*Mr. Mantell.*
24, 25. Creation of the mammalia.	7	Bones of mammiferous land quadrupeds, found only when we come up to the formations above the coarse limestone, which is above the chalk.†—*Cuvier's Theory, sect.* 20.
26, 27. Creation of man.	8	No human remains among extraneous fossils.—*Cuvier's Theory, sect.* 32. But found covered with mud in caves of Bize.—*Journal.*
Genesis, VII. The flood of Noah, 4200 years ago.	9	The crust of the globe has been subjected to a great and sudden revolution, which cannot be dated much farther back than five or six thousand years ago.—*Cuvier's Theory*, 32, 33, 34, 35, *and Buckland's Reliq. Diluv.*

* Sheaths.

† One solitary exception is since discovered, in the calcareous slate of Stonesfield, in the bones of a didelphis, an opossum, a tribe whose position may be held intermediate between the oviparous and mammiferous races.

In the above table, we have not taken advantage of the distinction which we conceive, we have gone far to prove, is expressed in the Hebrew text between the cryptogamous and the other classes of plants but have set down the whole vegetable kingdom as forming only one element in the table. We shall also allow that the 4th, 5th, and 6th Nos. may be liable to be interchanged among themselves, in respect of place and shall hinge no argument upon them, farther than what arises from the circumstance that they are all placed in one group. Yet, after these abatements from the number of particulars, the coincidences here shown between the order of the epochs of creation assigned in Genesis, and that discovered by geology, are calculated to excite the deepest attention. Human science, in the probabilty of chances, as illustrated by La Place, has put us in possession of an instrument for estimating their value; and we feel amply entitled to take advantage of it for that purpose, for no case could well be pointed out, where it would be more correctly applicable than in this, where the coincidences assume a definitely successive numerical form. We are entitled to adopt even the very language of La Place, and to say, "By subjecting the probability of these coincidences to computation, it is found that there is more than sixty thousand to one against the hypothesis that they are the effect of chance.*

It is thus, then, that the discoveries of geology, when more matured, instead of throwing suspicion on the truths of revelation, as the first steps in them led some persons to maintain, have furnished the most overpowering evidence in behalf of one branch of these truths. The result of these discoveries has been, in this respect, similar to those of the Chinese and Egyptian histories, and the Indian astronomy, but much more striking. Eminent men had pledged their fame in setting up these histories, and that astronomy, in opposition to the chronology of Genesis; but further and more careful inquiry into their true characters, discovered that, when rightly understood, they only tend to confirm it.

We are not afraid that we shall have here quoted against us the words of Bacon, "Tanto magis hæc vanitas inhibenda venit, et coercenda, quia ex divinorum et humanorum, male sana admixtione, non solum educitur, philosophia phantastica, sed etiam religio hæretica." We have only endeavored to illustrate and point out the consequenquences of the statement of Baron Cuvier, "that the order which the cosmogony of Moses assigns to the different epochs of creation, is

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* Syst. du Monde, book v. chap. 5.

precisely the same as that which has been deduced from geological considerations." We have been guilty of no improper mixing up of divine and human things. We have examined the meaning of the terms in the first chapter of Genesis, in consistency with the acknowledged rules of criticism, and only by the light contained within itself, or that thrown upon it by the other books, in the same language with which it is associated. The human science we have not extracted from any part of the Holy Scriptures; we have taken it simply as we find it in the works of eminent geologists. As the latter is not a philosophia phantastica, but a deeply interesting science, constructed by that method of careful observation and cautious induction, which Bacon was himself the first to reccommend; so neither can the sense of the Scriptures present to us a religio haeretica. If our science, thus constructed, and our religion speak so obviously the same language, as we see they do on one important point, what else in the strictest application of Bacon's philosophy, can we deduce from the circumstance, but that both are certainly true?

It does not come under our present subject to discuss the historical and moral evidences of the divine revelation of the Scriptures; but both are so full, even to overflowing, and impose upon us so many insuperable difficulties, in the way of our being able to account for the quality and consistency of these remarkable books, excepting on the ground which has been all along assumed by themselves, that they are of more than human origin, that in estimating the accuracy of any part of the matters contained in them, the fastidiousness of human science appears to be carried to an unreasonable extent, not to take these evidences into calculation. In this country, where for a long period, we have had the scriptures in our hands as a popular book, they among us who have been the most eminent for human learning and science, and whose fame has been in every view the most unsullied, have been so convinced by the force of these evidences, that they have in general been the most strenuous defenders of revelation.

Will not human science, then, condescend to borrow some light to direct the steps of its own inquiries, from a record, the accuracy of which it has itself proved, and which is supported by other proofs of the highest order? Or,* what should we say to the illustrator of the relics of Pompeii and Herculaneum, who should reject the light

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* The other part of this argument, we attempted to illustrate, in the first pages of the present discussion.—*Ed.*

thrown on them by the letters of Pliny, authenticated as these are by the existing remains of the buried cities, as well as the historical evidence which is proper to themselves?

Among the questions which geology is at present attempting to solve, is that of a different temperature of some regions of the earth at a remote age. The discoveries of Pallas and Adams, of a rhinoceros and elephant in Siberia, having coverings of hair fit to protect them from the cold of the northern regions, would seem to decide the question, so far at least to show, that there has been no change of temperature since the creation of animals. But the question does not seem yet so satisfactorily answered, so far back as to the age of the creation of vegetables. Does not the statement of Genesis, that the establishment of our present days and seasons was intermediate between the creation of vegetables and that of animals, give us a clew to direct our path in the inquiry?"*

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Having finished this long, but very important and apposite quotation from Prof. Jameson, we proceed to remark that we are aware, from much communication on this subject with eminent biblical critics and divines, how tenacious they are, of the common acceptation of the word day. On points of biblical criticism we have no right to speak with great confidence. But we may be permitted to remark, that from the best consideration we have been able to give the subject, aided by the light, afforded both by criticism and geology, it does not appear necessary to limit the word day in this account, to the period of twenty four hours.

1. This word could have had no definite application, before the present measure of a day and night was established by the instituted revolution of the earth on its axis, *before an illuminated sun*, and this did not happen until the fourth day.

2. The word day, is used even in this short history, in three senses, —for light as distinct from darkness,—for the light and darkness of a single terrestrial revolution, or a natural day; and finally for time at large.

3. In the latter case then, the account itself uses the word day in the sense in which geology would choose to adopt it, that is, for time or a period of time.

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* On submitting the criticisms of Professor Jameson to an eminent Hebrew scholar, no fault was found with them, although the inferences with respect to geology, were not admitted.—*Ed.*

In the recapitulatory view of the creation in the beginning of the 2d chapter of Genesis,—allusion is made to the whole work in the expression "*in the day* that the Lord God made the heavens and the earth."

4. If the Canons of criticism require that one sense of the word day should be adopted and preserved throughout the whole account, how are we to understand this verse? "These are the generations of the heavens and the earth when they were created, in the day that the Lord God made the heavens and the earth." Which of the three senses shall we adopt? If the last, then the whole work was performed not in six days, but in one day—of twenty four hours, in the popular sense;—in a sufficient period of time, according to the geological view. The canons of criticism were made by man and may be erroneous, or at least, they may be erroneously applied; the world was made by God, and if the history in question were dictated by him, it cannot be inconsistent with the facts.* Why then, should we not prefer that sense of the word used in the history itself, which is in harmony with the structure of the globe. It is said indeed, that the account in the 2d chapter of Genesis is a different one from that in the first. With this the geologist can have no concern; since he finds both adopted in a connected history, he receives them as one.

It is agreed on all hands, that the word here used for day, is that which in the Hebrew, usually signified a period of 24 hours and the addition of morning and evening is supposed to render it certain that this is the real sense and the only sense that is admissible, especially as this view is supported by the peculiar genius of the Hebrew language.

But, we would ask, is it unusual to preserve this allusion to morning and evening, when the word day is used for time; we speak for instance of the life of a man *as his day*, and in the same sense and in harmony with this rhetorical figure, we speak of the morning and the evening of life.

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* No opinion can be heretical but that which is not true. Truths can never war against each other. I affirm, therefore, that we have nothing to fear from the result of our inquiries, provided they be followed in the laborious but secure road of honest induction. In this way, we may rest assured, we shall never arrive at conclusions opposed to any truth, either physical or moral, from whatsoever source that truth may be derived; nay, rather that new discoveries will ever lend support and illustration to things which are already known, by giving us a larger insight into the universal harmonies of Nature.—*Professor Sedgwick's Address to the Geological Society, February* 19, 1830.

In all ages, countries and languages, this use of the word day is fully sanctioned, and it is frequently used in the scriptures in the same sense.* Indeed, it might not be too much to suppose that the arrangement by which the sun was to measure time was not completed until the evening of the 4th day, and then our difficulties will be confined to one day, namely, the 5th. The first three days, obviously, could not have had the present measure of time applied to them; and the work of arranging the crust of the planet was so far finished, by the evening of the 5th day, as to fit it for the reception of terrestrial quadrupeds, which first appeared on the 6th day, and finally, man was created, as would appear, at the conclusion of the same day; of course, the great geological revolutions, *beneath the bed of the ancient ocean*, must have been so far finished that the continents had emerged, and thus dry land was provided, both for terrestrial quadrupeds and for man, neither of which could, before this period, have existed on the earth.

In the usual mode of understanding the account, all the immense deposits of coal, and of vegetable and aquatic animal remains, with their vast strata and mountains, must have been made within 72 hours, for there was no dry land until the third day, and consequently no vegetables; they appeared on that day, aquatic animals on the 5th, and land animals, with man, on the 6th; but the latter could not, as observed above, have appeared until the continents had emerged, and consequently marine formations had, in a great measure, ceased, ex-

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* *Luke* xvii. 24.—So also shall the son of man be in his *day*.

John viii. 56.—Your father, Abraham, rejoiced to see my day; and he saw it and was glad.

2. *Peter* iii. 8.—One day is with the Lord a thousand years, and a thousand years as one day.

Genesis ii. 4.—These are the generations of the heavens and of the earth when they were created in the day that the Lord God made the earth and the heavens.

Job xiv. 6.—Turn from him that he may rest till he shall accomplish as an hireling his day.

Job xviii. 20.—They that come after him shall be astonied at his *day*, as they that went before were affrighted, (speaking of the life of the wicked.)

Ezekiel xxi. 25.—And thou profane wicked princie of Israel, whose day is come when iniquity shall have an end.

Proverbs vi. 34.—For jealousy is the rage of a man; therefore he will not spare in the day of vengeance.

"When day is used in the plural number, it often signifies a year. It is thus used in Leviticus xxv. 29.—If a man sell a dwelling house in a walled city, then he may redeem it within a whole year after it is sold."—*Higgins' Mosaical and Mineral Geologies, p.* 161.

cept such as may have been going on ever since. According to the popular understanding, the transition and secondary mountains with their coal beds, plants and animals were therefore, formed, in two or three natural days, by physical laws, which is incredible, because it is impossible.

We cannot conceive therefore, that even the limitation of morning and evening is decisive against the extension which we would claim, and we are left at liberty to interpret the word day in harmony with the facts of geology.

It is granted that Moses himself might have understood the word day according to the popular signification and that this sense would be the most obvious one to every mind not informed as to the structure of the globe; even those who are learned on other subjects, but ignorant of geology, always adopt, in this case, the literal and obvious meaning. This however proves nothing; for the truths of astronomy, are in exactly the same situation. Until the modern astronomy arose, no one whether learned or unlearned, entertained a doubt that the earth is an extended plain; that it stands on a firm foundation, even on pillars, and that the sun and starry heavens and the azure canopy revolve around it as a centre.

Such is still the impression of barbarous nations, but few even of the common people of enlightened countries would now fall into so gross an error; and no one in this age fears that he shall, like Galileo, be thrown into prison for declining (on this subject) to understand the scriptures in their literal sense.*

It is objected that as the sabbath is a common day and that as it is mentioned in the fourth commandment, and in other parts of the scriptures, in connexion with the other six days, they ought to be limited to the same *time.*

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* When the present system of astronomy was introduced, it met with the most violent opposition and the following is the "Judgment pronounced at Rome, in 1622, only two hundred and eleven years ago, on the Philosophy of Galileo, and on the Philosopher himself, by the seven Cardinal Inquisitors." "To affirm that the sun is in the centre, absolutely immoveable, and without locomotion, is an *absurd* proposition, *false* in sound philosophy, and moreover *heretical,* because it is expressly contrary to *Holy Scripture.* To say that the earth is not placed in the middle of the world, nor immoveable, is also a proposition *absurd and false* in sound philosophy; and considered theologically, is at least erroneous with respect to faith." "Whereupon Galileo so refuted, was compelled on his knees to abjure, curse and detest, the *absurdities, errors and heresies,* which the sagacity of the Cardinal Reviewers and Inquisitors had discovered in his writings."—*Penn's Compar. Estimate, &c. 2d. Ed. Vol. I. p.* 37.

We cannot see that this consequence follows. The sabbath is a moral enactment; all that precedes was physical, relating merely to the creation and arrangement of matter, and to irrational organized beings; the sabbath could have no relation to rocks and waters: it was ordained for man, as a rational being, and in mercy as a day of rest to the animal races that were to labor for him: it was a new dispensation and although the same word is applied both to this period and to those that preceded, it does not appear to follow that they are necessarily of the same length. The first three days that preceded the establishment of the relation between the sun and the earth could have no measure of time in common with our present experience, and it appears to be no unwarrantable liberty to suppose that they may have been of any length which the subject matter may require, although those three days were also verbally limited by morning and evening, and that at a period of the creation when there could have been no morning and evening, in the sense in which those words are now used.

The revolution of the earth on its axis in presence of an illuminated sun, was necessary to constitute morning and evening, and it must revolve with the same degree of rapidity as now, in order to have constituted such a natural day, with its morning and evening as we at present enjoy. But the sun was not ordained to rule the day until the fourth of those periods, and it is not certain that the early revolutions of the earth on its axis were as rapid as now. May we not therefore suppose that the historian, as he must employ some term for his divisions of time, adopted one that he found in familiar use, but that it is not necessarily restricted to the common acceptation of the word.

Is it asked whether Moses had any mental reservation, a double sense for the word day—one for the common people and one for geologists; we answer that it is very possible he had no geological knowledge beyond the order of time in the creation which his history exhibits. It is very probable that fossil and entombed organized remains and fragmentary rocks and indeed most of the facts which geology has developed were unknown to him and that, as he told a story for mankind at large, he told it in the same spirit and with the same understanding with which it is commonly received. This however decides nothing more than in the case of all the sacred writers who relate astronomical events, or who allude to astronomical appearances in the vulgar sense, which is in direct contradiction to the actual state of facts in astronomy; whereas geology contradicts nothing contained in the scripture account of the creation; on the contrary, it confirms the order of time and requires only that the time should be sufficiently extended to render it

physically possible—without calling in the aid of miracles in a case where natural successions are sufficient to account for the facts.

4. *It has been supposed that the succession of geological events may have happened in the first ages of the world, after the creation of man.*

This supposition is wholly irreconcilable with facts. The great series of geological events was inconsistent with the existence of man upon the earth: they precluded even the existence of terrestrial quadrupeds, which both geology and the scripture history assign to a late period in the order of things, the same period in the close of which man himself first appears; they were, until the period immediately preceding, incompatible with the existence of any beings that required more land than amphibious reptiles; and the vast deposits of fossilized and of crystallized rocks that preceded the period of reptiles, demanded an alternate and concomitant prevalence of water on the surface, and of fire beneath, which were entirely hostile to the quiet and firm state of the surface, such as we see it now. Beyond the effects of just such agents as are now in operation, water, temperature, storms, volcanos, earthquakes, &c. we have no reason to suppose that the earth has undergone any very important changes, affecting the integrity of its entire crust, since man appeared in the world.

5. *It has been supposed that a general deluge will account for all the geological events that have been described.*

This view is entirely inadmissible, except as to those superficial ruins which have been already spoken of as diluvial. In geology, without reference to sacred history, a deluge is a sudden rise and overflow of water. It has no exact limit in time, altitude or violence.

The facts revealed by geology demand many partial deluges, and they are admitted by all geologists, with greater or less extent, to account for the transport and deposition of those things which water alone could convey; it is necessary also to suppose, that both fresh and salt water, either by rise of water, or subsidence of land, alternately prevailed and retired after continuing an indefinite period; sufficiently long, however, to give time for the various animals and plants to be deposited and entombed, which we find in successive strata, now marine or littoral, or pelagian, now of fresh water, fluviatile, or lacustrine. The rise and subsidence of the land, by subterranean efforts and collapses, arising from igneous action, was the probable cause of these alternate movements.

Our concern, however, in this discussion, is with the general deluge, described in the book of Genesis, for, we are writing for the sake of those who believe in the genuineness and authenticity of that history. From many things that have been already said, it is obvious that the amazing geological depositions of the earth cannot be ascribed to that short, violent and transient catastrophe. Its genuine effects are exactly those which all geologists ascribe to diluvial action; namely, the transportation of the loose ruins of mineral masses, and of the organic world, which are found strewed every where over the surface of the earth.

Professor Buckland, in his Reliquiæ Diluvianæ, has most ably illustrated this subject; and it is obvious, that the former practice, of attributing the organized remains found in the solid strata, to this catastrophe, is founded entirely in an imperfect acquaintance with the subject, and that no man, at the present period, who had studied geology thoroughly, would fall into such an error.

It is not supposable, however, that all deposits of gravel, &c. are attributable to a general deluge, and it may be difficult to draw the line between a local and a general flood. It is not important to discuss that topic, nor the objections of those who reject the Mosaic account of a general deluge. To them it is sufficient to say, that as the earth bears every where marks of diluvial action, and is strewed with diluvial ruins, every observer will for himself assign to local deluges, or to a general debacle, as great a portion of the effects as may in his view be proper.

To those who would assign to the agency of a general deluge, the vast work of depositing the immense solid geological formations, with all their varied stores of animals, and plants, and fragments, and diversified successions, we can say only, that such effects, from such a cause, are physically impossible, especially within the limits of time and under the circumstances assigned in the Mosaic account. It is not necessary to go again into the induction of particulars.

As to the loose materials, their actual disposition and arrangement, as we now see them, is to be attributed, chiefly, to a diluvial ocean—no other cause being capable of reaching the regions remote from, and elevated above the present great waters of the globe.

The arrangement of the loose materials, on shores and in outlets, and in regions occasionally flooded, is, at least to some depth, and to some extent, to be referred to agencies now in operation.

It is also true, that water-worn pebbles are produced at the present time. No one who, on the sea shore, has observed the incessant lash-

ing of the waves, and has listened to the hollow hum of the stones and pebbles rubbing against each other, with ceaseless friction, can doubt, that rounded, water-worn pebbles are now every moment forming; and were they found no where else, except on the shores, and in moving waters, there would generally be no difficulty in assigning their origin to this cause. But rounded stones, water-worn pebbles, and bowlders, are found in every country, on the surface and in the soil, and in regions the most remote from the ocean. This of course proves the universal prevalence, sooner or later, at once or successively, of diluvial waters.

Why not attribute the rounding, as well as the position of the inland water-worn stones to the *diluvial* ocean? The answer which must be returned, is, that the time allotted by the deluge described in Genesis is too short for the process of grinding down hard stones, which would occupy a very long period. A general deluge could transport immense masses of these ruins, and deposit them where, to a great extent, we now find them; but it was not possible that it could, in so limited a period, have effected much, in grinding down the angular fragments of quartz* and of other hard stones, into ovoidal and globular pebbles, and bowlders. That effect appears to have been, principally, the work of the earlier oceans.

The form of the loose materials, that cover the rocks, more or less, in every country, is attributable chiefly to the wearing effects of agents, operating, *in all time*, to produce disintegration and decomposition; their present position may be fairly attributed to diluvial agency.

An ingenious author, Mr. Penn, convinced that the deluge could not account for the geological successions, has supposed them to be formed in the ocean, between the creation of man and the deluge, at which time the then existing continents were, as he thinks, sunk, and the bed of the ocean raised, to form our present continents, bringing up, of course, all the marine deposits of sixteen centuries.

It is not necessary to discuss this theory. It is disproved by the discovery in caverns, and in the loose wreck, on the surface of the ground, of immense deposits of the bones of terrestrial animals, which have not existed in those countries within the limits of human knowledge, and many of which could not live in the present climates of those countries; for instance, the tropical animals, elephants, tigers,

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* Topaz pebbles are found on the shores of New Holland: we have one which is perfectly ovoidal.

hyenas, hippopotami, rhinoceros, &c. are found now abundantly in the diluvium of England, and consequently England was dry land before the deluge that buried these remains, and therefore the existing continents have not been raised from the ocean since the creation of terrestrial quadrupeds, unless they were submersed after that epoch and then raised again, of which there is no proof. The coal beds also present indubitable proofs of having been formed from terrestrial vegetables, and therefore they were not submarine, although the occasional occurrence of a few marine shells or plants may prove that some of them were formed in islands or estuaries, where the sea had occasional access.

The result of all our enquiries, then, is this.

We find that the geological formations are in accordance with the Mosaic account of the creation; but more time is required for the necessary events of the creation than is consistent with the common understanding of the days. The history is therefore true, but it must be understood so as to be consistent with itself and with the facts.

It is agreed on all hands, that there may be time enough for the primitive rocks before the first day, and if the days be regarded as periods of time, so as to allow room for the events assigned to them, relating to organic beings, and to the masses in which they are entombed, all difficulty is removed.

On the contrary, if they are restricted to the usual popular sense, it is not physically possible that the events should have happened within the time assigned; but they did happen, and as there was no call for miracles in cases where natural operations alone were sufficient, there can be no doubt that sufficient time was allowed.

It is scarcely necessary to remark, that after the order and arrangement of the creation were fully established, and man appeared on the earth, the measures of time were, without doubt, the same as now, and therefore we are not at liberty, as there is clearly no occasion to regard them in any other than the usually accepted sense.

It is no valid objection to the supposition of more time than is commonly allotted to the week of the creation, that there were no human beings to be spectators of the work. Even upon the popular view, they were excluded, because the human race did not appear until the very last act of the creation. Had they, however, been co-existent, they would scarcely have understood what was passing, as most of the geological facts were veiled by the ocean. But there were not wanting spectators; God, and angelic beings, far superior in intelligence

and dignity to man, looked on, and in the beautiful and highly figurative language of the history—"the morning stars sang together, and all the sons of God shouted for joy."

Before closing these remarks, we will respectfully submit a few suggestions for the consideration of two very different descriptions of persons, namely, *those who deny, and those who defend, the truth of the Mosaic history.*

To the former class, so far as they are geologists, we will say, that, in relation to geology, any attempt to disprove the truth or genuineness of the pentateuch, and of Genesis in particular, is wholly superfluous, and quite aside from any question that can, in this age, be at issue between geologists. No geologist, at the present day, erects any system upon the basis of the scripture history, or of any other history. Still, historical coincidences with natural phenomena have always been regarded as interesting, because they are mutually adjuvant and confirmatory. The letter of Pliny, describing the death of his uncle, would have been true, although Herculaneum and Pompeii had never been discovered; and it would have been true that those towns were overwhelmed by a volcanic eruption, although the letter of Pliny had never been written; or being written, if it had been false as to the main fact of the death of the elder Pliny, or of there having been an eruption at the time assigned in that writing. But the existence of the letter, and its coincidence with the facts revealed by the discovery of the buried cities, flash conviction upon every mind, and afford some of those firm points of reliance upon which our confidence reposes with delight. Now if there is not sufficient proof in the appearance of the earth, that it was for a long time covered by water, and that the waters deposited, in the then forming strata and mountains, those organic bodies, of aquatic origin, which we find entombed in them, then no geologist of the present day would, on the authority of the first chapter of Genesis alone, assume the fact of terrene submersion, as the basis of his reasoning and as the foundation of a geological system.

In the same manner, if he find on the face of the earth no proofs of diluvial devastation; if there be nothing to evince, that mighty rushing waters have torn up and transported to a distance the moveable materials of the surface; then, as a geologist, he will never assume the Mosaic account of the deluge as the basis of a system of diluvial agency, any more than he will build similar conclusions upon the poetry, fables and mythology, or even upon the history, of the ancients.

But if he discover proofs, and those too generally admitted by well instructed geologists, of both the stupendous events named above, or of a succession and diversity of such events, sufficient, on the whole, to mark the entire earth, by their appropriate effects; if then he finds a history of high antiquity, and generally revered wherever it is known, describing such a state of things as the condition of the planet reveals, what rule of science or of philosophy can debar him from bringing the two into comparison, for mutual illustration, as is always done in the case of other antiquities. Why should any one object to his applying the terms of the history, as he understands them, and then measuring the phenomena by them, and them by the phenomena. If they agree, surely, it is reasonable that conviction should receive augmented strength in his mind. Should they, however, disagree, the phenomena, if correctly observed and correctly reported, will still be true, and the credit of the history will, of course, be impaired. Should, moreover, the genuineness or authenticity of the history be disproved, from other sources than the phenomena, the latter will still remain in all the obstinacy of fact, which history may indeed illustrate, but cannot, on the contrary, disprove. If the history, on the other hand, be confirmed by the natural phenomena, it has then received the greatest confirmation possible, and may well exult in so powerful an ally.

Should it, in the case of the pentateuch, be proved even, that there was never any such person as Moses, or that the books that pass under his name were written by others, or that they are compilations of ancient and vague traditions, or even of reputed or real fables, this would not, in the least, affect the system of geological truth that has been erected by an ample course of investigation and induction. But, as long as the Mosaic history is admitted to be both *genuine* and *true*, any geologist who receives the history in that character, may, with strict historical and philosophical propriety, illustrate the history by geology, and compare geology with the history.

This he will do merely on the ground of historical and geological coincidence, and without drawing for the support of his scientific views upon any portion of his moral feeling, towards a work which, as an individual, he may revere as a communication from his Maker for purposes far more important than the establishment of physical truth.

To personal imputations on his motives, his science or his skill, or on those of eminent philosophers with whom he has the honor to think and to act, while he leaves the case, with the grand inquest of the learned, the candid and the wise, he will reply in no other manner than by ex-

pressing the hope that powerful and cultivated, but unbelieving minds, may be influenced to see the harmony *of all truth*, whether historical, moral or physical, and to remember that man is, after all his acquirements in knowledge, a being, so darkly wise and rudely great, that he is constantly in danger of deviating into error, especially on subjects that have a moral, as well as a physical bearing. While, therefore, in geology, as well as in other sciences, we fully approve, and humbly follow the course of rigid induction—(the only safe and truly philosophical process of investigation, and basis of physical truth,) we hold it to be entirely proper in a scientific view, to avail ourselves of every apposite historical fact, from whatever credible source it may be derived. Indeed, no geologist hesitates to cite history, travels, personal narrative, and even poetry and tradition, in confirmation or illustration of earthquakes, floods, or volcanic eruptions; of the rising or sinking of islands; of alluvial increase or destruction; of ruptures of the barriers of lakes, irruptions of the sea—or whatever other fact may be the subject of his investigation. Why then should the scripture history form the only exception among historical authorities!

Having made these suggestions to those geologists who are not believers in divine revelation, we will now add a few remarks to believers who are not geologists.

The subject before us is not one which can be advantageously discussed with the people at large. A wide range of facts, and an extensive course of induction, are necessary to the satisfactory exhibition of geological truths, and especially to establish their connexion and harmony with the Mosaic history. It is a subject exclusively for the learned, or at least for the studious and the reflecting; but it can no longer be neglected with safety, by those whose province it is to illustrate and defend the sacred writings. The crude, vague, unskilful, and unlearned manner, in which it has been too often treated, when treated at all, by those who are, to a great extent, ignorant of the structure of the globe, or who have never studied it with any efficient attention, can communicate only pain to those friends of the bible, who are perfectly satisfied, after full examination, that the relation of geology to sacred history, is now as little understood by many theologians, and biblical critics, as astronomy was in the time of Galileo.

There is but one remedy; theologians must study geology, or if they will not, or from peculiar circumstances, cannot do it, they must be satisfied to receive its demonstrated truths from those who have

learned them in the most effectual way, not only in the cabinet, but abroad on the face of nature, and in her deep recesses. They will then be convinced that geology is not an enemy, but an ally of revealed religion; that the subject is not to be mastered by mere criticism; that criticism must be applied to facts, as well as to words, and that there is, at most, only an apparent incongruity—an incongruity which vanishes before investigation.

The mode in which the subject is now treated, or neglected, by many theologians and critics, (not by all, for there are honorable exceptions,) is not safe, as regards its bearing on the minds of youth. If they go forth into the world in the stiffness of the letter, and without the knowledge or proper application of the facts, it is impossible that they should sustain themselves against those who, with great knowledge, and no reverence, may too powerfully assail what they cannot defend. In the pulpit, however, geology can be but very imperfectly explained, even by him who understands it; for it is impossible that he should there, intelligibly and adequately exhibit his proofs; they rest on a multitude of facts unknown to a common audience; and they are too dependent on specimens, sections and other graphical illustrations, to be understood in such circumstances, especially by those who have enjoyed no mental preparation in kindred sciences, and in courses of inductive reasoning. As the subject has no other connexion with our faith as Christians, than so far as it affects the credibility of the early scripture history, it is therefore wise, as to the literal sense of the days, not to disturb the early and habitual impressions of the common people, or even of the enlightened, who are ignorant of geology. Any discussions before such audiences, and in such circumstances, will be misunderstood, or not understood at all, and will only prejudice the reputation of the speaker, without benefitting the hearer.

This, however, does not excuse the theologian from being fully prepared to meet the subject, in other places, and in situations, where it will be forced upon his attention. *It is a part of the panoply of truth, in which he should be fully clad,* although he may rarely draw his bow, and perhaps never let fly an arrow from his appropriate watch tower.

As the case now stands, with respect to most theologians in this country, the geological arguments in support of the Mosaic history, although powerful and convincing, are unknown and neglected, or they are avoided; and of course they can be, and they actually are, by some few geologists, turned, with too much success, against the

sacred records; it remains with the defenders of those records to say, whether the purloined weapons shall be returned to the armory where they properly belong, and from which they may be again at any time drawn forth, for efficient use.

Theologians who were trained before geology was understood, and before it was possible to acquire, in our seminaries, an adequate knowledge of its elementary truths, are not included in these remarks, and we are happy to observe the increasing attention which is paid to the subject by most of the students in theology who come within our personal view.

These suggestions have been hazarded, with the sincere and earnest hope of doing good, especially to those who greatly neglect a subject of high interest, which it must concern them to know. But it will be no new case, should a mediator between hostile armies fail to conciliate either party, and only provoke the artillery of both; nor would it create either surprise or displeasure, should the writer of these remarks be regarded as being *too geological for the theologians, as he is certainly too theological for some of the geologists.* Among the latter are, however, not a few who regard moral truth with quite as high interest as physical, and who are anxious to prove, that where others discover only discord, there is a principle of harmony, which a skilful hand may draw forth, in tones delightful to every discriminating ear.

REMARK.

Supposing that there are inhabitants at the poles of the earth, how might they understand the days of the creation? to them a day of light is six months long, and a night of darkness is six months long, and the day, made up of night and day, covers a year, and it is a day too, *limited by morning and evening.*

Such persons, therefore, must suppose, upon the popular understanding of the days of the creation, that at least six years were employed on the work. So *at* the polar circles, there is, every year, one day, that is one continued vision of the sun for 24 hours, and one continued night of 24 hours; while, every where within the polar circles, the days and the nights respectively are for six months, more than 24 hours, extending even as we advance towards the poles, through the time of many of our days and nights. How are these people to understand the week of the creation, if limited to the popular view entertained in countries between the polar circles?