LONG EXCURSION TO THE BIRMINGHAM DISTRICT.

THURSDAY, July 28th, to WEDNESDAY, August 3rd, 1898.

Directors : PROF. C. LAPWORTH, LL.D., F.R.S., W. JEROME HARRISON, F.G.S., W. WICKHAM KING, F.G.S., T. STACEY WILSON, M.D., M.R.C.P., AND PROF. W. W. WATTS, M.A., SEC. G. S.

(PLATE XIII.)

Excursion Secretary : F. MEESON, F.G.S.

(*Report by W. W. WATTS ; revised by the other DIRECTORS.*)

THE greater part of the area known as the Birmingham District is occupied by the Trias, a deposit which is a mile in depth where all its members are present in full thickness. Submerged more or less completely under the Trias, several ancient ranges of Palæozoic Rocks, the strikes of which radiate as it were from the Southern end of the Pennine Range, form a broken chain which crosses the district about its centre in a direction extending roughly from S.W. to N.E. Certain portions of these ridges are still high enough to peer out from beneath the Triassic covering, so that it is possible to study in them all the Palæozoic systems but two within a short distance of the city. The Ordovician Rocks have not hitherto been found *in situ*, although fragments of them are known to occur among the Bunter pebbles ; the Old Red Sandstone has, up to the present, only been met with in two sinkings in the South Staffordshire Coalfield.

The series of excursions was so planned that, on the whole, the oldest rocks were studied first, and the members of the Association were introduced to newer and newer rocks in order. The incidence of Bank Holiday interfered slightly with this sequence, while it also rendered it practically impossible to devote any time to Carboniferous Rocks except in distant views, for which the weather and atmosphere were exceptionally favourable.

After journeying to Birmingham on Thursday, July 28th, and taking up their quarters at the Grand Hotel, the party travelled by the first convenient train to Nuneaton, and began their week's work there. Roughly speaking, it may be said that the Nuneaton district consists of a strip of pre-Cambrian and Cambrian Rocks, striking N.W. and S.E., sandwiched between Triassic Marls to the N.E. and Coal Measures to the S.W. The Trias is separated from the pre-Cambrian (Caldecote) Rocks by a fault coursing N.W. and S.E. The pre-Cambrian strip is followed to the S.W., unconformably, by Cambrian (Harts-hill) Quartzite, Limestone (the Hyolite Limestone), and Shales (the Stockingford Shales). Farther still to the S.W. the basement beds of the Coal Measures follow with a marked unconformity.

NOVEMBER, 1898.]

On leaving the railway station the party at once made their way to a large quarry near, in which was seen the first exposure of Hartshill Quartzite; this is well jointed and pierced by a diorite dyke 40 ft. or 50 ft. thick. But the chief interest of the quarry is the unconformable junction with the Trias which is shown in its upper part. A breccia, made up of angular fragments of quartzite, here forms the base of the Waterstones, and it is followed by layers of well-bedded, red and brown sandstone. The junction is of importance, as it seems to show that the eastern boundary fault of the Palæozoic area is not a very great displacement.

The Lower Beds of the Quartzite (Park Hill Quartzite), and their numerous sills and dykes of diorite, were studied in a line of old quarries; but the hunt for the "needle rock"—a diorite with small hornblende prisms visible in it—was not as successful as had been hoped, owing chiefly to the unfavourable weather. Nor was a passing glance at the shales, interbedded with the quartzite, rewarded with the discovery of any pre-*Olenellus* fossils.

After halting under a shed for a sharp thunderstorm to blow over, the geologists next visited Mr. Boon's quarry, a locality now classic from the fact that the basement layers of the Quartzite, which are exposed here, are full of fragments, large and small, derived from the denudation of the underlying Archæan (Caldecote) Rocks. This exposure was one of the first which originally gave the required evidence as to the relative ages of the Caldecote volcanic series (pre-Cambrian) and the Quartzite (Cambrian). A recent excavation in this quarry (kindly brought under the notice of two of the Directors by Mr. Boon) has revealed an excellent example of beds near the base of the Quartzite, entirely made up of blocks and boulders, varying from 1 in. to 3 ft. in length. The boulders consist of different members of the underlying Archæan series and other ancient rocks. Thus specimens of basic and intermediate ash, quartz-felspar ash, quartz-porphyry, and porphyritic basalt, all of types recognised amongst the Caldecote group, with hälleflintas, fine green ashes, and quartzites resembling the rocks of the Charnian series (of Charnwood Forest), and pieces of plutonic rock from an unknown source, were collected by the members.

The next exposure visited was the well-known "Blue Hole" near Caldecote Hill House, in which the Archæan Rocks were for the first time seen *in situ*. Owing to the previous rainfall the rocks were not easy of access, but, when reached, they were found to be much improved by their recent washing. At this place a rock, which appears to be a quartz-felspar tuff, such as might have been blown out of a volcano discharging quartz-felsite lava, has been invaded and overlain by a porphyritic basalt, veins and strings of which were to be seen on the face of the exposure piercing their way into the joints and cracks of the quartz-felspar

rock, and even running in the finest threads amongst its disintegrated fragments. Specimens of the "mixture rock," with varying proportions of the acid and basic ingredients were carried away by the members for microscopical investigation.

The day's work was closed by a visit to the old tunnel near Caldecote Hill House. The remarkably fine, dust-like, laminated tuffs of Archæan age, part of the Caldecote series, are, or rather were, still to be found here; whether future visitors will find any or no is quite another question. Slightly coarser tuffs, not so markedly laminated, are, however, to be found here in plenty.

On *Friday, July 29th*, a few more quarries in the Lower and Middle Divisions of the Quartzite were visited. Amongst them were two of very considerable interest. The first, belonging to the Messrs. Trye, revealed what was left of the dyke shown on Plate X, Fig. 2. Here the diorite was plainly seen to cross the bedding of the Quartzite in the direction of its dip, although corresponding with it in strike. The quarrying which has taken place since the photograph was taken has revealed the fact that the dyke thins down from 3 ft. to 1 ft. in breadth, while a new sill, conforming to the bedding, has made its appearance.

A call for petrologists to make a detour in order to see an example of the nodular diorites—called "anchorites" by Professor Lapworth—revealed the fact that two-thirds of the party claimed this title. The spot was soon found, at the entrance to Messrs. Trye's quarry, where a thin sheet of diorite, intrusive into the lower layers of the quartzite, has segregated on cooling into basic clots and acid veins. A big block was soon extracted and dismembered, its fragments being carried off to decorate several museums ranging from Oxford to Exeter.

The entrance-cutting to Mr. Abel's quarry was next studied carefully, as it yields perhaps the most interesting to a geologist of all the numerous sections in the district; for this is the only place where the actual junction of Cambrian and pre-Cambrian rocks can be seen and worked out in detail. The pre-Cambrian, Caldecote rocks consist chiefly of quartz-felspar ash like that seen in the "Blue Hole," and they are similarly pierced and invaded by porphyritic basalt, which, in this case, traverses them as a vertical dyke. These rocks are covered by Quartzite, whose lower layers, as in Mr. Boon's and Mr. Trye's quarries, are made up of Archæan *débris*. In spite of this fact, and that the junction is somewhat irregular, any unconformity of the two sets of rocks is masked by their correspondence in dip and strike, and by the anticline over which both rocks are folded. The field evidence for unconformity rests on the boulder-beds and the pebbly and gritty layers in the Quartzite already mentioned, and also on the weathered condition of the quartz-felspar rock near its junction with the Quartzite. While this rock is sound and fresh at the bottom of the cutting, and far below the Quartzite junction, its

contact layers are weathered to a depth of 8 ft. or 10 ft., and split up into spheroids of all sizes, one being 6 ft. or 7 ft. across. Other evidence will be found on pages 393 and 394.

From this point the party travelled to the abandoned cutting near Camp Hill Grange, the site of the Hyolite Limestone, with its associated beds, now classed as the Highest or Camp Hill Division of the Quartzite. The succession was soon made out: Sandy, glauconitic, and phosphatic layers below; then the red limestone; then more layers of quartzite, calcareous bands, and sandstone; and, finally, the lowest purple beds of the Stockingford Shales pierced and altered by several diorite sills. Great masses of the red Hyolite Limestone were soon extracted, and specimens of *Coleoloides*, *Kutorgina*, *Orthotheca*, and several species of *Hyolithus* were carried off. Professor Lapworth, who had taken several opportunities on this and the previous day to explain the geology as the ground was traversed, here pointed out that the Hyolite Limestone, although it had yielded no trilobites, probably occupied the place of the *Olenellus* rocks of Shropshire, the Highlands and elsewhere, for the species of *Hyolithus* and other fossils in it compared more closely with those of the *Olenellus* zone of Norway and America than with any others. This identification fitted in with other facts; it placed the Harts-hill Quartzites in line with those of the Wrekin and of Erribol as the base of the Cambrian System, while it correlated the Camp Hill Quartzite with the Comley Sandstone of Shropshire, and the "Fucoid Beds" of the Highlands.

Joining the carriages, the party drove to Chapel End, and after lunch they pressed on to the new railway cutting now being made by Messrs. Trye, north of the village. This cutting exposes a fine section of black Stockingford Shales (Oldbury Shales), bent back and folded by the soil-creep down the hill-slope. In addition to this it shows the unconformable junction of the Coal Measures. The lowest Carboniferous rock is a conglomerate in which pebbles of vein quartz are very common, but fragments of quartzite and diorite are also of frequent occurrence. Yellow sandstones succeed, and the cutting plainly shows that the diorite dykes, like the shales, were cut off by denudation before the Carboniferous rocks were deposited.

Partly walking and partly driving, the members went on to a large exposure of diorite, intrusive into the shales at Raspberry Knob, near Purley Park, where very fresh examples of diorite, containing large crystals of hornblende, and a small amount of olivine, were collected. The lane near Purley Park, which was next visited, shows a fine exposure of the Lowest Division of the Stockingford Shales, the purple or *Purley Shales* named after this locality, the probable equivalent of the Menevian Rocks of North and South Wales. Several fossils, including *Obolella*, *Hyolithus*, and *Agnostus* were obtained, and for the first time the head of a

Conocoryphe was found by Mr. Ridley, and generously presented by him to the Mason College Museum.

A very beautiful drive through Merevale Park and past Merevale Abbey, by the kind permission of Lady Dugdale, brought the party to an old quarry, in which, with Professor Lapworth's assistance, a thin seam of grey shale was unearthed and yielded sufficient specimens of *Dictyonema* to provide most of the members with one. These shales, the *Merevale Shales*, form the highest division of the Stockingford Group, and seem to find their parallel in the Upper Dolgelly Division of the Lingula Flags of North Wales.

Tea at Atherstone concluded a day which rocks, fossils, and weather had combined to make delightful, and the party were charmed with the beauty of the country traversed, the wealth of exposures, and the generosity with which the owners of quarries and of property had allowed them to visit and collect over the whole country-side with the utmost freedom.

Saturday, July 30th, was not an ideal day for travelling, and it was only after many delays that the members of the Association alighted at Barnt Green and were able to resume their normal shape and size, after the compression necessary to put sixty people into a train every carriage and van of which was already over-full, and which still stopped, hungry for more passengers, at every station *en route*.

After hearing a brief account of the district from Professor Lapworth, the party invaded the grounds of Barnt Green House, the owner of which, Mr. Everett, had generously given them permission to examine the unique section of Archæan Rocks exposed along the brook. Here specimens of tuff, banded and otherwise, and of an intrusive basic rock, were collected, and the general correspondence of the rocks to those of Caldecote was pointed out, and it was suggested that we have here a fragment of the Southern ranges, now buried under the Trias, from which the Permian breccia material came down. On traversing a field on the way to Kendal End, the hedgerows were found to be full of angular blocks of similar rocks, which may be the result of present-day weathering, or may be part of a scree formed in Permian times. Perched on the top of this hill an outlier of Silurian (? Woolhope) Limestone, now entirely quarried away, originally rested on the top of the Archæan Rocks with apparent unconformity. The well-known dyke of diorite intrusive into the Archæan Rocks, and the black shale which Mr. Gibson discovered to the west of this spot, were visited, and also a corresponding diorite dyke on the east side of the hill. Crossing the transverse fault which separates the Archæan and Silurian Rocks of Kendal End from the Quartzite that makes up the core of Bilberry Hill, the party next halted in Bilberry Hill Quarry (See Plate XI, Fig. 1), and the remarkable

overfold in it was studied. The interpretation that the overfold was part of an inverted syncline was accepted, and the portion seen to the left in the figure seemed to have been let down by a fault. The quartzite of this exposure is in appearance like the lower divisions of the Nuneaton (Cambrian) Quartzite, with which it is now correlated, as its unconformable infraposition below Llandovery Sandstone renders it unlikely that it should be of any other age. Many seams, more or less conglomeratic, found in the quartzite of this quarry, like the basement layers at Nuneaton, are made up of *débris* derived from the (Barnt Green) Archæan Series below. These strengthen the view that the Barnt Green Series is Archæan; satisfactory proof by superposition is wanting.

An ascent of Bilberry Hill was next made, but the heat-haze interfered with a distant view. The salient features in the geology of the hills were pointed out by Prof. Lapworth, and then, on descending the other side, the Bunter Pebble Beds overlapping the western side of the hills were seen in a small quarry. The quarry in the Quartzite near the keeper's lodge furnished specimens of typical quartzite, often with well-rounded grains and well bedded, while grains of glauconite were common in many specimens.

After lunch the party pushed on towards the Beacon Hill, passing off the Quartzite over vertical layers of sandstone, and over the place of the Permian Marls on to the Permian Breccia, the latter standing up as a line of hills on account of the porosity of the rock which hinders the gathering of streams and the denudation resulting from them. The similarity of the breccia to the unconsolidated scree-material of the Archæan slopes already seen was remarked.

At the village of Rubery, Llandovery Sandstone was seen resting unconformably on the Lickey Quartzite. The junction

FIG. 1.—TRACING FROM PLATE XIII, FIG. 2, TO SHOW THE EXACT RELATIONSHIP OF THE LLANDOVERY SANDSTONE (STIPPLED) TO THE CAMBRIAN QUARTZITE (NOT STIPPLED). A FISSURE IN THE QUARTZITE, FILLED WITH SANDSTONE WILL BE SEEN ALONG THE LINE *f.f.*

FIG. 1.—VIEW (LOOKING SOUTH-WEST) FROM THE HOUSE OF MR. MANDER, "THE MOUNT," TETTENHALL, WOLVERHAMPTON.

a. Titterstone Clec Hill. *b.* Brown Clec Hill.

FIG. 2.—SECTION AT RUBERY TO SHOW LLANDOVERY SANDSTONE RESTING UNCONFORMABLY ON CAMBRIAN QUARTZITE. THE LLANDOVERY ROCK FILLS UP FISSURES IN THE QUARTZITE. (See Fig. 1 for Key).

(From photographs by Professor H. E. Armstrong).

was photographed when it had been cleared, and junction-specimens were collected, some of them with fossiliferous sandstone filtering into the cracks of the quartzite. A photograph (Plate XIII, Fig. 2) of this junction was taken by Prof. H. E. Armstrong, and the annexed tracing (Fig. 1) will serve as a key to it. It was the discovery of this section which first showed that the Lickey Quartzite was not of Silurian (Llandovery) age as had been previously supposed. In the grounds of the Asylum, to which the members were next conducted, the Llandovery Sandstone was seen to be succeeded by fossiliferous Woolhope Limestone, and that by Wenlock Shales.

After tea the party made their way to Rubery Station, and at Holly Hill they saw the most northerly exposure of the Quartzite in the district, a mass now being quarried away to furnish material for making a new reservoir on Frankley Beeches. A striking fault was seen to pass through this point and to throw down Carboniferous sandstone into contact with the Quartzite.

Some spare hours were taken up with a pleasant stroll from Aldridge past Barr to Barr Beacon and Sutton Park. A considerable area of Silurian rock ranges from Walsall and Rushall to Hay Head, in the parish of Barr, and in this the three Silurian Limestones are displayed, the Wenlock Limestone, as usual, being double. At Hay Head the lowest limestone, the Woolhope or Barr Limestone, used to be quarried for smelting purposes but the quarries are now abandoned, great grooves marking the former site of the outcrop. From this locality most of the characteristic fossils of the Woolhope Limestone have been obtained, including *Illænus barriensis*, named after the locality. The Association was fortunate in carrying away, amongst many other fossils, one almost whole specimen of this rare fossil and several imperfect but recognisable fragments. After a good hunt in the abandoned quarries the party rested on an old spoil bank, and the fortunate discovery by Mr. Garwood that small brachiopods were to be found there set everybody "beach-combing," with the result that each one carried away a handful of the tiny brachiopods so characteristic of the Wenlock Shale, including such of the rarer forms as *Streptis grayi*, *Retzia*, and *Waldheimia* (? *mawi*), as well as dozens of such forms as *Atrypa marginalis* and its varieties, *Cyrtia exporrecta*, *Orthis elegantula*, *O. elegantulina*, *O. hybrida*, and *O. biloba*.

A welcome halt at the foot of the hill near some old coal-workings was followed by a climb up the fine escarpment of Bunter Pebble Beds, known as Barr Beacon, from the summit of which there was a superb view both east and west as the Black Country smoke had settled down for its Bank Holiday rest. Three-fourths of the Coalfield were plainly visible, its south-west part being cut off by the line of hills which follows the Dudley anticline, Rowley, Dudley Castle, the Wren's Nest, and Sedgley

Beacon. Beyond the Coalfield there rose to the north the Wrekin, then the Brown Clee Hills and the Titterstone Clee, the last two being little coalfields capped by a sheet of dolerite like that of Rowley. (See Plate XIII, Fig. 1, taken from a photograph by Prof. H. E. Armstrong.) The Permian ranges framing the Black Country were clearly seen, culminating in the Clent and Lickey Hills to the south. To the north and east the view ranged over the woods and wastes of the Bunter Pebble Beds, which extend from Cannock Chase to Streety and Sutton Park.

Descending the hill the party next entered Sutton Park, where Mr. Harrison pointed out the remains of the old Roman road of Icknield Street, and, after a delightful walk through the Park to Blackroot Pool, they studied a capital exposure of Bunter Pebble Beds. The pebbles and matrix are traversed by joints, and where one pebble comes into contact with another the softer one is generally indented, while the smaller one is often crushed by earth movement so that it crumbles to pieces on being extracted. The pebbles are mainly of varieties of quartzite which have not yet been found locally *in situ*, but, in the course of the day, pebbles of Lickey Quartzite, and of Llandovery Rock sometimes fossiliferous, were collected. A few pebbles of fossiliferous *Grès Armoricaïn* were also obtained.

An early start was made on *Monday, August 1st*, for Wolverhampton, and a visit was made, under Mr. Jerome Harrison's direction, to the West Park, in which the Corporation have preserved a couple of large boulders—one from Criffel, and the other from Arenig or the Lake District (Fig. 13, p. 406). The party next drove to Tettenhall, where they were hospitably entertained by Mr. C. T. Mander at breakfast, after studying a fine collection of boulders amassed by that gentleman's father. The majority of the boulders had come from Lakeland and South Scotland, but there was at least one "Welshman" in the collection. The roof of the house commanded an excellent view over the country to the west, and there was no difficulty in recognising the features previously seen from Barr Beacon, while, in addition, the Longmynd, with Corndon beyond and the Stretton Hills in front of it, and the Abberley and Malvern ranges to the south, were well seen. (See Plate XIII, Fig. 1). After taking leave of their kind host the party drove on to Trescott, Trysull, and Seisdon, a country strewn with millions of boulders, amongst which the following were recognised: Granites from Eskdale, Skiddaw, and the Galloway region; granophyre from Buttermere; felsite from St. John's Vale (?); felspathic dykes from S. Scotland and Lakeland; tuffs and andesites from Lakeland and Arenig; hornfels, possibly from the Shap district; and a striking augite-andesite, most probably from Falcon Crag, in Borrowdale, though it had affinities with a

rock of the same age found near Shelve, in Shropshire. After traversing Abbott's Castle Hill and Highgate Common, the party halted for a while at Enville, one of Ramsay's classic localities, and then skirted Enville Park to see the Permian Calcareous Conglomerate, a bed which has recently been made the subject of a paper by Mr. W. Wickham King.

Before reaching Compton quarry a very beautiful view of Kinver Edge and the surrounding landscape tempted Professor Lapworth to develop his idea of the rejuvenescence of the Severn valley, owing to the diversion into it of the drainage of the Upper Dee in glacial times. The deepening of the main Severn Valley from Coalbrookdale to Stourport, due to the increased erosion brought about by the great increase in the water supply, had permitted the tributary streams entering this part of main valley to cut deep gorges for themselves in the lower parts of their courses. The slope of the stream-beds here became more steeply inclined, and the rate of transportation increased, resulting in a more rapid and more differential local denudation. The result is seen in the bold and picturesque scenery of the lower halves of their basins, in marked contrast with the more rounded and featureless country farther back, which remains as yet unaffected. The jointing of the Calcareous Conglomerate was studied and photographed, and Mr. King pointed out the chief kinds of Silurian and Carboniferous Limestone which made up most of the pebbles. The climb up Kinver Edge led past the dwellings of Holy Austin Rock which have been dug out of a hard bed in the Lower Mottled Sandstone. The summit of the ridge gave a fine view, including the Abberley Hills and the Malverns rising out of the Triassic plain. The drive back to Stourbridge Junction was past a couple of very fine exposures of Pebble Beds, that at Wollaston Ridge yielding several examples of fossiliferous pebbles.

The Director for *Tuesday, August 2nd*, was Mr. W. Wickham King, who met the Association at Stourbridge, and went on with them to Kidderminster. The object of this excursion was to study some of the complicated relationships of the so-called Permian and Triassic sediments to the underlying Palæozoic rocks. Mr. Wickham King has kindly furnished the following brief note on his views, as expressed by himself and Professor Lapworth to the Association on the ground :

"The fact of an inversion of the Silurian and Old Red Strata on the western flanks of the Abberley range was originally pointed out by Phillips. According to the views and discoveries of the Director, the structure of the district is in its way quite Alpine. Not only are there inversions, but there are actual overthrusts, the Wenlock and Aymestry Limestones and the Lower Ludlow Beds being repeatedly forced over on to the Old Red Sandstone and Upper Ludlow Rocks. The strike of the

axes of the main folding of the country is first north and south, in continuation of the main axes of the Malvern ridge (Malvernian folding), but at Abberley Hill it swings round almost at right angles to this direction, the axes now striking from west to east (Hercynian or Mercian folding). The great complication and overthrusting is at the 'elbow.' Upon these two major axes or directions of folding are superposed minor folds or 'ripples,' namely, on the Hercynian portion folds with axes running from N.W. to S.E. (Charnian or Woolhope folding), and on the Malvernian portion ripples with N.E. to S.W. axes (Scandinavian).

"The complicated Abberley elbow forms a fan-fold with overthrusts upon its outside edges and a sag in the middle. In this sag lies the so-called 'Permian Breccia' of the locality. The mountain-making movement must have commenced as early as Carboniferous times, for the Coal Measures rest unconformably upon the Downton Sandstone, and it must have continued far into Triassic time. At the time when the "Permian Breccia" of the locality was laid down the movement was not finally closed, for many of the fragments in it are slickensided. This complicated little district gives probably a rough idea of the rest of the Mercian Highlands, the ruins of which, with the exception of the Malvern, the Lickeys, etc., now lie buried deep beneath the Triassic mantle. The so-called "Permian Breccias" of the Severn basin, so intimately connected with these Highlands, are of several ages, ranging in time from the Upper Carboniferous to the Keuper."

On arriving at the Hundred House the party speedily made their way to Walsgrove quarry, where a little scrambling took many of them up to the point at which the Downton Sandstone and Upper Ludlow Beds are inverted and thrust over the Aymestry Limestone and the associated nodular beds. Proceeding through Abberley Park, which the owner, Mr. Jones, had kindly allowed the party to cross, abundant fossils were obtained from exposures in the Wenlock Limestone, the Aymestry Limestone, and the Upper and Lower Ludlow Beds. The offer of a reward for graptolites at one spot stimulated research to such an extent that several examples were unearthed, proving for the first time that the beds there were of Lower Ludlow age, inverted and probably thrust on to the top of the Upper Ludlow Beds, seen in a quarry just below, or on to the Downton Sandstone. From a new excavation near here one of the members was rewarded by the find of about a dozen heads of *Phacops*, showing the faceted eyes, and other members also found *P. longicaudatus*.

The route up Abberley Hill led past a grand exposure of "Permian Breccia," resting on the truncated edges of the Silurian, from which were collected many examples of various tuffs

and ashes of Archæan type, as well as sedimentary rocks which could be matched with local rocks found *in situ* in the vicinity. A brisk discussion between Professor Blake, Mr. King, and Professor Lapworth elicited the contrast between the old views that the breccia fragments had been borne by glaciers from Wales, and the new views that they were of local origin, and derived from the cores of the Malvern ranges and their continuation near Abberley. The theory that steep mountain ranges existed here in early Permian times, with overfolding and overthrusting like those of Alpine regions, was startling; and the view that the Permian breccia was probably the scree of overthrust Archæan masses once overlying the Silurian here, but now wholly vanished, seemed to many more like a fairy tale than sober geological inference. The top of Abberley Hill gave a fine view towards the Malverns, Radnor, Shropshire, and Wales; but the most curious feature was perhaps the horse-shoe shape of the hill itself, resulting from the superposition of a north-east ripple on the dominant N. and S. waves of the Malvern Range.

In the evening a large party assembled at the Grand Hotel, and the customary votes of thanks to the Directors and those who had otherwise contributed to the success of the excursion were passed.

The excursion to Dudley on *Wednesday, August 3rd*, was of a kind quite unusual to the Association. By Mr. Claughton's kindness, after the party had traversed the Castle Hill, and had the geology of the neighbourhood explained to them from the summit, they embarked in a limestone-charge and traversed the subterranean canal, excavated through the Silurian rocks which connect the Castle Hill and the Wren's Nest underneath the surface covering of Coal Measures. The weather broke somewhat on this day, but the showers were a matter of indifference to the members underground, and it was only after they reached the surface again that they were at all inconvenienced. Passing out of the canal, the party emerged into one of the groups of caverns formed by the excavation of the limestone for smelting and burning. This was brightly lighted up with hundreds of candles; and after Professor Lapworth had given an account of the geology of the hill as related to the industries of the surrounding districts, so far as they are dependent on the geology, the effect of the caverns was enhanced by the use of coloured lights. When the surface was reached, the geologists found a choice collection of Coal Measure plants obtained in the neighbourhood, and from this they were able to purchase such examples as they wished. Next, they collected specimens of brachiopods and corals from the Upper Ludlow Beds. Then, as the rain began again in a business-like fashion, the party walked from the Wren's Nest to the Priory, in answer to Mr. Claughton's kind invitation. Here they were most hospitably entertained, and after they had expressed their

thanks to Mr. Claughton for his goodness to them throughout the entire day, the members of the Association made their way to the railway station. On the way Dr. Fraser distributed a series of duplicate fossils from his own fine collection, and the party closed its week's work with a vote of thanks to Mr. Meeson, whose work as Excursion Secretary had done so much to make the whole excursion a success.

EXCURSION TO HILLMORTON AND RUGBY.

SATURDAY, MAY 7TH, 1898.

Director: BEEBY THOMPSON, F.G.S., F.C.S.

Excursion Secretary: W. P. D. STEBBING, F.G.S.

(*Report by THE DIRECTOR.*)

OF the members who availed themselves of this excursion, those coming from London reached Northampton about 10.55 a.m., and others joined later on at Kilsby Station, Hillmorton, and Rugby respectively. From Kilsby and Crick Station a walk of about $1\frac{3}{4}$ miles brought the party to the first section to be visited, that near Hillmorton.

RED-BANK BRICK-WORKS.—These brick-works, visited by permission of the proprietor, Mr. Young, of Rugby, are situated to the east of Hillmorton village. It is a comparatively new section of Lower Lias that is worked, and no fossils have, so far, been found to indicate the zone. Attention was particularly called to the capping of coarse gravel, and to the inclination of the clay surface to the north at the northern boundary of the excavation.

HILLMORTON SAND-PITS.—A few yards only separates the last-named section from the very extensive sand-pits owned and worked by the London and North-Western Railway Company. These pits were visited by permission of Mr. W. H. Williams, of Watford. The following interesting characteristics were pointed out:

The excavation now exposed is about 50 feet vertical at the eastern end, and consists of sand and gravel, but the sand has been proved within the limits of the workings for another 130 feet; thus the sand and gravel are together about 180 feet thick. Water is found within 2 feet of the present working level, and some few years back the L. and N.-W. Ry. Co. bored 145 feet with the object of procuring a supply, but the quantity available was too small to be of service. Mr. R. Lowe, district superintendent, to whom we are indebted for some of these particulars, informed us that 15 feet below the present working level the sand becomes darker in colour.

The upper part of the exposed section consists of some 8 to
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