

that Dr. Abbott would continue his researches relating to this extremely interesting subject. The party left Tunbridge Wells by the 8.11 train.

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 1898. R. S. HERKIES.—"Excursion to Crowborough." *Proc. Geol. Assoc.*, vol. xv, p. 450.

EXCURSION TO THE FROME DISTRICT, SOMERSET

MAY 28TH TO JUNE 1ST (WHITSUNTIDE), 1909.

Director ; L. RICHARDSON, F.R.S.E., F.L.S., F.G.S.

Excursion Secretary : G. W. YOUNG.

(*Report by THE DIRECTOR.*)

THE official party left Paddington on May 28th at 5 p.m., and arrived at Frome at 7.19 p.m., the headquarters being at the George Hotel, Frome.

The main object of the excursion was to study the Inferior Oolite of the Bath-Doultong District and its relations to the beds immediately above and below it.

In the circular of the Whitsuntide Excursion to the Middle and South Cotteswolds, etc., of 1908, it was stated that "in all some twenty-seven sub-divisions have been made of the Inferior Oolite Series in the West of England. Between the Upper Lias and a bed in the Inferior Oolite called the 'Upper *Trigonia*-Grit' should come twenty of these. Three, however, are not represented at all in the region between Chipping Norton and the Mendip Hills, and the others are not co-extensive with that tract; sometimes they are present, at others absent. This appearance and disappearance of the sub-Upper *Trigonia*-Grit Inferior-Oolite deposits has been found to be due to crust-pressures, which have from time to time thrown the deposited rocks into anticlinal and synclinal flexures—the rocks in the synclines being preserved according to their amount of depression, and those on the anticlines being removed according to their amount of elevation. The most intense flexuring that took place in Inferior-Oolite times preceded the deposition of the Upper *Trigonia*-Grit, and

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the geographical distribution of the pre-*Garantiana* Inferior-Oolite sub-divisions has been mainly governed thereby. Thus at Leckhampton Hill the Upper *Trigonia*-Grit is parted from the 'Freestone Series' by the Notgrove Freestone, Gryphite-Grit, *Buckmani*-Grit, and Lower *Trigonia*-Grit; at Birdlip the 'Upper *Trigonia*-Grit' and 'Freestone' are in apposition; in the neighbourhood of Swift's Hill, near Stroud, the 'Intervening Beds' are the same as at Leckhampton; but then, to the south of the Stroud Valley, they begin to die out, and from Selsley Hill to beyond Sodbury the Upper *Trigonia*-Grit and Freestone beds are in apposition again. Between the last locality and Bath even the 'Freestone Series' disappears, and the 'Grit' comes to rest upon the Sands of the Upper Lias."

From Bath to the neighbourhood of the Mendip Hills there is no Inferior-Oolite deposit of earlier date than this Upper *Trigonia*-Grit, and near Vallis Vale even this bed is overstepped by the equivalent of the *Clypeus*-Grit of the Cheltenham district, which there comes to rest directly upon the remarkably level-planed and bored surface of the highly-inclined Carboniferous Limestone.

On the south side of the Mendip Hills, however, in the railway-cutting at Doultong, the Upper *Trigonia*-Grit comes in again, and its marked resemblance to the conglomerate-bed of Wellow and of Maes Knoll, Dundry, is distinctly noticeable.

The Inferior-Oolite beds of the Bath-Doultong district between the Upper *Trigonia*-Grit and the Fuller's Earth are the equivalent of the *Clypeus*-Grit of the Cheltenham district, but whereas in the latter district the whole deposit is rubbly as a rule, in the former this feature is the exception.

The following sub-division of the Inferior Oolite of the Doultong district has been made:

	Sub-divisions.	Approximate thickness in feet.	
DOULTONG BEDS.	i.—Rubbly-Beds; <i>Terebratula globata</i> , auctt., non Sowerby, common, etc....	8	} = <i>Clypeus</i> -Grit.
	ii.— <i>Anabacia</i> -Limestones	8½	
	iii.—Doultong Stone; massive Freestone... (Upper Coral-Bed and Dundry Freestone wanting.)	44	
	vi.—"Conglomerate-Bed" [Upper <i>Trigonia</i> -Grit]	1½	} = Upper <i>Trigonia</i> -Grit.

The Members left Frome about 9.15 a.m. on Saturday, and drove to Maes Down—a hill about a mile and a half to the south of Doultong.

Here the Director pointed out the geography of the country embraced within the view, calling particular attention to the ever-inspiring Glastonbury Tor and the long line of the Mendips, which, he said, marked an anticlinal axis along which movement

had taken place time after time. During the course of the excursion they would have the opportunity of studying some of the effects of these movements in the littoral deposits of certain Neozoic rocks, Moore's so-called "dykes," and markedly planed surfaces. Away from the Mendip Hills the various deposits assumed their normal aspect, and here at Maes Down the Marlstone of the Middle Lias was present and well-developed. Its presence had been overlooked during the Geological Survey of the district, and was not shown therefore on the official map. An inspection was made of the quarry, and evidence of the basement-beds of the Upper Lias was also obtained in the form of many ammonites.*

Entering next the Farmcombe Quarry† a magnificent section was seen showing the upper portion of the Doultling Stone, the *Anabacia*-Limestones, Rubbly Beds and basal Fuller's Earth Clay. It was remarked that the Doultling Stone would be better seen in the next quarry to be visited—that called locally "Brambleditch"—but attention was directed to the fact that its topmost stratum had a waterworn and bored surface with oysters attached. Then come the *Anabacia*-Limestones. It is often somewhat difficult to separate them from the Doultling Stone on the one hand and the Rubbly Beds on the other. Typically, however, while the Doultling Stone is brownish, very sparry—as at the Chelynych Quarry—and not conspicuously oolitic, the *Anabacia*-Limestones are white and finely-oolitic, the oolite-granules being noticeably even-sized. At the recently-opened Holcombe-Lane Quarry, about a quarter-of-a-mile to the east of the Farmcombe Quarry, these distinctions are very well marked.‡

From the Rubbly Beds the *Anabacia*-Limestones are differentiable on account of their being typically not so brown, rubbly or fossiliferous. Crowds of *Terebratulina globata*, auctt., moreover, occur in the Rubbly Beds. The Rubbly Beds are subject to some variation in thickness, in the neighbourhood of Midford being represented only by a thin rubbly layer which is hard to separate from the Fuller's Earth. At the Doultling-Bridge or Brambleditch Quarry the Doultling Stone was finely exposed, and from the succeeding Inferior-Oolite and Fuller's-Earth Beds many fossils were collected—the crowds of *Ostrea knorri* eliciting particular comment.

The members of the party then viewed the section in the adjoining railway cutting from a bridge, and the Director pointed out where the bottom and conglomeratic bed of the Oolite rests upon the Lias; and the succeeding and thinner-bedded limestones of the Doultling Stone when compared with the superjacent massive beds of Doultling Freestone of commercial

* *Geol. Mag.*, 1906, p. 368.

† *Quart. Journ. Geol. Soc.*, vol. lxiii (1907), pp. 385-397. *Geol. Mag.* (1908), p. 511.

‡ Traces of Fuller's Earth (*Knorri*-Clays), filling in fissures in the *Anabacia*-Limestones, occur here.

fame. Farther along the cutting typical *Anabacia*-Limestones are excellently exposed and have their top-layer noticeably bored. Then come the Rubbly Beds and Fuller's Earth, so that a complete view of the Inferior Oolite as developed in this neighbourhood is obtained. Pointing to the higher ground to the south the Director stated that in the sides of the Chesterblade Road, just before it topped the hill, were to be seen crowds of valves of *Ostrea acuminata*, Sow. The horizon at which this oyster was most abundant appeared to be just below the well-known Fuller's-Earth Rock. In the ditches alongside the lanes on that high ground lay innumerable specimens of *Ornithella ornithocephala* and its multitudinous varieties; while in the Alham-Lane Quarry the sequence of (1) *Ostrea acuminata* and (2) *Ornithella ornithocephala* was corroborated by the former fossil being found in the clays which had been deeply cut into by the wheels of the carts ascending the bank to this quarry, and the latter occurring the most abundantly in the rubble and top-soil of the excavation.

Amongst the fossils that can be collected at Alham Lane are the following: *Pseudomelania*, *Pleurotomaria*, *Natica* (of *N. bajociensis*-group), *Serpula tricarinata*, Sow., *S. limax*, Goldfuss, *S. plicatilis*, *Diastopora michelini* (Lamarck), *Holcetypus hemisphericus* (Agassiz), *H. depressus* (Leske), *Rhynchonella smithi*, Walker, *Terebratula globata*, auct. non Sow., *Ornithella ornithocephala* (Sow.) and varieties and mutations, *Ceromya plicata*, Agassiz, *Chlamys vagans* (Sow.), *Cypricardia bathonica* d'Orb., *Gervillia acuta*, Sow., *Goniomya angulifera* (Sow.), *Gresslya peregrina* (Phillips), *Homomya gibbosa* (Sow.), *Lucina* (cast), *Lima duplicata* (Sow.), *Limatula gibbosa* (Sow.), *Pleuromya* sp., *Pholadomya* sp., *Protocardia buckmani* (Morris and Lycett), *Ostrea costata*, Sow. (rare), *O. knorri*, Voltz (one specimen), *O. acuminata* Sow. (rare), *Syncyclonema demissus*, auct., *Trigonia elongata*, Sow., *Volzella sowerbyana* (d'Orb.), *V. gibbosa* (Sow.), *Macrocephalites morrissi* (Oppel), *Teloceras* ? *sub-contractum* (M. and L.), *Teloceras* ? sp. nov., etc.

The next section in the Fuller's-Earth Rock worth visiting when one is proceeding in a southerly direction is at Bruton Station. Between Bruton and Charleton Horethorne it is, of course, well exposed in the railway-cutting near Shepton Montague, and again between Woolston and Holton, at the quarry commonly localised as "Maperton," but for a section that shows the sequence of the component beds, and one that can be studied at leisure (not being in a railway-cutting) there are few better than that in the lane-cutting near Blackford Lake (Geol. Surv. Map, Sheet xix) between Maperton and Charleton Horethorne. The section is worth recording here because it will assist in assigning to their correct horizons beds that are only imperfectly seen in isolated sections further north.

SECTION IN ROAD-CUTTING BETWEEN MAPERTON
AND CHARLETON HORETHORNE, SOMERSET.

		Thickness in ft. ins.		
FULLER'S EARTH ROCK.	a.	Limestone, whitish: seen	0 6	
	b.	{ <i>Ornithella</i> - Marl. Grey- and - white and yellow streaked somewhat shaly marl }	1 4	{ <i>Ornithella ornithocephala</i> (Sow.) and varieties and mutations, <i>Pholadomya ovalis</i> (Sow.), <i>Vol-</i> <i>sella gibbosa</i> (Sow.), <i>Oeco-</i> <i>traustes serrigerus</i> , Waagen.
	c.	{ Limestone in two layers with an intervening band of marl . . . }	1 1	{ <i>Ornithella ornithocephala</i> (Sow.), etc.
	d.	{ Polyzoa-Marl. Marl simi- lar to <i>b.</i> with whitish nodules embedded in it at the top: 8 to 10 inches }	0 9	{ <i>Diastopora michelini</i> (Lamarck), <i>Entalophora</i> , <i>Gervillia acuta</i> , Sow., <i>Coroia</i> sp., <i>Pleuromya</i> sp., <i>Serpula tricarinata</i> , Sow., <i>S. limax</i> , Goldfuss, <i>S. plicatilis</i> , Goldfuss, <i>Belemnopsis paral-</i> <i>lelus</i> (Phillips)
		1. Limestone	1 7	{ <i>Ornithella ornithocephala</i> (Sow.), and varieties and mutations, <i>Pholadomya ovalis</i> (Sow.)
		2. Parting: 1 to 2 inches	0 1	
		3. Limestone	1 9	{ <i>Rhynchonella smithi</i> , Walker, <i>Syn-</i> <i>cyclonema demissus</i> , auctt., <i>Siemiradzka aurigera</i> (Oppel).
		4. Parting: 1 to 2 inches	0 1	
	e.	5. Limestone	1 6	{ <i>Ornithella ornithocephala</i> (Sow.), and varieties and mutations, <i>Pleuromyia</i> sp.
		6. Parting:		
LOWER FULLER'S EARTH.		7. Limestone	1 7	{ <i>Terebratula globata</i> , auctt. non Sow., <i>Ornithella ornithocephala</i> (Sow.)
		8. Parting, brown clay: } 2 to 4 inches . . . }	0 2	
		9. Limestone, three beds .	6 0	{ <i>Ornithella ornithocephala</i> (Sow.) etc.
	f.	{ Marls with several beds of limestone: seen . }	6 0	
[Fault and dip less.]				<hr/> 22 5 <hr/>
LOWER FULLER'S EARTH.		{ Clays, pale grey and whit- ish, with several bands of rock. One band, about the lowest seen, full of <i>Pseudomonotis</i> : seen about . . . }	15 0	{ <i>Cucullæa concinna</i> , Phillips, and <i>Pseudomonotis echinata</i> (Sow.)

The lists of fossils are not intended to be exhaustive, but merely to indicate where the specimens named are found most commonly. *Ornithella ornithocephala* (Sow.) is commonest in the marly beds at the top of the section, and the same remark applies to *Pholadomya ovalis* (Sow.). The abundance of this fossil is a peculiarity of this section.

In the neighbourhood of Doulting the *Knorri*-Clays of the

Lower Fuller's Earth are well-exposed at the Farmcombe Quarry, and the *Acuminata*-Clays in numerous small way-side exposures, while the Fuller's Earth Rock, but neither the *Ornithella*-nor Polyzoa-Marls, are seen at the Alham-Lane Quarry. Across the eastern end of the Mendips, however, the Lower Fuller's Earth is thin, as the sections at Whatley and Bonnyleigh Hill indicate. In the neighbourhood of Midford—as a recent railway-cutting has shown—the Lower Fuller's Earth has increased in thickness again, to die out as an argillaceous deposit in the neighbourhood of the Rissingtons near Burford, Oxfordshire.

After lunch at "Ye Abbey Barn," Douling, a visit was paid to the large quarry at Chelynch—"Cheylinch"—that on the eastern side of the road. The Douling Freestone is here actively worked and its coarsely-detrital nature readily differentiates it from the white evenly-oolitic *Anabacia*-Limestones, which were pointed out as capping the Freestone just below the wall that parts the road from this portion of the quarry. Several rock-specimens of the two subdivisions were taken away and the fact that most of the gleaming surfaces of calcite in the Douling Freestone were probably due to broken derived fragments of Carboniferous-Limestone crinoid-ossicles lent additional interest. The method of working the Freestone is to clear the rock of its overburden of *Anabacia*-Limestones, etc., lay rails along the exposed surface of the freestone-beds, and place thereon a vertical engine that cuts deep grooves by means of chisel-like tools. The bed can then be divided by cutting at right angles and comes away along its lower bedding-plane.

The next halt was at the great Waterlip Quarry in the Carboniferous Limestone. Here Dr. Vaughan explained the geology. The following table will be found useful in dealing with the remarks on the Carboniferous Limestone.*

SERIES OF ZONES AND SUBZONES IN THE AVONIAN OF
THE MENDIP AREA.

KID- WELLIAN	{	<i>Dibunophyllum</i>	{	(D ₂)	<i>Lonsdalei floriformis</i>	.	.	500 feet.		
				(D ₁)	<i>Dibunophyllum</i> θ	.	.			
		<i>Seminula</i>	.	{	(S ₂)	<i>Productus</i> aff. <i>Cora</i> , mut.	S ₂	720 "		
					(S ₁)	<i>P. cf. semireticulatus</i> , mut.	S ₁			
CLEVEDONIAN	{	<i>Syringothyris</i>	.	(C)	<i>Syringothyris</i> aff. <i>cuspidata</i> , mut.	C	550 "			
					>γ<					
		<i>Zaphrentis</i>	.	{	(Z ₂)	<i>Zaphrentis</i> aff. <i>cornucopiae</i> †	.	800 "		
					(Z ₁)	<i>Spirifer</i> aff. <i>clathratus</i>	.			
		<i>Cleistopora</i>	.	{	(K ₂)	<i>Spiriferina</i> cf. <i>octoplicata</i>	.	450 "		
						(K ₁)	<i>Productus</i> <i>bassus</i>		.	
							(M ₁)		<i>Moxiola</i> -phase	.
									.	.
									.	.
									.	.
							3,020 feet.			

* T. F. Sibly, *Quart. Journ. Geol. Soc.*, vol. lxii (1906), p. 325.

† Z. aff. *cornucopiae*, Ed. and H. = *Z. konincki*, Ed. and H. (*vide* R. G. Carruthers, Esq.)

Dr. Vaughan informs me (*in litt.*, Sept. 4th, 1909) that he thinks that "the newer series of purely coral-zones is more useful than the Bristol sequence" given above. I append the table with which he has furnished me:

- | | | |
|---|------------------|------------------------------------|
| | S ₁ . | <i>Caninia bristolensis</i> . |
| | | (A cyathophyllid <i>Caninia</i> .) |
| } | C. | <i>Caninia cylindrica</i> . |
| | | (A giganteid <i>Caninia</i> .) |
| } | γ. | <i>Caninia</i> , sp. nov. |
| | Z ₂ . | <i>Zaphrentis konincki</i> . |
| | Z ₁ . | <i>Zaphrentis delanoui</i> . |

The following notes on the Carboniferous Limestone exposed in the Waterlip Quarries have been contributed by Dr. A. Vaughan:—

These quarries are in all ways comparable with the celebrated quarries of Tournai, in Belgium. The facies, both lithological and palæontological, are the same, and the zonal range exhibited is nearly identical.

As pointed out by Dr. T. F. Sibby, F.G.S., in his Mendip paper (*loc. cit. infra*), a continuous sequence is finely displayed from near the base of Z₁ to the top of C₁. A depression formed by lower beds than those displayed, doubtless indicates the K shales, and a similar depression beyond the highest beds of the quarries points to the presence of a dolomitic series in the middle of C, as at Burrington.

The lowest beds actually displayed (at the base of the north-eastern quarry) contain a rare specimen of *Zaphrentis delanoui*, the coral characteristic, in the South-West Province, of Z₁.

The lowest beds of the Great Quarry are high up in Z₂, and here the subzonal index-coral, *Zaphrentis konincki*, is abundant. There is also, in these beds, a band containing *Spirifer cinctus*, the zonal fossil of the same level in Belgium. The north wall of the quarry exhibits a sequence from γ into C₁, which is continued to the top of C₁ in the two quarries on the west of the road.

γ is marked, here as elsewhere in the South-West Province, by the presence of a new species of *Caninia* remarkable for its vertical tabulæ. In C₁, the giganteid *Caninia* (*C. cylindrica*) is common at certain levels; at the top of C₁, *Schizophoria resupinata* is not uncommon.

The lithological facies of the C₁ beds is interesting.

A thick series of nodular cherts, structurally equivalent to

flints, alternate with deposits of markedly shallow-water types, viz. :

- (1) Beds made up of a mass of large-stemmed crinoids.
- (2) Lenticular bands of limey clay.
- (3) Drift-marked and blotchy limestones.
- (4) Occasional dolomites.

There is therefore good reason for believing that the cherts themselves were formed in shallow water, and are comparable in origin with the concretionary beds at the top of S. The short time available for the examination of the Waterlip Quarries was devoted to the Z_2 , γ , and lower C_1 beds. Examples of all the characteristic fossils were found by members of the party.

Before going into the other quarries on the west side of the road the Members walked to the shallow cutting at the southern end of the main Waterlip Quarry. Here certain Rhætic and Lower-Lias rocks are exposed (which are not shown on the Geological Survey Map) with the Douling Stone faulted against them. The White-Lias beds are exposed at the northern end of the cutting, as shown in the section Fig. 14.

The details obtainable here may thus be summarized :

SECTION IN THE WATERLIP TRAM-LINE CUTTING.

		Thickness in ft. ins.				
INFERIOR OOLITE.	{	{ Somewhat fissile oolite such as occurs immediately below the <i>Anabacia</i> -Limestones (at the southern end of the cutting near the gate).				
		Massive-bedded freestone.				
		[Fault and clay-infilling.] Better-bedded limestones.				
LOWER LIAS.	{	marmoriz.	{	5 0	{ <i>Ornithella perforata</i> (Piette), <i>Ostrea arietis</i> . Quenstedt, ? <i>Thecosmilia</i> sp. (common along a certain line).	
						Limestones, whitish, in irregular nodule-shaped masses mixed with clay (cf. East-Milton Quarry, near Wells); Coral-Bed about the middle; about
	{	megastomat.	{	5 6	{ <i>Ostrea arietis</i> , Quenstedt, <i>Caloceras pirondi</i> (Reynès).	
						Limestone in more irregular layers at the bottom with shaly matter, but better-bedded at the top
	{	plan-orbis.	{	2 0		
						Limestone, four beds of hard whitish, rather barren
	{	Ostrea-Bed.	{	0 2		
						Shale, yellow, laminated
	{	?	{	0 8	{ <i>Ostrea liassica</i> , Strickland.	
						Limestone, hard, grey, shelly
	{		{	0 2		
						Shale
						Limestone, hard, somewhat fissile in appearance
	{		{	0 3½		
						Shale, brownish
{		{	0 2			

In the approach-cutting to the Sunnyhill Quarry, Professor Reynolds pointed out the place where, from the harder bands amid marly soft and yellow tuff, he had found Silurian fossils, and the band of tuff in the opposite side of the cutting where such excellent hand-specimens of the rock may be obtained. After the Members had collected hand-specimens of the several types of rocks and a few fossils, they entered the large Moon's-Hill Quarry. This quarry, as Professor Reynolds remarks, "is opened in a singularly uniform mass of compact andesite, dark purple or sometimes dark green in colour, with prominent dark green augites. It is never markedly amygdaloidal, and is much shattered and faulted, showing in places strings and patches of epidote."* A tunnel connects the Moon's-Hill Quarry with another large working, but in a little opening between these two main excavations, Professor Reynolds showed the Members a band of tuff whose presence had not been detected when he wrote his first paper.†

On leaving Moon's Hill, the line of rails from Long-Cross Bottom in the direction of Downhead was followed. First a cutting in sandstone and conglomerate (Old Red), dipping south at 45° , was passed through, and then one some 200 yards farther on was entered. It showed greenish sandy shales of Llandovery age, and proved to be highly fossiliferous along certain lines. Some time was spent in collecting, and the published list of fossils from the locality was considerably augmented. Continuing along the line the main-road was eventually reached.

A pleasant drive of about four miles brought the Members to Whatley. Here a brief stop was made to allow of an inspection of a Sarsen Stone at the crossing of the roads by the Church, and an exposure of Fuller's-Earth Rock in the lane-cutting somewhat farther east. This cutting, where the late J. F. Walker obtained so many interesting brachiopods, is now mostly overgrown, but the Members succeeded in collecting *Ornithella builata* (Sow.), *Ornithella ornithocephala* (Sow.), and its varieties and mutations, *Terebratulula globata*, Sow. (Richardson and Walker), *Ter. globata*, auctt. non Sow., *Rhynchonella Smithi*, Walker, *Ornithella triquetra* (Sow.), with *Stomatopora* on it, *Chlamys vagans* (Sow.), *VolSELLA ? Lonsdalei* (Sow.), *Trigonia* (cast), *Ostrea* 2 spp.

A short drive from Whatley brought the Members back to Frome.

Facilities were afforded for visiting Bradford-on-Avon for the Saxon Chapel and the celebrated Bradford-Clay sections.

On the outward journey the party stopped at a quarry about half-way between Woolverton and Telisford. It shows the Forest-Marble beds and some Cornbrash let in by a fault.

The Forest-Marble beds comprise a clay-bed at the top (as is

* S. H. Reynolds, *Quart. Journ. Geol. Soc.*, vol. lxiii (1907), p. 221.

† *Rep. British Assoc.*—Dublin, 1908. Section C.

the case also throughout the Cotteswold Hills), and typical false-bedded, shelly limestones below. The Bradford Clay would come below these false-bedded limestones. From the Cornbrash were collected: *Ceromya concentrica* (Sow.), *Isocardia minima* (Sow.), *Gresslya peregrina* (Phillips), *Pleuromya decurtata* (Phillips), *Ornithella obovata* (Sow.), *Terebratula intermedia* (Sow.), *Ammonites (Clydoniceras) hochstetteri* (Oppel).

Bradford-on-Avon was reached about 12.30 p.m., and a visit was at once paid to the well-known Saxon chapel.

After lunch the "Woodside Quarry," on the south side of the canal, was visited. Here the Great Oolite has been extensively mined beneath the Bradford Clay, which is an exceptionally fossiliferous, if somewhat sporadic, development of a portion of the bottom clay-bed of the Forest-Marble Series. It rests directly upon the Great Oolite, whose surface is water-worn, conspicuously covered with oysters, and, in the classic quarry alongside the canal, has the roots of the Bradford pear-encrinite, *Apiocrinus parkinsoni*, Schloth., frequently adhering. The fossil-bed shows every indication of having accumulated slowly, the well-rolled pieces of *Apiocrinus*, etc., being literally encrusted with Polyzoa and Serpulæ. They remind one forcibly of the *Webbina*- and *Serpula*-encrusted fossils of the Langton-Herring fossil-bed, which is on about the same horizon.*

On the way back an inspection was made of the old quarry at Bonnyleigh Hill, between Beckington and Frome.

BONNYLEIGH-HILL QUARRY.

		Thickness in ft. in.		
FULLER'S EARTH ROCKS.	{ Clay, with bands of pale earthy lime- stone; seen about	4	o	{ <i>Acanthothyris midfordensis</i> , Richard- son and Walker, <i>Asiarte excentrica</i> , Morris and Lycett, <i>Camplonectes</i> (fragments), <i>Goniomya angulifera</i> (Sow.), <i>Gresslya peregrina</i> (Phil- lips), <i>Ornithella bullata</i> (Sow.), <i>Ornithella ornithocephala</i> (Sow.), <i>Ostrea acuminata</i> (Sow.), <i>Phola- domya</i> , <i>Pleuromya</i> sp., <i>Protocardia</i> aff. <i>citrinoides</i> (Phillips), <i>Syncy- clonema demissus</i> , auctt., <i>Tere- bratula globata</i> . Richardson and Walker, <i>Trigonia costata</i> , Sow., <i>Volzella gibbosa</i> (Sow.).
IN- FERIOR FULLER'S OOLITE, EARTH.	{ Pale clay, with "race" nodules and bands of pale earthy lime- stone: about	8	o	<i>Ostrea acuminata</i> , Sow.
	{ Rubby beds of Oolite passing down into more massive- bedded strata; seen	12	o	{ <i>Terebratula globata</i> , auctt. (not un- common at the top), <i>Perisphinctes</i> <i>pseudo-martinsi</i> , Siemiradzki.

* *Proc. Cotteswold Nat. F.C.*, vol. xvi, part 3 (1909), pp. 267-272.

The above-named fossils were collected on this occasion.

On Monday, Frome was left at 9.30 a.m., and the Wanstrow Road was followed as far as Nunney Catch. Here the road to Holwell was followed, but just before descending to the hamlet the Members disembarked from the brakes and entered the now much-overgrown Marston-Road Section of the Somerset geologist, Charles Moore.

It was first of all pointed out that the day's work would be mainly concerned with the study of what Charles Moore called "abnormal deposits," that is, shore deposits, and with planed and much-bored surfaces. The explanation of these phenomena was to be found in the fact that the Mendip Hills mark a line of earth-unrest, and time after time have movements occurred along its axis. Between Vallis Vale on the north and Holwell on the south the Douling Stone of the Inferior Oolite usually rests directly upon the extraordinarily level and bored surface of the Carboniferous Limestone; but here and there are depressions in the Limestone-surface in which "abnormal" deposits of Lias and Rhætic occur, and often fissures filled in with similar material, together with—in certain cases—Oolite. It would appear that the main boring of the limestone and the final planing of its surface took place while the Dundry Freestone and Upper Coral-Bed were being formed in certain other areas, and then was laid down the Douling Stone that spreads all across this eastern end of the declining Carboniferous-Limestone mass.

At the Marston-Road Section the Rhætic breccia containing fish-remains was soon discovered firmly fixed on to the here irregular Carboniferous-Limestone surface, and many more examples of the characteristic Rhætic fish-remains were procured from the succeeding layer of yellow shaly matter. Another thin bed of Rhætic impure limestone follows, and then comes the Lias—mainly a whitish sparry rock with its top-portion conspicuously bored by *Lithophagi*. On this bored surface rests the Inferior Oolite containing *Acanthothyris spinosa* (Schlotheim), etc.

Crossing the brook the quarry on the north side of the road (immediately to the west of the Inn) was entered. The conspicuous "dyke" claimed first attention. It is composed of Rhætic and Liassic rock, with numerous fossils, particularly teeth, and once filled up a fissure in the Limestone. But whereas the quarrymen have removed the Limestone, they have left the infilling-material as useless for their purpose, and it now stands up a truly wall-like mass. Some discussion arose as to the origin of the fissures. The Director was inclined to regard some of them as having originated during the gradual uplift of the Mendips in Liassic times, and others perhaps during about *Garantianæ* or *Truellei* hemera, and that the Neozoic rock was washed in during initial temporary subsidence. Professor Reynolds maintained

the generally-accepted view that the fissures had been produced by water-action under subaerial conditions during Permian and early Triassic times.

A hollow in the Carboniferous Limestone filled up with White Lias was especially pointed out, because it contains, mixed up with the ordinary White-Lias limestone and marls, chunks of chert and well-rounded Carboniferous-Limestone pebbles encrusted with specimens of *Dimyodon intus-striata* (Emmerich). Frequently the Limestone-pebbles are bored.

On the other side of the road is the large "Microlestes Quarry," where, from one of the dykes—now with difficulty traceable—Moore obtained the teeth of the earliest known mammal, *Microlestes*. Mr. Richardson remarked that he had obtained several specimens of the teeth of this mammal from this Quarry, as well as an example of a *Ceratodus* tooth. Mr. E. T. Newton, F.R.S., at the request of the President, added a few remarks on the recently-raised question as to whether these teeth really belonged to a mammal or not (the general feeling being in favour of the old idea), after which Professor Reynolds, in the regretted absence of Dr. Vaughan, made some observations on the Carboniferous Limestone. He reminded the Members that while the rocks visited on Saturday at the Waterlip quarries were of Lower Carboniferous Limestone age and belonged principally to the *Zaphrentis*-Zone, those before them at Holwell, and to be subsequently visited at Vobster, and in the majority of the quarries at Vallis, belonged to higher zones—the *Syringothyris*- and *Seminula*-Zones.

Leaving the quarry and boarding the brakes again, the road to Nunney was followed. When on the top of the high ground the Carboniferous Limestone was noted by the road-side jutting through the Oolite. Passing into Nunney the Members disembarked near the footbridge that crosses the brook hard by the Castle. Here Sarsen Stones were much in evidence, but an enquiring question from the Director as to how they came to occur in that neighbourhood did not provoke the desired discussion. Instead, a piece was taken away for more detailed examination.

In Nunney Castle Mr. J. Parker gave an interesting discourse upon the ancient building. It was built in the reign of Edward III. by Sir J. Delamere and finished by his nephew in Richard II.'s reign. It was a strongly fortified manor-house, being an oblong, and measuring—inside the walls—61 feet by 25 feet, with a bold cylindrical tower at each corner. All the flooring and partition-walls must have been of wood, as there is no evidence of vaulting or partition walls now. In the Great Rebellion it was taken in Fairfax's campaign and reduced to much the same condition as it is in to-day.

Owing to repairs to the roads a somewhat devious course had

to be pursued to Mells. Crossing the brook in the village and ascending the hill the "Dolomitic Conglomerate" was seen beneath a wall by the road-side. After a brief halt at Mells for lunch the journey was continued to the great quarry in the Carboniferous Limestone at Upper Vobster.

Attention was first of all directed to the planed surface of the Carboniferous Limestone, whose evenness caused no little surprise. Generally the outcrop edges of the highly-inclined Carboniferous Limestone strata were level-planed, bored, and oyster-strewn, and were succeeded by the horizontally-bedded yellow limestones of the Lias. But here and there, closely and firmly fixed to that worn surface, were patches of Rhætic rock, the age clearly proved by the contained, if fragmentary, vertebrate-remains. Numerous specimens of the "junction-rock," which showed the Carboniferous Limestone and the grey and white Rhætic rock speckled with the black shining fragments of vertebrate-remains, were taken away. The surface of the Rhætic, and occasionally of the Carboniferous Limestone upon which the Lias rests, often has adhering to it small fossils, particularly gastropods of Liassic age.

The Lias limestone, which is not represented on the Geological Survey Map, Inferior Oolite being depicted as resting directly upon the Carboniferous Limestone at this locality, is principally of *Jamesoni-armati* hemeræ with fossils of *raricostati* hemera (and possibly earlier) remanié at the base. Amongst the fossils collected here were : *Derocheras Leckenbyi* (Wright), *Echioceras tardecrescens* (Tate and Blake, non Hauer), *Oxynotoceras aballensis* (d'Orb.), *Oxynotoceras* (fragment), **Echioceras Landrioti* (d'Orb.), *Ornithella indentata* (Sow.) and varieties, *O. Waterhousei* (Dav.), *Cincta dives*, S. Buckman, *C. pauper*, S. Buckm., *C. pernumismalis*, S. Buckm., *Rhynchonella furcillata*, von Buch, *Rh. variabilis* (Schloth.) and varieties, *Terebratula Edwardsi*, Dav., *Ter. subovoides*, Roemer, *Ter. punctata*, Sow., *Spiriferina rostrata* (Schloth.), *Pseudomelania* spp., *Discohelix* sp., *Pleurotomaria anglica*, Sow., numerous small gastropods, *Syncyclonema lunularis* (Roemer), *Inoceramus*, *Pleuromya Toucasi* (Dum.), *Pl. striatula*, Ag., *Lima succinta* (Schloth.), **Unicardium cardioides* (Phil.), *Radula pectinoides* (Sow.), *Gryphaea concava*, J. Buckman, *Alectryonia*, *Cardinia* sp., *Pholadomya ambigua*, auctt., *Montlivaltia* spp., *Belemnites*, etc.

There was little discussion over the once oft-debated question as to how the Upper-Vobster mass of Carboniferous Limestone came to occupy its seemingly peculiar position. The theories of earlier works were explained, but it was agreed that first of all it is desirable that the evidence for the statement that the Coal Measures are worked below the Limestone should be reviewed.

After tea at the Talbot Hotel, Mells, a pleasant drive by way

* Remanié.

of Elm brought the Members to the entrance of the picturesque Vallis Vale.

Close to Hapsford Mills was the first section to be described. It shows the Carboniferous Limestone, *Pteria-contorta*-Beds, "Upper Rhætic" (including the *Estheria*- and *Lycopodites*-Beds), White Lias, and Inferior Oolite. The *Pteria-contorta* and "Upper-Rhætic" Beds contain a number of conglomeratic layers of rock, and in the latter subdivision some of the white layers yield numerous plant-remains—*Lycopodites*. Professor S. H. Reynolds found some excellent specimens, and the plant-remains proved to be much commoner than had been previously supposed. The top-stratum of the White Lias came in for particular attention on account of its being much bored by annelids and *Lithophagi*. The Director pointed out that as they proceeded in a southerly direction the horizon marked by the borings would be found to come nearer and nearer to the Carboniferous Limestone, until in the last section he was going to show them that day, they would find the borings actually in the top-portion of the Carboniferous Limestone. Leaving this section close to the mills, a halt was called opposite a face of Limestone. Inferior Oolite was seen at the top of the section, and fallen blocks of conglomerate showed that the Rhætic still intervened between the Oolite and the Limestone. The pieces of conglomerate proved very interesting on account of their fossiliferousness and their containing pebbles of chert and Carboniferous Limestone that were well bored by the Lithodorous *Polydora ciliata* (Johnston). Future observers should search this conglomerate carefully for *Ostrea plicata*, Moore, an oyster that has only been found at this locality. Crossing the brook, the Members soon saw large quarries in the Carboniferous Limestone with the warmer coloured Inferior Oolite on top. Climbing the steep talus-slope in the second quarry, they saw the remarkably-planed surface of the Limestone covered with oysters and well-pierced with borings, and looking across the valley surprise could not be suppressed at the extraordinarily level surface of the highly-inclined Carboniferous Limestone (Plate VIII). After a short time had been spent in collecting from the Limestone and Oolite (Doulting Stone) the Members returned to the Hapsford-Mills end of the Vale, boarded the brakes again, and returned to Frome.

Tuesday was to have been primarily devoted to seeing how the Neozoic rocks, inferior to the Doulting Stone, come in between it and the Carboniferous Limestone as progress is made in a northerly direction. A rainy day, however, followed the exceptionally fine Monday, and the proposed proceedings for the excursion were consequently much interfered with.

A visit was to have been paid to the Lias at Writhlington, where in a face some 20 ft. in height there is exposed the White

Lias at the bottom and the Inferior Oolite at the top, with some 16 ft. in between to represent the *Planorbis*- (5 ft.) and *Armatus*-Beds (with fossils of *ruricostati* hemera remanié at the base, 2 ft. 6 in.), *Jamesoni*- (2 ft. 6 in.) and *Valdani*-Beds (1 to 2 ft.) and *Striatum*-Clays. One of the main features of Radstock Liassic geology is that the lower beds are thickest in a roughly circular belt around Radstock, which suggests that denudation followed a period of domical disposition of those beds; while another is that relatively thin limestones represent what are thick clay-beds in the Vale of Gloucester.

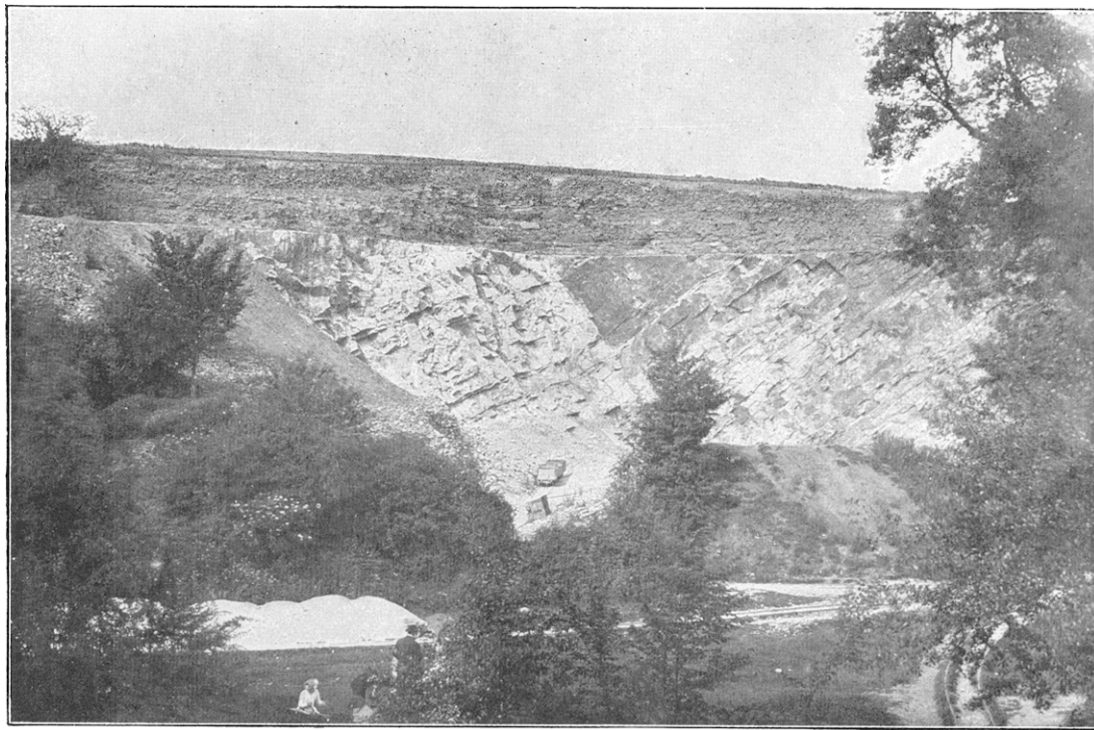
The visit to the Writhlington Quarry, however, had to be cancelled, and instead the Members proceeded straight to Brays-down Colliery. On the spoil-heaps many plant-remains were collected.

The drive was then continued to Wellow, where a bread-and-cheese lunch was obtained, after which the River Somer was crossed, and a large block of the Conglomerate-Bed (basal Inferior Oolite) was viewed close to a spring that issues from off the top of the Lias clay. The main interest in this locality lies in the fact that here the Inferior Oolite is close down upon the Lias, but as progress is made in a northerly direction Sands come in between, and Liassic clay, and Inferior Oolite limestone become increasingly widely separated.

Some of the party now returned to Radstock, but the remainder went on, proceeding through Wellow, across the Somer, and up the steep hill to Charterhouse Hinton. At the top of the hill an old quarry in the Great Oolite was observed, and the coarseness of the oolitic structure of the rock attracted particular attention.

Descending into Midford the members at once proceeded to the main-road section—that visited by the Association in 1893. At the bottom is seen the Midford Sands, then the Upper *Trigonia*-Grit (5 ft.), followed by the Upper Coral-Bed (8 ft.), Doulling Stone (11 ft. 9 in.), *Anabacia*-Limestone (11 ft.), and Rubbly Beds. Here the Director pointed out that there was a great thickness of Midford Sands between the Oolite and the Lias clay which was overlain by the Upper *Trigonia*-Grit, and that if they went yet farther north they would find the Grit and the Sands becoming parted by more and more Inferior-Oolite Beds, until the neighbourhood of Painswick near Stroud was reached. After that they would find the beds between the Upper *Trigonia*-Grit and the Lias appearing and disappearing according as to whether they were approaching or leaving recognised lines of weakness. The bored top-bed of the *Anabacia*-Limestones was pointed out with the rubbly layer full of *Terebratula globata*, auctt., resting upon it, while the Fuller's Earth succeeded this.

After tea at the Inn most of the Members returned by train to Frome.



[Photo by S. H. Reynolds.

SECTION IN VALLIS VALE SHOWING THE INFERIOR OOLITE RESTING UNCONFORMABLY UPON THE
CARBONIFEROUS LIMESTONE.

To face page 224.

A visit to Wells for the Cathedral, Milton-Lane Rhætic section and Wookey Hole was arranged for a few who wished to spend another day in Somerset.

At Wells they were joined by several other Members and friends.

First a visit was paid to Mr. Troup's residence to see the bones, pottery, ornaments and implements that he had found at Wookey Hole during his instructive and fruitful exploration in company with Mr. H. E. Balch. Next the Cathedral was seen and certain of the picturesque bits of Wells, after which a brake was chartered and the Members were driven to Milton Lane.

Mr. James Parker told the Members that it was at his instigation that Brodie visited and described this interesting section. First of all are exposed the Red Marls, then the "Tea-green" (with some very massive strata intercalated), followed by the *Pteria-contorta*-Shales. There is a thin Bone-Bed at the base, but the Shales are singularly destitute of hard bands. The Upper Rhætic succeeds, but unfortunately its relations to the White Lias are obscured by faulting. The White Lias is moderately developed, but the line of demarcation between it and the Lower Lias is not too easy to determine. The thick bed of pale-grey limestone that breaks up in its lower portion very readily on exposure to the frost, has its precise equivalent in the neighbourhood of Stoughton Cross, on the Wedmore inlier, and near Greinton on the Polden Hills. In all three neighbourhoods it is easily recognised, and has an equally bad reputation for withstanding the frost. It has no local name, and around Stoughton and near Greinton occurs at anything up to two and a-half feet above the Jew or Dew Stone. Immediately above it at Milton Lane are shaly beds and pale-grey and yellowish limestones with *Pleuromya crowcombeia*, auctt., to which succeed the ordinary limestone and shale beds of the lower zones of the Lias.

It is interesting to find so close to the Mendip Hills these Liassic deposits possessing their normal lithic facies. At East Milton, by the side of the lane to Wookey, is a quarry in beds mainly of *marmorea* hemera.

QUARRY AT EAST MILTON, NEAR WELLS.

	Thickness in feet.
Limestone, white, rubbly, and clay; <i>Ctenostreon tuberculata</i> (Terquem), <i>Grammatodon heltangensis</i> , <i>Ornithella perforata</i> (Piette), <i>Ostrea</i> , <i>Schlotheimia angulata</i> (Sow.), <i>Unicardium cardioides</i> (Phillips).	5
Limestone, five beds with clay partings; ? <i>Thecosmilia</i> .	4
Limestone, whitish, irregular, and clays; <i>Unicardium cardioides</i> (Phillips), <i>Ornithella perforata</i> (Piette), <i>Phasianella</i> , sp.	4
Limestone, well-bedded, brownish; <i>Ostrea liassica</i> , Strickland: seen.	6

As in the beds higher than the Downside Stone at Shepton Mallet, so here many of the fossils, other than casts, are in various stages of "beekisation."

Wookey Hole was explored under the guidance of Mr. Troup. Wookey Hole is situated at the head of a deep wooded dell, and from its mouth issues the river Axe, that has its headwaters high up upon the Mendips around Priddy, but has developed for itself a swallet-hole through the Carboniferous Limestone and Dolomitic Conglomerate. This swallet-hole is of course becoming larger and larger and now comprises a series of ramifying and often imperfectly-connected caverns, the loftiest of which measures eighty or more feet. The ordinarily-visited caverns are in the Dolomitic Conglomerate—the marginal deposit of the Keuper sea. On the east side of the dell is the Hyæna Cave which was explored by Professor Boyd-Dawkins and others, and yielded remains of the "Cave-hyæna, Cave-lion, Cave-bear, Brown-bear, Wolf, Fox, Mammoth, two species of extinct Rhinoceros, Horse, Urus, Irish Elk, Red Deer, Reindeer, and Man. The implements of flint, chert, and bone found in the Wookey-Hole Hyæna-den prove Man to have been a contemporary of the Cave-bear, Cave-tiger, Mammoth, and two extinct species of Rhinoceros, and to have belonged as truly to the Cave-fauna as any of the extinct Mammalia."*

The Rev. H. H. Winwood thanked Mr. Troup on behalf of the Members present for his able guidance, and congratulated him upon the success that had attended his and Mr. Balch's labours.

On the drive back to Wells the Red Sandstone of the Keuper was noticed well exposed in the road-side just before entering the city.

This Whitsuntide excursion of 1909 afforded the Members of the Association an opportunity of completing their investigations of the recent work that has been done in connection with the Inferior Oolite and contiguous deposits of the Stow-Douling region, the North Cotteswolds having been visited in 1904,† the Mid and South in 1908,‡ and the Bath-Douling district on the present occasion.

Far from being a homogeneous deposit, the Inferior-Oolite Series is distinctly heterogeneous. It is possible to make a number of sub-divisions. The primary division is into Freestone and Ragstone, but in the North Cotteswolds there comes in between a great series of deposits of clays, sands and tilestones, to which neither of these terms is applicable. The sub-divisions as a rule are well differentiated as regards their lithic structure, and correlated with this is an equal distinction as regards faunas. The greater the difference in the fauna and lithic characters of

* "Geology of East Somerset and the Bristol Coal-field," *Mem. Geol. Survey* (1876), p. 189. See also B. Dawkins, *Geol. Mag.*, vol. ii, p. 41: "Cave-Hunting," p. 64.

† *Proc. Geol. Assoc.*, vol. xviii, part 8 (1904), pp. 391-408.

‡ *Proc. Geol. Assoc.*, vol. xx, part 7 (1908), pp. 514-529.

succeeding sub-divisions the greater probably their non-sequence. A number of non-sequences have been observed in the Inferior-Oolite Series of the Cotteswold Hills, and their causes can be traced to crust-pressures that threw the deposited rocks into anticlines and synclines. The geographical distribution of the sub-divisions is mainly governed by the condition of deposition and erosion dependent upon repeated movements along these lines of weakness. The Moreton Valley and the Mendip Hills mark the lines of the two main anticlinal flexures. Here in consequence only certain of the Top-Beds of the Inferior Oolite are seen. The main syncline is indicated by Cleve and Bredon Hills. On Cleve the sequence of Inferior-Oolite deposits is as perfect as anywhere in the Cotteswolds. There is a minor anticlinal line of weakness at Birdlip, and a synclinal axis in the neighbourhood of Painswick, but from Painswick to the Mendips, with the possible exception of a slight roll, is one long anticlinal limb. South of the Mendips a synclinal area is soon entered; the Conglomerate-Bed of Douling—the equivalent of the Upper *Trigonia*-Grit—soon assumes its normal aspect, and in the Sunny-hill Quarry at Cole, near Bruton, some of the richly fossiliferous pre-*Garantianæ* Inferior-Oolite Beds of the South Somerset and Dorset type have made their appearance.

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EXCURSION TO TONBRIDGE.

SATURDAY, JUNE 5TH, 1909.

Director: E. W. HANDCOCK, B.Sc., F.G.S.

Excursion Secretary: A. C. YOUNG.

(*Report by THE DIRECTOR.*)

ON reaching Tonbridge Station at 2.20, the party, numbering twenty-three, proceeded to Pembury Road Brick Works, where an extensive tip-heap of Wadhurst Clay, formed when the Tunbridge Wells railway was made, was pointed out by the Director.

The next halting place was the highest point of Somerhill Park, from which an extensive view of the middle Medway Valley was obtained. The Director here alluded to the wide alluvial plain formed where the Medway had meandered to and fro' over the low-lying ground forming the out-crop of Weald Clay. The area was the principal hop growing district of the County of Kent, the soil being especially favourable for this crop, and also for apples.