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ORDINARY MEETING, 21st March, 1870.

The Rev. Walter Mitchell, M.A., Vice-President, in the Chair.

The Minutes of the last Meeting were read and confirmed.

The following elections were announced :—

Members—W. W. Hitchman, Esq., M.D., of Liverpool.
T. Wilkinson, Esq., M.D., of Brixton.

Also, the following presentation of a work to the Library :—

"The Week of Creation; or, the Cosmogony of Genesis considered in its Relation to Modern Science." By G. Warrington, Esq.
From the Author.

The following paper was then read by the Author :—

ON GEOLOGICAL PROOFS OF DIVINE ACTION.

By S. R. Pattison, Esq., F.G.S.

THE changes which matter forming the earth's strata has undergone, or is undergoing, may operate either in cycles of perpetual recurrence or by continual progression. The latter, again, may be either progressive by way of evolution,—*i.e.* by virtue of inherent property,—or by simple progression in a series of independent changes. In all cases it is government by law; the idea of a Divine Creator and Upholder may equally underlie either hypothesis.

2. The proposition which I shall seek to establish is, that the condition and disposition of the strata disprove the theory of perpetual recurrence or uniformitarianism, and support the theory of serial progression. The latter may well be styled evolution, if by this term is only meant the unfolding of phenomena connected by a common plan; but not if it is intended to express that every state contains the causation of its successor.

3. Another idea is also frequently ranked as a theory,—that of catastrophe. This affirms that the strata have been produced by operations similar to the present, but immeasurably more

violent and sudden. Geology shows proofs of great catastrophe too strong to be underrated, and of slow operations too plain to be overlooked. Both are true descriptions of different portions of the same great field: the manner in which each has operated is the story which this science has to tell.

4. Uniformitarianism dispenses with the idea of God as much as it is possible to do, without ignoring Him altogether. Yet it is but fair to say, that Sir Charles Lyell, the eloquent expounder and philosopher of this theory, admits all that we can ask when he says, "In whatever direction we pursue our researches, whether in time or space, we discover everywhere the clear proofs of a Creative Intelligence, and of His foresight, wisdom, and power."* The opinions of the evolutionists respecting the place of a divine power and providence in their theory, are not quite so satisfactory. Kant's dogma, recently brought into the place of honour by Professor Huxley,† is, that the universe was once an infinite expansion of formless matter; at one point a single centre of attraction is set up (*how* does not appear, and this is the fatal weakness in the foundation), and hence all things are developed in time, and in time again unmade, by the determination of heat-force driving them away from the centre; and so worlds are made. Professor Huxley thus describes the theory in 1869:—"It applies the same method to the living and the not-living world, and embraces in one stupendous analogy the growth of a solar system from molecular chaos; the shaping of the earth from the nebulous cubhood of its youth, through innumerable changes and immeasurable ages to its present form; and the development of a living being from the shapeless mass of protoplasm we term a germ." ‡

5. The *Edinburgh Review* of January last adopts and applauds the theory thus enunciated; and the Professor, in his second annual address, in February last, confirms and extends his former statements. He recalls an opinion which he had expressed in 1862, against the progressive modification of animal forms, and proceeds to reason that there is "a clear balance in favour of the doctrine of the evolution of living forms one from another." §

6. The evolutionists say,—Given force and matter, the results must be what they have been and are. Granted, if a third term is added,—a beginning. We can only know the law of succession by the fact of observed changes. We cannot penetrate to the ultimate causation; but by establishing the necessity

* *Principles*, vol. ii. p. 613.
† Address to the Geological Society, Anniversary, 1869.
‡ Address, p. 47.
§ *Nature*, report corrected by Professor Huxley.

for a beginning we prove the fact of ultimate causation. This being so, I am at liberty to assert that progress by law implies a lawgiver; and thus there is let in the whole doctrine of final causes which has been so abundantly stated and illustrated, but which is conspicuously absent from the propositions of the evolutionists.

7. I do not seek to meddle with life-force or any of its problems, but confine my argument to the physical phenomena of the strata. I shall endeavour to show a change of state in a given direction, not from necessity springing from any attribute of matter, but from the guidance of law; as Hooker says, "Those things which Nature is said to do are by divine art performed, using Nature as an instrument; nor is there any such art or knowledge divine in Nature herself working, but in the guide of Nature's work." *

8. The conclusions so firmly established by geologists, that there is a definite succession in strata, and that throughout all there has been no change in the law or system, have become axioms of science, and have passed into common thought and speech. The circumstance that many of the great changes in this succession are merely the sum of a multitude of minute changes, does not affect the question, whilst the fact of change remains. The thin clay-bed superimposed on a layer of rock-salt is not derived from or through the latter; they have no connection with each other, save as being the results of one system of law. There is no evolution in the sense in which it is said that one animal form has been evolved from another with the slightest possible variation between them. The physical work done in the ages is displayed in methods which we should call fitful and irregular, did we not believe that it is regulated by uniform law working from beyond our ken.

9. I propose to glance at some general cosmical considerations, and then to review, first, some of the minerals, and next, some of the rocks, in order to ascertain their testimony concerning the rival theories.

GENERAL COSMICAL CONSIDERATIONS.

10. Two processes are going on which, if continued, must bring the solar system to an end. First, the gradual cooling of the sun by the excess of heat given out over that returned; secondly, by the approach of the earth towards the sun. Although neither of these causes can operate any sensible change for a million of years, yet they suffice to displace the theory of endless duration. The limit of the earth's duration

* Book i.

is fixed by Sir W. Thomson at 300 millions of years by refrigeration; at 500 millions of years by the calculated age of solar heat; and at 100 millions of years by the retardation of the earth's orbit.

11. The first-named cause may be considered to be properly within the limits of geological inquiry. The actual composition of the earliest sedimentary rocks, derived from the disintegration of igneous products, and the outbursts of molten rock in all periods of the earth's history, point to a primitive molten condition of the globe. The state of the deposits proves that as the earth became cool it occasioned precipitation of water on a large scale. There is no trace of any repetition of these phenomena. The present state of things is not the result of an everlasting play of forces between the heat of the earth and the condition of the atmosphere, but of a law operating to produce further progress. The effect of modern volcanic action, though tending in the direction of restoring the wasting and levelling processes of meteoric causes, is yet only a residual phenomenon of that which was once so potent. It is now a tiny force compared with the power exerted by air and water.

12. The action of the carbonic acid of the atmosphere on the present crust of the earth is slowly to decompose and disintegrate the latter, leaving it a ready prey to the mechanical forces of denudation. Chemists assure us that this is but a feeble representation of the greater power which arose from the greater volume of carbonic acid during the early history of the earth; that all the carbonic acid, all the chlorine, all the sulphur, once existed in the atmosphere,—a state of things towards which there is certainly no proof of any tendency to recur.*

13. If all the force of the solar system is gradually becoming changed into heat, and if some of that heat remains on the earth's surface not reconverted into force, things must come to an end. All differences of temperature at the earth's surface will ultimately be merged in universal heat. The conclusion may be stated in the language of Adolf Fick :—

"We are come to this alternative: either in our highest, our most general, our most fundamental scientific abstractions, some great point has been overlooked; or the universe will have an end and must have had a beginning; could not have existed from Eternity, but must at some date not infinitely distant have arisen from something not forming part of the chain of natural causes, *i.e.* must have been *created*."

14. If progress in the physical world is admitted, I do not see how the notion of a beginning, and of a Creator, can be avoided.

* See Sterry Hunt's Lecture at Royal Institution, May 31st, 1867.

Time has not failed, and if progress has been going on from eternity, why is not the cycle completed? If we are still going on, there must be order, and order implies government. Progress must be measured by time; measurement is a rule, and thus we are brought to the old argument from design. True, we cannot explain why force is not an attribute of matter, nor why the origin and direction of force implies mind; but we have at least as good a right to our theory of design, and to say that it accords with our moral convictions, as any one can have to say that the contrary is in the constitution of things, though not further explicable.

MINERALOGICAL INSTANCES.

15. We will next allude to the mode of occurrence of a few of the predominant minerals occurring in the composition of rocks.

16. *Quartz.*—The actual development of this substance has always been either by deposit from water holding it in solution, by crystallization, by organic agency separating it in water, or by deposit from heated vapour. These modes have all been in operation from the first. The crystalline rocks contain silica in distinct crystals or grains; the sandstone rocks hold it in pounded fragments; the chalk displays it around foreign bodies or in layers from precipitation or deposit; volcanic springs and mineral veins show it as resulting from heated water or steam. It abounds in the ancient rocks in a chemical form, and in modern rocks in a mechanical form. The modern deposit from springs and water is wholly inconsiderable; it is removed from the soil by the plants at a rate which, according to Bischoff, would in 78,705 years yield a foot in thickness over the surface of the earth. Nowhere is it being elaborated in the same fashion or degree as is manifested in the older strata.

17. Certain minerals are characteristic of particular periods of geological time. Thus glauconite, a silicate of magnesia, is formed on foraminifera, in the lower cretaceous system, more abundantly than elsewhere. Wavellite, a hydro-phosphate, occurs in the Devonian grits in a similar manner; and so of numerous other minerals.

18. *Limestone,* a crystalline or compact precipitate from water, or formed by organic processes, is one of the most notable constituents of rocks. It exhibits great variation in the order and mode of its occurrence.

19. *Pyrites,* which occurs in all formations, is specially abundant in the older rocks. Pyrites may be produced by treating rust of iron slowly with sulphur, but no manufactory in the deposits now in course of formation is known to us which could produce

the large thick layers held by the ancient rocks. The operation of evolution ceases on the formation of the mineral in its present condition. It is made, and then with other products preserved for use in the bosom of the earth without further change.

20. *Lava,* a product of modern volcanoes, depends for its composition on the rocks which were fused for its production. It is not a recurrence of ancient greenstone, of which it is probably the representative in place, but not in time.

21. *Iron-ore* is being daily deposited, in the shape of bog-ore, beneath thin coverings of moss or mud. It is usually found in irregular beds or lumps on the hill-sides and in marshes, and in grains in the beds of lakes. It is a deposit from water holding iron, precipitated by carbonic acid derived usually from vegetation. It is of similar structure to the great deposits of iron-ore imbedded in the coal-measures. The latter are, however, immeasurably larger than the former. Bog-iron ore does not, except in very few cases, increase in thickness beyond a few inches or feet. Subsequently to the oolitic age the additions of oxide of iron to strata have not been on the same extensive scale as before. Cycles of ages have occurred, but there has been nothing in the deposition of iron ores since the times of the oldest sedimentary rocks, which can be properly termed recurrent.

22. With regard to metallic minerals in lodes or veins, whether deposited by the wet way, *i.e.* from water traversing the solid rock, carrying the metals, and depositing them in fissures; or, in the dry way, by sublimation from heated vapour; both these ways may go on now: the one throughout the mineral kingdom, the other in the neighbourhood of volcanoes. But, as matter of fact, the results of mineralization attributable to modern operations are extremely small compared with the ancient exhibitions. So, too, there have been in all geological ages some deposits of metallic minerals; but the palæozoic epoch was the chief time of the display of this kind of action. The work may be now going on, but it is impossible to overlook the difference. The rocks are now as capable of being permeated by heated vapour, and the fissures are still open to the effects of sublimation; but we see no mineral veins in course of formation to be compared with the lodes of the old rocks.

23. The whole evidence from minerals appears to dispose of recurrence, and to denote simple progression by one prevalent system of law—evolutionary by virtue of force, its factor. We cannot, in the phemonena, find the ultimate origin of force, just as in the parallel vital series we cannot find the origin of life. We are therefore at liberty to adopt our own theory, derived from another record, without any fear of a demonstration to the contrary.

24. Viewing the action as divine, we may describe it in the language of Professor Fairbairn: "There is here what is incalculably more and better than some occasional proofs of interference or fitful displays of power, however grand and imposing. There is clear-sighted, far-reaching thought; nicely-planned design; mutual adaptations, infinitely varied, of part to part; the action and reaction of countless forces, working with an energy that baffles all conception, yet working with the most minute mathematical precision, and with the effect of producing both the most harmonious operations and the most diversified, gigantic, and beneficent results."*

CRYSTALLINE ROCKS.

25. Viewing these and their allied effects as a whole, the following progression may be observed:—first, granitic rocks; secondly, greenstone penetrating the former; thirdly, deposits in veins by hydro-thermal action; fourthly, modern volcanoes and thermal springs. These phenomena point to a common origin; they are the results, it may be, of one force, but they are neither recurrent nor evolutionary. Granite differs from greenstone, and both differ from lava; they belong to different epochs. Granite rocks exist in every quarter of the globe; the bulk of them are more ancient than the coal-measures. Greenstone, though it may have originated in a still lower stratum, is of newer development. Lava is still more modern, and has notably a less quantity of silica than either. No modern instance of an outburst of either of the former is recorded. The preponderance of silica in granite renders it constantly different from greenstone. Besides this variation in composition, there is an enormous difference in the relative development of either, as any geological map will show. The extensive spread of the granite rocks, and the frequent occurrence of veins and bosses of greenstone, at particular epochs before the secondary epoch, has no parallel whatever in the feebler vulcanism of the tertiary and modern periods.

26. The metamorphic rocks point to the same conclusions. The bulk of these lie below the Silurians. Metamorphism has been diminishing in the upward course of the formations. The most terrible volcanic action of modern days is but as summer lightning compared with the grandeur and duration of the fiery effects written in the beds of Snowdon. Mr. Hopkins has shown that the present condition of the globe, as regards heat, is not permanent; that it does not belong to an infinite

* Fairbairn, *Revelation of Law in Scripture*, p. 7.

series of things.* If the facts forbid the supposition that, either by the internal heat, or by the accession of stellar heat, the temperature could be kept the same for an indefinitely long space of time, then it follows that metamorphism of rocks by heat cannot have gone on for an indefinite length of time. It must have had a beginning, it must be tending towards an end. If all things continue as at present, the denudation of continents not balanced by the decreasing terrestrial heat-effects, the result will be that all the land will be swept into the sea. But the earth and the solar system may move amidst other laws of which we know little or nothing; all that we see may, for aught we know, be modified at any moment by an unsuspected expression of highest law, saying, "Thus far shalt thou go and no farther!"

SEDIMENTARY ROCKS.

27. The lowest rocks with which we are acquainted, omitting igneous substances, are the coarse hard rocks now called the *Laurentian*. They are, like granite, characterized by excess of silica. They consist of gneiss, mica-schist, hornblende-rock, quartz-rock, felspar, and limestone. They are in Canada 30,000 feet thick, and are found in various parts of the world. They are the most ancient of the rocks with laminated structure, and were, until lately, termed primitive. As a series they are wholly unlike any other. The quartz rocks of the lower Laurentian formed a base, on which was deposited the thick limestone containing the earliest organic form hitherto found, the *Eozoon Canadense*. The uppermost beds contain fragments of the inferior ones, broken off, rolled, and imbedded by external force.

28. The next formation in the ascending scale is the *Cambrian*, with which, for our present purpose, may be classed the overlying *Silurian* and *Devonian*, forming together a vast series, at least 70,000 feet thick, differing greatly in its composition from the Laurentian by, amongst other peculiarities, the presence of a larger quantity of alumina and less of silica. This difference has furnished the materials for the development of slaty cleavage. Cleavage is not wholly absent from the rocks below, nor from certain rocks immediately above, but it has its chief home amidst these Cambrian, Silurian, and Devonian

* "With respect to inorganic matter, the theories of uniformity and non-progression appear to me incompatible with our most certain knowledge of the properties of heat,—that ever-active agent in the work of terrestrial transformation."—*Anniversary Address to the Geological Society*, 1852. See also Hopkins on Change of Climate, *Quarterly Journal of Geological Society*, vol. viii. p. 56; and *Cambridge Essays*, p. 215.

strata. We do not find it characterizing more modern rocks of analogous composition or condition. The existence of enormous deposits of rock, containing three-fifths silica and one-fifth alumina, exhibiting true slaty structure, is peculiar to this age of the geological scale. Such rocks are found extending over a large portion of the area of the land on the globe. The same composition and structure have been ascertained to exist in rocks of the same geological epoch right across both hemispheres, and well-nigh from pole to pole.

29. The *Carboniferous* system is distinguished by the vast amount of carbon, in the form of coal, accumulated in its layers. The condition of things in regard to the growth of the vegetation whence the coal was derived was similar to the present. The sunshine and rain, winter and summer, river and lake, have all written their annals in the coal-beds. But there was a different distribution of land and water, and of terrestrial temperature, for we find traces of sub-tropical vegetation in the coal-shales of the Arctic regions. Though coal has been formed both before and after the carboniferous and oolitic epochs, yet in the former was its principal development. Looking at the enormous development at this epoch of forest and swamp, composed of nearly identical vegetation in all parts of the world, we have only to remark that there has been nothing like it since, and that all subsequent formations have shown wider and wider divergences from the carboniferous type.*

30. Doubtless there have been loose statements erroneously made concerning the complete universality of ancient deposits. But, allowing for this, it cannot be denied that the crystalline schists, slate rocks, Devonians, and carboniferous strata, were spread on both sides of the equator, and around the globe more uniformly than can be paralleled since.†

31. Formations apparently similar may not have been strictly contemporaneous, and dissimilar formations may have been so. Along the same line of river or coast there is being deposited at the same time gravel in one place, sand in another, mud in a third, all dependent on the amount of force in the stream and the nature of the banks or coast. Identity in composition is not

* "No coal-fields, to last even a single century, are now growing at the mouths of our rivers; no metallic veins are spreading through the rocks that we can explore; no great catastrophe breaks down the barriers of seas, or opens picturesque glens through the ridges of the mountains."—Phillipps, *Origin of Life*, p. 166.

† "As a rule, the older the rock is in the history of the world, the greater will be the area over which its chemical composition and character remain unaltered."—Haughton, *Manual*, p. 88.

proof of synchrony in time. There is nothing to distinguish lithologically a grit of the slate rocks from one of the coal series, or even from a tertiary. There is, however, nothing in all this to invalidate the conclusions to which, partly from stratigraphy, partly from organic contents, and partly from structure and composition, geologists have uniformly arrived, that the great rock formations are wholly different from each other, and that this difference is not one of recurrence, but that each forms a step in a true progression.

32. From the specialities of the *Triassic* system, the New Red-sandstone, I single out one, viz., the prevalence of rock-salt. This is a marine deposit, and occurs sparingly in rocks of all ages, but in excess in these red rocks, whence it is obtained for economic use. The saliferous strata are often subjected to the action of springs, which dissolve the salt and bring it up for use. The deposits underwent dislocation and denudation. The same sea-water, before parting with its salt, had parted with its sulphate of lime (gypsum), and this action took place with many successive quantities of water over the same area; afterwards a change of conditions occurred, and the deposit became covered with clay, stored, as it were, for future use. A similar process is going on now in the great salt lake, the Dead Sea, and other lakes holding concentrated solutions. They receive the slightly saline waters of rivers, and the latter become concentrated by evaporation.

33. The *Jurassic* system, composed of frequent alternations of clay, sandstone, and limestone, may be likened to a portion of the present earth and ocean in the vicinity of the Torres Straits. The similarity is increased by the slight subsidence of some portions of that coral sea. But here the comparison ends. The oolitic period was ushered in by the upheaval of the Jura range, and closed by that of the slopes of the Côte d'Or; in the interval there were frequent sudden changes of material, as from the clean sand of the coral rag, to the thick and wholly different Oxford clay; and entire changes of condition, as from marine beds of the lower oolite, to the freshwater and land surfaces above, and then a descent again into the sea; and again, an elevation for the growth of terrestrial plants, and so on. An examination of the Yorkshire coast, the observer realizing the fact that all the successive beds were either sea-bottoms or land-surfaces, will serve to disperse all idea that the present is a mere recurrence of the past. The various and dissimilar beds of the oolite, though denoting immensely long periods for their formation, point to the evolution of some causation not involved in the visible phenomena, but apart from them. The arguments of those who would persist in looking for causation in the rocks, remind us

of Zeno's reasoning, ridiculed by Cicero: "If well-tuned pipes are formed out of the olive-tree, is it to be doubted that there is an innate skill of piping in the olive-tree itself?" *

34. *Chalk.*—The ooze at the bottom of the Atlantic, as examined by the nautical explorers in 1858, and by the dredging expedition in 1869, contains a multitude of foraminiferous creatures (globigerinæ) mingled with fragments of diatoms and sponges. This occurs more especially in the course of warm currents. These are interspersed with colder spaces floored with sand, and less marked by organic life. These deposits are analogous alike to the chalk and to older shales and sediments. They are the present representatives of beds common in the geological periods, and specially manifested in the white chalk. The latter is found in borings at great depths, and also at heights 10,000 feet above the present sea-level. The Atlantic formation is increasing at a rate hardly appreciable; it is undergoing drifting and re-sorting by change of currents; thus bringing it into analogy with the old deposits. But the amount of fine calcareous sediment of one description, accumulated and spread out in the upper chalk formation, upwards of 1,000 feet thick, extending from Sweden to Spain, and from Ireland to the Black Sea, is so enormously in excess of any modern operation, that the latter cannot be considered as a return to the cretaceous cycle, but merely as an instance of the feebler action of similar causes. If the Atlantic sea-bed were so deep as to afford space for the accumulation of 1,000 feet of foraminiferous marl, and if the whole were then lifted up with the sands, clays, and gravels of the base to form a land-surface, and then again lowered so deep as to form a bed for the tertiary marine formations,—that is to say, if something quite imaginable but not at all observed, were to occur, then the conclusion would be correct that chalk was recurrent or continuous. The Atlantic ooze certainly forms imperfect oolite and imperfect chalk, just as bog-iron forms imperfect iron-bands, and peat imperfect coal-beds; but it is obvious that the chalk will continue to maintain its title to be considered as the leading product at one period, just as the others were the characteristic products at other stages of the great progress.

35. The *Tertiary* formations might be supposed to yield the most obvious proofs of recurrence or evolution, if either of these is a true theory. Yet when we examine them ever so slightly we are led to opposite conclusions. Consider the tertiaries underneath London. We have first an estuary deposit of pale-coloured sands and clays called the Woolwich beds,

* Cicero, *De Natura Deorum*, book ii.

and overlying it a deep-sea formation of dense dark clay, capped after a long interval by clean bright sands. The materials of these beds are of course quite different, the proportion of iron and the condition of the iron different in each, each was not derived from its immediate predecessor, but from the disintegration of other rocks. The forces employed were, of course, analogous to all forces displayed before and since; but the phenomena are connected only by a law which embraces the whole of the diverse operations and effects.

36. The lesson from the tertiary rocks is, that species of rock and rock-formations, go on increasing with the age of the earth. There is no mark of a return to the simpler and fewer deposits of eozoic date. Cotta says, "they have been increasing continually ever since the first solidification of the earth's crust." *

37. We have thus hastily reviewed formations extending through eighteen miles of thickness, as developed at one place or another on the earth's surface. They afford the strongest presumption against the theory of recurrence in a cycle. The force of the argument in question, and the nature of the evidence for progression by a law more deeply seated than the phenomena, is expressed in the variety of the great natural successions into which the whole series is divided by characteristic differences.† We take the table from Professor Haughton:—

	Thickness in feet.
Eozoic	26,000
Lower Silurian	25,000
Upper Silurian	5,500
Devonian	9,150
Carboniferous	14,600
Permian	3,000
Triassic	2,200
Jurassic	4,590
Cretaceous	11,213
Tertiary	9,000

* Cotta, *Rocks*, p. 395.

† The argument against uniformitarianism was long ago admirably epitomized by the insight and mental force of Professor Sedgwick, thus: "If the principles I am combating be true, the earth's surface ought to present an indefinite succession of similar phenomena. But as far as I have consulted the book of nature, I would invert the negative in this proposition, and affirm that the earth's surface presents a definite succession of dissimilar phenomena."—*Anniversary Address*, Feb. 1831.

38. In the present inquiry we have only for our guide the actual constitution of things. It may therefore be urged, looking at this alone, that succession is a necessary result of matter and force. But a consideration of the various facts above referred to may certainly allow, and probably does encourage, our concluding, with at least equal plausibility, that things might have been otherwise. Evolution may be a necessary product of matter and force; but evolution *in a particular direction* is not, or may not be, a necessity. The variety of the changes indicated in the table, look as if the ultimate determining force was not *necessity* of any kind.

EARTH MOVEMENTS.

39. Mountain-chains are elevations of portions of the earth's crust, occasioned by lateral pressure springing from contraction of the nucleus. This elevation has taken place during all epochs of the geological succession save the present. We must presume either that the rate of cooling no longer produces contraction, or that its force is exhausted elsewhere than at the surface. The modern phenomena which represent the ancient upraising of the strata are too minute for comparison. Since the tertiary there are no marks of extensive dislocations.

40. In like manner denudation has removed enormous masses of all the ancient formations, sometimes planing off thousands of miles of deposits. The older denudations are more wide and deep than the more modern. There are proofs (according to Professor Ramsay*) of the intervention of a vast lapse of time, during which this destructive work went on, between the fundamental Laurentian gneiss of Scotland and the overlying Cambrian slates; of a second interval between the latter and the Lingula flags; and so between these and the Tremadoc slates; between the last and the Llandello rocks; again, before we come to the Llandovery, and before we come to the Wenlock; and so down through the geological scale these dark spaces are repeated. Ten such physical breaks are enumerated, and many more might be named. These, though they occur in a series, yet are so diverse in their duration, extent, and power, so obviously unconnected with anything in the structure of the strata themselves, that we must attribute their occurrence to some appointment of which we see the effects but cannot discern the cause. They are not the products of matter and time conjointly; for, as the Duke of Argyll pithily observes, "Time does nothing by itself except by the aid of its great ally Force."†

* *Quarterly Journal of the Geological Society*, May, 1863.

† *Quarterly Journal of the Geological Society*, vol. xxiv. p. 272.

41. The question is not whether volcanic force similar to that now in operation, and rain and rivers on the present scale, are sufficient to produce the phenomena referred to; but whether, on the whole, the evidence is that they have actually done so or not.

42. The insensible rising of the land, stated to be going on along the line of the Andes, and on the Pampas, and in Scandinavia, and the depressions now occurring in Greenland and other places, may be effects flowing from the same causes which raised the existing mountain-chains. But when we consider that sedimentary deposits have been actually tilted and raised up in the Alps 8,000 feet, in the Andes 14,000 feet, and in the Himalayas 16,000 feet, by action frequently violent and sudden, we fail to find in the one occurrence anything but the slightest similarity to the other.

43. The work of earthquakes is a parallel case. It is doubtless of the same nature as the crust-disturbances of ancient days. But who, after examining any old trappean district, such as North Wales, would think of comparing the modern effects, in magnitude, with the ancient. We admit Sir Charles Lyell's statement that there has been no interruption in the continued action of change from the remotest period, but the vast differences in the amount of action displayed constitute a real discrepancy. The oscillations of the surface which have left their bench-marks on the strand of geological time were quicker and more intense in proportion to their high antiquity. The strongest instances of modern action are those which probably had their commencement before the most modern epoch. Such are the vertical valleys, 2,000 feet deep, in the Cañons of the Colorado, and the accumulation of globigerina mud in the depths of the Atlantic. The accumulation of peat-moss is an instance of an operation displayed only in recent times.

44. The present phenomena, though displaying the same kind of force as the most ancient, yet differ so immensely in its amount, as to entitle us to mark the distinction. We have no instance whatever of the formation of a mountain-chain in the modern period, and we are thus warranted in concluding that the formation of mountain-chains is characteristic of a former period of the earth's history. Mr. Page thus expresses the conclusion:—"Physically and vitally, the same phenomena may never be, and indeed are never likely to be, enacted again in the same region; and thus it is that the doctrine of uniformity must be held in connection with that of progression and advancement."*

* *Chips and Chapters*, p. 55.

45. I submit that the facts thus reviewed indicate the progressive law of a Law-giver, enacted from a beginning and towards an end. There is nothing in them to favour the heathen hypothesis of God *in* nature, as against the Christian hypothesis of the God *of* nature. I claim a right, in the face of all the facts, to the doctrine of the personality of a Governor, "not as the soul of the world, but as the Lord of the universe"; * who, in the further language of Newton, acts as "perceiving and governing all things by His essential presence, and constantly co-operating with all things, according to fixed laws, as the foundation and cause of all nature, except when it is good to act otherwise."

46. It may be considered that the result of our inquiry is of too negative a character to be worth the pains of the pursuit. But, on the contrary, I would urge that, if as each new philosophical hypothesis arises, we can show that it offers no obstacles to the maintenance of our most cherished beliefs; if we can step into the arena of science and say, We too have a theory grounded on your facts, at least not inconsistent with them, and equal in probability to any other,—we have secured a hearing. And if, when the way is thus cleared, we can submit to the understanding of the man of science facts from another department of inquiry, the historical, purporting to embody a message from the Divine Governor, awakening or evolving an echo in the depths of our own consciousness, we may help to promote fruitful moral action and lasting mental peace.

47. It remains that I should briefly suggest the accordance between the conclusions thus derived from natural science, and the testimony of Scripture. We have seen that the order and correspondence of created things declare antecedent law, the archetype of which must be in the mind of God. The Bible plainly proclaims a beginning, reveals a Creator acting by law throughout the ages towards an end. It unfolds to us the mind of God, "before the world was," †—at the creation,‡—during its course,§—and after its close.‖ The evolution found therein is that of this divine purpose and plan. Along both lines of knowledge we are in One presence. We consider the twofold revelation, and find that the results which are being evolved on the stage of the earth, during the unrolling of the map of Time, were, in purpose and plan, arranged in eternal counsels. Are we not then ready to utter in the halls of

* Newton.

† John xvii. 5, and numerous parallels.

‡ *Inter alia*, Gen. i. 1; John i. 1-3; Heb. i. 10; Rom. i. 20.

§ Ps. cxix. 90, 91. ‖ 2 Pet. iii. 7.

science the grand conclusion of the future:—"Thou art worthy, O Lord, to receive glory and honour and power: for Thou hast created all things, and for Thy pleasure they are and were created"?*

The CHAIRMAN.—I am sure you will all agree that we ought to return a cordial vote of thanks to Mr. Pattison for the very able paper which he has put before us this evening. It is a paper which contains matter fruitful of discussion, and I hope it will obtain that attention which it deserves from this Institute. Mr. Pattison has brought forward what I may call the orthodox interpretation of geology, and we shall now be glad to hear what is to be said on the other side of the question. (Hear, hear.) I need only add that we invite not only our own members, but also any of our friends who may happen to be present, to contribute to our discussions. What we want to get is the utmost discussion of a subject both from those who think with us and from those who are opposed to us, because we believe that a fair and honest debate is the best means of arriving at the truth. (Cheers.)

Mr. REDDIE.—I would like to offer a few observations, not as a geologist, but simply as a contributor towards the discussion of the paper, more especially in regard to its own propositions and in reference to what we have already printed in our records. I confess that, while joining with you, Sir, in thanking Mr. Pattison for his very able statement, I think we might have had more unquestionable proofs of Divine action from what we find in geology, and I am sorry to say that a great deal that is assumed by Mr. Pattison appears to me to be of a somewhat ancient kind as regards geological theory. At all events, whether our other authors have been right or wrong, we have already in our printed transactions a great deal of matter that does not agree with the view of geology which is here laid down for us. I quite agree with Mr. Pattison that we must trace Divine action in contemplating the facts of geology, whatever theory we accept. In a paper which I had the pleasure of reading at our last meeting, I argued from the very motion of inanimate nature to the necessity of a mover, because inanimate or dead matter could not move of itself. So that, in any kind of succession, whether by cataclysms or recurrence, or continued progression or evolution, or what you will, we should still have progression in inanimate nature; and my argument tended to show some power in the force that moves it, and that would not be a dead blind force, for such a force would be just as incapable of producing motion, as the dead matter itself. In fact, the whole must be guided and permeated by one really moved by intelligence. (Hear.) But I do not think that the proofs of Divine action to be found in this world and in the earth beneath us are to be aided by the particular theory which Mr. Pattison has put forward, and I am not at all clear as to what that theory in all respects is. I do not understand the word

* Rev. iv. 11.

"uniformitarianism." If it means the same thing over and over again, uniformitarianism would be impossible, for there must be some progression. I have thought the theory was founded upon a notion of the special interference of the Deity at different times after the world had come to a deadlock, so as to have something fresh and to give the world another start. All geologists are aware that the theory of successive creations is now an exploded one. It is not to be found in the Old Testament; and, without going into the day-theory as to whether the days of creation were days of twenty-four hours each or cycles of the sun, or any other periods of time, there is nothing in the Scriptures to prove that there was any particular pause in creation, and nothing like the marshalling of the different works created on one day before another day commenced. With reference to the catalogue given by Mr. Pattison in the 37th section of his paper, I am reminded of what Mr. Hopkins stated in his papers on geological formations, the first of which was read at this Institute in December, 1866, and the other in February, 1867. On adding up the thicknesses of the various strata from the Eozoic and Lower Silurian up to the Tertiary stratum, we get no less than 110,253 feet of strata. Mr. Pattison himself calls it eighteen miles of thickness;—there are, of course, qualifying circumstances at one portion or another of the earth's surface. But what leads us to suppose that the strata are piled up one above another in this way? We cannot possibly know what is in the earth at a depth of eighteen or twenty miles. As was stated in one of our former papers, we have not yet gone down a fortieth part of this distance. We have not penetrated the earth for more than half a mile, and, under these circumstances, for people to tell us what the earth's crust is at a depth of twenty miles, seems to me really anything but a scientific mode of dealing with the question. (Hear, hear.) In Mr. Hopkins's first paper he referred to this mode of drawing what he called "ideal geological sections," and he says this:—

"As far as the sedimentary beds of England are concerned, these sections might be accepted as representing the general order and character of the beds, provided they are not made to appear to cover each other over the whole area."

It is not even true in England. Look at that geological map of England on the wall of this room, and observe the dark places marked for coal. You have not got coal all over England, but only in a few districts; and other strata crop up in other places. The conclusion that these thousands of feet of various strata lie in a particular order and thickness, arises simply from the fact that one stratum has been found tilted in a certain direction, and it is supposed that it goes down for a very long distance. But all that is mere supposition, for we have no such complete knowledge of the surface of the earth; and in the paper by Mr. Hopkins to which I have referred, that gentleman tells us that in South America, in Australia, and also in New Zealand, there is nothing like these beds which we have here—more recent beds of coal on the top of what are called the primary rocks. But the most

important point which is assumed in the paper, in the course of the argument in favour of divine action, does not depend upon that. If I have understood Mr. Pattison rightly, he rather holds to the old and exploded fused granite theory. He quotes Cotta, who talks of "the first solidification of the earth's crust;" and with regard to the quotation from Professor Huxley as to Kant's, or what is more commonly called Laplace's, nebular theory, which is apparently received, or to some extent adopted, by Mr. Pattison, we all know that there is no proof whatever of that theory. It is given up by Lyell, who is our greatest authority, and you will all remember that Professor Kirk read a valuable paper on "The Past and Present Relations of Geological Science to the Sacred Scriptures" before this Institute, in which he quoted from Mr. Geikie and the *Geological Magazine* for 1866—one well known to Mr. Pattison—and conclusively showed that the crystalline rocks, supposed to have been formed by the cooling of the nebular world, are themselves sedimentary rocks. Here is one passage from Mr. Kirk's paper:—

"'At last,' says Mr. Geikie, 'I am therefore forced to conclude that the crystalline rocks described above have resulted from the alteration, *in situ*, of certain bedded deposits.' It is interesting to see the effect of this conclusion as to sandstone passing into trap and granite. In connection with these rocks passing into each other, Sir Charles Lyell says: 'It would be easy to multiply examples to prove that the granite and trap rocks pass into each other, and are merely different forms which the same elements have assumed according to the different circumstances in which they have consolidated from a state of fusion.'—(*Principles*, vol. iii. p. 362, edition 1833.) Now, sandstone and even clay passing into trap and granite must be classed among the fused rocks too, or the whole 'fused' theory of trap and granite must be given up."

Recollect that Professor Kirk in his paper gives us a very fair *resumé* of the subject without committing himself or us to anything like a new theory. I do not believe we have a new theory, for I have not yet got an answer on the subject, although we have with us an eminent geologist like Mr. Pattison, who has written a very able pamphlet in reply to Sir Charles Lyell, and with a great deal of which I agree. But still, in the present state of geology, it would be a great pity for any one to suppose that any argument in favour of divine action rests on the theory that Mr. Pattison holds to, he being more steadfast in his devotion to it than Huxley and Hamilton and other presidents of the Geological Society, who have recently given it up. But I want to say one or two words with reference to certain parts of this paper which have not been quite plainly expressed. I have had some difficulty in finding Mr. Pattison's exact view as to the uniformitarian theory; I maintain that the uniform action of certain forces, once created, could go on steadily from the first without supposing that it took the very long periods of time which Mr. Pattison and Mr. Geikie seem to think it did. I consider the fact would be precisely that which would reconcile the theory of cataclysms and the theory of uniformitarianism together. We know very well that if you bend a bow or any elastic substance, you may go on bending

it until the two ends meet. In the case of a non-elastic substance, you would merely crack it, and away it would go. So it is with the crust of the earth: you have a constant pumping out of water from below, and there must be some subsidence, and a very material subsidence, from the constant pressure of gravitation forcing downwards. A great many geological changes are likely to have been produced by that pressure and subsidence. You will have heat produced, depending in amount on the chemical action within, the heat not being uniform all the way down. The idea of approaching a central fire is nonsense. Take constant forces acting in a uniform way and straining this great globe. You can understand that, after straining steadily for years, a cataclysm would take place suddenly; not that the action is different, but the results are different. No one can look at the rocks which are riven off and not suppose they were riven off by some sudden cataclysm. As to any theory of upheaval, that was disposed of and torn to tatters in Professor Kirk's paper, although in a very kindly way. Under such a theory as that, there would be a great escape of internal fire, the operations of which we should see; but there really is nothing of the kind. I do not know whether Mr. Pattison believes in the upheaval of the Scandinavian coast which he has mentioned, but I may point out that in the *Geological Magazine* of two years ago there is a paper by the Earl of Selkirk, who surveyed that coast and found no proof of that rising. He went to the very place where Lyell had examined the shores, and to other places also, and the result of the survey seemed to depend very much upon whether it was high or low tide when the examination was made. The arguments which Mr. Pattison uses to show that a different action went on before to what takes place now, are inconclusive. He says it is because we do not see these things. True, we do not see a man grow, but he goes away a boy and he comes back a man; and he is the same person, although a change has taken place in his appearance. I am not at all clear, in reference to one of Mr. Pattison's statements,—that the accumulation of peat-moss has only occurred in recent times. It is true that we know very little of what has happened, but it is very obvious that if peat-moss got overwhelmed it would go down; and how do you know that you do not get petroleum and other similar oils from that source? We know very little about it, and I should be glad if Mr. Pattison had seen his way to proving divine action from the wonderful uses to which the metals and the oils and the various things got out of the earth can be applied. They are so admirably adapted to man's use, that we should not know what to do without them. But as for building up an argument on any one particular geological theory, I should hope no one would suppose that the proof of divine action rests on that. There is one passage where Mr. Pattison quotes Mr. Page in the following words:—

"Mr. Page thus expresses the conclusion:—'Physically and vitally, the same phenomena may never be, and indeed are never likely to be, enacted again in the same region; and thus it is that the doctrine of uniformity must be held in connection with that of progression and advancement."

I never understood anything else, but what I want to know is, why cannot the same combinations produce the same effects again? I really do not see the point of the argument. The whole thing amounts to this: that some of the old geological theories are exploded by recent discoveries, and I think Mr. Pattison has scarcely done justice to the recent discoveries in the Atlantic. I am not at all clear that it is a fair way of putting it to say, that "the colder spaces in the Atlantic are less marked by organic life than the warm currents." It is true that life is more prolific on the surface in warm places, but Dr. Carpenter removed that impression from my mind as to the marked difference. There may be a difference in some less degree, but not to the extent that one would suppose. You have the Arctic fauna and flora, so to speak, almost alongside the fauna and flora that belong to warmer regions, and I quite understood that they were almost as prolific the one as the other. I think that, as regards geology at present, it would be much better if we could wait till we have tabulated the new facts and placed them side by side. I cannot accept this paper as a fair *resumé* of the existing state of geological opinion or of geological science. If you were to take away the introduction and the concluding passages, which seem to have been inserted with reference to this Society, and were to read the paper as a statement of the present condition of geological opinion before the Geological Society, I do not think it would have many supporters. I do not gather that the paper accords with Huxley's views, or with those of Mr. Hamilton, the former President of the Geological Society, and it is somewhat at variance with a great many of what I believe to be the facts of geology. I am sorry that I cannot do anything more than put forward, as it were, second-hand opinions upon the subject; but I think, when we have issued a copious *Journal of Transactions*, and thrown down a challenge to the Scientific world, that if those positions which were taken up by Mr. Kirk and by Mr. Hopkins can be assailed and overthrown, it is almost a duty to attempt to overthrow them, and not quietly to ignore them. We are not entitled to say that we know so much about the Atlantic sea-bed as Mr. Pattison assumes to do. We do not know what amount of accumulation is going on there—we have not the slightest idea. It may be twenty times as much as Mr. Pattison supposes: we know nothing of it. When Professor Huxley delivered his Address in Sion College two years ago, he put the Globigerinæ down as among the dead animals, and he almost laughed at me when I asked if they were not alive and breeding. But we now find that they are. I hope some one better qualified to continue this discusssion will now speak, but I wish to enter my protest against the statements and views of this paper being accepted in the face of those other statements which have already been recorded in our journals. (Cheers.)

Mr. BRADLAUGH.—There are one or two points in the paper read this evening—a paper of which a great proportion, however we may disagree with the remainder, cannot be too widely admitted or too strongly maintained; but there are one or two points entirely different from those raised by Mr. Reddie, which occur to my mind. On the 6th paragraph of the paper, near

the commencement, an objection occurs to me. The point is taken as against some people called the evolutionists, and Mr. Pattison says,—

"The evolutionists say,—given force and matter, the results must be what they have been and are. Granted, if a third term is added,—a beginning."

Now it will be precisely in reference to that third term that I shall address the few words I wish to put to you, and I address these few words in consequence of the very frank invitation which you, Sir, threw out to any one, whether connected with this Institute or not, to take part in the discussion. (Hear, hear.) I confess that I have not gathered from this paper any notion of a beginning in relation to existence. I have gathered change of phenomena, but I have not gathered the application of the word "beginning" to substance. I have not gathered the slightest atom of evidence in favour of an absolute annihilation in thought, of that which exists, whether you describe it as Mr. Reddie has done, as "dead inanimate matter," or whether you describe it, as it is spoken of here, as "nature." I see nothing in the paper to lead me to the possibility of thought on the beginning; and if that is so, it appears to me, with all submission, that the paper entirely breaks down in that which it was set forth to prove, because the whole paper puts it that the assumption of a beginning and of a creator is fairly deducible from the change of phenomena. But surely that is hardly so. All that the paper shows is change—cessation of existence there is not an attempt to show. But it may be said: "Yes, that is dealt with in the 13th section." How is it dealt with? Mr. Pattison says,

"If all the force of the solar system is gradually becoming changed into heat, and if some of that heat remains on the earth's surface, not reconverted into force, things must come to an end."

I suppose the reason why that would be so is clear to the mind of the writer, but I confess that it is not at all clear to my mind. One class of phenomena is changed into another class of phenomena, and the author of the paper assumes, therefore, that there must be an end of existence. But I do not see how the change of the phenomena and the change of the conditions has anything to do with an assumption of the cessation of existence. It may be simply the incapacity of my mind to follow out reasoning of this kind; but when Mr. Pattison takes a quotation from a very able writer, the matter becomes still more startling. Mr. Pattison quotes from Adolf Fick, as follows:—

"We are come to this alternative: either in our highest, our most general, our most fundamental scientific abstractions, some great point has been overlooked; or the universe will have an end and must have had a beginning; could not have existed from eternity, but must at some date not infinitely distant have arisen from something not forming part of the chain of natural causes, *i.e.*, must have been created."

Now, I fancy, that it is very easy to get into a loose way of using big words without being quite clear what we mean by them. What is meant by

"having existed from eternity"? Simply, I suppose, that past duration is to the mind of the one attempting to limit it entirely beyond any power of limitation which in imagination he can apply to it. It simply means illimitable past duration. Then what has the author done? He has shown you the past, a period which to him is an illimitably vast period of change of phenomena, and he says: "Because there has been this, therefore there has not been an illimitable period of existence." Well, that may be true, and perhaps if I had better opportunities of accustoming myself to the mode of reasoning pursued by Mr. Pattison I might better grasp it; but it seems to me that the conclusions are exactly the opposite of the evidence, so far as I can follow the matter, and admitting the whole of the evidence to be, in point of fact, thoroughly reliable evidence. But let us look at this a little further. One passage in the quotation is:—

"The universe will have an end, and must have had a beginning."

Is there any justification of such a position in the paper itself? There may be evidence that the condition of existence may cease to exist as such, but surely that does not touch the great question at all. I do not know whether I shall be in order in commenting on what has fallen from Mr. Reddie, but if I am, I should like to say a few words, because I do not understand what is meant by "dead inanimate matter." The phrase is to me one which entirely begs and assumes the whole question against one standing, fortunately or unfortunately, in the same position as myself, and I should deny the right of any one to take any conditions of existence and to coolly fasten on them a deficiency for the purpose of manufacturing some cause for supplying the deficiency which only actually exists in the definition you give to it. We are told of force and its action in connection with that matter which is spoken of as "dead and inanimate," and of force evolved out of divine action, because we are told of that divine action not in nature, but as contradistinguished from the force acting in nature; so that the writer of the paper assumes, and Mr. Reddie must be taken to assume, not a dead inanimate state of things, but all sorts of capabilities for action so far as they are involved in that word "force"—all sorts of capabilities for action as the necessary result of a certain condition of existence. Now I know how extremely difficult it is, when one man is in the habit of thinking in a particular direction, and he meets other people in the habit of thinking in an exactly opposite direction, to make one's thoughts clear. The great difficulty in a discussion of this kind is that we stand upon opposite sides of the stream, and instead of throwing at one another we throw away from one another, because the words we use do not convey the same meaning to one another's minds. The difficulty occurs to me, why cannot dead inanimate matter move? You say it must have a mover. Is it because the movement is unlike anything which you can conjecture of dead inanimate matter that you have to imagine a mover for it? If so, you are driven into a series of dilemmas by your argument. If you assume that the inanimate cannot move because like cannot result in unlike, then you are placed in this dilemma, that the governing force, or Deity—call it what you will—

could not have created inanimate matter. I feel the extreme difficulty of saying what one might wish to say on a paper of this kind, necessarily limited by the particular scope which the paper has; and if what I have put before you is, as I am sure it is, utterly incomplete, I hope you will understand that there are words in this paper which do not convey meanings to my mind, and evidence which does not seem to me to apply to the argument which you use, or which seems to me to lead up to entirely different conclusions.

Mr. REDDIE.—I would only say, as Mr. Bradlaugh was not present at our last meeting, that the argument he has used to-night was more the subject of our then discussion than of the one now before us. Of course, Mr. Pattison did not profess to argue out this particular point, for he says: "Granted, if a third term is added—a beginning," and that lays those people now discussing the question open to a charge of weakness which does not belong to them. I do not wish to stand between yourself, Sir, and Mr. Pattison, or I could easily explain and clear the ground with regard to the distinction which I drew between dead matter and force; for instance—there is a great difference between a dead man and a living man.

The CHAIRMAN.—I am sure we are all very much indebted to Mr. Bradlaugh for his clear remarks. (Hear hear.) There is great value in the ideas which he has set forth. He has, however, laboured under the disadvantage of not being a member of our Institute, and of not knowing what we have already had before us.

Mr. BRADLAUGH.—If I am not out of order, I may say that it seems to me that if the paper was not intended to prove the view upon which I have argued, it fails to be anything more than an interesting paper on geology.

Mr. REDDIE.—It was intended to prove divine action, not the existence of a God; there are plenty of arguments to prove that.

Mr. BRADLAUGH.—But they are not in the paper—the paper really assumes a deity.

The CHAIRMAN.—I think it is much fairer that the writer of the paper should be the last speaker, than that I should have to sum up the arguments. I must say that though I thoroughly and heartily agree with the conclusions of Mr. Pattison, I disagree, most thoroughly, with his scope. It limits the paper entirely to a state of geology which, I think, is passing away, and hence the paper would not be accepted now as a perfect *resumé* of the present state of geological science. I think it is somewhat out of the atmosphere of this Society after the exhaustive papers we have had from Professor Kirk on this subject. Geology is about the one science the most in its infancy. It has worked very hard, and it has done very good service by the vast number of facts which it has accumulated; but, at the same time, it has pressed on what I believe to be one of the weaknesses of human nature on the part of those who have accumulated those facts, inducing them to consider themselves all-wise, and bound to account for facts as soon as they have accumulated a few. (Hear, hear.) Very often those who are concerned in these things are not so much patient observers of facts as generalizers of them when

they get hold of a few. They wish to put them at once into the form of a theory. Men acquire a greater reputation, as they suppose, from inventing theories than from carefully examining and tabulating facts. The real benefactors of science are the slow accumulators of facts, and not the inventors of theories; and that is shown throughout the whole course of geology. The facts of the last fifteen or twenty years have almost entirely annihilated the theories of the previous twenty years. Any one who studies the exceptional character and history of geology must arrive at that conclusion, and I think that some such feeling as that has been present in Mr. Pattison's mind, for I find he most carefully avoids, as far as he possibly can, those theories which are now exploded in geology, but which have been lying at the foundation of it, as we may say, for the last quarter of a century. How did geology take its origin as a science? It took its origin as a science from the power of observation of Mr. Smith, the eminent first English geologist, to whom even the continents generally have to give the palm as the founder of the science. How did he found his quasi-science of geology? From the fossil remains of certain strata which enabled him to identify those strata in other parts of the country. He was exceeedingly well acquainted with the nature of certain strata throughout England, and when taken into museums in different places, he astonished the collectors of fossils by being able to say: "You found that fossil in such a stratum, and you found that one in such another." The being able to identify the fossils from the various strata in which they were discovered, and *vice versâ*, was soon formed into a theory; there being so many strata, there must have been so many different series of creations that lay at the bottom of all ancient geology, as we may call it. Every distinct stratum was marked as a distinct creation. Take that catalogue of strata given by Professor Haughton, and which Mr. Pattison gives in his 37th paragraph. You have the Eozoic stratum, thousands of feet thick; the lower Silurian, so many more thousands; and a long list of other strata. Each of those strata has a different series of animals peculiar to itself; so that, given a certain animal, you at once identify its stratum. You hear and read about the cretaceous stratum, nearly all chalk, with a little silica mixed with it; the carboniferous stratum; the sandstone stratum; and so on. And now you begin to think that there are certain chemical or lithological characteristics of strata. Now, I have been present at discussions among the most eminent authorities on geology, and I have heard them give up all idea of anything like a lithological arrangement of strata. There is no identification of strata at all according to their lithological character, but only according to their paleozoic character. Given the fossils—the animal or vegetable remains in the stratum—and you can identify not only the stratum from which those fossils are derived, but its age in the earth's history. That was a certain hypothesis which was a very good solution of a certain number of facts as they were then accumulated, but how have the facts changed? It has been found that there is not that paleozoic distinction between the strata which was at first asserted. The first thing which we were then told was that there was a part of one stratum penetrating the

stratum next to it, and carrying with it some of its animal and vegetable remains. That was another theory. Then we came to a new theory; that stratum A contains so many per cent. of the remains of stratum B; and stratum C contains so many per cent. of stratum B; while stratum B contains so many per cent. of strata A and C; and that there was that uniform jump always to be found. I have heard an eminent geologist in this Society break down all these theories, and still say:—"But we can fight for three distinct creations, for three distinct leaps or chasms between some of these strata." But I ask whether the present state of geological science will do anything of the kind, and I maintain that it will not. The whole of the old geology depended on this particular hypothesis. It was carried into theological matters because certain geologists thought that they had got a very convenient opportunity for the interpretation of the first chapter of Genesis; and because, I believe, they were good Christians and what Mr. Bradlaugh would call orthodox men; but they were weak in their faith, and could not wait for the slow development of their facts. They thought that out of the facts which they then professed, they could interpret the first chapter of Genesis. It was all very well so long as they found the marine fauna low down, and the terrestrial fauna much higher up; but when the terrestrial fauna was found low down in company with some of the most ancient marine fauna, then their favourite theory of a succession of creations fell to the ground, to be followed by a new theory, interpreting the days in Genesis as meaning unlimited periods of time. Well, that theory took the popular fancy, and was for a long time a very universally received one. But we come now to the slow development of these facts. The first great onslaught upon these geological theories dates from the dredgings of Professor Forbes. Now the dredgings of Professor Forbes were one thing, his theories were another, and his theories have already fallen into oblivion on account of other facts which have come up since. He first pointed out that grand phenomenon in nature that the marine fauna were dependent, in a great measure, on the temperature of the ocean in which they were deposited, and that the Gulf Stream touched upon a certain portion of our coast with its warm water impinging upon our shore; while the Arctic stream touched upon another portion of our coast, so that you had within a mile of one another—ay, even more closely together than that—animals belonging to the coast of Spain, with their exuviæ lying deposited in the sand; and animals belonging to the shores of Sweden, and even of a more thoroughly Arctic character, being deposited. When he carried on his researches further, he found that on a portion of the coast you have an African fauna. Now what have you here? He pointed out to men's minds the fact which had never struck them before—and a most important fact it is—that if we had by some cataclysm or some extraordinary phenomenon quite within the possibility of occurrence—if we had the coast of Devonshire raised above the surface and left dry, according to geological theories you would say that the Arctic fauna belonged to one age, and that the Spanish or the African fauna belonged to another age. Now that was a great fact made out by Professor

Forbes; and his observations led us to see how rash it was to judge hastily from a few specimens dredged up from the bottom of the sea. He contended that there were various zones of vegetable life, but at a certain depth of the sea all these zones ceased, and you had none at all under a depth of 300 fathoms. Of course there was a reason given for this; it was, that there was not enough to nourish animal or vegetable matter. It was said that shells became more and more colourless the deeper you went down; that beyond a certain depth they became white; and that at a little lower depth there were no such remains whatever to be found; and that in that way you came in the ocean to a perfectly azoic part. But since that time the progress of civilization and the necessary development of science have brought about the laying of an Atlantic telegraph cable, and before that could be done it was necessary to plumb the depths of the Atlantic, not at enormous depths certainly, but at depths of three miles, and then with exceeding difficulty and at great cost both of money and time, we got up from the bottom of the Atlantic a few specks—literally only a few quills full—of the ooze of the Atlantic. Those few quills of Atlantic mud gave the death-blow to the old theories of geology. (Cheers.) They showed that a cretaceous formation was going on at the present time, and therefore, given a cretaceous formation, you cannot tell how old or how young it is. It might be the work of yesterday, or it might be the work, so far as science could say anything to the contrary, of a thousand or of a million years. You have brought up an ooze from the bottom of the Atlantic, showing a cretaceous formation which is identical with that cretaceous formation which we are told, on the evidence of the old geologists, must have existed for I do not know how many thousand years. Professor Huxley at Sion College, when lecturing the clergy on geology, told them how many thousands of years this formation must have existed; but upon what data are you to make your calculations? That was the first thing that took place in laying the Atlantic cable. Then there was an attempt to lay another cable, and the ships went a little more to the north, and, to the astonishment of all the naturalists, they pulled up, from depths far below the azoic depths of Professor Forbes, living star-fish as red as boiled lobsters. (Laughter.) When these things were brought up, the first thing that the theorists had to say, was that these fish changed their colour as they were brought up. (Laughter.) There was another thing found which has never yet come out in public to my knowledge, and which I saw with my own eyes. A small portion of the old Atlantic cable was dredged up, and it had well-developed eggs attached to it; we could not determine what eggs they were, but they were living eggs of fish, attached by pedicles or foot-stalks to a portion of the cable not much thicker than my finger. That utterly put an end to all Professor Forbes's theories of the non-existence of animal life at certain depths, and under a certain pressure. All this has been confirmed, and thoroughly confirmed, by Dr. Carpenter, who went out with better dredging appliances, which enabled him to get up larger quantities of these things from the bottom of the ocean. At the same time these matters only show us the vast amount of our ignorance. Suppose the

whole of England were to be submerged, and that certain currents operated to take off all the grass land and denude, in one part, all the cretaceous downs of Wiltshire ; in another part all the clay lands, such as we see around us here ; in another part the slate of Wales ; and in another part the bare rocks. And then suppose men to go plumbing down over England to take a geological survey of the country at a depth of three miles under the ocean by quills full of mud and ooze—what notion would they have of the geological formation of England, even if the country were wholly denuded of its grass? But what have such experiments done for us? They have exploded very many of the old geological theories. What is the proportion of the marine fauna of the strata with which we are conversant compared with the proportion of the terrestrial fauna of the earth? What do we know of the marine fauna at present existing in the world? What has been done for us by these latter experiments? They have carried the existing generation, as it is called, back to long-past epochs, and not only have we now got living animals identical in species with those which are found in the cretaceous series, but we have gone down even to the oolites. (Hear, hear.) Now I say that all this shows how dangerous it is to argue upon theories which are invented to account for the slow accumulation of facts. The accumulation of scientific facts is a very hard and a very laborious work ; the invention of theories is a very easy, and a very engrossing, and a very seductive kind of study. But when you compare what is done by the two classes of workers who pursue these two different branches of study, you find that the theorists have their work undone by the slow accumulation of facts. Looking at this paper of Mr. Pattison's, I find that to some extent it is based on what I believe to be a vulnerable point in the old geology,—I find it is working upon the uniformitarian system, the evolutionary system, and others. Even if we had more facts, I do not know that we should ever have sufficient to account for these things. People seem to think that if they can only get a few facts they can easily account for everything. It is like that celebrated problem,—given, the number of a ship's masts, the shape of her sails, her course, and the price and quality of the wood with which she was built, to tell the captain's name and the number of his seamen. (Laughter.) That seems to be like some of the things which many so-called scientific men take upon themselves to determine. But when we know how very slow is our advance, and how hard it is to arrive at truth with anything like mathematical precision, we should always doubt where our data are few, and where there are so many things interfering with them that it is difficult to arrive at a decision. Turn for a moment to astronomy. Who can say that we know very much of the planetary theory? If the orbits of the planets were more elliptical than they are, and they diverged from one another more ; if the sun were not so extremely large in proportion to the size of the planets, that you must include the disturbance of all the other planets with regard to any particular one, and then take the mean of disturbance ; if it were not that the orbits are nearly circular, you would have to arrive at a planetary theory and a

human theory under a far altered state of circumstances. If the conditions were so altered, you never would arrive at a clear theory by mathematics; it is only because the problem was one adapted to the state of your intelligence that you have been able to arrive at anything like accuracy in it. In matters of geology we are in a far worse position than in either astronomy or optics, and we know how far astray men have gone in both those sciences. I thoroughly agree with Mr. Reddie in the blot he has found as to this unhappy catalogue of strata made by Professor Haughton, and quoted by Mr. Pattison in his 37th paragraph. How does he know that the Eozoic stratum is 26,000 feet thick, and the lower Silurian 25,000 feet? In order that we might arrive at a sound conclusion about that, it would require us to know the crust of the earth for a depth of at least fifteen miles. What do we know of the crust of the earth at that depth? Have we scratched into that crust for anything like such a depth? Have we gone a mile and a half, or even a mile deep? We have had very learned inferences as to the pressure of the atmosphere and various other conditions which would take place at a height of five miles in the air; but when that height really was attained in balloons, it was found that all the theories which had been worked out as to temperature and other matters were entirely blown to the winds.

Mr. REDDIE.—The thickness of the strata given by Professor Haughton is 110,000 feet, which would really make it twenty-one miles.

The CHAIRMAN.—Well, then we have twenty-one miles of theory and about half a mile of practice. (Laughter.) It would be all very well provided these theorists gave us such a hypothesis as would leave no other way to account for their facts. At present, we have already had sufficient experience, from the manner in which theories have failed, to wait until a few more facts have been accumulated, and then we may complete our theory. I was very much indebted to Mr. Bradlaugh for some remarks he made which show us how we reason with matters fully, perhaps, in our own mind, and yet fail to make one who views the question from a different stand-point appreciate or understand our position. Any one would be able to follow the difficulty of this kind which he pointed out in relation to Mr. Pattison's paper, and in relation to Mr. Reddie's distinction between dead and living matter. Now, I believe that there is such a thing as action and such a thing as motion in dead matter as well as in living matter; and I think that Mr. Bradlaugh pointed out a very important thing in this question, though I do not know whether he would arrive at my conclusion. I suppose not. It is from the action that I see going on in dead matter that I am as much convinced of a beginning, and an originator, and creator, as I am in the design which is displayed in the motion of what we call living matter.

Mr. REDDIE.—That was precisely my argument.

The CHAIRMAN.—I believe that there is an enormous distinction between dead matter and living matter—that there is a hiatus, a chasm between the one and the other which no science has ever been able to bridge over. But yet I would grant to Mr. Bradlaugh, that I do not see how, from the exist-

ing state of matter, you can prove an end of it. I do not think that is to be arrived at logically, and I think that Mr. Bradlaugh pointed out a difficulty there; but whether it arose from a want of clearness on the part of Mr. Pattison or not I am unable to say. Suppose the astronomical theory believed in before Laplace were true. Up to that time it was supposed that there were certain changes going on in the orbits of the planets, which in the end would inevitably drag all the planets into the sun. Suppose that the sun is a mass of heated matter, and that all the planets fell into the sun and were destroyed. Still the matter of which the planets consisted would not be destroyed. (Hear, hear.) I perfectly agree with that view, and I am indebted to Mr. Bradlaugh for coming here; because we want people to come and point out the holes in our armour, and we ought to feel obliged to men who show us where we are faulty. If you burnt up all the planets, still something would remain. For instance, when this gas by which we now see is burnt, it is not destroyed, it is only changed in its form and conditions; and if all the planetary bodies were burnt up, there would not be a particle of matter destroyed. I quite grant that, from the mere examination of matter itself it is impossible to arrive at any argument as to its ending or beginning, so far as dead matter is concerned. There is one argument that a geologist may take up: he may say: "No matter what theory you adopt with regard to living matter—whether you take the slow processes of evolution, whether you take a nebular earth slowly cooling and then forming granite, and so on, or whether you take a slow series of changes going back to an indefinite time—the earth does show the convincing fact that there must have been a commencement of those phenomena which we call life, entirely distinct from the remarkable phenomena belonging to dead matter." If I were to confine myself to dead matter, I believe I should have as strong an argument for design as I should find in living matter. I take up the simplest crystal which is united with others in forming a small piece of granite, of whose origin I have not the slightest notion. I know that granite is formed of crystals, composed of three and sometimes more distinct mineral substances, penetrating and interlocking one another, and yet each one a distinct crystal; but I have no conception, from what I know of art or nature, of how that mysterious substance can be formed. I find nothing corresponding to it in life, or in the rocks of other periods. Mr. Pattison in his paper has fallen into the old notion that granite or the granitic rocks are the oldest of all. That was the old theory among geologists, but it has been acknowledged by Sir Charles Lyell in his last book that you may find granite of all ages, and granite formed in any given age. But I have no means of conceiving how, either by volcanic action or by any process of crystallization, the granite rock can be formed. But leaving that point, I say again that if you take any of the crystals of the granite (for there is not any silica found by itself, but it is in combination, and the most extraordinary combination, with other substances, as mica and felspar, most composite minerals),—if you take the crystals or the chemical constituents of the granite rocks, you have the

chemical constituents of everything else on the earth's surface. If I were put to it, I could find as good an argument for design in these things as I could find in such marvellous works as the eye, or the ear, or the heart of man, which I cannot conceive to have been formed without design ; and it is when I go back to the argument of design that I am led up to feel that none of these things could have originated from chance. I would appeal to that to which the men of science are obliged to come when they use their eyesight or anything else. They bring me a piece of flint, chipped, and they say :—"We found that in a certain stratum, and it contains strong evidence that man must have been in existence when it was deposited in that stratum, for it could only have been chipped in that way purposely by some one using intelligence." I say I do not believe it, and I think certain geologists say they do not believe it—but call it a mere piece of broken flint. I recently went with a friend of mine to a gravel pit, and we saw heaps of average specimens of these things. But it is said by certain scientific men,—"Oh, there can be no doubt that there was a certain amount of design displayed in the manufacture of that. It is shaped like the head of an arrow, or it has certain marks round it which could not be the result of mere accident arising from the chipping of many flints together." Now if, on the other hand, they bring me a piece of iron hammered out in the form of a fish-hook or a spear-head, with a piece adapting itself to the ferrule, I should be called perfectly mad by any geologist or archæologist if I said that it was an excellent piece of natural iron formation. But if I appeal to the eye as an evidence of design, or to crystals or other dead formations, what do they say ?

Mr. BRADLAUGH.—Let me say at once that if I admitted design, I should see it quite as much in the crystal as in the eye. I think the argument would be rather stronger in the one case than in the other.

The CHAIRMAN.—I quite agree with you ; but was alluding to the views of other people. We are very much indebted to this argument of design. There is nothing in the mere chemical laws of matter which will give it to us, but it is obtained when we find these chemical laws of matter combined with other things. For instance, if there had not been a particle of animated matter on the earth's surface, we could get an argument for design from all the chemical formations of the earth, and its position and revolutions round the sun ; but we must come back to those things which are fixed in our own minds, and which we cannot get rid of—those things upon which we have to build all our sciences. We cannot get our science of mathematics without definitions, and without certain things being granted which we form into axioms. There are portions of our nature which we cannot prove to anybody —we can give no reason for them, but still we must assume them. These things, I say, do not belong to the laws of time or space, to the laws of geometry, or to those of dynamics ; but they enter into all human knowledge. They are so innate in man's nature, that he cannot get rid of them ; and if I had such an article as that inkstand brought before me, that would be a sufficient argument to me that it was not an ordinary formation

or combination of the various particles of matter without an intelligent operator acting upon it. Unless I were a lunatic, I should be bound to say that it displayed human skill and invention. But then I point to works which are infinitely greater in their combination of matter and which show infinitely greater wisdom than man can display, and a greater acquaintance with the profound laws of mathematics, and with the profound laws of chemistry and every other science; and I put those works before you and say:—"I have a ten-thousandfold accumulation of proof that I must be a greater lunatic if I deny the existence of a superior designer and creator in all this than I should be if I denied that the inkstand was a proof of the existence of a man with a mind capable of conceiving and executing such a thing." That is the difficulty which we have to get over, and we must always go back to these things as our first principles. (Cheers.)

Mr. PATTISON.—I feel like one of those figures in Poussin's "Deluge," where the rocks are torn from their beds, and everything is topsy-turvy (laughter); and I feel that many persons, not excepting Mr. Bradlaugh, will look upon my facts as a complete chaos. But, notwithstanding the shafts which have been aimed against the old geologists, I must plead guilty to the soft impeachment that I am one of them. And I will add to that, that there is no fact in modern geology which does not fall in with and supplement the facts of old geology. Theories I do not know much about, but with one's hammer in one's hand, one carves out certain facts which I have attempted to bring before you, founding upon them certain conclusions. Mr. Reddie says we cannot prove that the earth has eighteen miles' thickness of strata. I have not said that they do exist in any one place, and because of that he says they are not so thick as we make them out to be. Now I do not know whether it has ever fallen to Mr. Reddie's lot to help a piece of tart or bread-and-butter pudding among his children. (Laughter.) The little ones want to know what is at the bottom. The spoon is put in, and part of the pudding is turned up, and we soon have evidence of what is at the bottom.

The CHAIRMAN.—But did you ever put your spoon eighteen miles deep? (Laughter.)

Mr. PATTISON.—No, but I say, thank God, He has done it. Strata that would for ever be buried are broken up and brought to our sight. We measure them; we measure the various layers, trying to exclude all reduplications and faults; and those measurements, so far as I can judge, are certainly within the truth. But perhaps one is wrong in attempting to do more than give the facts; I was asked for a paper, and I supposed it was to have a certain scope, and therefore it is that I took a certain line of argument, I tried to make it bear upon a certain conclusion. I did not go into the argument from design, because that has been so beautifully done, so abundantly done, and so ably done in the Bridgewater Treatises and by Hugh Miller. It would have been hopeless to attempt to give you anything new on the subject, and impossible to give you anything half so beautiful as the works I have referred to. But, seeing the present state of geological

theory, I did attempt to bring before you an argument to show that the doctrine of evolution, which seems to be accepted now, is one which, within certain limitations, is not altogether contrary to the beliefs which we here hold. That was the scope of my argument, and I still think that though I may not have proved that which I did not attempt to prove, I have indicated the limits of geological thought and reason, and shown that within these limits I can take the facts and say that there is nothing in them, granting evolution, which is at variance with my theory. I do say, and I think I have a right to say, that, looking at all these long ages, and the circumstances they indicate, they prove the existence of order which implies a governor, and that that governor had a design. (Hear, hear.) Therefore I bring in this argument, and I do not think it has been upset or displaced by what has fallen from Mr. Bradlaugh. I have not attempted to convince him—I have only pointed out what is the standing-ground for my view, and I believe that that is all of which the subject is capable, and that when you attempt to do more you will do mischief. Therefore it is that I have brought forward this form of argument in order to show the safe foundation on which you may rest in the acceptance of beliefs. That is really the aim of this paper. I may have been mistaken, and suppose I have been, for I have tried to quote Page, and Lyell, and others whose opinions may be supposed to be the least favourable to my own, and some gentlemen have seemed to think that they were my opinions. But that is not so, and I am only sorry that I have expressed myself so badly. We physical people should not meddle with metaphysics. I think that, notwithstanding all that has been said of the old facts of geology, they are facts as much as the existence of St. Paul's is a fact. We have a definite succession of strata, known by certain characteristics, and to my mind that definite succession of strata indicates a governing by law, which law has been indicated from the first. With regard to the conclusion as to a beginning, I have put that just as it struck me, that the facts do indicate that you cannot escape from the idea that there has been a beginning, if you prove that their definite order and form cease to be uniformitarian. Mr. Reddie has advocated the cause of the uniformitarians, but he has misapprehended the ultimate scope of their argument. Their argument is, that there is no trace of a beginning or end, and that we need nothing more than present causes to produce all the effects that in millions of years have worn the earth down and by volcanic agency brought it up again. I admit it is against that argument that I have directed the feeble forces of my artillery, and think I have proved that it is not a true conclusion ; and if so, I claim to have proved that there was a beginning.

Mr. BRADLAUGH.—Would you mind saying how change of phenomena can possibly involve the discontinuance of phenomena ?

Mr. PATTISON.—It does not.

Mr. BRADLAUGH.—How can you imagine change of phenomena without discontinuance ?

Mr. PATTISON.—The character of the change is one that indicates to me there was a purpose in it.

Mr. BRADLAUGH.—But does not change of phenomena always presuppose a precedent phenomenon, and therefore a discontinuance?

Mr. PATTISON.—No, I know nothing beyond the phenomena, nor do you.

The CHAIRMAN.—Mr. Bradlaugh must admit that we must come not to physical causes, but to metaphysical causes, for origination. (Hear, hear.)

The Meeting then terminated.