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George Fairholme Esq.

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XLIV. *Some Observations on the Nature of Coal, and on the Manner in which the various Strata of the Coal-measures must probably have been deposited.* By GEORGE FAIRHOLME, Esq.

To the Editors of the Philosophical Magazine and Journal.

Gentlemen,

IN submitting the following observations to your notice, and to that of the readers of your very able and instructive periodical work, should you consider them worthy of a place in its pages, I am chiefly induced by the growing interest now so universally taken in geological subjects, and by the high importance which must always attach to such new facts, when they come to light, as bear forcibly upon the science of geology in general: and I feel persuaded that even a departure from received theories, if expressed with temperance, and supported by reasonable arguments, or by undeniable facts, will not have the effect of excluding from your pages opinions which, if unfounded, must thus become exposed to immediate refutation.

In the remarks which I propose to make upon the coal strata, I have no intention of entering upon the question which, at one period, occupied so much of the attention of geologists, with respect to whether that valuable substance was of *vegetable* or of *mineral* origin; for I imagine that it will be pretty generally admitted that this point has already been completely set at rest, by the discoveries of late years, both in geology and in chemistry, and that the vegetable origin of coal is now placed quite beyond dispute*. Everything, indeed, connected with coal, seems to tend to this important truth. Its immediate and invariable contact with stony strata, in which vegetable substances of every size, from the minutest grasses to the tallest trees, are so beautifully displayed; its bituminous

* I have lately had an opportunity of examining a great variety of coal, and have found a distinct vegetable texture in many different specimens; but the most obvious instance I have ever remarked is in the fine coal from Stobart's main near Sunderland, which exhibits in the cleavage, in every part, the appearance of crushed wood, like charcoal. From these and other specimens, I am led to conclude that the soiling quality of most coal is derived from the ligneous portions of it; and that, but for the existence of this substance, the clear and shining bituminous coal would be as clean in the hand as any other specimen of a mineral nature. In all the instances which I have observed, the transverse fracture was clear and brilliant, while between the laminæ the appearance of charcoal was displayed on the surface of each side.—[See our report of Mr. Hutton's paper on the structure and origin of coal, in the preceding volume, p. 302.—*EDIT.*]

character; its colour; its combustible nature, which is found in no other mineral; its frequently displaying a distinct ligneous texture; and, in corroboration of these, the conclusive experiments and reasoning of many able chemists;—all tend distinctly to prove that the arguments formerly maintained by some geologists, who considered it an original chemical formation, entirely unconnected with a vegetable origin, may now be classed amongst various other concessions which have, of late years, been made to the Wernerian theory.

Setting out, then, upon the principle that coal is, in every situation, *a mineralized vegetable substance*, and, consequently, that it derived its origin from successive depositions in water of the vegetable productions of former periods, it becomes a point of the highest interest to speculate upon the manner in which this deposition must have probably taken place; and upon the evidences which the attendant phenomena may exhibit, as to the period of time which was occupied in the process.

The first point which arrests our attention in the consideration of the coal-fields of every quarter of the world, is their being *invariably* situated in similar districts, and their exhibiting, on every scale of magnitude, the form of the *basin*. I am not aware of any exception to this fact in any part of the world in which coal has been discovered. In forming an idea, however, of those basin-shaped hollows in which the vegetable deposits have taken place, we must not be misled by attaching to them a great regularity, or roundness of form. On the contrary, the coal basins are found to be as diversified in form, as the various lakes and valleys now existing on the present surface of the earth. We find in some places such basins of not more than a mile in diameter, and which, in the hills of the West Riding of Yorkshire, are termed *swilleys*, filled like the larger basins with coal and its usual attendant strata. In other districts of greater extent the basin obtains the name of a *field*, extending over many miles of country, but differing in no other material degree from the smaller basins to which I have just alluded. These distinct basin-shaped deposits have greatly tended to support the theory of coal being a *lacustrine* formation, in the supposition that such basins were, at very remote periods, and for a prodigious lapse of years, filled with fresh water; and that the deposition of vegetable substances took place by a slow and very gradual process, and by the submersion of such vegetables as either grew on their shores, or were washed into them by rivers. This mode of accounting for the coal strata, which has long been considered as the most plausible by geologists, is open to insupera-

ble objections, which must occur to the mind of every one who is adequate to the consideration of the present circumstances of inland lakes, even in the most thickly-wooded countries. But without dwelling upon these objections, I shall proceed to notice two facts which have but lately been brought to light, and which appear to me to be of the most conclusive nature, and utterly destructive of this long-received theory.

The first of these facts is the very recent discovery of extensive strata in the coal-fields, containing *sea shells* in great abundance, of which an interesting account has already appeared in your pages from the pen of Mr. J. Phillips, in your Number for November 1832. Nor are these marine strata so situated with respect to the beds of coal as to leave the smallest doubt of their having been actually deposited *by the sea*. They are found to extend over a very wide district, and it cannot therefore be for a moment supposed, that the sea-shells were, in a manner, *accidentally* introduced amongst what have hitherto been looked upon as fresh-water deposits. I have lately had presented to me specimens of sea-shells from a bed of coal shale near Wigan, in Lancashire; and as this locality is situated on the western margin of the same great coal-field which has been so ably traced by Mr. J. Phillips, as having an intermixture of marine strata, it appears probable that the specimens now in my possession have been derived from a continuation of the same beds; although I have not yet ascertained the particular situation in which they were found. These shells are bivalve, of about two inches in diameter, are much injured by pressure, but may still be distinctly defined. They appear to me to resemble most nearly the genus *Mac-tra*, and especially the *M. Lutraria* of Wood's Catalogue. So singular and conclusive a fact, although similar instances have not yet been brought to light in any great variety of cases, not only affects most materially the very foundation of the lacustrine theory, but even brings at least one portion of the coal strata distinctly within the catalogue of *marine* deposits; and when we consider that the existence of these marine strata has only lately become known, not in a new series of coal mines, but in a district supposed to be perfectly well known to geologists, we cannot but anticipate a speedy increase to our store of similar facts, as the lights of science begin to shed a more steady lustre on those who are most intimately connected with the coal districts.

The second class of facts to which I before alluded, have even a stronger bearing upon the *manner* of the coal deposits than these marine strata have upon their general character. I mean the existence of large entire trees, in various parts of

the strata, *placed in a vertical position*, and intersecting, in many instances, a great variety of beds. It is scarcely necessary to enumerate the instances in which this remarkable position of the fossils has been observed. The facts connected with these vertical stems, *projecting through beds of coal, of shale, and of sandstone*, and assuming in a greater or less degree, the character of each bed with which they come in contact, must now be well known to all geologists; and it only appears surprising that the discovery of even one such fossil tree, in any well-defined coal district, should not have had the effect of utterly exploding from our systems the theory of a *slow and gradual deposition*, whether in salt or in fresh water. Such trees have sometimes been found with roots spreading, as it were, in their natural position, and they have in such cases been generally described as *in situ*, or as having originally *grown* where their stems are now found*. It seems altogether unnecessary to refute so extraordinary and unnatural an idea. For where, in the present course of things, are we to look for anything analogous on which to ground an argument? Where, in our existing lakes, are we to hope to find even the slightest indication of growing beds of coal *with intervening strata of sand or clay*? And even if such are to be found, where shall we find a tree of 50 or 60 feet in length, *in a growing state*, and enduring patiently the tardy process of *slow lacustrine deposition*, by which its lofty top shall be as well preserved for the inspection of future geologists, as the roots which are nourished in the loose sands which cover them?

Such considerations are, perhaps, sufficient to show the erroneous nature of our theories, with respect both to the *nature* and the *relative age* of the coal strata. We must of necessity either admit the *rapidity* of formation of such deposits as exhibit entire vertical trees intersecting from 50 to 70 feet of variously stratified rock, or we must produce, in the existing system of the world, some instances in the vegetable kingdom of *thousands of years' duration*, and so tenacious of life as to continue growing, and yet not materially increasing, while they become thus gradually covered up *in the bottoms of fresh-water lakes*.

But there is another most important consideration which belongs to this subject, and which militates with equal strength against the theory entertained by some, that deposits of coal have at all times been in progress on the earth, and must even

* For such a description, see the Annals of Philosophy for November 1820, where an account is given of a tree with roots discovered in the coal sandstone near Glasgow.—[See also a paper by Mr. Witham, in the Phil. Mag. and Annals, N.S., vol. vii. p. 23.—EDIT.]

now be going on in the fresh-water lakes of every wooded region. If this had been the case in the very remote epochs assumed by many geologists, we never could have expected to have found the coal strata in the invariable position, with respect to other beds, in which they are actually placed. If, as some able writers have taught, the progress of nature has, in all past ages, been regular and uniform, fresh-water lakes must at all times have existed, vegetable deposits of coal must at all times have been in progress; and we should consequently have found such beds in every part, indiscriminately, of the surface of the earth. Such, however, is by no means the case; and no part of the geological system is more exactly defined than the nature of the districts in which coal may be expected to be found.

If we find, then, an insuperable argument against the theory of a *slow* deposition, in undefined periods of great extent, in these entire trees which intersect various parts of the coal-measures, to what species of action are we to attribute the *rapidity* of formation which these *carbonometers*, if I may so call them, so plainly indicate? Are we to ascribe this rapidity of action merely to the formation of the actual strata in which such trees have been found, or are we, on the contrary, to extend the principle, by fair analogy, to other portions of the series both *above* and *below* these interesting and instructive indexes? We may surely be permitted to reason from analogy, that if any one portion of an extensive series, exhibiting throughout a similarity of character, can be proved to demonstration to have been deposited in so short a space of time as to cover up and retain *in equal preservation* a vertical stem of 60 or 70 feet in length, the other portions of the same series must have been deposited in a manner extremely similar, if not strictly identical. If we have, then, a reasonable ground for such conclusion, can we continue to look upon the coal strata as lacustrine deposits, from fresh water, formed in the course of *thousands*, or as some think, of *millions* of years? It must be evident that either the facts to which I have alluded are erroneous, or the usual line of reasoning on the coal-measures must be unfounded. The facts, however, speak for themselves, and are fully open to the inspection of every one. It may therefore be fairly assumed that suspicion must rest upon the theories in question.

In the paper by Mr. J. Phillips to which I have already alluded, we find sections of the coal strata in the neighbourhood of Halifax and Leeds, in one instance amounting to about 50 yards, and in the other to upwards of 170. These

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sections, which are of the very same character as those of the mines of the North of England and the South of Scotland, contain no one stratum differing in any material degree from those through which tall and entire stems, of great diameter, have in numerous instances been found to penetrate *vertically*; and it is nearly certain, that if we could bring into one spot the various stems found at various depths in different parts of that coal-field, we should obtain a regular series of *measures* from the present surface of the ground down to the utmost depths of our coal mines. When we unite, therefore, the evidence adduced by these stems, and that of the *marine* strata in contact with the coal, we arrive at the natural conclusion, that instead of a long-continued and gradual process in the bosom of fresh-water lakes, these invaluable and interesting formations must have taken place *in the waters of the sea*, and by a *violent and rapid process*, at some period of unusual destruction in the vegetable kingdom.

Although no geological writer has yet, as far as I am aware, brought these *speaking witnesses* to bear with their full power upon the general theory of progressive formations, I find that my own opinion respecting them cannot be looked upon as singular; for Mr. Bakewell, in his very able "Introduction to Geology," makes the following remarks upon them, while treating of the coal-measures. "In some places where sections have been made in the sandstone strata accompanying coal, instances of fossil stems of large plants occur in a *vertical position*. In Burntwood quarry, at Althouse, near Wakefield in Yorkshire" (which is situated in the very same coal-field as Halifax and Leeds, where the *marine* strata have been remarked by Mr. J. Phillips,) "*several vertical stems of large magnitude* have been found. One stem which I measured in the quarry, was 9 feet long and 10 inches in thickness: but, what is very remarkable, this stem cut through three strata of sandstone *parted by regular strata seams*. It had therefore," observes this author, (not being aware, at the time he wrote, of the intermixture of *marine strata* amongst these very formations,)—"it had therefore probably *grown where it stood*; for it is difficult to believe that any vegetable stem could pierce through three strata of sandstone, the lower of which, at least, must have been partly *consolidated*. *This fact proves that the strata were deposited rapidly*." p. 148. To the "*difficulty*" here mentioned by Mr. Bakewell, I shall only add the still greater one of believing that a living tree could be rapidly covered up *where it grew*, and its top imbedded in the very same substance in which its roots had before found nourish-

ment. Had this strange idea been well founded, we must have discovered such fossil trees in many more instances than we do: they must have been almost always upright, and invariably furnished with *roots* and *branches*. This, however, is rarely the case; they lie in every degree of inclination from horizontal to vertical: they have not always roots, very rarely branches, and I have never heard of an instance with the smaller twigs and leaves. If this able geologist was deeply struck with a fossil stem of only *nine* feet, and piercing *three* strata of sandstone, what must he think of such stems as have since been frequently found (as in Craighleith quarry near Edinburgh,) of from 50 to 70 feet in length, and *piercing ten or twelve different and distinct strata* * ?

Before concluding these cursory remarks on the coal formations, I am also desirous of calling the attention of your scientific readers to another very remarkable fact, with regard to these carboniferous strata, which, I believe, has only been described by the same able writer whom I have just cited, and which also appears to me to offer a powerful resistance to our most received theories respecting them.

After describing the remarkable deposits of coal near Cologne, in which are imbedded “trunks of trees deprived of their branches, *which proves their having been transported from a distance*, and also nuts which are indigenous to *Hindustan and China*,” Mr. Bakewell proceeds as follows: “But a still more remarkable formation occurs at Alpnach near the lake of Lucerne, in Switzerland, where a bed of coal is found at the depth of 280 feet from the surface. Over this coal there is a *stratum of limestone containing fluviatile*” (?) “*shells, and the bones and teeth of a species of Mastodon, and of other large land quadrupeds*. Notwithstanding the occurrence of the bones of large mammalia in this stratum over the coal, in this place, the coal approaches in character nearly to mineral coal; and the strata of micaceous sandstones and shales above it, have a close resemblance to those of our English coal-fields: but though from these organic remains we are compelled to place the coal of Alpnach amongst the *tertiary strata*, or else to admit the occurrence of an anomalous formation like the one at Stonesfield, still I believe the true geological position of this coal is problematical; and it deserves the particular attention of some

* [A notice of the fossil tree discovered at Craighleith in 1826 will be found in Mr. Witham's paper before referred to; but this tree, we have to remark, was found in a nearly horizontal position, corresponding with the dip of the strata.—EDIT.]

English geologist well acquainted with the coal-fields of his own country, and the lignite formation in different parts of Europe." p. 173.

The singular anomaly here presented to the geologist powerfully supports the argument which naturally arises from the specimens of vertical trees, to which allusion has just been made. According to geological theories, such deposits of vegetable matter, *accompanied by micaceous sandstones and shales*, were formed *long previous* to the creation of such mammalia as are here described*; and yet we have only to suppose the highly probable existence of vertical trees in this coal basin of Alpnach, such as are elsewhere found in similar localities, to perceive the rapidity of this formation also, and that it took place at a period when the destruction of animal life was such as our upper diluvial deposits more usually demonstrate.

I must apologize for having thus trespassed upon your attention and that of your readers; but I cannot help thinking that the facts I have mentioned are well worthy of the deepest study by all true lovers of a consistent geology. My own line of reasoning upon these facts may, in the opinion of some, be open to many objections; but, be that as it may, it must be admitted that a scientific explanation of these phenomena, opposed as they are to the most approved geological theories, would be considered as an essential service done to this most interesting science, and that they loudly call for the learned interference of some of the great leaders of the geological world. I have the honour to be,

Gentlemen, yours, &c.

Ramsgate, June 17, 1833.

GEO. FAIRHOLME.

* [We leave Mr. Fairholme's theory of the rapid production of the coal strata to the consideration of our geological readers and correspondents; but it seems requisite that we should offer a remark on his allusion to the coal of Alpnach. It is not "according to geological theories" (by which we mean the generalizations of facts which have been established by modern geologists,) to suppose that such strata as those of Alpnach here alluded to, were formed "*long previous*" to the creation of the mammalia in question: all that can be deduced from the occurrence of remains of the latter in the stratum overlying the coal, is that the entire formation belongs to the tertiary series, and probably the animals were contemporaneous with the plants which furnished the coal. It is now fully established that coal has been produced at many epochs subsequent to that of the Great Coal Formation; and we may also observe, that no geologist of the present day would infer the high antiquity of a formation containing coal, merely from the mineral characters of the accompanying strata.—*EDIT.*]