Notes on the geology of the neighbourhood of Wells, Somerset / by Horace B. Woodward.

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THE NEIGHBOURHOOD OF

Wells, Somerset.

INTRODUCTION.

THE interest attaching to the Geology of Somersetshire has been frequently brought before the notice of the Members of the Somersetshire Archæological Society, and more particularly by Mr. Charles Moore, whose labours are so well known; but although much has been written on the subject generally, it may be useful to draw attention to some of the local features, if only to show that there remain many points to be worked out and many questions to be solved, ere the geological structure is thoroughly understood or its history complete.

Wells is admirably placed for the study of geology, as within a walking distance representatives of aqueous, igneous, and metamorphic rocks may be studied. The Upper Palæozoic and Lower Mesozoic rocks are well displayed; while the superficial deposits, the phenomena of denudation, and the relation of the different rocks to the form of the ground, furnish topics of much interest.

TRAP DYKE.

One of the most important discoveries made by Mr. Moore* was that of the Basaltic dyke near Stoke Lane,

* *Quart. Journ. Geol. Soc.*, vol. xxiii. p. 451.

and which my colleague Mr. Ussher has traced from Tadhill House, Downhead, to near Long Cross Bottom, six miles from Wells in a direct line. It appears to occur in bosses; but its exact nature is not clearly shown, and although it creates a good deal of disturbance in the old red sandstone which it has pierced, it nevertheless does not seem to have created any marked metamorphism in it.

PALÆOZOIC ROCKS.

The structure of the Mendip Hills is well known to be an anticlinal, modified in places by minor folds, and even by an occasional inversion.* The oldest rock, the old red sandstone, appears at North Hill near Priddy, and again at Pen Hill, consisting of red micaceous sandstones, which pass gradually upwards into the lower limestone shales, and these again by similar gradation pass into the mountain limestone. The shales may be observed in the Harptree Road, north of East Milton. Considerable interest attaches to the section of these lower carboniferous rocks and the old red sandstone of the Mendips, when one considers their relation to the Devonian question.† The carboniferous slate in Ireland, which in places fills the whole of the interval between the top of the old red sandstone and the base of the coal measures (the mountain limestone there being but locally developed and passing into the slate), may be taken as the equivalent of our lower limestone shales and mountain limestone, and it was the slaty beds of Lynton, Combe-Martin, Ilfracombe, and Mortehoe, also those of Baggy, Marwood, Pilton, and Barnstaple, that the late Professor Jukes identified with these lower carboniferous rocks.

* See *Geol. Mag.*, vol. viii. p. 149.

† See "Review" in *Quart. Journ. Science*, January, 1873.

Whatever be the true age of the slaty beds of North Devon—be they of old red sandstone age or carboniferous or both,—they show different sedimentary conditions from our East Somerset beds, for we cannot make out the same lithological divisions as we have in the Mendip Hills. The rocks, however, which occur in West Somerset at the base of the slaty series, are generally considered as lithologically identical with typical old red sandstone.

The millstone grit occurs in several places along the northern borders of the Mendips, but no exposure had until lately been traced on the southern slope,* although its probable occurrence has been indicated in sections drawn to explain the structure of the hills and the probabilities of coal beneath the flats of Sedgemoor. Large masses of quartzite crop out by the lane between Easton and Priddy (near the bend) which belong to the millstone grit, and in the ravine leading towards Ebber rocks, traces of lower limestone shales and old red sandstone occur, into which a shaft was sunk in search of coal so recently as 1871.†

There appears to me to be another indication of millstone grit shales immediately south of the high road south of Dinder, in the lane leading to Worminster. These indications are not altogether valueless in regard to the prospects of coal to the south, but they also, from their position, show minor rolls in the mountain limestone.

The prospects of coal to the south of the Mendips have been indicated by many geologists, and there seems a probability of its being reached at the depth of about 1000 feet in the neighbourhood of Meare, Polsham, Wedmore, or Pilton. Trials further south might be equally productive, as at Langport or Somerton, but while the trial would

* See De la Beche, *Mem. Geol. Surv.*, vol. i. p. 213.

† H. W. Bristow and H. B. W., *Geol. Mag.*, vol. viii. p. 500.

anywhere be one of considerable risk, to the south there is more chance of hitting the unproductive pennant grit, which might be avoided further north.*

KEUPER ROCKS.

The different deposits of keuper age met with at Wells are the red marl and dolomitic conglomerate. Their relations are those of a beach deposit to one of deeper water. On the borders of the Mendip range, as shown by Sir Henry De la Beche,† these beds dovetail one into the other, but as a rule the conglomerate extends much higher up the hills, as would be natural with a beach. In the coal district the dolomitic conglomerate (called "Millstone") is usually found at the base of the red marl in the pit-sections. This is not because the conglomerate as a whole was deposited before the marl; it shows in these sections that conglomerate locally preceded the marl, and the area being a subsiding one, deeper water conditions came on, while the formation of conglomerate went on at the margin of the red marl sea, and continued throughout the deposition of the marl, even in places into the Rhætic series (as we find traces of Rhætic conglomerate near Nempnet); while again the lias conglomerate continued in places at the margin of that deposit.

The remarkably even manner in which the mountain limestone has been denuded is well shown at Wallcombe, near Wells, where the keuper beds rest on the basset edges of this rock. This even line is also very conspicuous in the vales near Frome.

The road to Wookey Hole on the one side of Wells and that leading to Dulcot on the other, show in places in the

* See last-mentioned paper, also Moore, *Proc. Somerset Arch. and Nat. Hist. Soc.*, vol. xv.

† *Mem. Geol. Survey*, vol. i. p. 239.

red marl a bed called the "Wonder stone," described by Messrs. Buckland and Conybeare as "a beautiful breccia, consisting of yellow transparent crystals of carbonate of lime, disseminated through a dark red earthy dolomite."

RHÆTIC BEDS.

The Rhætic or Penarth beds, which form a gradual passage between the new red marl and the lower lias,* are exhibited in numerous localities around Wells. One of the best sections in this country is that shown in the railway cutting near Shepton Mallet, which was originally described by Mr. Moore.† The beds attain a thickness of forty feet, which however is nearly quadrupled at Watchet and Penarth, according to the measurements of Messrs. Bristow and Etheridge. Nevertheless at Shepton Mallet the section is complete, showing the three members—the white lias, the black avicula-contorta paper shales, and the grey marls. There is no appearance here of the Cotham marble which at Bath is so well shown at the base of the white lias, in the cuttings of the Midland Railway,‡ but it occurs (2 to 3 inches in thickness) at East Horrington.

In a lane at East Milton the Rhætic beds are also very fairly exhibited, and their junction with the lower lias is so gradual as to render it difficult to fix the exact boundary.‖

In the numerous outlying hills situated in the red marl near Wells, the Rhætic beds may be observed, as at Whurt Hill, Pen Knowle, Tilbury, Twine Hill, &c.

LOWER LIAS.

The lower lias is largely developed at Shepton Mallet,

* H. B. Woodward and J. H. Blake, *Geol. Mag.*, vol. ix. p. 196.

† *Quart. Journ. Geol. Soc.*, vol. xvii. p. 515 ; vol. xxiii. p. 505.

‡ See section by the Rev. H. H. Winwood, *Proc. Bath Nat. Hist. and Antiq. Field Club*, vol. ii. p. 204.

‖ This section was originally described by the Rev. P. B. Brodie, *Quart. Journ. Geol. Soc.*, vol. xxii. p. 93.

and at Street, where are the famous reptilian quarries. Nearer Wells, on the borders of the Mendip Hills, we find those conglomeratic modifications of the lias which have been pointed out by Sir Henry De la Beche and Mr. Moore, and which indicate the margin of the deposit. These beds are the representatives of the Sutton stone and lias conglomerate of South Wales, and although a Rhætic age was assigned to the former series at one time, its true position as a part of the lias was demonstrated by Mr. Moore* and Mr. Bristow.†

CHERTY BEDS OF HARPTREE.

Very interesting modifications of the liassic and keuper beds are to be found in the neighbourhood of East and West Harptree. The lower lias limestones and the white lias (Rhætic) which possess their ordinary characters near Green Down Cottage, are represented a short distance to the west by a compact chert which occurs in massive beds; while associated with the ordinary red marls and dolomitic conglomerate of keuper age near the Harptrees, we find here and there a chert of a more or less sandy nature. These deposits have attracted some attention from previous observers: Mr. Weaver‡ considered them to be most nearly allied to the greensand formation, and certainly their lithological character and the nature of the ground find their counterparts on the Blackdown Hills near the Wellington monument, where the greensand occurs, composed in its upper part of chert seams, and in its lower of sand. The Rev. W. D. Conybeare‖ in 1822, while hesitating to give any decided opinion, concluded on the whole

* *Quart. Jour. Geol. Soc.*, vol. xxiii. p. 449.
† *Idem*, p. 199.
‡ *Trans. Geol. Soc.*, 2nd ser., vol. i. p. 364.
‖ *Geology of England and Wales*, p. 304.

that they belonged to the magnesian (dolomitic) conglomerate age. A year later Messrs. Buckland and Conybeare* in a joint paper read before the Geological Society, treated the beds in some detail, and likewise referred them with hesitation to the dolomitic conglomerate.

The true distinction between these deposits was recognised by Sir Henry De la Beche in the Geological Survey Map, and by Mr. Sanders in his large map of the Bristol coal fields.

The greater part of the ground at Harptree Hill contains numerous hollows and pits, but these rarely afford a section. They were mostly dug for calamine or ochre ; a few of them, however, are natural "swallet holes," and such is the large one on the east of the road between East Harptree and the "Castle of Comfort," and about half way between the village and this *uncomfortable* inn. The pit is about 60 feet in diameter at the mouth, it is funnel-shaped, and about 25 feet deep. The beds exposed are massive bedded chert, occurring in layers of from one to three feet in thickness, separated by thin clayey beds an inch or two in thickness, and containing heavy spar in places. *Ammonites planorbis, Lima gigantea, L. pectinata, Myoconcha psilonoti, Ostrea Liassica, and Pecten Pollux*† are not uncommon in the upper beds. Possibly the lower beds may be representatives of the white lias, but they yield no fossils. True Rhætic beds are however exposed near the cottage on Harptree Hill. Here we find a pit dug in hardened reddish-brown sand crowded with *Pullastra arenicola.* The same sands occur by the road a quarter of a mile south of the "Castle of Comfort." Some of the hollows yield blocks of sandstone containing *Pecten valo-*

* *Trans. Geol. Soc.*, 2nd ser., vol. i. p. 294.

† These fossils were identified by Mr. Etheridge, F.R.S., &c.

*niensis, Avicula contorta, and Anomia (Placunopsis) Alpina.**

The cherty beds which are associated with the keuper beds may be seen in the vicinity of East Harptree, north of Green Down Cottage, and on either side of the road by Eastwood House, west of Cawley. They are more broken up than the liassic beds, and pass in places into a fine grained sandstone. At Rhud, near West Harptree, immense blocks of hard silicious and cherty rock, also silicious conglomerate may be seen, which are probably of keuper age, although they resemble the cherty lias, which is in some places conglomeratic.

In regard to the origin of this metamorphism, for so it may strictly be called, I have advanced the notion that it was due to some igneous eruption when the beds were under water, the change being produced by the heated water, the dyke itself not coming into contact with the beds.† I need scarcely add that there is room for much further observation on these interesting beds.

Leaving these cherty beds we may turn our attention to some other objects worthy of notice in this neighbourhood.

LEAD AND ZINC MINES.

The lead and zinc mines of the Mendips present very feeble activity now, but they have been worked from very early times. The district was occupied by the Belgæ, and subsequently the Romans, probably tempted by the rich mines, made it one of their first points of occupation. In the time of Edward IV it is said that these mines furnished employment to 10,000 miners, and the immense deposits of slags and slimes indicate the extent of the workings.

Near Wells we have lead-workings at Stoke Hill near

* See *Geol. Mag.*, vol. viii. September, 1871.

† *Geol. Mag.*, vol. viii. p. 400.

Priddy, East Harptree, and Tar Valley near Chewton Mendip. The refuse-deposit at Stoke Hill is about a mile in length, from 200 to 300 yards in width, and from 12 to 20 feet deep. It is estimated to have contained about 500,000 cubic yards of material.* The stream which runs along the hollow on the lower limestone shales, plunged into a swallet-hole at the junction with the mountain limestone, and issued again near Wookey Hole. It was used in washing the ores at the mines, and thereby the water became so polluted, that it was spoilt for the paper manufactory at Wookey Hole. Consequently great disputes took place between the parties interested, which led to a law-suit, and finally to the protection of the owner of the paper-mill against injury arising from polluting matter thrown into the water.

The old material worked at Stoke Hill is found to yield on an average about 10 per cent. of lead. The slags are said to yield about 20 per cent. of the metal; the slimes about 5 per cent. There are about a thousand yards of chimney attached to these works, through which the gas and smoke from the smelting process escape; and the deposit found in this flue yields 50 and sometimes 60 per cent. of lead. Occasionally bits of galena turn up in the refuse, sometimes even a barrow-load, but it is rare to get any.

The works at East Harptree are similar to those at Stoke Hill. Amongst the refuse heaps, besides bits of galena, numerous old tobacco pipes of the earliest type (16th century) occur. Few minerals of any value can be obtained, and Mendipite is not now to be found even at its native place Churchill. Zinc ore (calamine) is very

* H. C. Salmon, *Mining and Smelting Mag.*, vol. vi. p. 322.

sparingly worked at the present time on the Mendip Hills. Like lead ore (galena), it occurs both in veins as well as disseminated in the strata, which include the dolomitic conglomerate and the mountain limestone; but zinc ore appears to be more abundant in the former, lead ore in the latter.

Mr. Moore has drawn prominent attention to the palæontology of the mineral veins on the Mendip Hills, from a study of which he concludes that in general all the veins which traverse these hills are of liassic age. I have ventured to differ from Mr. Moore on this point, and consider that the organic remains found in the veins were introduced at a subsequent period, when the area was no doubt brought within the influence of the sea, and probably in glacial times. The formation of the veins themselves may have been going on ever since the consolidation of the rocks which they traverse, for contraction and repeated elevation and depression must have formed cracks and fissures, which would soon receive mineral deposits. The veins may therefore be of all ages subsequent to the carboniferous period, and we can understand the occurrence of the ores disseminated in some of the strata, which would be due to the destruction of veins in the older rocks.*

This topic leads me to consider some of the phenomena of later tertiary and quaternary times, and to make a few observations on denudation, a subject however which has been treated in a large way by Professor Ramsay.†

CAVERNS, COMBES, AND ALLUVIAL DEPOSITS.

There is a striking absence of drift deposits over the Mendip Hills, and this is the more remarkable as the

* *Mining Mag. and Review*, vol. i., March, 1872.

† *Mem. Geol. Survey*, vol. i. p. 297.

country to the north including the Cotteswold Hills, also South Wales, and Devonshire, contain drift gravels and glacial deposits.*

Near the trap dyke on Downhead Common, and in several places along the line of the old red sandstone in this neighbourhood are traces of gravel; but they are due almost entirely to local disintegration of the quartzose conglomerate of old red sandstone age. At Wells there is gravel, also other traces occur near Polsham and Wookey; these are all made up of the rocks in the neighbourhood, and are ordinary valley or river gravels. No traces, so far as I am aware, of any flint implements or mammalian remains have been found in them, but this may be due to the want of local energy in looking out for them.

In regard to the cavern deposits and their included organic remains I need say nothing, as they have been described so fully by Mr. Boyd Dawkins and Mr. Ayshford Sanford. But I may refer to the theory expressed by the former gentleman in regard to the origin of the Cheddar Cliffs, namely that they were due to the removal of the roof of a gigantic cavern. This theory has been applied by the Rev. J. M. Mello† to explain the origin of some of the Derbyshire dales. He remarks that they were, probably in many instances, originally caverns, which have been through countless ages eaten away by the streams, till at length the roofs have fallen in, and in their turn have been for the most part carried away by the same powerful agent.

The application of this theory to the origin of the Cheddar Cliffs seems in many respects plausible. The

* See *Geol. Mag.*, Dec., 1872; July, 1874.

† Sketch of the Geology of Derbyshire, *Trans. Chesterfield and Derbyshire Inst.*, 1872.

cliffs are formed in the mountain limestone, and may be termed a serpentine gorge. The have evidently been *worn away*, not disrupted by any great convulsion, as popularly supposed. The dip of the strata on either side of the gorge coincides, and though possibly some crack which occurred during the elevation of the hills may have given the direction to the cliffs, they are clearly the result of gradual wearing away, of denudation, the result of the action of water. It has been asserted that the sea was the agent that wore them away,* but I can see no traces of its action. The tendency of the sea is rather to form long lines of cliff than narrow gorges. I am therefore inclined to look upon the Cheddar Cliffs as formed by the agency of rain and rivers, both with chemical and mechanical action ; but whether originally as a cavern or not, it is hard to say. In North Wales there are gorges formed by mountain torrents, which present on a small scale a resemblance to the Cheddar Cliffs—that particularly which runs from Pont-y-Pant to Bettws-y-Coed. The rocks here too are worn into curious hollows by the eddies and spray of the rushing water.

At Cheddar the dip of the limestone has evidently had very great influence on the formation of the cliffs : on one side, the abrupt one, the dip being away from the cliffs exercises a conservative agency, whereas on the opposite side the dip being into the ravine, a slope has been formed, the tendency being for the beds to break off and fall into the gorge.

The Ebber rocks, a short distance from Wells form a gorge like Cheddar, though on a smaller scale, and differing from it in being in a more natural state. Instead of the

* Mackintosh, *Intellectual Observer*, vol. xii. p. 30. See also *Scenery of England and Wales*, by the same author.

carriage road we have to pick our way along a rugged path, over loose blocks and fallen débris. The ravine is well wooded and far more picturesque, though not so grand as Cheddar.

Ravines like this, which are characteristic of a mountain limestone country, as Mr. Dawkins has pointed out, appear in different stages in the Mendip Hills and Broadfield Down: some being deeper and bolder than others, but all perhaps still undergoing the same processes, though in a feeble degree, to which they owe their origin. Mr. Valpy, F.G.S., tells me that since his recollection, Burrington Combe has altered very materially, from the effects of subaërial denudation. One thing must strike one, where has the material gone to which once filled these gaps? The present meteoric action is rather to choke up the combes, as the streams where they occur are very small, and most of the water which falls on the Mendips drains away underground, through the numerous joints and fissures in the mountain limestone. The dolomitic conglomerate, the beach deposit of keuper seas, which is made up so largely of mountain limestone, runs up here and there in to hollows, and is found in spurs along the Mendips. Yet it has itself suffered much denudation, and the features of the combes show that they were not formed by marine action during the keuper period, for the combes occur irrespective of the conglomerates, which are cut through occasionally, as is the limestone. They are clearly of a date subsequent to its deposition. Possibly the waters which once spread over the now alluvial flats may have helped to clear off the débris.

I may draw attention here to another subject which has received considerable discussion of late. Many years ago Dr. Buckland drew attention to certain small holes in

the faces of limestone rocks, which were usually found to contain specimens of the common living land snails, and he attributed the formation of these holes to the burrowing power of their molluscan inhabitants. Although it is evident that they have the power of boring and rasping, yet it has not been shown to what extent they have actually been known to bore. I shall not not stay to discuss this interesting question, but merely put in a note by the way which I have gleaned from some memoranda made by my father, the late Dr. S. P. Woodward, when on a trip to the Mendips in 1842. He observed that Dr. Buckland's "snail holes" occur frequently on the rocks and in the rock walls, often low down, but always on the windward side. *Helix nemoralis* was the usual occupant. They are, he added, clearly due to weathering, and not to snail action. One may observe that the faces of the rocks are in many places perforated with holes and burrows, which penetrate the stone in every direction, and appear devoid of any regularity. They occur on exposed situations, and may be seen on the surface of the ground after removing the turf. They are due to the action of rain, and the carbonic acid which it imbibes in its course from the atmosphere and soil. Even in old limestone quarries groves and hollows may be traced on the faces of the rock beds, which have evidently been formed since the pit was opened by man. They show what rain does do in a short space of time. Blocks with these perforations are the usual ornaments in the cottage gardens.

The alluvial flats of Sedgemoor which commence around Glastonbury and extend westwards to the sea border are full of interest, not only as regards their purely physical relations, but also as being so intimately connected with historic times.

The whole of these vast tracts of moorland have evidently formed estuaries or tidal creeks, something like those of the Blackwater and the Crouch on the east coast of Essex. The sedimentary matter of which they are made up is largely due to the denudation of the surrounding hills, while a large portion of it was no doubt derived from the sea, being the mud brought into it by the Severn. Periods occurred when these flat grounds were sufficiently drained to allow of the growth of peat, which appears at the surface in some places, and in others is covered with alluvial soil.

The gentle fall of the rivers and their small size render them inefficient in heavy rains to carry off the water that drains into them. Hence the frequent floods which occur over the moors. The small size of the rivers is in a great measure to be attributed to the character of the watershed, this being so largely a country composed of mountain limestone, which contains joints and crevices that serve to conduct the water underground. Wells no doubt owes its spring, called St. Andrew's Well, to this underground drainage from the Mendips, and being brought to the surface by a siphon arrangement, it rises from the mountain limestone through the overlying red marl and gravel.