paratively minute scale. We find that pressures acting upon ordinary sediments in Palæozoic or later times do not produce more than colourable imitations of crystalline schists. We find that when they act upon the latter the result differs, and is generally distinguishable from stratification-foliation. We see that elevation of temperature obviously facilitates changes and promotes coarseness of structure. We see also that the rocks in a crystalline series which appear to occupy the highest position seem to be the least metamorphosed, and present the strongest resemblance to stratified rocks. Lastly, we see that mineral change appears to have taken place more readily in the later Archæan times than it ever did afterwards. It seems then, a legitimate induction that in Archæan times conditions favorable to mineral change and molecular movement—in short, to metamorphism—were general, which in later ages have become rare and local, so that, as a rule, these gneisses and schists represent the foundation-stones of the earth's crust.

On the other side what evidence can be offered? In the first place, any number of vague or rash assertions. So many of these have already come to an untimely end, and I have spent so much time and money in attending their executions, that I do not mean to trouble about any more till its advocates express themselves willing to let the question stand or fall on that issue. Next, the statement of some of the ablest men among the founders of our science, that foliation is more nearly connected with cleavage than with structures suggestive of stratification. In regard to this I have already admitted, in the case of the more coarsely crystalline rocks, what is practically identical with their claim, for they also assert that when the banding was produced, very free movement of the constituents was possible; and in regard to the rest I must ask whether they were speaking of cleavage-foliation or stratification-foliation, which had not then been distinguished, and I know in some instances what the answer will be. The third objection is of a general nature. To prevent the possibility of misstatement I will give it as a quotation:—"To a geologist (especially one belonging to the school of Lyell) it is equally difficult to conceive that there should be a broad distinction between the metamorphic rocks of Archæan and post-Archæan age respectively, as that the pre-Tertiary volcanic rocks should be altogether different in character from those of Tertiary and recent times." Of course in this statement much depends on the sense attached to the epithet "broad." As an abstract proposition I should admit, as a matter of course, that from similar causes similar consequences would always follow. But in the latter part of the quotation lurks a *petitio principii*. During the periods mentioned volcanic rocks appear, as we should expect, to have been ejected from beneath the earth's crust similar in composition and condition, and to have solidified with identical environment. Hence the results, allowing for secondary changes, should still be similar. But to assume that the environment of a rock in early Archæan times was identical with that of similar material at a much later period is to beg the whole question. My creed, also, is the uniformitarian; but this does not bind me to follow a formula into a position which is untenable. Other studies with which I have some familiarity have warned me that a blind orthodoxy is one of the best guides to heresy. "The weakness and the logical defect of uniformitarianism"—these are Prof. Huxley's words—"is a refusal, or at least a reluctance, to look beyond the 'present order of things' and the being content for all time to regard the fossiliferous rocks as the *Ultima Thule* of our science." Now, speaking for myself, I see no evidence since the time of these rocks, as at present known, of any very material difference in the condition of things on the earth's surface. The relations of sea and land, the climate of regions, have been altered; but because I decline to revel in extemporized catastrophes, and because I believe that in Nature order has prevailed and law has ruled, am I therefore to stop my inquiries where life is no longer found, and we seem approaching the firstfruits of the creative power? Because palæontology is, perforce, silent; because the geologist can only say, "I know no more," must I close my ear to those who would turn the light of other sciences upon the dark places of our own, and meet their reasoning with the exclamation, "This is not written in the book of uniformity?" To do this would be to imitate the silversmiths of old, and silence the teacher by the cry, "Great is Diana of the Ephesians."

What, then, does the physicist tell us was the initial condition of this globe? I will not go into the vexed question of geological time, though as a geologist I must say that we have reason to complain of Sir W. Thomson. Years ago he reduced our credit at the bank of time to a hundred millions of years. We grumbled, but submitted, and endeavored to diminish our drafts. Now he has suddenly put up the shutters, and declared a dividend of less than four shillings in the pound. I trust some aggrieved shareholder will prosecute the manager. However, as a *cause célèbre* is too long a business for the end of an evening, I will merely say that, while personally I see little hope of arriving at a chronological scale for the age of this earth, I do not believe in its eternity. What, then, does the physicist tell us must have been in the beginning? I pass by those earliest ages, when, as "Ilion, like a mist, rose into towers," so from the glowing cloud the great globe was formed. I pass on to a condition more readily apprehended by our faculties—the time, the *consistentior status* of Leibnitz, when the molten globe had crusted over, and its present history began. Rigid uniformitarian though you may be, you cannot deny that when the very surface of the ground was at a temperature of at least 1000° F., there was no rain, save of glowing ashes—no river save of molten fire. Now is ending a long history with which the uniformitarian must not reckon—of a time when many compounds now existing were not dissolved but dissociated, for combination under that environment was impossible. Yet there was still law and still order—nay, the present law and order may be said even then to have had a potential existence—nevertheless to the uniformitarian gnome, had such there been, every new combination of elements would have been a new shock to his faith, a new miracle in the earth's history. But at the times mentioned above, though oxygen and hydrogen could combine, water could not yet rest upon the ruddy crust of the globe. What does that mean? This, that assuming the water of the ocean equivalent to a spherical shell of the earth's radius and two miles thick, the very lava-stream would consolidate under a pressure of about 310 atmospheres, equivalent to nearly 4000 feet of average rock.*

But on the practical bearing of this consideration I will not dwell. Let us pass on to a time which, according to Sir W. Thomson, would rather quickly arrive, when the surface of the crust had cooled by radiation to its present temperature. Let us, merely for illustration, take a surface temperature of 50° F. (nearly that of London), and assume that the present rise of crust temperature is 1° F. for every 50 feet of descent, which is rather too rapid. If so, 212° F. is reached at 8100 feet, and 250° F. at 10,000 feet. Though the latter temperature is far from high, yet we should expect that under such a pressure chemical changes would occur with much more facility than

*If we take the specific gravity of water as unity, and that of mean rock as 2·7, the pressure would be = 3911·1 feet of rock.