



XXXIII. Geological Observations

W.H. Gilby M.D.

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ists among them, not only in the laws of their motions, but in the figure of their masses; they have not failed to remark the flattening at the poles, which can be observed in some of them, similar to that of our globe, proving a similar state of fluidity from which this figure has originated; and they have endeavoured even to draw from the aspect which they exhibit, indications of the stage of progression in which they now are*. But they have presented no pleasing prospect of the final adjustment of this series of revolutions. Regarding the planets as extinct suns, or fragments of suns, or at least as masses which have been hot and luminous, they have supposed them to be in a state of gradual refrigeration, which will terminate in the total cessation of movement and animated existence. The assumption on which this gloomy hypothesis is built,—that of the unlimited escape of heat from each planetary mass,—is fortunately as false, as the view to which it leads is unworthy of the order and magnificence which the system of nature displays; and instead of this termination, in what one of these philosophers emphatically calls the state of ice and death, of silence and repose, we may with more confidence look to the equal diffusion of heat through the mass of each planet, as the state of permanence under which it will exist, and to the equal interchange of heat among all, as the perfection of the system they form.

XXXIII. *Geological Observations.* By W. H. GILBY, M.D.

To Mr. Tilloch.

SIR,—IN the present communication, I shall offer a few observations as to the situation which the mountain limestone and red sandstone usually associated with it hold in the Wernerian system. I shall then proceed to make some remarks upon the red ground, chiefly for the purpose of showing how repeatedly the beds of this formation have been confounded with the red sandstone accompanying the mountain limestone; as also to point out the great mistakes that prevail in regard to the beds which may be considered as forming a part of the red ground. Such being the object of my communication, if it is likely to be of any interest to you or your readers, you will oblige me by inserting it.

I am, sir,

Yours very respectfully,

W. H. GILBY, M.D.

* *Histoire de l'Astronomie Moderne*, tom. ii. p. 726.

I BELIEVE it is an opinion with many, that the limestone which so constantly incloses the coal-fields in England belongs to the transition series. This opinion is most distinctly stated in a recent publication by Dr. Kidd, who has at some length endeavoured to show the correspondence of the gray mountain limestone of Somersetshire, and elsewhere, with the transition limestone of the Wernerian arrangement. This opinion appears to me to be very erroneous; for, in the country which I have described, there are, I think, sufficient grounds for referring it to the first floetz series. In geological examinations it frequently happens that individual rocks are so indifferently characterized, that it is impossible, without attending to the formations with which they may be accompanied, to refer them to their true position in a systematic arrangement. When a rock, as limestone, occurs in all the grand divisions of a system, it is most hopeless, without such correlative evidence, to guess at its true geological rank; for limestone, whether from a primitive transition or a floetz country, must still be carbonate of lime; and it is hardly to be expected that the same substance should assume characters decisive of the class to which it belongs. Thus the primitive or granular limestone, which is well characterized by its highly crystalline fracture, sometimes occurs among floetz and transition strata; but no geologist, in seeing the granular limestone *in situ* with mica slate or gneiss, would hesitate in calling it primitive; for these rocks never occur among those of the floetz or transition description. In the same manner, no one upon seeing limestone associated with gray wacke, would doubt as to its being transition, for gray wacke is a rock exclusively of transition formation. Provided therefore our system be correct, however puzzling it may be by external characters alone to refer any rock, common to all the divisions of the system, to its true position, by attending to its geological relations we soon find a solution of our difficulties. I have made these remarks, because Dr. Kidd, in considering the mountain limestone to be transition, has been a good deal guided by its sometimes (though never where I have seen it) agreeing, as to its external characters, with those which Mr. Jameson has ascribed to transition limestone, while he has completely misunderstood or overlooked its relation with other rocks.

It will be seen, by referring to my Description of the Neighbourhood of Bristol, that the mountain limestone rests upon a red sandstone. I have only, indeed, mentioned two places where this connexion can be observed; but this I am persuaded is owing to the sandstone occupying the champaign and cultivated parts of the country, so that it is difficult to ascertain its existence and relation with the limestone, excepting where the stratification

tion is displayed by some such section as I have described. My friend Dr. Prichard of Bristol informs me, by letter, that he has observed the same arrangement, *i. e.* the red sandstone dipping under the limestone at the north part of the basin about Cromhall.

Herefordshire and Monmouthshire, as I have remarked in my former paper, exhibit the same stratification, which, according to Dr. Prichard, continues into Brecknockshire*. Other writers have mentioned the same disposition of strata. It appears from Mr. Bakewell's section and account of the geology of Northumberland and Durham, in the Philosophical Magazine for February last, that in crossing the island from the coast of Durham to the Irish Channel, the mountain limestone is immediately succeeded by the red sandstone. Mr. Aikin, in his account of the great coal-field of Shropshire, says that the limestone, which from its lying immediately beneath the coal can be no other than the mountain limestone, is associated to a very considerable extent with sandstone; and in another part he considers this sandstone as identified with the old red sandstone. From these authorities it appears that the mountain limestone is pretty constantly accompanied by the red sandstone, which is constantly is situated below it. I have little doubt that this arrangement will be found still more general through the coal districts in England; but hitherto, most unfortunately, the red sandstone has been perpetually confounded with the red marl, and has been extravagantly considered as one of its beds†. With regard to the geological position of the red sandstone, there can, I think, be but one opinion. It answers exactly to the description of the old red sandstone of Werner, and precisely resembles the red sandstone in the neighbourhood of Edinburgh, and in the isle of Arran, which are considered by Professor Jameson as characteristic localities of the formation in question. This opinion, as I have just now mentioned, is distinctly stated by Mr. Aikin. If, then, this be the old red sandstone of Werner, the first of the floetz series, we may fairly presume that the limestone,

* Vide Thomson's Annals for June 1815.

† The siliceous pudding-stone, or more properly conglomerate, consisting of pebbles of quartz fixed in a basis of sandstone, which I have described as intervening between the red sandstone and limestone, is found, as I am informed by Professor Jameson, very generally accompanying the red sandstone. It is by him considered merely a variety of this rock. He is of opinion, that the red sandstone is a pure chemical deposit, and that the pebbles which occur so abundantly in particular strata, are to be viewed not as the result of mechanical attrition, but as contemporaneous with the basis in which they are set, being formed by some particular modification in the process of crystallization, by which the siliceous particles were attracted together in the form of pebbles, instead of grains of sand.

This

stone, which in so many districts is associated with and lies upon it, is the first floetz limestone. The bituminous marl-slate which is said to characterize this particular formation, I have found, in its usual situation under the limestone, in the neighbourhood of Bristol. But any thing I can say will be of far less consequence than the opinion of Professor Jameson, who allows me to state that, as far as he can judge from the description I have given and the specimens I have shown him, he considers the red sandstone and mountain limestone as members of the first floetz formation.

It is a point yet to be ascertained, whether the limestone associated with the coal-field of Derbyshire is to be considered as belonging to the floetz or transition series. The red sandstone which so commonly accompanies the mountain limestone in other parts of England, is here wanting, and its constant alternation with amygdaloid distinguishes it from the mountain limestone of other quarters. The strata too, or measures accompanying the coal, as far as I can make out from the perplexing language and confused description of those who have seen most of the Derbyshire coal-field, seem to be quite different from those usually associated with the coal in England.

Dr. Prichard, in a late number of the *Annals of Philosophy*, has endeavoured to show that the mountain limestone belongs to the transition series; because the organic remains which it contains are similar to those which are assigned to transition rocks. And hence he concludes that the first floetz limestone of Werner, to which another description of fossils belongs, is more recent than the rocks of the coal formations in England. The fact, however, that the fossils of the mountain and transition limestone are of the same description, does not appear to me to warrant the conclusion which he wishes to deduce from it; for, if the mountain limestone be transition, it is very evident that the red sandstone which lies under it must also be transition. But we have seen, and he himself allows it, that this rock

This opinion Mr. Jameson extends to many rocks which appear to exhibit marks of mechanical action, as gray wacke, trap tuff, breccia, &c.; and I think it is only necessary to see the specimens and hear the argument which he advances in support of this opinion, to be convinced of the truth of it. Dr. Kidd in his recent publication, I find, entertains the same opinion, and has advanced many ingenious arguments in favour of it, apparently without being aware that it had long before been proposed by Professor Jameson, in his paper on Conglomerate Rocks, published in the *Wernerian Transactions*, and has also been announced in Dr. Thomson's *Annals of Philosophy*. This appears the more strange, because Dr. Kidd seems to have read every author from whom he could derive information on geological subjects, and of course could not but have given the *Wernerian Transactions* a diligent perusal.

agrees

agrees with the old red sandstone of Werner, the first of the floetz series. The only legitimate conclusion, therefore, that can be drawn from the fact above stated is, that the same fossils which occur in transition rocks may also occur in those of the first floetz series.

If then we regard the mountain limestone as a member of the first floetz series, it may be asked, Does transition limestone occur in England? Geologists in several places have described limestone which certainly widely differs from mountain limestone; and in several instances such limestones appear decidedly transition. The limestone of Plymouth Dr. Berger describes of a blueish colour frequently intersected by veins of calc spar, of a crystalline grain and destitute of organic remains; though, according to a notice in the *Annals of Philosophy* for February, it contains shells in quarries at Stonehouse-hill and dock-yard. Dr. Berger speaks in the most decided manner of its being transition; and Dr. Thomson, in his *Account of the Geology of Cornwall*, says that it is associated with clay-slate, and "that there can be no hesitation in considering it transition." Mr. Horner, in his *Account of the Geology of the Malvern Hills*, has described a formation of limestone resting on the west part of the range. This I have seen; and it appears to me very different in its general structure from the mountain limestone; which, as far as I have seen, generally occurs in strata of considerable magnitude: the strata however of the Malvern limestone seemed to me never to exceed the thickness of a foot or a foot and a half. Mr. Horner considers them as decidedly transition; and as it appears that they rest in the sienite of the Malvern Hills, which is indisputably transition; and since, as Dr. Prichard informs us, they dip under the old red sandstone of Herefordshire,—there can, I think, be no doubt of their being entitled to this denomination. In a paper of Mr. Horner's lately read before the Geological Society, and of which Dr. Thomson has given an extract in his *Annals of Philosophy*, the Quantock Hills are described as being composed of a gray wacke formation alternating with strata of clay-slate. Within the latter strata beds of limestone are included, which are therefore manifestly transition. Mr. Allan, in his *Remarks on the Transition Rocks of Werner*, (Thomson's *Annals*, p. 416, vol. i.) says that the limestone at the lakes of Windermere and Coniston, which contains organic remains, is transition.

In Thomson's *Annals of Philosophy*, vol. v. p. 456, there is a notice of a paper of Mr. Buckland's, read before the Geological Society, On the Rocks situated to the east of Appleby, between Malmerly and Morton in Cumberland; in which it appears that these rocks are chiefly composed of greenstone and slate,

slate, and that a few thin beds of *transition* limestone occur in the slate. These, as far as I have been able to collect, are the only instances of the occurrence of transition limestone in England: it is yet to be ascertained, whether the primitive or foliated limestone anywhere exists in this country. The only primitive districts in England are Cornwall, the Isle of Man, and North Wales. The two former have now been minutely examined, without any locality having been given of this rock:—the probability of its occurrence is therefore confined to North Wales.

Having made these remarks upon the classification of the limestones in England, I proceed to offer some observations on the red ground, in order to show that much confusion prevails in regard to the beds that properly constitute this formation. If we attend to the general succession of rocks in England, we observe a striking conformity to the truly admirable system of Werner. In Cornwall, and in the Isle of Man, we have granite and clay-slate; and in North Wales, according to Mr. Aikin (see his *Tour through North Wales*), we have granite, mica-slate, hornblende-slate, serpentine, and other primitive rocks. In the above-mentioned districts, upon the primitive rocks rest those of the transition formation, consisting of gray wacke, limestone, and gray wacke-slate, which, however, sometimes, as at Malvern, in Cumberland, &c. are found unassociated by the older rocks.—Upon the transition series, as has been well remarked by Dr. Prichard in the paper above referred to, repose in almost every district the members of the first flötz formation, the old red sandstone and mountain limestone, upon one of which all the coal formations in England, with the exception of that in Derbyshire, seem to recline.—Independent of these formations, an extensive series of horizontal strata is observed in many parts of England to cover the coal-fields, and the mountain limestone and red sandstone by which they are inclosed. Of this class of strata, the lowest, or those immediately covering the coal-fields, and their inclosing strata, are the beds of what is called the Red Ground. Above these occurs the lyas limestone, which is followed by several varieties of oolite, and then again by the chalk. From this statement it is obvious, that the red ground or rock marl must be of later origin than the coal-measures or the first flötz formation. But such have been the inaccuracy and confusion of those who have had the best opportunities of ascertaining the true nature of the red ground, and its relative position with other formations, that not only members of the flötz but even of the transition series have been referred to this formation. Thus, Mr. Farey in his account of Derbyshire, when enumerating the beds, or, as he calls them, the products of the red ground, mentions after gypsum and sandstone strata, sienite and roof

roof or clay-slate, and probably, says he, the sienite of Malvern belongs to this formation. (Report, p. 152.) It is quite unnecessary for me to make any comments upon so strange an error as that of placing the sienite and slate of Derbyshire and Malvern hills (which certainly belong to the transition series, but which some have even called primitive,) in the same formation with the gypsum of the red ground, between which and the sienite, in point of regular succession, there intervene the red sandstone, mountain limestone, and coal deposit with all its accompanying measures.—As well, I apprehend, might Mr. Farey, upon seeing a mountain of granite rising 3000 feet above the surface of sand or gravel which surrounds its base, call the granite a bed in such matters, as the sienite a bed or product of the red ground. But Mr. Farey, in fact, seems to despise every thing like a systematic arrangement, and calls, forsooth, the confusion which he wishes to introduce, English Geology.

Mr. Townsend in his work upon Moses vindicated for veracity, &c. has committed a mistake not less important. At p. 156, he describes the quartz sandstone of Brandon hill near Bristol, which, as I have stated in my former paper, always lies in a conformable position on the mountain limestone, as a bed in the red ground; whereas the least observation might have convinced him that the true beds of the red ground have a position quite unconformable to this quartz sandstone, and that between it and the former there intervenes, as to the æra of their formations, the whole of the coal deposit. Not less inconsistent is he when he asserts the micaceous sandstone to be a part of the red ground. Upon this belief, it seems strange that he did not follow up his mistake, by saying that every stratum of coal in the Gloucestershire and Somersetshire basin belonged to the red ground; for the micaceous sandstone, or Pennant stone, is universally a coal measure; and in whatever light we consider one, under the same point of view must we regard the other.

Dr. Kidd in his late publication has likewise, I conceive, fallen into a mistake respecting this formation. He there confounds the red ground with the old red sandstone, and gives it as his opinion, that they both belong to the same formation. Nothing, however, as will plainly appear from what I have above stated, can be more different than the situation of the beds of the red ground and the red sandstone. No spot is more favourable for observing this difference than the neighbourhood of Ness, which the Doctor says he has examined. He would there most distinctly see the old red sandstone dipping under the mountain limestone,—a situation, as every one will acknowledge, perfectly inconsistent with the red ground formation. A similar error, I conceive, has been committed by Mr. Horner in his

Account

Account of the Salt-works near Droitwich, published in the second volume of the Geological Transactions. The prevailing rock around Droitwich, says Mr. Horner, is a fine-grained calcareo-argillaceous sandstone of a brownish red colour, which contains beds of a greenish-gray colour, in which are slender veins of crystallized gypsum. This sandstone, continues he, is the same as that which Mr. Aikin has described as occurring to so great an extent in Shropshire and Staffordshire, and which he considers to be the old red sandstone of Werner. The sandstone which Mr. Horner here describes, answers exactly to the description of that which I have mentioned in my former paper, as forming one of the beds of the red ground near Bristol, and is characterized by its strongly effervescing with acids, and by its being sometimes associated with gypsum: whereas the old red sandstone, independent of its different geological situation, as Mr. Aikin very justly remarks, does not effervesce with acids, contains spangles of mica, and, as far as I have seen or read, is never accompanied by gypsum. The occurrence of gypsum and rock-salt in England is, I am convinced, in every instance to be referred to the red ground; even in Scotland, where the old red sandstone is so widely distributed, its occurrence with gypsum is so rare, that Professor Jameson, in his Lectures, if I remember right, only gives two instances of it. Having made these remarks upon Mr. Horner's paper, I quote with great pleasure some passages from a notice of a paper of his lately read before the Geological Society, On the Structure of the Quantock Hills*, where the red ground is described to cover the old red sandstone (in the same way, I apprehend, as I have described in my former paper), so that the distinction between these two formations is clearly made manifest. "Where the hills of gray wacke (says he) sink down into the lower country, their sides are covered with beds of conglomerate passing into red sandstone. These beds appear to consist of the same materials as the gray wacke formation, but decomposed to a considerable degree." This conglomerate is merely a common variety of the old red sandstone, and is covered by a red argillaceous sandstone containing a variable proportion of calcareous matter. It is of a fine texture, never contains fragments, is in some places traversed by veins of gypsum, and appears to be the same rock as that in which the salt-beds of Cheshire and Droitwich are situated. To this succeed the strata of lias limestone, which are sometimes seen distinctly resting on the red gypsum rock.

Having, as I trust, now shown that many strata have been referred to the red ground, which have not the smallest relation

* Vide Thomson's Annals for May 1815.

to that formation, it may be asked, What are the true beds of the red ground? by which term I mean that deposit which, as to the æra of its formation, is later than all the coal strata in England, and of course than their inclosing rocks, and which lies immediately under the lias. As far as I have seen, the lowest stratum of the red ground is a very coarse breccia, or rather conglomerate, which becomes finer as we ascend. The contained masses are rounded and angular, and consist of limestone, hornstone, quartzzy sandstone, &c. To this succeeds a fine-grained calcareous sandstone, which is sometimes of a deep red and sometimes of a white colour. Above these, I believe, lies the great deposit of red clay, abounding in many districts with gypsum both foliated and fibrous, and sometimes containing sulphate of strontites. I do not pretend to say that no other beds can with propriety be referred to this formation; but, as far as I may be allowed to speak from my own experience, and the descriptions of others, these only appear to me to belong to this formation. It may be worth while mentioning, that the conglomerate which I have formerly described as one of the red ground beds near Bristol, has also been noticed by writers as occurring in other districts. In a short account of the stratification of Glamorganshire in the xlvth vol. of the Philosophical Magazine there is the following passage:—"About a mile west of Dunraven, a calcareous breccia similar to that described by Mr. Gilby underlies the lias." The following is a note which I have extracted from some author, but unfortunately have neglected to take down the name, but I think it is from Dr. Kidd.—"A circumstance in the history of rock marl is its alternating with and transition into beds which would usually be called conglomerate. Thus the red cliffs at Budleigh, Saltstoun near Teignmouth, and those also of Teignmouth itself, consist of argillaceous beds with beds of sandstone and breccia."

The calcareous sandstone has also been noticed by other authors. I have mentioned above Mr. Horner's description of its occurrence in his account of the Quantock Hills.

Mr. Buckland, in the paper above referred to, on the rocks situated to the east of Appleby, mentions that on the west part of the range there occur strata of limestone, either by themselves, or with thin seams of coal interposed nearly vertical. Then comes in a *sandstone* in nearly horizontal beds, forming, in his opinion, part of the great deposit which overspreads the vale of Carlisle, a large part of Cheshire, and vale of York, in which are contained the great quarries of *gypsum* and beds of *rock salt*.

Before closing this paper, it may be interesting to state the occurrence of a trap rock in the neighbourhood of Bristol. I had frequently remarked, in travelling from Bristol to Gloucester, that

that the road is repaired about Newport with an amygdaloid, but I had never an opportunity of visiting the spot from whence it was brought. My friend Dr. Prichard, however, informs me, by letter, that it is quarried from a hill at Micklewood to the east of Newport, a few miles beyond the northern boundary of the limestone ellipsis. The hill itself is of very inconsiderable extent, and perfectly unconnected with the surrounding high country, which to the north of it is of oolite; and in walking south of it we first come on the red sandstone, then on the sandstone conglomerate, both of which we find further south at Cromhall, dipping under the limestone. — From this account, there can be no doubt, I think, that the amygdaloid rests upon the red sandstone. The specimens that I have seen of the amygdaloid consist of a basis of a sort of iron-clay containing almond-shaped portions of calc spar and green earth.

With regard to the point at issue between Mr. Farey and me, it would be a most unprofitable waste of time to dissect his sesquipedalian sentences, and to answer each part separately: I shall content myself with stating, that after reading Mr. Farey's letter, I referred to the original account of Mr. Strachey in the Philosophical Transactions, on the coal-pits near the Mendip Hills, and find the unconformable position of the red ground is most distinctly mentioned both in his section and description; so that the merit of having first observed this appearance belongs neither to Mr. Farey nor to myself, but exclusively to Mr. Strachey. My ignorance of this circumstance arose from not having had an opportunity, while writing my paper, of consulting the Philosophical Transactions themselves, but was obliged to content myself with referring to Dr. Thomson's Abridgement, where the particulars relative to the occurrence of the coal are accurately given, but this point of the unconformable position of the red ground is altogether omitted.

XXXIV. *On the Strength of Beams.* By A CORRESPONDENT.

To Mr. Tilloch.

SIR,—BUFFON found by his experiments, that the strength of beams decreased in a much quicker proportion than the inverse ratio of their lengths. The cause has not been satisfactorily explained; but may it not be accounted for by the tendency of the weight to compress the beam, in the direction of its depth, at the place of fracture? To ascertain the effect of this kind of pressure, I fixed one end of a bar of deal $\frac{1}{4}$ of an inch square, and suspended a weight of 17 lbs. at 12 inches distance from the point