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The following Paper was then read by the Author :—

## *ON THE STRUCTURE OF GEOLOGICAL FORMATIONS, AS EVIDENCE OF DESIGN.* By DAVID HOWARD, Esq., F.C.S.

THE examination of the structure of geological formations has shown to a surprising extent the simplicity of the processes that have brought about the present condition of the earth's surface. We propose, therefore, briefly to examine how far this simplicity extends, and whether the evidence of a Creative Hand in nature is in any way diminished by these discoveries.

2. The idea of some, indeed, is, that, given a nebulous mass, the forces of nature of which we know are quite sufficient to explain the formation of the world. Now, even if this be true, such theories are not necessarily antagonistic to a true belief in a Creator? Whence came this self-evolving nebula? So marvellous a creation needs a Creator no less than the fully-evolved world around us. And what are the forces of nature of which we so glibly talk? It is well for us to consider how little we really know what they are, or whence they come, before we attribute to them that self-existence which belongs to the Divine Essence. It is undoubtedly the case, that the more we study the structure of the earth the clearer do we find the indications, in many of the strata at any rate, of the probable mode of formation from pre-existing rocks; but the more carefully we follow out the problem into detail, the more we shall be struck by the order and fitness which prevail everywhere in the result, and which show an overruling design so well marked, that it is absolutely inconceivable that it should be the result of chance. If we find that the "forces of nature" in their action through past ages, have been so tempered as to preserve that fitness for supporting life that we see in the world around us, and by marvellous compensation reproduce the very strata that they seemed to destroy; if, instead of bringing

about that dead level of uniformity which chance would produce, they still preserve what seems a superfluous richness of diversity in the result, the conclusion is surely forced upon us, that the whole has been the work of a guiding intelligence; and this conception of creative might, followed by formative energy, ever moulding the universe with startling simplicity of means, yet with amazing diversity of result, is surely not less worthy than the cruder one, which would attribute to the Creator creative acts, yet refuse to trace the process of those acts.

3. The highest results of human invention or constructive skill are always marked by simplicity in method and diversity in result. If we trace, for instance, the history of the steam-engine, we find that progress has been always in the direction of simplicity; the earlier engines are distinguished by complex arrangements, which in the later forms are replaced by others at once more simple and more effective. In the steam-valve, we begin by clumsy complexity, and end in a result so simple, that the wonder is that it was not the very first thing tried. If this be true of human work, need we fear to trace the same notes of perfect workmanship in nature? It is specially from this point of view that the study of geology is interesting to a chemist. We see clear evidence in the past of the forces now at work around us, of the disintegration of older rocks by air and water, and the formation of others from the detritus. But the general tendency of these forces is the mixture of the elements upon which they work; we see and understand how the varied rocks of a watershed are reduced to the state of formless mud that we find at the mouth of a river. But so far from river mud being the chief result of this formation, we find that the elementary bodies are distributed with the most perplexing inequality.

4. The chemist can, no doubt, in his laboratory effect with more or less success the separation and combination of the elements; but the processes he uses are in most instances of a nature which it is absolutely impossible to conceive to have produced the natural minerals, and almost every specimen in a mineralogical collection suggests chemical problems of the most interesting nature. Here, then, we have just those marks of the highest workmanship of which I have spoken; if we have learnt anything from geology at all, the forces that have been at work are startlingly simple, and yet the variety of the results is such that not only we cannot with all our complex apparatus and varied means reproduce more than a small fraction of

them, but we are utterly at a loss to understand how those forces can have produced all this variety. By all means let us study the formation of stratified beds of sandstone or clay, and fathom if we can the mysteries of the chalk and coal formations; but let us not lose sight also of all the other less conspicuous chemical problems that must be solved, before we can boast that we have grasped the whole mystery of the world around. The more we do this the more we shall be struck by the complexity of the problem, and the more we shall find to admire in the first cause of what we see.

5. There will, I fear, be some who, realizing the marvellous nature of the result, will rest content to see the first cause in the forces of nature; but if we in any measure fathom what is the result, we shall surely see that blind chance, or a fortuitous concourse of atoms, has not formed the world; and I would ask those who still rest content in accepting the forces of nature as the causeless causes of the world, if these forces are more comprehensible than a Creator, or if in denying the Creator they have diminished in the slightest degree the difficulty of the explanation of the creation.

6. Let us fully examine the globe, and the stages through which it has passed, and then see if a nebulous mass left to itself can be conceived as the origin of it all; and let us fully realize all that the laws of nature have wrought, all that zoology and chemistry can teach us of the marvels of their work, before we deny the conclusion, at once most natural and most true, that such a creation has had a Creator, and that such laws are but the expression of the working of Him "in Whom we live, and move, and have our being."

7. Among the most brilliant discoveries of modern science is the application of the spectroscope, not only to the analysis of the terrestrial bodies, but also to the analysis of the sun and stars themselves. The presence of a large majority of those elements most familiar to the chemist is clearly shown in the sun. The same analysis applied to the fixed stars, however, gives most unexpected results; the spectra they give make it plain that they are in a condition similar to the sun, but by no means identical in composition; the black lines, which are the indices of the presence of volatilized metals, in the solar atmosphere are there, but they are not identical with those given by the light of our sun. Some of the most familiar lines are present in the light of almost all of the stars that have been examined, those of hydrogen being present in forty-

eight out of fifty examined, those of sodium and iron in a considerable number, but others are absent. It is perhaps too soon to say that the elementary bodies of which these suns are composed are different from those we know; but, at any rate, we may be sure that the proportions must differ widely from those in our sun. The results of the examination of certain nebulæ are even more remarkable; they prove to consist of incandescent gases, not of a light-giving sphere, surrounded by vapour, as in the other cases. This has been assumed by some to prove that they are future worlds still in a nebulous condition; owing to the dimness of their light, it is impossible to speak with certainty of the absence of elements; but so far it is remarkable, that gaseous matter only has been shown to be present; and, as far as chemistry can show, no condensation could develop the solid substance of the world from these few elementary gases.

8. These differences of composition among the different systems of the heavens are most interesting, carrying us back for their origin to the very foundation of the worlds, to that first beginning of things when the vast systems round us took their form; and even then we see that no mere chance ruled, but that we must look for a cause sufficient to explain these diversities of composition. We may go a step further still, and ask, "What is the cause of those different forms of matter which we call elements?" It is well not to be too certain in scientific questions; some day we may fulfil the dreams of the alchymists, and transmute one element into another; but if that day does come, we shall have to relearn the first principles of chemistry, and perhaps most of our other sciences too; and till then we may assume that there are about sixty-four elementary bodies. We are so used to take this for granted, that we do not consider how totally unable we are to explain it. All our knowledge of the forces of nature is entirely at fault here; yet, till we can give an explanation of this first of our problems, we cannot boast of a complete knowledge of creation.

9. The recent investigations showing that motion, light, heat, electricity, magnetism, are mutually interchangeable, make this essential diversity of the matter on which they act still more remarkable; and it is contrary to all *à priori* conceptions that it should be so; we can much more easily conceive of matter as one, and the forces as many; than of matter as various, and the force as one. Even if it should be that all these elements are but forms of one matter, the extraordinary

persistency of the elementary forms is equally remarkable, resisting as it does all the forms of force that can be brought to bear upon it.

10. If we begin at the lowest rocks, we are at once met by one of those problems, the solution of which still remains a mystery,—I mean the formation of granite. Occurring as it does among the very earliest rocks, so many of which bear the most evident traces of fusion, it was for long taken for granted that this singular formation also was of the nature of a lava, and that it resulted from the cooling of a melted mass.

11. The separation and rearrangement of its constituents into the well-known definite crystals of felspar, mica, and quartz, that make up granite, by gradual cooling, is conceivable, though we are quite unable to repeat the process by again fusing and cooling the mass; but this hypothesis is shown to be untenable, by the curious fact that the crystals of felspar are found to be embedded in those of mica and quartz; felspar, however, is the most fusible of the three constituents; and therefore, if the crystallization was caused by the cooling of a fused mass, must have formed last, in which case the quartz and mica would have been embedded in felspar. Finally, we find veins of granite running through rocks which do not bear, as we should expect, signs of the tremendous heat to which they must have been exposed to allow the granite to remain fluid while penetrating into the vein, and this point should specially be noted, as the structure of granite could not possibly be produced except by slow cooling.

12. All these considerations lead us to the conclusion that we must look to some other cause for the origin of granite; and though we may vaguely guess that it may probably have been formed by the combined effects of heat and pressure in the presence of water, the guess is but a confession of our ignorance of the conditions of its formation, and still more of the causes that brought about those conditions.

13. We are thus, in the very first step of the inquiry, brought face to face with a problem well suited to impress us with the vastness of those forces, that, guided by some directing cause, have so wonderfully wrought upon the face of our earth.

14. There is somewhat less difficulty in understanding the formation of the other igneous rocks, though we cannot but be struck by the diversity of composition, which marks a selective power in nature, of which we can form but little idea. Here, too, in this simpler question we find curious difficulties; the

structure of porphyritic lava is altogether different from that of recent lava from active volcanoes, and tends to show that other forces than mere fusion and solidification have been at work. The origin of metamorphic rocks also remains still unexplained.

15. They present evident signs of stratification, as if deposited from water, and contain fossil remains, and yet possess a more or less crystalline structure, closely resembling that of the primary rock. Strange theories have been made to explain this double character, and fire and water, electricity and magnetism, have been called in to account for them, without an attempt being made to explain how they can have produced the result. A careful and patient study of these rocks may ultimately lead to an understanding of their true nature, but will also without doubt impress us with the variety of conditions that have been brought about in their formation. The pseudo-morphic minerals form in this respect a most interesting study. In them we have the form of one mineral, and the constitution of another; showing that since the first formation of the mineral, other agents have so altered it, that it is in fact a cast of the original crystal in new matter. Probably in all these cases, the element which has been substituted for another, has acted in solution upon the original crystal, the original constituent being carried off in solution, without alteration of the original form of the mass. But when we endeavour to trace the origin of these solutions which have acted thus locally, and as it were capriciously, we find it impossible to do so.

16. To a certain extent the formation of the stratified rocks is less difficult to understand. The disintegration of primary rocks, and the gradual elutriation of streams, give an easy explanation of the formation of the sand and clay, which form the basis of the non-calcareous rocks. An examination of the geology of Dartmoor or Cornwall will easily show us the decomposition of granite, and the separation of the detritus by elutriation into clay and sand, the alkali being carried off in solution, and we can almost watch the progress of the process.

17. If, however, we examine the beds deposited in the Moreton Hampstead Valley, we shall see that this has gone on with very different rapidity at different times. If it were continuous, the valleys should be filled by a continuous deposit, but we find alternations of clay and sand, and peat, evidently pointing to great changes of the condition of formation.

18. The consolidation of sands and clay into sandstone and

slates and shales we can in some measure trace, though even here there are links missing in our knowledge. We know but little, for example, of the origin of the amorphous silica, which cements the grains of sand together to form sandstone. I have never been able to find, however, even an attempt to trace quantitatives, the relations between the constituents of the primary rocks and those of the different rocks of each succeeding period, and till we have done this, we cannot claim to have certainly traced their origin. But besides the clays and sands of which we have spoken, there is a no less important class of rocks, the origin of which is a most difficult question. We can actually watch the formation of clay; but what about limestones? The analytical process which can extract a pure marble from a diluvial mass is certainly a most remarkable one. The chemist is here at fault. The methods he would use, however effectual in the laboratory, are certainly not those of nature, and we must look elsewhere for the explanation. There is one agent, no doubt, that we find in nature which can effect this separation, and as far as I know only one—that is, the life of the lower animals. By that mysterious power of which we know so little, that we call life, a zoophyte can extract the dissolved lime from water and give us a coral of pure carbonate of lime; and the combined labours of countless myriads of globigerinæ have sufficed to build up the chalk to its vast thickness. No branch of investigation has given more interesting results than those of the deep-sea soundings of the *Challenger*, showing, as they do, that the process of chalk-formation is now going on, in the same manner that had been determined from the examination of the chalk of past ages. It may be that chalk and coral are examples of the mode of formation, which alone in the past ages of the world has produced the limestone formations, and the crystalline form induced afterwards by subsequent changes; at any rate, we have no certain knowledge of any mode by which carbonate of lime is separated in a pure state in nature except by the operation of animal life.

19. In the chalk formation, as we all know, occur the flints, which again in later formations supply the material for gravel, when the chalk has been washed away; a process familiar enough to any one who has walked over the shingle at the foot of a chalk cliff. Much as we know about the formation of chalk, we have yet learnt very little of the origin of the companion flint. It has been attributed to marine infusoria and sponges, but this is, as yet, little more than a guess, as

we have no knowledge of such growth, capable of producing the solid masses that make up the vast beds in question.

20. There is another very well-known formation, which may also serve to remind us of the past influence of that mysterious power of life upon our globe. We acknowledge that coal is the result of vegetation, with but little realization of the stupendous luxuriance of growth that must have been required to produce the thick seams of coal that we have so extravagantly dealt with, yet before we think we have grasped the problem of the world, we should be prepared to show whence all that wealth of carbon was derived, whether it was all previously existent in the atmosphere as carbonic acid, and what must have been the effect of its withdrawal. I may here remark that all calculations made with a view of proving the length of time that has passed in the formation of the various strata, from the rate at which similar formations take place at the present moment, are vitiated by the impossibility of proving that the conditions were absolutely identical with those which we are observing. We know that a comparatively small difference in the depth of water is sufficient to put a stop to the growth of coral, and that the variations of temperature that the zoophyte can bear are very limited, but we do not yet know how rapidly it is possible for the coral formation to go on when all the conditions are favourable, and specially when the supply of the requisite carbonate of lime is abundant. The same remarks are true of the chalk formation: it may be that what we are now able to observe of ocean life is but a faint survival of the teeming vitality that has been supported in the sea in past ages, the records of which are written in the vast chalk-beds. The clay deposits of which we have spoken give us another example of this uncertainty.

21. It is very tempting to say an inch of deposit has been formed in a year, therefore if the deposit is 1,000 inches thick it is 1,000 years old; yet nothing can be more fallacious. We see the stream in summer running perfectly clear from the spring on the moor, bringing down no deposit at all, but, on the contrary, cutting its way through the mud previously brought down. A thunderstorm passes over the moor, and in a few hours it is pouring down a muddy stream, carrying more sand and clay in a minute than a century of its former current could have moved; and if it change thus from hour to hour, how can we form even a slight idea of what effect the tremendous changes of climate, of which we see traces, have had on the

time occupied by geological changes of which we see the result? A change of temperature, of moisture, of carbonic acid in the air, may not merely make our calculations somewhat inaccurate, but almost infinitely wrong.

22. We see, then, that the process of formation of the more familiar strata of the globe is in great measure comprehensible to us; though the more we examine the subject the more we shall be struck by the proportion and fitness that prevail everywhere, and which point most clearly to a guiding power, rather than to blind force.

23. There are other deposits, however, which we cannot, as yet, trace to their origin. Iron ore is found in beds, some of which are of almost pure oxide; the separation of it in this state is most difficult to account for. We do not know by what alchymy of nature the conditions required for such formation could have been brought about, or by what selective process the iron was thus collected together, instead of being, as we might have expected, distributed through the rocks. The same difficulty meets us in a still stronger degree, when we examine the deposits of other metals; by what power were they separated into the veins of the rocks where we now find them? and how comes it that in one vein we find copper ore, or, stranger still, metallic copper, in another lead ore, in another tin, in another silver?

24. We must be struck with the prodigal variety of nature, if we may use the word, which has enriched the earth with substances, the use of which in the economy of nature remains still a mystery to us; and the means by which they have been kept in a separate state is yet more perplexing to us.

25. Of the sixty-four elements, but a small portion make up the mass of the globe; the proportionate quantity of the rarer elements is almost infinitely small. By what power have they been preserved from total loss in the general mass, and why do we find them distributed in small deposits, with no assignable cause for their separate existence?

26. This is not only true of the rarer elements, but also of special conditions of the more familiar ones. In Asia Minor and elsewhere we find beds of carbonate of magnesia, of which some portions are chemically pure. The structure of the rock is very curious; it is not crystalline, but would seem to have been consolidated from a moist precipitate by great pressure.

27. Chemistry can produce a crystalline carbonate of magnesia from a solution in water and carbonic acid, but if we

attempt to produce an amorphous carbonate by precipitation, we lose a considerable portion of the carbonic acid, and obtain a mixture of hydrate and carbonate. Now, before we can explain the formation of this magnesite, we must show not only how the carbonate of magnesia was precipitated in an absolutely pure state, but how it was thrown down in a precipitate of this remarkable constitution. The natural compounds of boron, borax, boracic acid, and borate of lime, are another example of an element of comparatively rare occurrence, yet which is found in great quantities in particular places. In Tuscany, the steam from certain suffoni is impregnated with boracic acid, which collects in the water, through which the steam forces its way into the air; in South America, borate of lime is found in beds in rounded masses, which are dug up like potatoes. In some parts of California or Nevada, in addition to these deposits of borate of lime, there are also found lakes, the water of which is so strongly impregnated with borax that crystals of it are found in the mud at the bottom; and similar lakes in the North of India yield the tincal of commerce.

28. There has been much speculation as to the probable derivation of these various deposits from boracic acid from suffoni, but no one has hazarded an explanation why this element should be thus abundant in rare spots on the globe, and almost unknown elsewhere.

29. It would be easy to multiply instances of this unknown analytical power in nature, which has thus balanced the tendency which we see in the processes going on around us, to mix all things into one even mass; but enough has been brought forward to show that a balance of forces has existed and still exists, that it is incomparably easier to conceive as the result of design, than of blind chance. The study of geology, and the light it throws upon the formative processes that have been at work upon the earth, thus show us that the compensative power which causes the waste and destruction of the animal to be the life and growth of the vegetable, and the vegetable to be the sustainer of the animal, has been at work from the earliest ages, ever unravelling the seemingly tangled skein of counteracting forces, and ever reproducing from the waste and destruction of the earth's crust a fresh, yet ever-varied, repetition of forms of matter. We can, it is true, trace in some measure the action of these forces; but there are wide gaps in our knowledge even of the details of those processes the operation of which we know most of; and these processes of which we know anything

are but a small portion of those that must have contributed to produce the world we see. We are utterly unable to grasp the whole, or to feel that we have mastered not the details only, but the very plan itself of creation. We see, then, processes so simple that they perplex us by their very simplicity, giving results of infinite complexity, results which we can only avoid attributing to a Creative Intelligence by using language about the forces of nature, which, if words have any meaning, attribute deity to those forces.

30. The old argument from design is thus left strengthened, not weakened, by the progress of our knowledge, and still with those unexplained points which are the necessary evidence of its truth. We sometimes speak as if it were needful, in order to prove an intelligent author, that we should be able to explain the whole scheme on which He worked, instead of boldly claiming the difficulties of such a proof as its strongest evidence. If the design is fully within our grasp, there is clearly no proof so far that the designer is of higher intelligence than ourselves. We may pursue the study of geology with no fear of that result; we shall still find the clearest evidence of design, and of the design of an intelligence infinitely above ours, which we may reverently study, but can never fathom.

The other branch of geological study,—that of the successive forms of life upon the globe, is too wide a subject to enter upon now, yet I cannot avoid alluding to one point which is more directly allied to the questions we have been considering.

Great as have been the discoveries of modern chemistry, they have thrown but little light upon the mystery of life; the old distinction between organic and inorganic products has been found untenable, and it has been found possible to produce from bodies undoubtedly inorganic products that would certainly be classed as organic; yet the distinction between organized and unorganized bodies is brought out more strongly than ever by these very discoveries.

We can in a measure imitate the destructive processes of life, and form the compounds that are the result of secretion and decomposition; but the constructive powers of the living organism are as much beyond us as ever.

No light has been thrown upon the origin of life, and thus each fossil that we find, even of the simplest form, is a proof of the Divine power, which alone can bridge over the gulf that separates the living from the dead.

The researches of Pasteur and Tyndall masterpieces of

accurate scientific study, prove, as far as it is possible to prove anything in science, that all life, even of the most elementary forms, is derived from antecedent life.

If this is true now, we must suppose it true in the earliest geological periods, and are therefore left with no explanation of the great mystery of the presence of life upon the globe, but that, at once old and true,—the fiat of Omnipotence.

The CHAIRMAN (the Master of the Charterhouse).—I am sure I may convey the thanks of the meeting to Mr. Howard for his interesting paper.

Rev. Dr. FISHER.—(*A Pause.*)—Perhaps it is because the paper is so much beyond the reach of hostile criticism that no one rises to speak upon it. I have had much pleasure in reading it over at my leisure, and also in hearing it read; but perhaps a friendly critic may say that it is, if anything, rather modest in some of its statements. It might advance a little further than it has done in some things, and instead of speaking hesitatingly, it might assert, most strongly, the point at which it aims. In the 24th paragraph I find this passage :—

"We must be struck with the prodigal variety of nature, if we may use the word, which has enriched the earth with substances."

Now, I think a good many of our difficulties, at present, arise from the want of good definitions, and adhering with precision to those definitions. There must arise here the question of what is meant by Nature. Do we mean by Nature the whole of existence, or do we mean the whole of created existence? Shall we say, as Chatham said in one of his speeches, "God and Nature," or shall we say "Nature"? Almost all the sceptics admit something of creation; scarcely any of them will say there is no such thing, or they confound and contradict themselves. We first hold by Nature as the sum of created existence, and then stand up for God as the creator of all, and then we can understand the "prodigal variety"; but Nature of itself, we hold, is blind. Nature of itself can do nothing, except through processes which the God of nature produces. This is, in my opinion, an important point: we should have good definitions first, and precision of language in speaking afterwards.

Rev. Prebendary ROW.—There are few things in the actual statements in the paper with which I should be disposed to find fault, but it appears to me that it fails to realize the point stated in the programme. The paper is entitled "On the Structure of Geological Formations as Evidence of Design," but it seems to me that the evidence of design has been nowhere pointed out, except in one case, where we are told that the various stars are composed of different materials from the earth or the sun. No doubt if that is established as a fact, it will prove the presence of design, because

otherwise, we should expect to find that all the materials of the universe were alike, and therefore such a variation would, no doubt, prove the presence of some power which has prevented the whole from being fused in a common homogeneous mass. But I cannot find in the paper what are the distinct points of design which Mr. Howard supposes the paper to prove; there is a great deal of interesting matter in it, but I want to know what this has to do with proving the presence of design, or, as I should like to call it, adaptation, because the term "design" is, as it has been used, open to considerable objections, and it is better to get rid of those objections. But the real question at issue in these modern days, is not so much the fact of the presence of adaptation, for that I believe is conceded by all unbelievers, but the cause of it. It is whether adaptation proves the presence of Intelligence. This is the all-important point which we want particularly to turn attention to—for I apprehend that none of our physical philosophers deny the plain fact that there are certain things which prove adaptation—and it is not dealt with in this paper. I have no particular complaint to make with regard to the contents of the paper in relation to its facts, and I agree with Dr. Fisher that in the present day one of the most important wants in this controversy is a succession of clear definitions, or else we shall fall into an inconceivable mass of confusion. For example, Dr. Fisher selected that term "nature"; I forget how many senses it bears in natural science, according to the Duke of Argyll in *The Reign of Law;* but in Webster's Dictionary it has fourteen different senses, and "law" twenty-seven; and our whole argument depends on the sense in which we use these words. If I mean by "nature" the material universe, there is something intelligible in the use of the term, but if I include in it man and his volition, it becomes a wholly different idea. We should not allow confusion of that kind to exist. That confusion is very common, not only in scientific but in theological treatises on the subject of miracles. Then the phrase "forces of nature" is also very misleading. I am inclined to think that this has caused a great deal of the confusion into which we have at present fallen, for I cannot take up any book, theological or philosophical, without finding these terms used with an interchangeable meaning. There is one thing I consider of great importance, that it by no means follows, because we cannot find traces of adaptation in some cases, that that invalidates the proof in those cases where we do find it. It is often argued that there are certain things to which it is impossible to assign a use; but suppose that is so, does it by one single atom invalidate those cases where the adaptation and the use are as clear as the sun in the heavens? I apprehend not. (Cheers). We may not be able to understand the whole of a complicated piece of machinery, but that does not get rid of the fact that certain parts of the machine show adaptation which we can understand. Mr. Howard's paper professes to deal with that

portion of creation in which the smallest amount of adaptation is shown, and I think it rather unwise to put forth the weakest proofs of our argument. If we can prove adaptation, which we most certainly can, I hold it to be a great error to concede, as some theologians are prepared to concede, that we cannot prove the being of a God from the adaptation of the universe. The one great argument by which common sense will infer the existence of a Deity, is the adaptation of the universe. If this does not prove the existence of intelligence, other arguments will fail to persuade the great mass of mankind; and therefore I maintain that we are bound to show, and to establish distinctly, the fact that adaptation and order—the adaptations of the universe and the order of the universe—do unquestionably prove the presence of intelligence, and that the assertion of materialists, that this is nothing better than anthropomorphism, is beside the mark. The plain fact is, that no scientific man can express himself except in anthropomorphic terms; such are all the terms of language. To except, therefore, against the use of such terms, as is constantly done, is absurd. When I argue from the fact of adaptation to the presence of intelligence, I am told that that only proves the presence of human intelligence. I say it does not: it proves the presence of intelligence generally, and our minds are so constituted that I am sure we cannot believe otherwise. If we see an exceedingly complicated piece of mechanism of any kind—take the human body for instance—we cannot believe that it has resulted from the concurrence of a set of blind forces. Blind forces produce nothing but confusion. But as I have implied already, the real strength of the argument can only be found in the various structures which possess life. I allow that the construction of the heavens proves adaptation, but in a very inferior degree the geological formations. They are not powerful enough to do more than bring up the rear of the argument, and ought not to be placed in the forefront. It is very undesirable to place in the forefront the weakest points instead of the strongest: let us always put the strongest first. The thing we want, in these days, is to have the force of the adaptation argument thoroughly discussed and most clearly set forth. It does not do merely to quote instances of adaptation, which are in numbers numberless, but the point is, Does adaptation prove intelligence? Many philosophers say it does not; that it can result from other causes than intelligence; and the real question is, Are we right or they, when we see these adaptations and affirm that they prove the presence of a superintending and intelligent mind? (Cheers.)

Mr. W. Melmoth Walters.—The object, I take it, of this paper, is rather to supplement the stronger argument of the evidence of adaptation *on the lines of Geology*. It is quite true that in that particular line we do not see what the design may be; but the argument, I take it, is, that the arrangement of minerals in particular directions where we should not expect to find

them, is an evidence of some design. Mr. Row thinks we should be sure what that design is before we adduce the fact as evidence of design at all; but I do not agree with that view, for it may show that there is a design, although what that design is we are not in a position to say. The paper before us rather avoids the ordinarily-adopted ground of giving instances of *design* and *adaptation*, and simply shows us that where we find certain arrangements of geological strata, where we should not expect such formations, there must have been some directing mind to place them in those positions. Rather anticipating the objection raised by Mr. Row, Mr. Howard says in his 30th paragraph—

"If the design is fully within our grasp, there is clearly no proof so far that the designer is of higher intelligence than ourselves. We may pursue the study of geology with no fear of that result; we shall still find the clearest evidence of design, and of the design of an intelligence infinitely above ours, which we may reverently study, but can never fathom."

I think Mr. Row is wrong in saying that the paper contains no evidence of design. We find such evidence in the 2nd paragraph, where Mr. Howard says—

"If we find that the 'forces of nature,' in their action through past ages have been so tempered as to preserve that fitness for supporting life, that we see in the world around us, and by marvellous compensation reproduce the very strata that they seemed to destroy; if, instead of bringing about that dead level of uniformity which chance would produce, they still preserve what seems a superfluous richness of diversity in the result, the conclusion is surely forced upon us, that the whole has been the work of a guiding intelligence."

Then further on, in the 3rd paragraph, we find this:—

"But the general tendency of these forces is the mixture of the elements upon which they work; we see and understand how the varied rocks of a watershed are reduced to the state of formless mud that we find at the mouth of a river. But so far from river mud being the chief result of this formation, we find that the elementary bodies are distributed with the most perplexing inequality."

This is another instance of the proof of design. Then we go on further, and in the 23rd paragraph we find this passage:—

"We do not know by what alchymy of nature the conditions required for such formation could have been brought about, or by what selective process the iron was thus collected together, instead of being, as we might have expected, distributed through the rocks. The same difficulty meets us in a still stronger degree when we examine the deposits of other metals. By what power were they separated into the veins of the rocks where we now find them? and how comes it that in one vein we find copper ore, or, stranger still, metallic copper, in another lead ore, in another tin, in another silver?"

This, again, is evidence of design, but what the design may be, we cannot say. The design may be that these metals shall be brought within reach of the inhabitants of the earth, to be worked by them. Then Mr. Howard says in his 29th paragraph—

" It would be easy to multiply instances of this unknown analytical power in nature, which has thus balanced the tendency which we see in the processes going on around us, to mix all things into one even mass."

It seems to me that the point of the paper is to show that there is a design, although the writer of the paper does not point out, what is beyond his ken, what that particular design is. I should like to ask one question for the sake of information as to the nebulous bodies being known to consist of inflammable gases. Is there any reason why they should not be solid substances surrounded by incandescent gases? It does not follow that there does not lie behind that incandescent gas a solid body. (Cheers.)

Mr. J. E. HOWARD, F.R.S.—The only fault I should find with the paper is that it is perhaps too short. If the argument had been carried more deeply into the chemical part of the question it would have left nothing to be desired. At the same time I admit that this would involve treating questions incomprehensible to minds not trained in that particular line of research. It would be as difficult to lay before ordinary hearers the problems of chemistry, as to teach the children in our common schools the higher branches of mathematics. It seems to me that the constitution of matter, particularly in its chemical aspects, thoroughly indicates the working of an infinite mind and infinite wisdom. Nobody who studies the subject can possibly be drawn to any other conclusion. I will not take up the time of the meeting by illustrating this. But in proportion as we ascend in the scale of creation we certainly find greater difficulties in proving our point, because when we come to the vegetable and then to the animal world, although we find marvellous instances on every hand of adaptation *and* design, we are met by the evolutionists, who say that there are gradual changes taken advantage of by some obscure force of so-called natural selection, and wrought out without the help of any Deity or any mind at all, in some incomprehensible way, into something advantageous to each particular creature. Of course, this argument cannot be carried back into the antecedent portion of the subject—into the arrangement of atoms, and the atomic forces of matter. A Darwinian must be very much enamoured of his view indeed if he carries it back so far, and declares that atoms are the parents of each other! Although I have seen attempts to insinuate even this absurdity. In proportion as we ascend in the scale of creation we meet with greater difficulties, of which theology takes account, and of which the opponents of the doctrines of theology take advantage; but the greatest difficulty of all is man. The adaptation of man is to fill the highest place in creation, but he is marred in many respects by his fallen self-will. We find a great want of order in his actions; but there is no such want in the actions of the atoms and the molecules. They all act perfectly right, but man's acts are very often perfectly wrong. Taking the scriptural explanation, the argument holds good with regard to man just as it does with regard to everything else. But the point where we meet with the fewest

difficulties is the constitution of matter itself, though this is not easy to make properly intelligible to the whole world.

The CHAIRMAN.—Before Mr. Howard replies, I would just say a few words in reference to this subject, although I do not pretend to have that knowledge of it which would make me at all a competent critic. I listened to the paper with a great deal of interest, as I have also listened to the discussion. It has been said by Mr. Row that the point is not so much to prove adaptation, as to show that adaptation indicates an intelligent Being. I do not quite understand how that proposition is capable of proof. It seems to me to be a kind of inference that we naturally make in our own minds, when we begin to examine the instances of adaptation, and when those instances become numerous and diversified. The only mode, so far as I can see, by which we conclude that these are evidences of an intelligent superintending Being is, by the analogy which we observe with regard to human action and human works. All our arguments of this kind must depend upon the assumption of that analogy between the human mind and human actions, and the higher mind and higher actions. We see works which resemble the works of man in that respect, and we conclude, by way of analogy, that there must have been a similar operation on the part of a superintending Cause. I suppose that this is not exactly capable of proof, but is an inference. But that inference becomes stronger and stronger in proportion as the instances of adaptation are more numerous and diversified. It is precisely in this way that the value of the paper may be estimated. I do not agree with Mr. Row in wishing that the author had selected greater and more leading proofs of adaptation. The striking, clear, and patent instances have been constantly insisted upon. Mr. Howard seems to have purposely selected the less obvious instances of adaptation, and that selection seems to me to be a very valuable addition to this argument. We all know the great and leading instances of adaptation, or many of them, and as they are multiplied they become more forcible and remain in our minds, but when we find these less obvious instances also, they strike our minds with peculiar force. We look, for instance, at the atomic structure of the globe, if I may use the term, and at first sight it may not seem to indicate traces of particular adaptation, but when we look at it more closely, as the author of this paper has done, we see most singular instances of adaptation and order, although we cannot trace the reason for them. We see some interposition, which is evidently an adaptation to serve a particular purpose, and possibly to serve more purposes with which we are not acquainted. I suppose our ancestors, when they first observed coal or iron, knew very little indeed of the great purposes which these great beds of coal and reservoirs of iron were to serve with reference to the wants of the inhabitants of the globe. As time goes on those purposes become apparent, and are served; and as we find the different uses to which the different materials are put, we begin

to see more and more the adaptation of these structures to the uses of man, and possibly to other great purposes as well. In that way we may go very much further in our admission of adaptation than our knowledge of present adaptation would warrant, and therefore this paper seems to me to be very valuable, in extending and enabling us to examine more particularly these less obvious arrangements and adaptations. Mr. Howard has done good service in pointing out these things, and in showing us that here we have arrangements which in a less scientific age would have been regarded as serving no particular purpose, except to form the soil on which man trod, but which, the more we examine them, prove that they were intended to serve purposes, and are adapted to needs which become more clearly discoverable as time goes on. When we see the great extent and multiplicity of these arrangements and adaptations, the conviction is more clearly forced upon our minds, that there must have been some infinitely intelligent Being who has made all these things. It seems to me that the paper before us was precisely intended to seize the less obvious instances and from them to bring forward arguments which are not the less strong because they are not at first sight discoverable to the inquirer. (Cheers.)

Mr. David Howard.—I must thank those who have taken part in this discussion for the kind way in which they have spoken of this paper. Of its shortcomings I am more conscious than any one else can be, for it is more difficult than would commonly be supposed, to bring before an audience, not previously trained to the work, the peculiar force of these chemical problems. I suppose that to any one who never tried to make a solid piece of magnesia, a piece of magnesite will ever be a perplexity. You cannot explain it fully to any one untrained. You can only explain "this is noi the ordinary magnesia which is tolerably familiar to us all—or was when we were children." This is one example out of many. I was tempted to draw the paper out into detail, but I feared that I should fail to make the details either interesting or comprehensible. As to the use of the words "law" and "order," and so on, it is difficult to avoid the use of popular terms, inaccurate as they are. As Dr. Fisher has pointed out, the word "nature" is sometimes used to mean God, sometimes to mean κόσμος, sometimes one thing, and sometimes another: we can only use these inaccurate terms in the best way we can. The word "force" is an example. No doubt the more accurate word is "energy," but the use of the Greek word does not get us far out of the difficulty, for ἐνέργεια in Liddell and Scott is defined as "force." I sought to bring out that the same constructive power which made the stars of different compositions, has been acting throughout—that it has been no mere change, but a constructive agency in nature, which has produced what we see of adaptation to the use of man. I do not think the Christian can avoid taking this for granted as being the object of the adaptation and formation of the world. When we say that the world was created for the benefit of man, there is an evidence of that in

the crust of the globe ; and I have been endeavouring to avoid metaphysical or theological questions, and to treat the crust of the globe by itself. If in a foreign country we came upon a wall, we should regard that as evidence of man, and say "there has been a builder here," even though we might not have the remotest idea of what the wall was built for, and so when we see in the crust of the globe indications which show, not merely to the metaphysical mind, but to the commonest observer, signs of adaptation, we say "these are evidences of design." It is the instinct of one's nature to come to that conclusion. We cannot always show evidence of *adaptation*, but I do not think any observer can avoid being struck with the evidences of *design* in the sense of intelligent guidance of the laws of nature, and it is in that sense that I use the word design. That it is as good an argument as the more evident ones I do not venture to maintain; but, on the other hand, it is often urged—not in fixed terms, for the attacks on Christianity or Theism are often not made in fixed terms, but by the general tendency of the language used—that geology is so simple that there is no need of any Creator there ; that the forces of nature will do all that is required ; that if you stir up a nebula and leave it to itself it will compose a world, because you can decompose granite, and produce Thames mud, and so on. (Laughter.) It was to that result that I wished to apply myself. With regard to the question asked me about the constitution of nebulæ, I will try to explain, though it is difficult to do so in a few words. If you examine the sun with a spectroscope, you see *black* lines, which are identical with those produced by certain vaporous gases as *bright* lines. The common light of salt gives under the spectroscope two intense yellow lines, and if you throw a light through that you can get a complete spectrum, with two black lines. The rule, therefore, or the law is—that any light passing through a coloured light will show black lines, where the coloured light would show coloured lines, and applying this principle, it can be proved that the light of the sun passes through an incandescent atmosphere of intense heat sufficient to keep iron in a state of vapour. In nebulæ you have the nitrogen line, and it is not conceivable that you can have a heat sufficient to make nitrogen luminous with a cold solid body behind, as it requires a much greater heat to make gas luminous than would be required to heat a solid globe to incandescence. Of course this is so far guess-work, as it is only the result of experiments in the laboratory ; but this is the argument on which it is inferred that nebulæ are merely gaseous bodies. If they contained all the elements of a world, we should expect to find not merely the lines of gases, but the lines of the sun's spectrum. (Cheers.)

The Meeting was afterwards adjourned