ORDINARY MEETING, MAY 4TH, 1877.

Professor JOHN MORRIS, F.G.S., President, in the Chair.

The following Donations were announced :—

“Abstracts of the Proceedings of the Geological Society,” Nos. 334-335; from the Society.

“Journal of the Society of Arts,” April, 1877; from the Society.

“Transactions of the Manchester Geological Society,” Vol. xiv., Part 8; from the Society.

“Annual Report of the Smithsonian Institution for 1875;” from the Institution.

“Geology of Northamptonshire,” &c., by W. J. Harrison, F.G.S.; from the Author.

“The Hertfordshire Ordnance Bench Marks,” by John Hopkinson, F.L.S., F.G.S.; from the Author.

“The Grotto Geyser of the Yellowstone National Park” (U.S.A.); from Dr. F. V. Hayden.

The following were elected Members of the Association :—

William Mason Cole, Esq.; William Bancroft Espcut, Esq.; Thomas Floyd, Esq., F.G.S.; John Edward Marshall Hall, Esq.; Miss A. Maria Horsnail; Francis M. Jennings, Esq., M.R.I.A., F.G.S.; J. Love, Esq., F.R.A.S., F.G.S.; Frederick Short, Esq.

The following Papers were read :—

1. ON THE GEOLOGY OF LEICESTERSHIRE.

By WILLIAM J. HARRISON, Esq., F.G.S., Curator of the Town Museum, Leicester.

The rocks of Leicestershire are more varied in age, character, and composition than those of any of the adjoining counties. Probably no district could be chosen which would better illustrate the effects of geological structure upon the life and occupations of its inhabitants.

If we take a brief general survey of the county, we shall find the rock-masses fall into five broad divisions (see Sections, page 135) :—

I. In the north-west rises the hilly, almost mountainous, region of Charnwood Forest, composed of igneous and metamorphic rocks.

II. Besides eight isolated masses of Carboniferous Limestone, we find the Coal Measures extending westwards of Charnwood, beyond the boundary of the county, into Derbyshire. Fragments of Permian pebble-beds rest upon the Coal Measures in small and scattered patches.

III. "Red Rocks" of Triassic age, form much of the land north, east, south, and south-west of the Forest region, covering in fact all the western half of the county not occupied by the rocks already mentioned.

IV. In the eastern half of the county stiff bluish clays of Liassic age preponderate with a hard bed of Marlstone; whilst above them, in the extreme north-east, and in a few outlying masses, sands and limestone of Oolitic age are found.

V. Lastly, scattered in varying thickness, and with great irregularity over all the rocks already mentioned, there are beds of clay, gravel, sand, and pebbles, which we call Drift, relics of the last Glacial Period and submergence beneath the sea. The alluvial deposits of our rivers—still in course of formation—bring our geological history down to the present day.

Let us now consider each of these great rock divisions a little more in detail.

I. THE CRYSTALLINE AND SLATY ROCKS OF CHARNWOOD FOREST.—These have long been regarded as a geological puzzle. No fossil remains have ever been found in them which we might have compared with those found in rocks elsewhere. In structure they resemble both the Cambrian rocks of Wales and the Silurian beds of the Lake District; whilst it is not impossible that they may be older than either, and belong to the Laurentian system. In appearance and composition they present a remarkable variety, and the question of their origin has not been less debated than that of their age. Extending from Blackbrook on the N.W. to Bradgate on the S.E., a distance of about seven miles, a line can be traced, dividing the slates, &c., which can be seen to dip to the N.E., from those which dip S.W. This anticlinal line was first noted by Sedgwick in 1833. East of it we get coarse gritty slates, ashy in appearance, at Moorley Hill, Nanpantan, &c., with intrusive masses of syenite at New Cliff and Buck Hill. At

Whittle Hill the rock is so fine-grained and siliceous as to pass into a quartzite. This is very much jointed, breaking up readily into prismatic masses. It is quarried for hones, which are known throughout England as the "Charley Forest" oilstones. Passing over Beacon Hill, where the slates attain a height of 840 feet, we notice in some little quarries near Woodhouse Eaves some markings on the bedding planes which have been considered of organic origin. At Swithland and Groby there are some extensive slate quarries. At the former place the principal pit is nearly 200 feet deep. The beds here dip nearly due east, at from 30 to 40 degrees. On the eroded edges of the slates, the Triassic Red Marls are seen to rest, the bedding following to some extent the inequalities of the ancient surface. The Midland Railway Hotel, at St. Pancras Station, is roofed on one side with Swithland, and on the other with Groby slates. They have also been used in the steps round the Albert Memorial in Hyde Park.

Mountsorrel is an outlying mass of syenite, passing into a hornblendic granite by the presence of a small quantity of mica. There are very extensive quarries here, and the stone is much used for kerbs and paving-sets. Between Swithland and Mountsorrel we have a very interesting exposure in Basil or Brazil Wood of a curious kind of gneiss. It is within a few feet of a syenite boss, and just outside the wood a mass of diorite is to be seen. It is intended to excavate at this point, so as to lay bare the junction of the three rocks. On the west of the anticlinal line, there are some large quarries in the syenite knolls of Groby, Markfield, and Cliff Hill. Bardon Hill rises to a height of 902 feet (the highest point in Leicestershire), but the rock here, as shown in the very large quarries, is a kind of felstone. From this point by Peldar Tor, to High Cademan and High Sharpley, we get a most interesting region, most of which appears to be composed of beds of volcanic ashes and agglomerates. Nearly in the centre of the elevated and craggy surface of this tract stands the Monastery of St. Bernard. To the north-east (but still west of the anticlinal) we find a limited area of compact, hard, pale-coloured quartzites. It is difficult to match these with any rocks east of the central axis, and it seems probable that a fault runs along the anticlinal, with an upthrow to the west. If this be the case, these quartzites (which are exposed near the Old Reservoir, &c.) are about the oldest beds of the Charnwood region.

We can trace a southerly extension of the Charnwood axis in the bosses of fine-grained syenite, which are worked in South Leicestershire at Enderby, Croft, Stoney Stanton, Narborough, and Sapcote.

The comparative proximity of Charnwood Forest to London, and to the east and south-east of England generally, ought to ensure the rapid development of its excellent syenite, granite, and slate quarries; and with improved means of communication, the future will, doubtless, see a great development of the special industries of this district.

II. THE LEICESTERSHIRE COAL-FIELD.—When the seams of coal with their accompanying strata were first deposited, they doubtless stretched continuously all over the region of Charnwood Forest, and were connected with the Nottingham Coal-field. Since the upheaval of the Forest district, all the Coal Measures which once covered it have been swept clean away—denuded off—together with a vast thickness of the syenites and slates themselves, until now not a patch of coal is left on that area.

The lowest beds of the great Carboniferous System are those of the *Carboniferous Limestones* which are found cropping out at intervals to the north-west of Charnwood, at Grace Dieu, Osgathorpe, Barrow, Breedon Cloud, and Breedon. This limestone is very impure, containing much carbonate of magnesia; it is in fact a “dolomite,” and is largely quarried for lime burning. It also occurs at Dimmingsdale, where it contains ores of lead, copper, iron, zinc, &c., but in small quantities only. Several fossil shells occur, mostly as casts, *Productus* and *Bellerophon* being the most common. The limestones are overlaid by beds of shale, which are well seen in the quarries at Grace Dieu. They are about fifty feet thick in this district, and are capped by the *Millstone Grit*—a very hard, coarse sandstone, which is only exposed in one or two small patches near Thringston, &c.

The Coal Measures.—About 2,500 feet of sandstones, clays, shales, and coal-seams overlie in this district the Millstone Grit. Of these, however, the lower half may be regarded as unproductive, the coal-seams contained in it being too thin to admit of profitable working. The Coal-seams of the upper part, too, do not spread in uninterrupted sheets at regular depths. The same great upheaval which acted chiefly under Charnwood Forest also dislocated and disturbed all the surrounding country, elevating

portions here and there above the rest, and so breaking the continuity of the Coal-seams and producing what are called "faults." The surface inequalities so produced have since been worn down to a tolerably level surface, so that we only know of the existence of these "faults," when in following a coal-seam we find it suddenly stop short, abutting on a rock of quite different character. The chief "faults" run from N.W. to S.E. parallel to the anti-clinal axis of Charnwood Forest. They are named (1) the Coleorton, or Boundary Fault, which stretches from Ticknall to Bardon Hill; (2) from this the Heath End Fault seems to branch out, whilst further to the S.W., the Boothorpe Fault and the Moira or Main Fault run nearly parallel to it. A number of minor faults run nearly at right angles to these.

The effect of unequal upheaval was to elevate the district between the Heath End and Boothorpe faults, *i.e.*, all the part to the N.W. and S.E. of Ashby-de-la-Zouch. From this part thus exposed to denudation, the coal-beds were speedily pared off, and we thus have the lower unproductive measures standing like a wall between the western coal-producing districts of Moira and the eastern or Coleorton division. We may therefore suppose that the chief seams of coal of these two latter districts are identical, and were once continuous; and from the general similarity in character, number, and order of succession of the beds in each, this seems a fair conclusion.

In the Moira district the main-coal is $14\frac{1}{2}$ feet in thickness, but it is not of equal quality throughout, and is not all extracted. In the Coleorton district it is about six feet thick. The boundary of the Moira district by Stanton, Gresley, Donisthorpe, Measham, Willesley, and Woodville is pretty clear, the coal-seams cropping out on all sides; but the Coleorton district extends southwards and eastwards beneath the New Red Marl to an unknown distance. At Whitwick Colliery a bed of dolerite was struck at a depth of 155 feet. This is a true volcanic rock, and was probably ejected from a vent somewhere in the great fault at the foot of Bardon Hill. It was 60 feet thick, and had turned the bed of coal on which it rested to cinders. Still further to the south, coal has been reached at Ibstock, Nailstone, and Bagworth; whilst recently similar beds have been proved further east at Desford, but this is probably close to the eastern boundary. About six miles south of Desford, at Elvesthorpe, a boring of 1,500 feet

in depth found unproductive coal-measures dipping nearly vertically. But westwards, between the Nuneaton and Ashby coal-fields, the ground is as yet untried, and would seem to present fair probabilities of success.

The Permian.—In a few spots to the south and west of the Ashby Coal-field, as at Measham, Packington, &c., there occur beds of pebbles embedded in a paste of red marl. These are almost certainly of Permian age, and as the pebbles they contain can be traced back to the Carboniferous and Silurian rocks of the West of England, whilst they are angular and some even striated, they probably afford a proof of the recurrence of glacial periods at various geological epochs.

III. THE NEW RED SANDSTONE, OR TRIAS.—The lowest division of the “Red Rocks” is the *Bunter (variegated) Sandstone*. Pebbly beds of this age occupy the district about Netherseal and Donisthorpe. In Leicestershire, as elsewhere, there is considerable difficulty in separating the Triassic and Permian beds, from want of good sections, and the absence of fossil evidence. Both are unconformable to the Carboniferous rocks, and also to one another. Above the Bunter Conglomerates come the *Keuper Beds*. The lowest member is a thick sandstone, called the “*Waterstones*,” from its everywhere affording an abundant supply of water when pierced by wells sunk through the Red Marl above.

The Red Marl with Upper Keuper Sandstone constitutes the greater part of Leicestershire west of the River Soar, and usually extends a mile or so east of that river. The town of Leicester is built on the uppermost beds of this division. It contains a bed of sandstone seen at Orton-on-the-Hill, Diseworth, and especially at the Dane Hills close to the west side of Leicester. Here, in a cutting of the Leicester and Burton Railway, a fine section is seen, showing the characteristic “false bedding” (produced by the action of currents) in perfection. A little crustacean, *Estheria minuta*, is found in these beds, with teeth and spines of *Hybodus*. A massive nodular band of gypsum occurs towards the top of the Red Marl. It is well seen in the cutting of the Midland Railway’s Main Line near Thurmaston. It is in the Red Marl of Shropshire, Cheshire, and elsewhere, that thick beds of rock-salt occur. Indeed, the whole Triassic system seems to have been deposited in inland seas, saturated with salt. In Leicestershire we have

traces of this in the numerous casts of salt crystals which cover the surface of the light-coloured marls in many places. Ripple-marks, sun-cracks, and rain-pittings afford further signs of the condition of things at that period. The red colour of the marls is due to the presence of oxide of iron, and it is generally found where this is abundant that traces of life are few.

IV.—THE LIAS AND OOLITES OF EAST LEICESTERSHIRE.—*The Rhætic Beds.*—Resting on the top of about 1,000 feet of Red Marl and Sandstone, there occur certain thin bands of Grey Marls, Black Shales, and Nodular Limestones, whose fossil contents are of the highest interest. The only clear sections of them at present known in this county are to be seen in certain brick-pits at the northern extremity of the Spinney Hills, a low range forming the eastern boundary of the town of Leicester and of the Soar Valley. These I was fortunate enough to discover in 1873. The top of the Keuper Red Marl is there visible, and above it is a thick bed of Grey Marl, which in turn is surmounted by the famous Bone-Bed, a layer some three inches thick, composed of remains of *Ichthyosaurus*, *Plesiosaurus*, *Labyrinthodon*, with numerous fish remains, as *Hybodus*, *Ceratodus*, *Nemacanthus*, &c., with numerous other interesting fossils. Next come about 9ft. of black and light-coloured shales, containing the characteristic shells, *Avicula contorta*, and *Cardium Rhæticum*, and the whole is capped by bands of hard nodular limestone. It is still a matter of dispute whether these beds belong to the Trias or to the Lias. Probably they are true “passage beds,” having in the lower part Triassic, and in the upper Liassic affinities. In these beds I found a new species of star-fish, since named *Ophiolepis Damesii*, and a fish—*Pholidophorus Mottiana*. The outcrop of the Rhætic Beds can be followed northwards by Barrow-on-Soar and Elton to Newark.

THE LIAS.—The *Lower Lias* beds have long been worked at Barrow-on-Soar, and more recently at Kilby Bridge. They consist of alternations of dark shales with valuable hydraulic limestones, surmounted by a great thickness of shales. At Barrow the lowest limestone bands are nodular, and contain *Ostrea liassica* in great numbers. Above them we find the Fish, Insect, and Saurian Beds. *Ammonites planorbis* is met with in the shales, and *A. angulatus* a few feet above it; but another form which I have been in the habit of calling *A. catenatus*, appears to

be new, and will be described by Dr. Wright in his forthcoming "Monograph on Ammonites" (Palæontographical Society). At Kilby we get rather higher beds. Here *Ammonites Bucklandi* and *A. Conybeari*, with *Gryphea incurva* and *Rhynchonella variabilis* occur in great numbers.

The total thickness of the Lower Lias Beds is about 600 feet, for a boring for coal near Billesdon Coplow reached that depth entirely in this formation; had it been persevered with a little further, it would doubtless have entered the Red Marl. The district occupied by the stiff bluish clays of this division is mostly in the condition of pasture land, and forms the chief portion of the great hunting and stock-rearing district of East Leicestershire. The tunnels on the Nottingham and Melton Railway now in course of construction have lately afforded some good sections of the upper part of these beds. They contain *Hippopodium*, *Cardinia*, and *Pleurotomaria* in abundance.

The Marlstone or Middle Lias.—The "Rock-bed" is a limestone containing much iron. Exposed to the air it weathers brown, and constitutes excellent corn land. In the north-east, at Wartnaby and Holwell, it is about 25ft. thick, but decreases to about one foot between Keythorpe and Hallaton. Its outline is very irregular, as it sends out bold spurs to the west, as at Burrow Hill and Billesdon, and, indeed, forms an escarpment along its whole extent. At its junction with the clay beds beneath numerous springs issue. A good example is in the picturesque little ravine of Holwell Mouth, where the River Smite issues from the base of the Rock-bed in this manner.

The Upper Lias Shales are rarely seen, being covered over with Drift. The "Fish and Insect Beds" are to be seen in some pits near Keythorpe.

THE OOLITES.—Resting upon the Upper Lias Shales is a stratum called the *Northampton Sand* from its development further south, where it is extensively worked for ironstone. In Leicestershire it only occurs in detached patches or outliers, although no doubt it was once continuous over the whole district. Robin-a-Tiptoes, a hill about some 750ft. high, and about 11 miles east of Leicester, is capped by hard calcareous beds of Northampton Sand, as are the adjacent eminences of Whadborough Hill, Barrow Hill, &c. Near Neville Holt it is about 20ft. thick. Ironworks were commenced here, but have been discontinued.

The Lincolnshire Limestone.—The labours of Mr. J. W. Judd have made it clear that this important bed belongs to the *Inferior Oolite*, thus being older than the Great or Bath Oolite, with which it was formerly considered contemporaneous.

The main line of outcrop just enters the county on the N.E., near Crown Point, and near Croxton Kyrial. From the latter point it extends westwards to Sproxton, sending, what is probably a long spur, down nearly to Waltham and Stonesby. Here there are several quarries, and fossils are abundant, but occur mostly as casts. In South-east Leicestershire we also get an interesting outlier of the Lincolnshire Limestone on the top of Neville Holt Hill.

V.—POST-TERTIARY DEPOSITS.—There are many interesting exposures of *Mid-Glacial* or *Pre-Glacial Beds*. These are usually sandy, composed of detritus derived from the neighbouring rocks only, and are seen to be overlaid by true Boulder Clay. They contain a few derived fossils, and much carbonaceous matter, which admirably indicates the false-bedding. Good sections are seen in the brickyards at Rotherby, Melton Mowbray, Billesdon, Broughton Astley, and at Ayleston, Leicester Abbey, &c.

Boulder Clay.—The usual appearance of the Boulder Clay in Leicestershire is as a stiff bluish clay, often weathering brown where exposed. It is full of quartz pebbles, &c. Attempts have been made to divide the *Drift* in Leicestershire into three portions. The gravelly beds containing flints and Chalk fossils have been distinguished as *Eastern Drift*, the constituent rock-fragments appearing to have principally come from that direction. The Boulder Clay proper, with large transported masses of Millstone Grit and Carboniferous Limestone, is entitled *Northern Drift*, while, lastly, Charnwood Forest seems itself to have acted as a centre of distribution of boulders, which constitute the *Forest Drift*. No hard and sharp line of demarcation can be drawn between the Eastern and the Northern Drift, although the former appears to be the older of the two. In the present state of our knowledge of the Glacial Deposits, it is, however, useful to retain these names as expressing general facts.

Pre-historic Man.—Although I have very carefully searched the river-gravels, I have as yet obtained none of the roughly chipped flint instruments assigned to the *Palæolithic* age. As bones of the

FIG. 1.—WEST LEICESTERSHIRE. GENERAL SECTION.

FIG. 2.—EAST LEICESTERSHIRE. GENERAL SECTION.

Mammoth, Rhinoceros, &c., however, occur rather plentifully, it seems possible that by continued research we may identify the presence of man at the same period.

The later or *Neolithic* stone implements are not rare. Many celts, hammer-heads, scrapers, &c., have been found. When the use of stone tools had been superseded by others of metal, the former tools were still used in religious ceremonies, political observances, household rites, &c., in which it has been the custom of all nations to preserve, as far as possible unchanged, the outward signs and tokens of such usages. In this way it can readily be imagined that these curious stone objects would gradually come to be regarded as sacred, and this alone is a proof of their great antiquity. Thus, in the British Museum there are two beautiful Etruscan gold necklaces, each of which has, as a pendant, a small flint arrow-head. In the Leicester Museum there is a "Lucky-stone" from Wymeswold, which was the centre of a similar superstition. It is an oval flint pebble with a hole passing through it, and had been preserved in one family for many generations. It was reputed to keep off witches, prevent the entrance of fairies into the dairy, charm off warts, keep milk from going sour, with various other valuable virtues. But such a belief was at one time not uncommon, and the children's song—

" Lucky-stone, lucky-stone, bring me some luck,
To-day or to-morrow, by twelve o'clock,"

is another remnant of a wide-spread superstition, whose origin may date further back than is generally supposed.

2. ON THE DISTRIBUTION OF FLINT IN THE CHALK OF YORKSHIRE.

By J. R. MORTIMER, Esq.