"Report of the United States Geological Survey of the Territories," Vol. ii. "The Vertebrata of the Cretaceous Formations," by E. D. Cope; from Dr. F. V. Hayden.

"Bulletin of the United States Geological and Geographical Survey of the Territories," No. 6, Second Series; from Dr. F. V. Hayden.

"Abstracts of the Proceedings of the Geological Society," Nos. 315 and 316; from that Society.

"Journal of the Society of Arts," March, 1876; from that Society.

"Transactions of the Manchester Geological Society," Vol. xiv, Part 2; from that Society.

"Transactions of the Watford Natural History Society," Vol. i, Part 3; from that Society.

"Proceedings of the South Wales Institute of Engineers," Vol. ix, No. 4; from that Institute.

"Proceedings of the Warwickshire Naturalists' and Archæologists' Field Club," 1875; from that Club.

The following were elected Members of the Association:—

Alfred K. Huntington, Esq., Memb. Phys. Soc.; the Rev. Robert Johnson; and H. Wolfram, Esq.

The following Paper was read:—

ON THE VOLCANOES OF ICELAND, WITH SPECIAL REFERENCE TO
MOUNTAINS WHICH HAVE RECENTLY ERUPTED.

By WILLIAM LORD WATTS, Esq.

EXCURSION TO GRANTHAM AND NOTTINGHAM.

EASTER MONDAY, APRIL 17, 1876, AND FOLLOWING DAY.

Directors—THE REV. ALEXANDER IRVING, B.A., B.Sc., F.G.S.,
and W. H. HOLLOWAY, Esq., F.G.S., H.M. Geological Survey.

(Report by THE REV. MR. IRVING.)

The Directors, chosen for their special knowledge of the geology of this part of the country, were W. H. Holloway, Esq., F.G.S., one of the officers of Her Majesty's Survey, at present employed in the district about Grantham and Newark; and the

Rev. A. Irving, F.G.S., who is known in Nottingham from his former connection with the High School. The programme was a somewhat extensive one, and moreover time had to be allowed for the journey of the major portion of the party from London on Monday morning. It included the examination of sections in the various formations lying within easy reach of Nottingham, which range from the Lincolnshire Limestone (Inferior Oolite) downwards to the Coal Measures.

On the way by train from Peterborough to Great Ponton, glimpses were obtained of most of the Lower Oolite series. At the former place the Cornbrash is seen in the bank at the side of the station premises, and its exposure extends thence nearly two miles along the line towards Essendine. At the Casewick cutting is a freshwater gravelly deposit, containing freshwater shells and fossils derived from the Oxford Clay. The Cornbrash is seen at the bottom of the cutting, and again in the Banthorpe cutting. On leaving Essendine Station the Great Oolite limestone is seen overlying the clays of the Upper Estuarine series. In the Dane's Hill cutting a slight synclinal curvature of the strata has exposed :—

1. Cornbrash (a little on the top near the north end).
2. Great Oolite Clay.
3. Great Oolite Limestone (two very hard distinct bands).
4. Upper Estuarine Series.
5. Inferior (Lincolnshire) Oolite, reached at the south end.

From this place to Little Bytham, cuttings occur in Lincolnshire Oolite, with clays of the Upper Estuarine series occasionally overlying it; and from thence to Corby these ferruginous sands, with frequent false-bedding, are very well exposed in a number of cuttings. From Corby to Great Ponton we have first a small cutting in the Great Oolite limestone; next a long cutting through Boulder Clay; then (leading to the tunnel) a cutting in which numerous blocks of limestone are seen jutting out of the Boulder Clay. On leaving the tunnel the Boulder Clay is still seen resting on the eroded surface of the limestone not far from Ponton.

Work with the hammer commenced in the Great Ponton cutting, where the train from London arrived at twelve o'clock on Monday. Here the party was joined by the local conductor from Grantham, and Mr. Holloway gave a short lecture on the nature and fossil contents of the strata (of which about 30 feet are exposed at this

spot), embodying the chief results of the labours of Professor Morris and others in the district, some twenty-five years ago. The beds exposed belong to the upper part of the Lincolnshire Oolites. The section may be roughly represented by the following tabulated statement :—

1.—Rubbly Oolite	5 feet.
2.—Eight to ten beds of Shelly Oolite (in some parts soft), very fossiliferous, with five zones of <i>Terebratula</i> and <i>Lima</i> , in various stages of growth ...	15 feet.
3.—Soft Marl, containing Oysters in abundance at the north end, dividing and becoming thinly laminated towards the south	4 in. to 1 foot.
4.—Marly Rock, with Corals, <i>Nerinea</i> and <i>Turbo</i> , somewhat irregular	2 feet.
5.—Coarse Shelly Oolite and Freestone...	15 feet.

Owing to the recent widening of the cutting, unusual facilities were offered for examining this section and procuring fossils, and after plying the hammer vigorously for half an hour or so, the party proceeded to another section in the same formation, which has been formed by the Little Ponton cutting. The courtesy of the Great Northern Railway Company deserves special acknowledgment here. Not only did they respond promptly to the request made by the Secretary for permission to work upon their line at these two spots, but to ensure the party against accidents from trains they generously gave the Association the services of one of their own officers, whose special knowledge of the traffic relieved the Directors of the Excursion from some anxiety and responsibility. At Little Ponton, the cutting is much deeper than that at Great Ponton, and (the strata lying in both cases nearly horizontally) a greater range of beds is exposed. At the former place, too, they are much thicker than at the latter, more massively bedded, but much more sparsely fossiliferous. They are much disturbed and broken in one or two places, the numerous fissures resulting from this being, in many cases, lined with stalagmite and other forms of carbonate of lime. The nature of the beds examined in this section may be seen from the following (in descending order):—

1.—Rubbly Oolite composed of "Rag" and very comminuted Shelly Beds, with compact Shelly Beds, some "pisolitic"	15 feet.
2.—Thin band of Slaty Clay	2 to 3 inches.

- 3.—Compact Marly and Shelly Rock, with *Lucina*,
Pinna, *Ostrea*, *Trichites*, and Corals ... 5 feet.
- 4.—Marly Oolitic Rock, containing *Gervillia acuta* ... 5½ feet.
- 5.—Compact Marly Rock, with few Oolitic grains ... 1 foot.
- 6.—Thin bed of Clay ... 2 to 3 inches.
- 7.—Coarse-grained Oolitic Rock ... 6 feet.
- 8.—Stratified Grey Sandy Clay ... 1½ feet.
- 9.—Marly Oolite full of small *Pectens* ... ½ foot.
- 10.—Compact Marly and Sandy Rock, with *Gervillia*
acuta and *Trigonia Phillipsii* ... 3½ feet.
- 11.—Ferruginous Sandy Oolite, with shells in fragments,
forming the base of the series known as Lincoln-
shire Limestone ... 1 foot:

This fine section, replete as it is with stratigraphical interest, furnished few complete specimens, owing to the broken and comminuted condition of its organic remains. The above sections were furnished by Mr. Holloway.

The Members having regained their carriages, made for Grantham. Before passing over the railway to the south of this town, they drove along an elevated tract of country, formed by the ferruginous beds of the sands which mark the passage from the Upper Lias clays to the Inferior Oolite. These beds may be seen in the cutting to the south of the bridge, capping the dark blue clays of the Upper Lias. They correspond with the lower series of the Northampton Sands, which have been very extensively worked of late years for iron ore. From the investigations of Samuel Sharp, Esq., F.G.S., of Northampton, it appears that the Lincolnshire Limestones lie between two such series of ferruginous sands of estuarine origin; and that the thinning-out of the limestone about Oundle allows the upper and lower series to coalesce, and so form the thick deposit of ferruginous ore which has made the country about Kettering and Wellingborough famous. From Grantham the route lay through Harlaxton and Denton to Croxton. On the way a fine view was obtained of the Lincolnshire "Cliff" (a worn-down escarpment of Lincolnshire Oolite), and two interesting road-sections were obtained—the first exhibiting the junction between marlstone and clays of the Middle Lias series; the second the passage from the Upper Lias clays into the ferruginous sands described above. One incidental feature of this Easter excursion was the quantity of drifted snow through which the carriages had to pass, from the heavy downfall of the previous Thursday.

At Croxton the party was met by W. Ingram, Esq., of the Duke of Rutland's estate, who pointed out various features of the surrounding country (including some remarkable terraces in the valley of the Devon) as the route was continued towards Belvoir Castle, where, through the liberality of his Grace the Duke of Rutland, the lovers of geology were to be regaled with a sumptuous luncheon. To this justice was soon done under the presidency of W. Green, Esq., the Duke's agent, and a cordial vote of thanks having been passed to his Grace, the party, refreshed and invigorated, proceeded—some to view the interior of the castle, others to see the magnificent gardens and rock-work. Bidding adieu to these lofty towers, the party arrived, after about an hour's drive, at Elton Station. The night was fast closing in by this time, and therefore a very imperfect examination only could be made of the Rhætic Beds which are exposed here, and of the gypsum quarries which are worked in the uppermost beds of the Keuper series. So the first day ended by the party taking the train to Nottingham, and being soon snugly housed at the George Hotel.

THE SECOND DAY (Tuesday) was well-occupied. Leaving Nottingham by the 9.30 train in the morning, paying a visit on the way to the Nottingham Natural History Museum, which had been opened for the purpose through the kindness of the Mayor and the Museum Committee, the extensive stone-quarries in the neighbourhood of Mansfield were visited. The stone quarried hereabouts is not a pure dolomite or magnesian limestone, but consists of an admixture of (roughly speaking) about 45 per cent. of carbonate of lime and magnesia, with from 1 to 3 per cent. of oxide of iron, and about 50 per cent. of silica. Hammers were freely called into play, and specimens procured of both the white and the red varieties of "Mansfield stone." As good fortune would have it, the progress of the works at the quarries belonging to R. C. Lindley, Esq., of Eastwood (who had readily granted access to the Members of the Association) had necessitated the removal of the Upper Permian Marls which overlie the Magnesian Limestone, and the Members present had a good opportunity of viewing the uneven and eroded surface upon which these marls were deposited. After visiting Mansfield Woodhouse, and spending some time in examining the purer beds of dolomite which are quarried in that locality, and afford great facilities for studying "irregular bedding" and

"oblique lamination" on an unusually large scale, the party found its way back to the Swan Hotel, at Mansfield. Taking the train for Bulwell, they made their nearest way to Cinder Hill. In the brick-yards belonging to C. Seeley, Esq., the Upper Permian Marls which had been examined at Mansfield were again recognised, resting, as in the former instance, upon the Magnesian Limestone strata. The marls are succeeded (in ascending order) by rather hard deep-red sandstones, considered by the geological surveyors to be the highest member of the Permian System; a group of strata which some geologists prefer (on a more complete review of the evidence) to consider as "Lower New Red Sandstone." There is no unconformity apparent between the highest bed of the "Permian" and the lowest bed of the Triassic series (Bunter) at Cinder Hill; the only line of demarcation is a band of brecciated materials which varies in thickness from a few inches to about three feet. The breccia contains a variety of fragments, the greater number consisting of sub-angular pieces of limestone, much altered by the action of water, and somewhat dolomitic in character. They appear, however, to be derived, not from the Magnesian, but from the Carboniferous Limestone, since many of them contain undoubted fragments of encrinites; and in the same breccia at Kimberley such fragments are even more frequently met with. This being so, there remains no evidence to be drawn from this breccia-bed, of any very great period of time having elapsed between its deposition and that of the Permian strata beneath it, to which it belongs just as much as to the Bunter above, passing as it does in some places underneath the uppermost layers of the sandstones of the Upper Permian. In the examination of this section much valuable assistance was obtained from E. Wilson, Esq., F.G.S., of Nottingham, who has done good work in the Permian and Triassic strata of the district, and to whose well-drawn sections the members of the party were much indebted. Much interest was added to the study of this section, and of the faults by which it is intersected, by a short lecture on the ground from George Fowler, Esq., F.G.S., the mining-engineer of the collieries, who gave a clear and perfect explanation of the effect of the faults upon the Coal Measures underneath the Permian at this place, and by the diagrams by which this was illustrated. The Magnesian Limestone is here faulted up against the Upper Permian and Bunter strata, and while these two formations are equally

affected by the fault, the Coal Measures below them have been proved by actual measurement to be dislocated by some 60 yards of vertical displacement more than the two series which here crop out at the surface. The enormous lapse of time which must be postulated to allow for 60 yards of displacement by the slow sliding of the strata against one another on opposite sides of the fault, before the Permian strata were deposited upon their denuded surface, is recorded also at Kimberley, where the base of the Permian System is now exposed in two new railway sections resting unconformably upon the planed-off edges of Coal Measure shales and sandstone. Much interest appeared to be aroused by the evidence which the brickyard sections and those in the railway cutting not far distant afforded of the close relation that exists between the so-called Permian strata and those of the Bunter above them, the conclusions inferrible from the examination of them in this district being very different from those which we draw from the perusal of ordinary text-books of the science, and tabulated statements published by persons in authority. A walk from Cinder Hill along the new railway afforded opportunities for further study of the Bunter and so called Permian strata, and in the cuttings which form the approaches to the tunnel at Watnall magnificent sections were obtained. Here and near Kimberley, on the new Midland line, the Magnesian Limestone and Marl Slate series may be studied with unusual facility at present. They rest upon a base of exceedingly hard calcareous breccia, which forms the base of the Permians over a large district in Nottinghamshire. Very compact in texture, this breccia varies in thickness from one to three feet; and throughout the calcareous matrix numerous small angular fragments are dispersed, the origin of which cannot be easily determined. Small cavities, too, are of frequent occurrence, lined, in some instances, with calcite; in others with iron pyrites. Above it about twenty-five feet of Marl Slate occur, in which Mr. Wilson has found casts of *Axinus*; below it the Coal Measure clays and shales, containing nodules of hæmatite, dip to the north east, with an unconformity of about 15 degrees.

A walk of about three miles brought the party to Ilkeston, where the train was taken for Nottingham and London.