The following table gives particulars of the wells visited during the excursion :—

	<div> <div> <div>Feet.</div> <div> <div>Well.</div> <div>Continued by boring to</div> </div> </div> <div> <div>To Chalk.</div> <div>In Chalk.</div> <div>Total.</div> </div> </div>				<div> <div>In Feet above O.D.</div> <div> <div>Level of Surface.</div> <div>Level at which Water stands when not pumping.</div> <div>Level to which Water is pumped down.</div> </div> </div> <th>Length of headings (in feet).</th> <th>Average quantity pumped per day (million gallons).</th>				Length of headings (in feet).	Average quantity pumped per day (million gallons).
Chadwell Spring	Chalk at Surface.				112	110	—		av. yield 3½	
Wells :										
Broad Mead .	17	9	26	831	110	106	90	none	1½	
Amwell End .	36	36	72	419	109	105	48	none	1½	
Amwell Hill .	—	90	90	160	133	104	70	375	3½	
Amwell Marsh .	14	95	109	392	110	104	48	336	2½	
Rye Common .	19	185	204	none	110	94	3	371	3½	

The standing water-level of the Wells is approximately that of the River Lea near by. The quantity pumped is that taken from the several wells when required.

EXCURSION TO BATH, MIDFORD, AND DUNDRY HILL, IN SOMERSET, AND TO BRADFORD-ON-AVON AND WESTBURY, IN WILTSHIRE.

WHITSUNTIDE, 1893.

Directors : THE PRESIDENT (HORACE B. WOODWARD, F.G.S.),
the REV. H. H. WINWOOD, M.A., F.G.S., W. H. WICKES,
and EDWARD WILSON, F.G.S.

(Report by THE DIRECTORS.)

I. BATH AND MIDFORD.

Director : THE PRESIDENT.

THE Members of the Association have on previous occasions visited Bath : in 1872, under the guidance of Charles Moore and the Rev. H. H. Winwood, and in 1879 when Moore again acted as Director.* On no occasion however have the sections at

* Record of Excursions, pp. 345, 347.

Bradford-on-Avon and Westbury, and those of Midford and Dundry, been hitherto visited by the Association.

Early in the afternoon of Saturday, 20th May, the Members arrived at Bath, and the luggage being sent on to the Fernley Hotel, they started at once for Midford. Proceeding by Lyncombe, past the Abbey Cemetery, the ascent of Combe Down (522 feet) was made along Blind Lane. On the way a small section of the Fullers' Earth Rock (rubbly marl and limestone) was examined, and this yielded *Isocardia*, *Waldheimia ornithocephala*, etc. Higher up, the basement-beds of the Great Oolite were seen, and on top of the Down one of the freestone quarries was visited. Here from 9 to 10 feet of oolite is worked under the name of "Combe Down Stone." It is more or less wedge-bedded and in places minutely current-bedded, and some of the blocks are traversed by thin veins of calc-spar, but it is a good and durable freestone. To some extent it has been naturally seasoned, for it occurs near the surface on Combe Down, whereas in most places the Bath Stone is obtained by underground workings. Attention was drawn to the variability of the stone-beds, both in thickness and character, as they are traced from one locality to another. The freestone of Combe Down was overlaid by rag-beds and rubbly stone that are used for ashlar, road-metal, etc. Some of these layers are fossiliferous, and yield *Ostrea Sowerbyi*, *Pecten vagans*, *Rhynchonella concinna*, *Serpula*, *Apiocrinus*, etc. Sparry cavities are met with in the rocks, and these are sometimes due to the decomposition of Corals. Descending the hill, under the guidance of the Rev. H. H. Winwood, into Horsecombe Vale, attention was next drawn to a section of the Inferior Oolite and Midford Sands, shown in a cutting of the Midland (Somerset and Dorset) Railway. Passing on to Tucking Mill, a halt was made to see the tablet inserted in the dwelling-house (by Members of the Bath Natural History and Antiquarian Field Club) in memory of William Smith, "the Father of English Geology," who resided there in 1798-99, while he was engaged in the construction of the Somersetshire Coal Canal.

Through the kindness of Mr. Henry Newson Garrett (Proprietor of the Midford Fullers' Earth Works), the various processes undergone by the Fullers' Earth clay, to render it marketable, were examined and explained by the foreman. The raw earth is dug in the hill-side not far from the Cross Keys Inn, and it is conveyed in trucks down a steep incline to a "Pug mill." There it is ground up, with about three times its own bulk of water. The compound, known as "slurry," is then turned into a series of little tanks or "catch-pits," and while the fine Fullers' Earth remains in a state of suspension, the coarser particles sink to the bottom. The liquid, which still contains "impurities," is then allowed to run into a long earthenware drain, laid under-

ground, which conveys it to the works, more than half-a-mile distant. Here the turbid water flows into a long shallow trough called a "maggie," and the coarser particles still contained in it then subside and are caught by a series of little wooden steps placed across the bottom of the trough. By these processes the Fullers' Earth is purified. It is now run into large tanks and the suspended earth is allowed to settle down gradually; while the surface-water that is drained off is said to be very soft, pure, and drinkable. These operations take about thirty days; and now a damp clayey mass remains in each tank. This material is removed to a large drying shed, where by means of a furnace and hot-air flues, it is thoroughly dried, and is then ready for market.*

The economic Fullers' Earth is from 4 to 7 feet thick, and is worked by means of galleries driven into the hill side. No good section of the overlying beds was to be seen, but they comprised blue and brown marly clays with bands of nodular earthy limestone. Among the fossils there occurred *Belemnites*, *Ceromya*, *Cypricardia*, *Waldheimia ornithocephala*, *Rhynchonella varians*, etc. Small nodules of limestone occur in the economic Fullers' Earth and these sometimes yield fossils. The Fullers' Earth is of a yellow colour at its outcrop, and blue underground; but there is no difference in the commercial value of the two varieties. Analyses of the earth had been made by Mr. J. Hort Player (details of which would be published in a Geological Survey Memoir); they showed that the peculiar detergent properties were due to physical characters and not to any special chemical composition, the earth not being plastic like ordinary clay, but falling to a powder under water. It was mentioned that a number of *Ostracoda* from the Fullers' Earth of Midford had been described by Prof. T. Rupert Jones and Mr. C. D. Sherborn.†

The Members now proceeded along the road near Midford Castle, to the road-cutting south of Midford railway-station. There the Inferior Oolite was again well seen, overlying the Midford Sands. It was pointed out that the Inferior Oolite belonged to the zone of *Ammonites Parkinsoni*, no traces of the lower zones of *A. Humphriesianus* and *A. Murchisonæ* having been observed. Thus there was locally a break between the Oolite and the underlying Midford Sands, which yielded *Ammonites radians*, *A. striatulus*, etc. Reference was made to Mr. S. S. Buckman's views on the palæontological zones in the Cotteswold, Midford, and Yeovil Sands;‡ and the Director maintained that the term Midford Sands was useful as a stratigraphical division that should include the Sands at those several localities. The Inferior Oolite at Midford yielded remains of *Lima pectiniformis*, *Trichites*, *Rhynchonella spinosa*, Corals, etc. Fossils were most abundant in

* These Notes are taken from an article printed in "Bladud," for 16th March, 1887. copies of which were kindly presented to the Members by Mr. Garrett.

† *Proc. Bath Nat. Hist. Field Club*, vol. vi. p. 245.

‡ *Quart. Journ. Geol. Soc.*, vol. xlv. p. 440.

the lower beds ; and at the base, as pointed out by Mr. Winwood, there were pebbles of limestone, suggesting some reconstruction of the layers that marked the interval between the Midford Sands and Inferior Oolite at this locality. Casts and moulds of *Trigonia* were found in the higher beds of Inferior Oolite. Leaving this section the Members returned to Bath by train, and took a peep at the Roman Baths on their way to the Fernley Hotel.

In the course of the evening the President drew attention to some of the geologists who have made Bath famous. He first mentioned John Walcott, whose "Descriptions and Figures of Petrifications, found in the quarries, gravel-pits, &c., near Bath," was published in 1779. Walcott then figured the fossils now known as *Apiocrinus Parkinsoni* and *Terebratula coarctata*. William Smith was more intimately associated with Somersetshire than with any other part of England (perhaps Yorkshire excepted). He had examined the strata at High Littleton in 1791, and resided in Bath in 1795, and again in 1799. One of his friends, the Rev. Joseph Townsend, rector of Pewsey, had in 1813 first published some of Smith's accounts of our Oolitic strata and their fossils. Townsend's work was entitled "The Character of Moses Established for veracity as an Historian, recording Events from the Creation to the Deluge." Reference was made to the Rev. J. J. Conybeare, who for eleven years was rector of Batheaston ; and also to the fact that there was still living at Bath one of Sedgwick's earliest pupils, the Rev. Leonard Blomefield (formerly Jenyns), who had attended the Professor's lectures at Cambridge so long ago as 1819-20.* A fuller account was given of William Lonsdale, founder of the Bath Geological Museum, who, according to his own statement, became a geologist from hearing the conversation of two ladies in the library at Bath.† His memoir "On the Oolitic District of Bath," read before the Geological Society in 1829, was spoken of as an example of careful and accurate study ; and one of his MS. geological maps (now in the possession of the Geological Society) was exhibited. Mr. Winwood also exhibited some of his MS. catalogues, which are marvels of neatness. Allusion was finally made to the enthusiastic labours of Charles Moore.‡

II. DUNDRY HILL.

Director: EDWARD WILSON.

ON May 21st a party of members set out from the headquarters and took the 10.5 train for Bristol. They were met at Bristol station by the Director and Mr. W. H. Wickes, and having taken

* The Rev L. Blomefield died in September, 1893, aged 93.

† See Memoir by W. S. Mitchell, *Proc. Bath Nat. Hist. Club*, 1872.

‡ See Memoir by the Rev. H. H. Winwood, *Ibid.*, 1892.

their seats in a large brake, which was awaiting them, were driven rapidly through Bedminster and along the Bridgwater road, in the direction of the west end of Dundry Hill. The day was beautifully fine, and this with the charming prospect around, rendered the drive most enjoyable. A halt was first made at a quarry close to the edge of Bedminster Down. The attention of the members was here directed to a small section which showed some three feet of the regularly bedded limestones and shales of the Lower Lias (*Ammonites planorbis* beds), resting on about the same thickness of the rubbly limestones of the "White Lias," and beneath these a few feet of the greenish-grey laminated shales of the Upper Rhætic series, with an irregular bed of the well-known "Cotham marble" or "Landscape stone" at the top. The President considered that the arborescent markings of this bed were produced by changes amid the dark and light sediments during the solidification of the rock. In some places the bed is represented only by a banded limestone in a continuous layer. Where the arborescent markings occur the stone is interrupted, more or less nodular, masses with a corrugated surface. Hence he thought these peculiar markings were due to the partial inter-mixing of the dark and light layers of mud during consolidation, when the soft sediment solidified in an irregular manner.* The Director said he understood an unsuccessful attempt had been made to manufacture fullers' earth from the Upper Rhætic shales, and that this accounted for the exposure of the Cotham marble at this point. Proceeding about a mile farther along the Bedminster Down, the party made a second stoppage at a quarry close to the point where the footpath from Clifton to Dundry crosses the main road. Here a good section was exposed, showing about fourteen feet of the thin nodular limestones and dark blue shales of the *Ammonites angulatus* zone of the Lower Lias, covered by six or seven feet of the more regularly bedded limestones of the *A. Bucklandi* series. Amongst the fossils obtained from the spoil-banks of this quarry, and mostly if not entirely derived from the lower of the two series, were: *Am. angulatus*, *Nautilus* sp., *Gryphæa arcuata*, *Lima gigantea*, *L. pectinoides*, *Ostrea* sp., *Cardinia* sp. (casts), *Waldheimia perforata*, and *Rhynchonella calcicosta*.

Taking the road on the left just before reaching the first of the Barrow-Gurney reservoirs, the drive was continued up the hill until the gradient became too steep, when the brake was left by most of the members, and the rest of the climb made on foot. A cross road was presently entered, which cuts a little notch in the N.W. corner of the hill, and gives a small but interesting exposure of the lower beds of the Inferior Oolite (zone of *Am. concavus*), whilst at a little lower level on the same road, the local equivalents of the "Cephalopoda bed" of the Cotteswold Hills,

* See *Geol. Mag.*, 1892, p. 110.

with some of its characteristic Ammonites are disclosed in rubble in the bank. Although evidences of fossils in the Inferior Oolite were plentiful, the section was not in good working order, and little was obtained except the Brachiopods *Terebratula Eudesi*, and *T. Cortonensis*, and a few small Corals (*Montlivaltia*).

The members then walked to Dundry village, along the edge of the escarpment, from whence a magnificent prospect of the country to the north was obtained. The air being clear the chief physical features of the district—the range of the Cotteswold Hills from Kelston Hill on the south to Nibley Knoll and Stinchcombe on the north, the estuary of the Severn, and the elevated Palæozoic lands of South Wales beyond—were readily distinguishable, whilst nearer, the well-wooded hills of Carboniferous Limestone ranging from Clifton to Clevedon, the Gorge of the Avon, and the city of Bristol lying to the right, were interesting features in the landscape. Lunch having been taken at the village inn near the church, one of the adjacent freestone quarries in the Inferior Oolite (zone of *Am. Parkinsoni*) was visited. The Director showed a small series of the more typical Ammonites of the Inferior Oolite of Dundry, including specimens of the following Dundry fossils figured by Sowerby :—*Am. leviusculus*, *A. corrugatus*, *A. Sowerbyi*, *A. Braikenridgii* (?), and *A. Brocchii*.* Although the beds on the horizon of *Am. Parkinsoni*, which form the capping of the Dundry outlier, are fairly well exposed in the various quarries and at other points in the hill, the presence of the characteristic Ammonite of the zone was stated to be of extreme rarity. The complete sequence of the beds of the Inferior Oolite of Dundry has yet to be determined, and in particular the nature of the lowest beds of the series. It has sometimes been supposed that the "Cotteswold" or "Upper Lias Sands" of Gloucestershire, are represented in an attenuated form in Dundry Hill, but there is no visible evidence of their presence, and in some instances, at any rate, it appears that other beds have been mistaken for the "Sands."† There is, however, satisfactory evidence of the presence of all the important zones of the Inferior Oolite from that of *Am. opalinus* upwards, and also, as had been already observed, of the beds below on the border line of the Lias and the Oolites, known as the "Cephalopoda-bed" of the Cotteswolds. Whilst the close agreement of the Inferior Oolite of Dundry and Dorset, both in lithological and in palæontological characters and sequence—which has been indicated by the President of the Geological

* E. Wilson, "Fossil Types in the Bristol Museum," *Geol. Mag.*, 1890.

† R. Etheridge, On the Inferior Oolite of Dundry, in a paper by the late Dr. T. Wright, "On the Subdivisions of the Inferior Oolite of the South of England compared with the equivalent beds of that Formation on the Yorkshire coast." *Quart. Journ. Geol. Soc.*, vol. xvi. (1860), p. 20.

W. W. Stoddart, "Geology of the Bristol Coal Field, pt. 5, Jurassic Strata (Dundry Hill)." *Proc. Bristol Nat. Soc.* New Ser. vol. ii., pt. iii. (1878-79), p. 279.

Society and by Mr. S. S. Buckman, F.G.S.,* may be readily granted, and its divergence from the same series in the Cotteswold Hills, also freely admitted; yet every geologist will not perhaps be prepared to accept the precise form of the theory by which the latter authority attempted a few years ago to account for this divergence.

The party then walked across the fields to the far quarry on the Chew Stoke road. On the way fine views of the Mendip Hills were obtained, and at one point the President described the leading stratigraphical and topographical features of this remarkable range. The quarry now visited had not been worked very recently, and the section was somewhat concealed by fallen debris; so only a short stay was made, and beyond *Lima Etheridgei* and *Rhynchonella subtetrahedra* very little in the way of fossils was obtained. Rackledown quarry, another small exposure on the southern edge of the escarpment, about half-a-mile further east, was next visited, and being at the time in work, yielded the members more fossils. A good specimen of *Am. Sauzei* was found by Mr. Barham; and amongst other fossils, *Am. Murchisonæ*, *Ceromya Bajociana*, *Pholadomya Murchisonæ*, *Terebratulæ Eudesi*, and *T. Cortonensis* were obtained. The zones represented in each of these two quarries were indicated as those of *Am. Murchisonæ*, *A. concavus*, *A. Sauzei* or *A. Humphriesianus*, and *A. Parkinsoni*.

A pleasant walk across the fields brought the party to the quarry on the Chew Stoke road near the Butchers' Arms, on the north edge of the escarpment. Here the same sequence of beds was shown as at the last two quarries, with the exception that the working is not carried deep enough to expose the *Am. Murchisonæ* beds. Some blocks of the iron-shot oolite (*A. Sauzei* beds) had been got down by the quarrymen in anticipation of the visit of the Association; and these, with the heaps of road-metal in the quarry, supplied adequate material for the energies of the more vigorous members for an hour or so. Amongst the fossils obtained, Mr. Henderson found *Am. Brongniarti* (?), and Mr. Duce *Opis similis*, whilst other members secured specimens of the following species: *Am. Brocchii* (senior and junior), *Pleurotomaria elongata*, *Trochus Zetes*, *Astarte excavata*, *A. elegans*, *Lima pectiniformis*, *Myacites Jurassi*, *Modiola* sp., and *Rhynchonella (Acanthothyris) paucispina*. The find of the day, however, was made by Mr. H. W. Monckton, who obtained a very fine fragment of a Crustacean, identified by Dr. H. Woodward as the carapace of *Eryma*, from a block of limestone apparently derived from one of the top beds.

* *W. H. Hudleston*, "Monograph of the British Jurassic Gasteropoda," *Pal. Soc.* part i. (1887), (Gasteropoda of the Inferior Oolite), p. 56.

S. S. Buckman, "The relations of Dundry with the Dorset-Somerset, and Cotteswold areas during part of the Jurassic period." *Proc. Cotteswold Nat. Field Club*, vol. ix, pt. iv. (1889) p. 374.

The following generalised section of the strata exposed in the two quarries on the Chew Stoke road has been published by Mr. S. S. Buckman*:

	ft.	in.
9. Limestone	6	0
8. Marl	0	9
7. Soft whitish stone	4	0
6. The Iron-Shot Bed. Hard brown iron-shot oolite, <i>Sonninia</i> , <i>Stephanoceras</i> , <i>Pleurotomaria elongata</i> , etc. [Zone of <i>Ammonites Sauzei</i> .]	1	0
5. Rubbly stone	0	4
4. Greyish limestone	0	7
3. White Bed below the Iron-shot. Greyish white stone, with numerous ferruginous grains. <i>Witchellia</i> frequent	0	6
2. Irregular marl	0	1
1. Nodular Bed. Marl, with irregularly-bedded limestone nodules, <i>Liocras concavum</i> , <i>Hyperliocras</i> . [Zone of <i>Ammonites concavus</i>]	0	6

After tea at the Carpenters' Arms, the members again took their seats in the brake, and the return journey was made in such good time that they were able to catch the 6.5 train for Bath.

III. BRADFORD-ON-AVON.

Directors: THE REV. H. H. WINWOOD AND W. H. WICKES.

ON Monday, May 22nd, there were several additions to the party, including Mr. W. H. Hudleston (President of the Geological Society) and Mrs. Hudleston, Profs. J. F. Blake and Lloyd Morgan, with a Bristol contingent of geologists, increasing the numbers to about sixty. The 10.18 a.m. train was taken to Bradford, whither some of the more archæologically disposed of the party had started by an earlier train, the ostensible reason being an inspection of the celebrated Saxon Ecclesiola there, though by some it was shrewdly suspected that the early visit was made in order to secure the first pick of the Bradford Encrinites: it is almost needless to add that this suspicion was groundless. The real work of the day commenced under the directorship of the Rev. H. H. Winwood, who led the way to a section on the right bank of the canal, south of the town, and pointed out that the members were now at one of the classical sections described by Lonsdale, whose careful and painstaking labours in this district had been so well touched upon by their President on the previous Saturday evening. The section before them consisted of the upper beds of the Great or Bath Oolite upon which rested a bed of greyish clay, here about 10 feet thick. This deposit was considered by Lonsdale and the Geological Survey as belonging to the Forest Marble series and as being only a local member of that formation, but owing to the rich fossil-bed which occurs at its base, it had locally received the name of the Bradford Clay.

* "Monograph of the Inferior Oolite Ammonites of the British Islands," *Pal. Soc.*, pt. vi. (1832), pp. 292-3, footnote.

Though resting here on the Great Oolite, at Frome the latter formation was absent, and there the Forest Marble rested directly on the Fullers' Earth. In the opinion of the President the absence of the Great Oolite in this region south of Bradford-on-Avon, was due to the unconformable overlap of the Forest Marble series, for the horizon of the Bradford Clay had been traced in Dorsetshire, where it rested directly on the Fullers' Earth formation.* (See Fig. 1.)

Near the top of the Bradford Clay there might be seen two or three thin layers of gritty and shelly limestone very similar to the Forest Marble. Its chief celebrity is due to the beautiful specimens of the "Bradford Encrinite," *Apiocrinus rotundus* (or *Parkinsoni*), obtained here and more especially at Berfield by the late J. Channing Pearce, who is reported to have purchased a field near Bradford for the purpose of securing the specimens in a perfect condition. Some of these he (the Director) had seen in a local museum in the city of Bath, and most beautiful they were. Through the kindness of Dr. J. C. Pearce, F.G.S., the fine collection made by his father was visited by the Geologists' Association at Brixton in 1885; but it has since been removed to Ramsgate.†

Locally known as "Peg tops," and "Coach wheels," from the resemblance of the head and stem to those articles, these "Pear Encrinites" would be found mainly at the base of the clay, and, owing to recent excavations for puddling-purposes, the roots of the Crinoids might be seen firmly attached to and forming a portion of the upper shelly layer of the Great Oolite. The other characteristic fossils were *Waldheimia digona*, *Terebratula coarctata*, *Rhynchonella varians*, *Ostrea Sowerbyi*, *Avicula costata*, etc. Sufficient time having been allowed for the fossil-collectors to add to their stores, Mr. Jones' quarry, called "Woodside," on the opposite side of the canal, was visited. Here the Bradford Clay is seen overlying the Great Oolite, but at a higher level than in the first section, where a local disturbance had thrown the beds down somewhat. The Director pointed out that the workable beds of fine Oolite or Freestone were some 10 or 15 feet thick here, that they were comparatively unfossiliferous and were thus more readily worked; the thick beds above and below them, called "rags," being coarser and more fossiliferous, were left to form the roof and floor of the quarries. Several of the members went underground to inspect the method of cutting out the freestone-beds, whilst others employed themselves in hunting for fossils in the Bradford Clay above. A thick bed of blue limestone lying on the top of the clay indicated the coming in of the Forest Marble which capped the rising ground above, and a section of which, worked for its fissile slabs, was seen on the right hand of the gate leading out into the Westwood Lane. A well at Leigh

* H. B. Woodward, *Geol. Mag.* 1888, p. 467.

† See *Proc. Geol. Assoc.*, vol. ix., p. 165.

Green, sunk through the Forest Marble and Bradford Clay probably into the Great Oolite, was said to be "main deep." This expression, as interpreted by a native female, meant about 150 feet, and this would give some idea of the probable thickness of the beds here.

Passing on to the Avoncliff (Ancliff) sections, still in the Great Oolite, a rotten band of limestone some 8 or 10 feet above the entrance to the main quarry was pointed out as the horizon whence Lonsdale and the Rev. George Cookson (who formerly resided at Westwood) had obtained many minute Gasteropods, some of which had been figured by Sowerby.* These included species of *Cylindrites* (*Actæon*), *Neridomus*, *Nerita*, *Pileolus*, and *Rissoina* (*Rissoa*). Polyzoa were also abundant. Mr. Hudleston remarked in reference to the Gasteropods, that it was to be regretted that such small forms had been taken as types, because some of them, at any rate, might be regarded as immature organisms.

Some of the ladies of the party were glad to rest for a while on a grassy mound and enjoy the lovely view of wooded slopes and winding river; whilst others descended to the river banks and ate their lunch under the welcome shelter of the "Cross Guns." After a short rest, the canal (here carried over the river by an aqueduct) was crossed, and on the north side, close to the bank, a veritable Troglodyte was seen. In a cave of the Inferior Oolite has lived for the past eight years one Charles Norris—(called locally Hookey Norris)—born as he said in Japan: short of stature, deformed in feet, with crooked hands and bushy beard obscuring a long and high coloured face, he looked scarcely human as the Director one day suddenly came across him squatting on a mound outside his cave and sunning himself. He seems to gain his living by making eel baskets, at which occupation he was engaged on this occasion. He pays a shilling a year for his shelter and was anxious to show the members his bedroom in a recess of the rock, and said that his chief visitors were the rats from the canal-banks in front.

Mr. Winwood now yielded up his leadership into the hands of Mr. Wickes, who led the members up a steep path to the high ground at Winsley. The Great Oolite Freestone is worked in the open as on Combe Down. The quarry showed a considerable amount of "head" or disintegrated oolite on top. After a short examination of this exposure the Director (Mr. Wickes) conducted the party by a pleasant and picturesque way to the old quarry of Murhill. Here a rich treat awaited the members in the shape of Corals, Polyzoa, and tiny univalve Mollusca like those of Ancliff. The quarry was worked some seventy years ago, but has long been abandoned. The fossil-beds lie above the freestone,

* The "Ancliff" fossils in the Bristol and other local museums are attributed to the researches of Lonsdale; Mr. Cookson's specimens are in the Sowerby collection at the British Museum.—W. H. WICKES.

and tumbled masses of these "rag-beds" strewed the floor of the quarry, which extended for several hundred yards along the scarp.

In some places the Coral and Polyzoan Beds were almost entirely composed of fossils. The Director pointed out the identity of the beds with those at "Ancliff," as illustrated by the following sections :

ANCLIFF.		MURHILL.	
	ft. in.		ft. in.
Rags and Rubbly Beds . . .	5 0	Coral Band, with <i>Calamophyllia</i> , <i>Isastræa</i> , etc.	6 0
		Clay parting	0 4
Rags and Coarse Freestone :		"Fossil Bed" : with Polyzoa,	
"Fossil Bed"	15 0	<i>Entalophora (Spiropora) straminea</i> ; Echinoderms, <i>Acrosalenia</i> ; small Ga-teropods, etc.	16 0
Marly clay	1 6	Clay, with Sponges, small Oysters, Crustaceans, etc. . .	1 6
Iron-bed and Rag	6 6	Rag	7 0
Freestone	5 0	Freestone	7 0

The members of the party then distributed themselves through the quarry, some examining the rocks *in situ*, whilst others searched among the fallen blocks on the floor of the pit ; many fine specimens of Coral, especially *Calamophyllia (Eunomia)*, were found here, and some good collections made. The Polyzoa Bed particularly attracted attention, and part of the "root" of a Bradford Encrinite was found in it. Several members searched for the small Gasteropods, which are found but sparingly in the Polyzoa Bed, and considering the time at their disposal, a good collection was made. Mr. Hudleston, to whom this little collection was handed, has kindly supplied the following list of species :—

<i>Cerithium costigerum</i> , <i>Piette</i> .	<i>Rissoina acuta</i> , <i>Sow.</i>
<i>Exelissa formosa</i> , <i>Lycett</i> .	— <i>duplicata</i> , <i>Sow.</i>
<i>Nerinæa</i> , sp. (immature).	<i>Rimula</i> ? <i>clathrata</i> , <i>Sow.</i>
<i>Pseudomelania</i> or <i>Fibula</i> (immature).	<i>Rissoa</i> ? <i>lævis</i> ; <i>Sow.</i>
<i>Mathilda</i> , sp. cf. " <i>Chemnitzia</i> "	<i>Turbo Burtonensis</i> , <i>Lyc.</i>
<i>constricta</i> , <i>Lyc.</i>	<i>Solarium turbiniforme</i> , <i>Lyc.</i>

Mr. Hudleston remarks that owing to the state of preservation, one or two of the above determinations are open to doubt. Fragments of other species of Gasteropoda occur. The average length of the specimens is stated by him to be about 3mm., a rolled example of *Nerinæa* alone considerably exceeding this.

Attention having been called by the Director to the false-bedding and other features of the quarry, a rest was made at a spot overlooking the Avon Valley, one of the most beautiful views in the neighbourhood.

FIG. 1.—DIAGRAM-SECTION FROM NEAR BATH TO FROME.—*H. B. Woodward.*

FIG. 2.—DIAGRAM-SECTION TO SHOW THE RELATIONS OF THE OOLITE AND CRETACEOUS STRATA IN WILTSHIRE.

H. B. Woodward, "Geology of England and Wales," Edit. 2.

The Members then descended the hill towards Limpley Stoke. On the way Mr. Winwood drew attention to the discovery of the Musk Ox (*Ovibos moschatus*) in the valley-gravel near Freshford; and some remarks on the formation of the valley were made by the President, and by Prof. Lloyd Morgan, and Prof. J. F. Blake. The Members took tea at the Hydropathic Establishment at Limpley Stoke, and then returned by train to Bath.

IV.—WESTBURY, WILTSHIRE.

Director: THE PRESIDENT.

ON Tuesday morning, May 23rd, the members had an opportunity, through the kindness of Mr. Winwood, of seeing the Bath Museum, and of inspecting the far-famed collection of fossils made by Charles Moore.*

Soon after ten o'clock the members started by train for Westbury. On arriving at the station they were met by Mr. J. R. Tennear (the Secretary of the Westbury Iron Company), who kindly guided the party over the iron-works. Very extensive excavations have been made to obtain the iron-ore, and the various sections showed in sequence the following divisions:—

		ft.	in.
KIMERIDGE CLAY.	Blue Clay with <i>Ostrea deltoidea</i> , and ferruginous seams.		
	4. Oolitic Ironstone, with seams of dark greenish and grey clay, and shelly layers composed of <i>Ostrea deltoidea</i>	10	0
CORALLIAN BEDS	3. Grey and brown sands with seams of clay	4	0
	2. Rubby beds of marly oolite and pisolite, and marly clay	12	0
	1. Fine wedge-bedded oolite	10	0

The Director pointed out that the Ironstone (No. 4) occurred in the same position as that at Abbotsbury in Dorsetshire; bed No. 3 might represent some of the Sandsfoot Beds of that region, while bed No. 2 perhaps included the horizon of the famous Coral-bed of Steeple Ashton. Bed No. 1 was the main mass of Coralline Oolite. These beds had been described by Messrs. Blake and Hudleston, but the lower strata were much more fully exposed than was the case at the time of their visit, and now Westbury afforded some of the finest sections of Corallian Beds in the country.

The false-bedded oolite at the base yielded *Echinobrissus scutatus*. The rubby beds (3) proved more fossiliferous, and a fine example of *Ammonites plicatilis* was obtained by Mr. Hudleston.† Traces of Corals were found by Mr. Wickes, and a layer

* See *Record of Excursions*, pp. 347-350.

† Mr. Hudleston remarks that the specimen closely resembles the figure in D'Orbigny's "Terrains jurassiques," pl. cxci, recorded in the text as *A. plicatilis*, Sow. It is probably the same as *A. varicosatus*, Buckland.

with *Pseudomelania* (*Chemnitzia*) *gigantea*, *Bourguetia* (*Phasiarella*), *Natica*, etc., also occurred in the upper portion of these rubbly beds.

In the iron-ore a number of fossils were obtained, and among them some fine Ammonites. Two specimens, obtained by Mr. Leighton, were identified by Mr. Hudleston as *Ammonites Berryeri* and *A. decipiens*. *A. pseudocordatus*, *Cardium delibatum*, *Pholadomya hemicardia*, *Pecten distriatus*, etc., are among the species recorded by Messrs. Blake and Hudleston. Portions of lignite were observed.

There were two furnaces, but only one in blast. The ore is put into the furnaces with a certain amount of coke, and with some of the Coralline oolite for "flux." At two o'clock the members witnessed the interesting sight of the flow of the molten iron from the blast-furnace, the fiery stream running into moulds of sand, where it solidified in the form of "pig-iron." The slag was utilised for building-purposes and road-metal, and a paving material was made with the help of cement. A smart shower delayed the out-door proceedings for a short time, but the interval was occupied by an "extraordinary meeting" held in the waiting-room of the railway station, where Mr. Hudleston made some remarks as to the nature and possible origin of the iron-ore. He said that the deposit occupied a well defined position at the junction of the Corallian Beds with the Kimeridge Clay, and is very nearly on the same horizon as the ironstone of Abbotsbury about forty miles off, no similar beds being known to occur between the two points. The chief difference in the composition of these two ores lies in the more thorough oxidation of the Abbotsbury ore and its greater freedom from phosphates. He pointed out that the beds at Westbury shared a feature very common in Mesozoic ironstones, viz., an abundance of large *Monomyaria*, such as *Oysters*, *Limas*, *Pectens*, etc., in the associated beds, and that where this feature occurs there is often a large charge of phosphorus in the ore, due in part at least to the decomposition of the animal matter of these molluscs and associated organisms. Where the ore remains chiefly in the state of carbonate, as at Westbury and also in the Cleveland seams, the percentage of this impurity is usually rather considerable.

The question of "where did the iron come from?" was perhaps less easily answered with respect to these limited deposits at the top of the Corallian series than in many other ores of Jurassic age. He wished them to bear in mind that eighteen years had elapsed since he last visited this place, and now when they wanted to note the surroundings of the ore-beds, and more especially of the upper and overlying deposits, this unlucky shower had prevented them from doing so. In most cases a bedded ironstone, oolitic or otherwise, is the result of the ferrugination of calcareous beds, and such ferrugination had been

effected either shortly after deposition or at a considerable interval. In almost all cases it is due to the leaching out of the iron in the overlying and surrounding beds through the action of organic acids arising from peaty and woody decomposition. Whatever the ultimate stage of oxidation may be, the charge of iron is in the first instance conveyed as carbonate, and the metal itself is derived from exhaustion of sands and clays which have been permeated by acidulous waters. Those members of the Association who went to Northampton a short time ago had an excellent opportunity for studying the result of operations of this nature, as almost every stage in the process of ferrugination of limestones through the leaching of overlying beds may there be traced.* He could not undertake to say that the iron ore of Westbury was due to precisely similar causes, though he recollected that the remains of much fossil wood clearly indicated the probability that organic acids had played an important part in concentrating the iron in the form in which it now occurs. This still remains for the most part in the form of carbonate, in consequence of the protection afforded by the overlying Kimeridge Clay, while the reddish-brown ironstone at the outcrop had subsequently been oxidized or "rusted." The lower Corallian beds showed little or no signs of ferruginous infiltrations, therefore he thought that this was an additional proof that we must look either to contemporaneous or overlying beds for the immediate source of the iron in the workable deposit.

The rain had now abated, and after visiting some other sections in the ironstone the members proceeded to the Eden Vale brickyard, where Gault clay is dug for the manufacture of red bricks, etc. According to Mr. Jukes-Browne the beds yield *Ammonites interruptus*, and contain small phosphatic septaria; on the present occasion no fossils were obtained. The Gault here rests on the Kimeridge Clay, having overlapped or overstepped the Lower Greensand which is exposed at Seend and other places near Devizes. There were therefore two unconformable overlaps; of Lower Greensand, and of Upper Cretaceous strata in this area. (See Fig. 2).

The proceedings terminated with a meat-tea at the Lopes Arms, Westbury.

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* See *Proc. Geol. Assoc.*, vol. iv, pp. 127-130; vol. xii, p. 186. See also W. H. Hudleston, "On the Geological History of Iron Ores," vol. xi, p. 104.

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EXCURSION TO DORKING.

SATURDAY, 3RD JUNE, 1893.

Directors: PROF. G. S. BOULGER, F.L.S., F.G.S., AND
 T. LEIGHTON, F.G.S.

(*Report by THE DIRECTORS.*)

THE object of this excursion was, as set forth in the Monthly Circular, to examine the district described by the Directors in a paper read before the Association on December 2nd, 1892. Full details of the controversy on the area in question having been published so recently (*ante*, page 4) no lengthened report is now necessary. The party arrived at Dorking at about half-past three, and proceeded at once to the southern end of the Horsham Road cutting (Section *A*); the other sections were afterwards visited in the order as lettered and described in the paper, up to and including Section *F*, at Buryhill. The key section at “The Rookery” was then visited, with the adjoining sections of Bargate and Hythe Beds in the cutting on the road to Wotton Hatch. The party then returned to Dorking to tea.

At Section *B* the extremely dry weather had made it clear that the mixed character of the beds there shown was due to the slipping down of Folkestone Beds from above over the “dirty” sands, presumed to be of Sandgate age, below. The possibility of this is suggested in the paper. The section of the “clayey” sands on the western side of the road was carefully examined, and in it nodular concretions were found containing casts of fossils.*

* A chemical examination of these nodules has kindly been made by Mr. W. Tate, A.R.C.S., who finds them to consist mainly of insoluble material (sand): the portion soluble in acid gives good reactions for Iron and Phosphoric Acid, while Calcium Carbonate is present in very small proportion.

OCTOBER, 1893.