while the 18·6 year tide in the body of the earth would keep the earth fast from 1862 only to June 30, 1871, Professor Newcomb's observations would show that the earth has been going fast, at least down to the latter part of last year—1877; and besides the changes caused by the 18·6 year tide could not, I believe, be as large as those deduced by Professor Newcomb from the apparent variations of the moon's motion.

NOTICES OF MEMOIRS.

I.—Geological History of the North American Lake Region.[1] By George Maw, F.L.S., F.G.S.

FROM Haysville I proceeded to Toronto, thence down Lake Ontario, with flat shelving shores here and there, with a low cliff of lake silt, in which, as far as I could observe from the steamer, glacial boulders were absent, though inland from the lake glacial drift was everywhere visible. The "Thousand Islands," at the eastern end of the lake, seemed to consist in part of glacial drift; some of the smaller islands of granite or a hard metamorphic rock, the whole densely covered with low deciduous woods and Hemlock Spruce. The low rocks were thoroughly rounded by ice action, possibly by post-glacial floating-ice passing over them, prodigious quantities of which are annually carried down the river during the spring thaw. The lake gradually narrows amidst an archipelago of little islands, and tapers imperceptibly into the great river. One of the most striking features throughout its length to Montreal is the absence of that sloping conformation of the land towards the river channel, the result of graduated subaërial drainage which is characteristic of most large river valleys, and the St. Lawrence seems placed inharmoniously in relation to the adjacent land contour. It has its channel between low banks, and that is all, and the observer fails to detect that graduated contour which the contributory ramifications of all ancient rivers have sculptured from their watersheds to their main channels of drainage; moreover, the St. Lawrence has an indecisive course, here splitting itself up against trifling obstacles into numerous channels, again uniting and spreading itself out into broad shallow lakes over the land, reminding one of the behaviour of a sudden rush of storm-water over a course unprepared for it. The St. Lawrence is obviously a new river and supplies a fresh line of drainage compared with the ages of many other rivers, and its history must be viewed in relation to the origin of the great chain of lakes of which it is the outlet.

The surface levels of the lakes step gradually upwards. Ontario is 235 feet above the sea; Erie, 564 feet; Huron, 595 feet; Superior, 627 feet above the sea. But their depths have no relation to the order in which they occur from the watershed to the sea, for the bottom of Ontario nearest the sea is 365 feet below the sea-level. The bottom of Erie is 462 feet above the sea-level of Huron, 145 feet above the sea; and of Superior, at the inland end of the chain

[1] Extracted from "American Notes," *Gardeners' Chronicle*, 1878, pp. 169, 170.

of lakes, 65 feet below the sea. Michigan is merely a great bay lying off from the main line of drainage. It is obvious that the present relative depths of the connected chain of lakes are inconsistent with their being merely the flooded sections of an old river valley, for the bottom of Ontario, the lake nearest the sea outflow, is 365 feet below the sea, and 600 feet below its own outflow into the St. Lawrence; the bottom of Superior, the lake furthest inland, is 65 feet below the sea, and 527 feet below the bottom of Erie, which intervenes, and no less than about 570 feet below the river-bed outlet of Erie.

A glance at the map will show how closely the watershed line environs the great lake district. The lakes receive no long rivers, and it is a mere narrow belt of land that drains into them, beyond which the drainage goes north towards Hudson's Bay, south towards the Mississippi, and east by the Ottawa. Several of the rivers running into the great lakes have on the map a curious aspect of continuity with the tributaries of the Mississippi system; this is especially noticeable in the case of the Wisconsin flowing into the Mississippi, and Fox River flowing north-east into Green Bay of Lake Michigan. The same relation is observable between the Wabash flowing into the Ohio, and the Maumee running into Lake Erie; and it is worthy of observation that the tributaries of the Maumee are bent back in a direction rather ranging with the direction of the confluents of the Wabash than with that of the Maumee, with which their main course forms an acute angle *against the stream.* If the lake area is a region of depression, it seems possible that the extremities of the confluents of the Mississippi may have been depressed towards the lakes, and the waterflow diverted northwards without the old valleys being obliterated.

We must set aside the view that the chain of large lakes is due to glacial excavation; for Ontario, the deepest of the lakes running east and west, is in lower latitude than Huron, the bottom of which is 510 feet above that of Ontario, and there is no high ground about Ontario from which ice could have originated as a preponderating mass, capable of excavating Ontario 600 feet deep; nor is there any such mass of *débris* anywhere to be seen about the lake as would represent such an excavation.

New York State, bordering on Ontario, abounds with small lakes, running north and south, between escars and drift ridges, evidently of glacial origin, and which have nothing in common with the direction or character of the larger lakes, which must be the result of the subsidence of the area, bounded by their environing watershed, resulting in a fresh basin of drainage towards the Atlantic, the former drainage of which was divided between the Mississippi basin, Hudson's Bay, and the Ottawa. The contour of the land surface north and south of the great lakes seems to indicate that the subsidence of the containing area was subsequent to the glacial excavation of the numerous small lakes running north and south, and it seems probable that the Niagara gorge, as well as the St. Lawrence, down to its junction with the Ottawa River, are of post-glacial origin.

II.—On the Geology of the Environs of Dublin.[1] By Prof. E. Hull, M.A., F.R.S.

THE author remarked that the subject had been ably treated by the Rev. Maxwell Close, President of the Royal Geological Society of Ireland, in the hand-book issued by the Local Committee of the British Association. An excellent account of the same subject had been given by Mr. Baily, and also in the very interesting publication called "Science Gossip." It had been the habit to begin the meetings of the Section by giving a short description of the locality in which the Section met, and in conformity with that custom he would give a brief account of the geological structure of the environs of Dublin. Before doing so, he might refer to the physical features for the benefit of the strangers, who had honoured them with their presence. The first feature that strikes the stranger upon entering Dublin Bay is the beautiful range of hills, with their several sharp or prominent peaks, lying to the southward. These are the extremely northern points of the Dublin and Wicklow mountains, which might be called the south-eastern highlands of Ireland. They commence in the neighbourhood of Kingstown and Killiney, and extend in nearly a southerly direction to Waterford, a distance of about 40 miles, with an elevation at Lugnaquilla of 3039 feet. To the north and west of this range extends the great central plain of Ireland, which stretches from the shores of the Irish Sea, between Dublin and Dundalk, across the country towards Galway Bay. It is bounded on the south of this range of hills, which commences at the Devil's Bit, extending southwards towards the county Limerick, crossing the Shannon above Limerick, and going towards Clare and Galway; thus forming the outworks of the great south-western highlands, which includes the mountains of Kerry, Cork, and Waterford. To the north there is another range of hills of not so great an elevation, and then to the west are the western highlands of Galway, Mayo, and Sligo, including the beautifully picturesque tract of Connemara. All these hills are of older formations than the central plain. They rise from beneath that plain, throwing off the newer formations in every direction. It is a curious geological paradox that the oldest formations generally occupy the highest ground. As to the geological structure, it might be better to take the order of deposition or natural order of birth. The oldest formations in Ireland are represented in the neighbourhood of Dublin to the north and south of the bay. This formation is called the Cambrian, similar to the Lower Cambrian in North Wales. They consist of enormous thicknesses of reddish and green slates, grits, and quartzites traversed by great fissures. These beds are very well laid open along the railway cuttings at Bray Head, where some would have an opportunity of inspecting them on Saturday; also at the Hill of Howth, where the strata was of a precisely similar character. They were characterized by very simple forms of animal life—*Oldhamia* of two

[1] Read before the British Association for the Advancement of Science, Dublin, (Section C.), August 15, 1878.

https://doi.org/10.1017/S0016756800151027 Published online by Cambridge University Press

species, and also by tracks and borings of marine worms. This formation was immediately succeeded by what was called the Lower Silurian, which formed the main tract of the country, ascending the mountains in some instances even to the summit of Lugnaquilla, the core of the range being granite. This granite had been intruded through the Silurian rocks, and, curiously enough, not through the Cambrian rocks, but had affected the Lower Silurian rocks to such a degree that, from being formed of fossiliferous slates and grits of a darkish grey and brown colour, they had been converted into what was called "metamorphic strata," accompanied by the development of certain minerals. Mica had been developed where these rocks came into close proximity with granite. Granite was, therefore, of a newer date than these Lower Silurian rocks, for otherwise the Lower Silurian would not have been metamorphosed by contact with the granite. The junction was very well seen in numerous places, especially at the foot of Killiney Hill, where the dykes of granite could be seen penetrating the slaty and micaceous schists, also at the remarkable gap, the Scalp, and on ascending Glendalough Valley. The chief limestones were to be found at the chair of Kildare, and on the east coast opposite Lambay Island. These were representatives undoubtedly of the Bala limestone of North Wales, and had yielded a magnificent series of fossils representing the Lower Silurian period. This brought them to the subject of the age of the Dublin and Wicklow mountains; when they were first elevated; when they first received their great foldings and contortions, and when the enormous mass of molten matter now constituting granite was first intruded amongst these bodies. To determine this question they had of course to refer to formations newer than the Lower Silurian. At the extremity of the Wicklow and Wexford range they found Old Red Sandstone resting discordantly on the upper edges of the Silurian rocks. Therefore, the Old Red Sandstone was newer than the period of metamorphosis, which was the period of the first birth of these mountains. Just as in Scotland, along the flanks of the Grampian Hills, they found the Old Red Sandstone resting upon the crystalline rocks, which were of the same age as those of the Dublin mountains. Thus they had in both countries similar phenomena. The Silurian rocks were upheaved and converted into land before the Old Red Sandstone period. He believed the age of the Dublin and Wicklow mountains might be placed at that interval of time which elapsed between the close of the Lower Silurian period and the commencement of the Upper Silurian period. The Old Red Sandstone was scarcely represented within the area described, except in the neighbourhood at Kiltorcan, on the borders of the counties Wicklow, Wexford, and Carlow. It had, however, yielded some magnificent ferns and other fossil plants which could be seen in the Museum of the College of Science. The next formation was the Carboniferous, which was, perhaps, the most important, extending over the plain north and south, and principally represented in the neighbourhood of Dublin. It consisted of three divisions—lower, middle, and upper. The

https://doi.org/10.1017/S0016756800151027 Published online by Cambridge University Press

middle was of an earthy character, darkened by carbonaceous material, probably that of marine algæ. The whole formation was undoubtedly a great marine or oceanic deposit. It was in the first place full of marine shells, the same as those existing in the sea at the present day. Taking a thin section of any specimen of Carboniferous Limestone, however dense and apparently unfossiliferous, let the slice be so thin as to be transparent under a microscope, and they would find it consisted of a mass of shells resembling those of the little animals of the simple forms of life which exist in such vast numbers over the floor of the ocean at the present day, namely, *Foraminifera*. The Carboniferous Limestone was in all about 3000 feet thick, so that the building up of the great organic formation over the floor of the ocean must have taken a period of indefinite duration. When they went to Kilkenny and Carlow, they found the representatives of the Middle and Upper Carboniferous series analogous to that of the British and Welsh Coal-fields. Professor Hull then proceeded to refer to glacial deposits. No one had contributed more to the elucidation of this subject than the Rev. Maxwell Close. He had shown that the whole of this part of Ireland was at one time covered by a thick sheet of ice, which has left its marks upon the solid rock wherever that rock has been sufficiently protected to prevent the marks being obliterated by time. Those who would be able to be present at the examination of Bray Head on Saturday would have an opportunity of seeing the glacial scorings and groovings upon the surface of the quartzite near Killiney Hill. Drift formations were well represented in the neighbourhood of Dublin. They consisted of three divisions. The oldest was Boulder-clay—a formation which disgusted and dismayed engineers and contractors, but had furnished a good deal of interesting speculation to geologists. It contained blocks of rock generally glaciated or worn by ice, grooved, and scored. Some of these glacial stones were to be found in the present excavations at Stephen's Green. The stones were not only grooved and scored, but had a polished surface, showing that they had been ground and rubbed over solid rock as the ice was moving along. Undoubtedly the Lower Boulder-clay was the result of the original ice-sheet which covered the whole country, moving in the neighbourhood of Dublin from the north-west towards the east and south-east, and, what was very remarkable, moving through the central plains over the hills which rise between it and the sea, by a force he was not going to speak further of. Let them just fancy that sheet of ice being obliged to pass from the lower ground over such hills as Killiney and Bray Head out towards the sea. The Lower Boulder-clay was succeeded by another series of drift strata, entirely different, consisting of stratified sands, gravels, and marine shells. A beautiful selection of these shells was open for examination at Howth, close to the telegraph-station at the beach, and in half an hour an excellent collection of glacial shells of the period might be obtained. These shelly gravels were, of course, deposited under totally different conditions from Boulder-clay, which underlay them, because they were evidently deposits which had been formed in the sea of the period.

These shelly gravels only covered portions of a lower tract of country in the neighbourhood of Dublin, and they ascend the flanks of mountains to the height of 1100 or 1200 feet above the sea, showing, he thought, that the land had subsided to that extent beneath the sea, so that only the mountains of higher elevations would rise above the level of the water and appear as islands. There was another very remarkable formation, that of the Upper Boulder-clay, which could be seen at Howth, and which succeeded that to which he had alluded. There was only one other formation to which he would refer, and that was the remarkable raised beach which extended along the eastern coast from Wicklow to the Giant's Causeway, round to Donegal. This raised beach was represented by a terrace of shelly gravel belonging to the neighbouring seas, and showed that the shore had been within a very recent period elevated from 3 to 4 or 10 feet in the neighbourhood of Dublin, and to a greater degree in the North. This beach was shown by the Esplanade at Bray, which was really an old sea-bottom raised five or ten feet above the original position. In the North of Ireland the shelly beach was found to contain some of those arrow-heads and flint instruments to which the President had alluded. They would see from what he had said that they had within a short compass a very considerable series of formations, and he hoped the sketch he had given would enable geologists, and those who took an interest in the subject, to better understand than they otherwise would some points of interest in the geological structure of the neighbourhood of Dublin.

III.—On some New Pre-Cambrian Areas in Wales.[1] By Henry Hicks, M.D., F.G.S.

During some recent researches in Wales the author has been able to add many new areas to the pre-Cambrian rocks already described. In these examinations he has been assisted at different times by Prof. Torrel, of Stockholm, Prof. McKenny Hughes, Mr. Tawney, F.G.S., and Dr. Sterry Hunt, of Montreal. The additional areas to be now added to those previously known are:—

1. Some cupriferous schists with their associated greenstone bands (the so-called intrusive greenstone of the Geological Survey) to the north of Dolgelly, and including a great portion of Robel Tawr.

2. Masses of granitoid rocks, porphyries, and greenstone breccias, in the neighbourhood of Pwllheli.

3. The porphyries and granitoid rocks forming Mynydd Mynytho, and extending in a northerly direction towards Nevin, including also Nevin mountain and the porphyries and greenstone breccias to the north-east of Boduan.

4. The Rhos Hirwain syenite and the so-called altered Cambrian beds to the west of that mass in Caernarvonshire, and also Bardsey Island.

[1] Abstract of paper read before the British Association for the Advancement of Science, Dublin (Section C.), August 19, 1878.

5. The granitoid rocks, felstones, and porphyries, forming the Rivals (yr Eifl) range of mountains.

6. The so-called altered Cambrian rocks to the west of the Penygroes porphyry.

7. The so-called intrusive granite in Anglesea, and the whole of the area marked as altered Cambrian in that island. In addition to these he has also extended some of the areas and defined more clearly the order of superposition of these rocks in Pembrokeshire. In North Wales, as in South Wales, he found that the pre-Cambrian rocks resolved themselves into three well-marked and very distinct types, and that these indicated separate formations, each of which, on careful examination, and when found in juxtaposition, proved to be unconformable to the other. At St. David's the granitoid rocks occur at the base, and, resting unconformably upon these, are found the quartz-felsites. These are again succeeded unconformably by the agglomerates, breccias, greenstone bands, and schists of the Pebidian group.

In North Wales this was also exactly the order in which the various rocks were found to succeed each other, but the middle or quartz-felsite group was found more largely developed in Caernarvonshire.

As this middle group had not previously been separated under a distinguishing name, the author now proposed to adopt for it the name *Arvonian*, from the Roman name *Arvonia*, and from which the present name of Caernarvon is derived. So many of the large ridges and lofty mountains of Caernarvonshire are composed of these felsitic rocks, that it appeared to the author and his friends that this name would be very appropriate for the formation. The distinguishing characters most marked in these three pre-Cambrian formations may be briefly summed up as follows:—

1. *Dimetian:* Granitoid gneiss and quartzose rocks.

2. *Arvonian:* Quartz, felsites, and porphyries (Helleflinta of Torrel; petro-silex rocks, Hunt).

3. *Pebidian:* Green and purple agglomerates and breccias, green chloritic schists, with massive greenstone bands, talcose schists, etc.

In these formations the bedding is usually easily recognized, but at present the actual stratigraphical thickness cannot be correctly estimated. It is perfectly clear, however, from the sections exposed, that each must have a vertical thickness of many thousand feet. That they have a very extended geological distribution over the British Islands is also daily becoming more and more evident.

IV.—On the Supposed Radiolarians and Diatomaceæ of the Coal-Measures.[1] By Professor W. C. Williamson, F.R.S.

THE author called attention to the *Traquariæ* of Mr. Carruthers, found in the Lower Coal-measures of Lancashire and Yorkshire, which small spherical objects that observer believed to be Radiolarians like those still living in existing seas. The author showed

[1] Read at a Meeting of the British Association, Dublin (before Section D, Biology), August 19, 1878.

that the radiating projections with which these spheres are surrounded were not siliceous spines like those of the Radiolariæ, but extensions of a continuous membrane which inclosed the entire organism, and which, therefore, could not have the spicular nature attributed to them. He then demonstrated that within this external membrane is a second inner one, which latter is fitted with numerous small vegetable cells like those shown to exist in the interior of fossil spores and reproductive cryptogamous capsules, found in the same beds as those which furnish the *Traquariæ*. These conditions are so different from those existing in any known recent species of Radiolarian as to lead Professor Williamson to reject the idea of their Radiolarian character. Their close organic resemblance to some obviously vegetable conceptacles found in the same Coal-measures suggest that the *Traquariæ* are also vegetable structures. The Mountain Limestone deposits of some British localities contain a vast multitude of minute calcareous organisms, which Mr. J. W. Sollas and other observers regarded as Radiolarians. These structures, however, seem to exhibit no satisfactory evidence of being so. In the first place, these organisms are calcareous instead of siliceous. It has been suggested that their siliceous elements were removed and replaced by carbonate of lime, but this appears to be most improbable. Professor Roscoe and Professor Schorlemmer agree in stating that they would require overwhelming evidence before they would be prepared to accept such an explanation of the present condition of these objects, or of the fact of the substitution of carbonate of lime for silica, which such an explanation renders necessary. Count Castracane has published[1] an account of a process by which he reduced numerous specimens of Coals to very minute quantities of Coal-ash, and has stated that he found in these ashes numerous marine and freshwater Diatomaceæ. Professor Roscoe kindly allowed one of his ablest assistants in his laboratory at Owens' College to prepare analyses of a number of Coals according to Count Castracane's method. The residual ashes of these preparations have been tested microscopically by Professor Williamson, and in no one of them can a trace of a Diatom be found. Beyond stating the fact, he is wholly unable to account for the discrepancy between his results and those of the Italian observer. So far as his present observations go, he finds himself compelled to conclude that we have no proof of the existence of Radiolarians or of Diatomaceæ in the British Carboniferous rocks.

V.—Underground Waters.[2] Fourth Report of the Committee on Underground Waters in those Districts in England where they are not at present used. By C. E. De Rance, F.G.S., Assoc. Inst. C.E.

THE author referred to the great value of the maps of the Government Geological Survey as a basis for the investigation

[1] See Geol. Mag. 1875, Decade II. Vol. II. p. 414.

[2] Read before the British Association for the Advancement of Science, Dublin, 16th August, 1878 (Section C).

in question of the water supply. He stated that the area occupied by permeable formations capable of yielding water in wells sunk in suitable situations was no less than 26,687 square miles, which, receiving a rainfall averaging 30 inches a year, would yield up to wells not less than 6 to 15 inches, or a daily quantity of not less than 200,000 gallons for each square mile of surface, or a total quantity far in excess of that required by the population of England and Wales. The great value of these supplies for the towns and districts of the Midland districts was insisted on by reason of their purity, and from the absence of strong Parliamentary opposition, which is encountered in all large gravitation schemes, whether the water be proposed to be taken from natural lakes, as in the scheme for Manchester, or from artificial reservoirs, as in the proposal for Liverpool. The well-boring at Bootle, near Liverpool, completed for the Liverpool Corporation by Messrs. Mather and Platt, was described as of great interest, the boring having reached a depth of 1,000 feet without reaching the base of the New Red Sandstone. The Committee expressed a hope that this boring may be continued, as it will settle several questions, not merely of local interest, but of national importance.

VI.—On the Rocks of Ulster as a Source of Water Supply.[1] By W. Traill, M.A.I., F.R.G.S.I., of the Geological Survey of Ireland.

THE author first contrasted the backward state of the study of hydro-geology in Ireland with its advanced progress in England. The necessity for better water supplies had been recognized by the larger towns, which had accordingly been supplied, but too many of those, with populations of 5,000 to 1,500 inhabitants, were still supplied only by shallow surface wells, a source universally condemned as scarcely possible to be free from sewerage pollution, the fruitful parent of disease. The two great systems of water supply were contrasted, that by catchment basins with large reservoirs, and that by deep wells or borings, the latter where practicable being undoubtedly considered the best. The rocks of Ulster were then reviewed with regard to their suitability as sources of water supply. The Lower Silurian rocks of Down, Louth, Armagh, and Monaghan did not possess the essential qualities necessary for success; neither did the granitic tracts of Mourne, Newry, or Rathfriland, nor the metamorphic rocks of Donegal and part of Londonderry, nor the districts of the Carboniferous Limestone. The New Red Sandstone formation, one of the great sources of water supply in England, was shown to occupy in Ulster a very limited surface area, in some districts yielding water by boring, and likely to prove productive in other places also, but requiring special selection of sites for operations. The Chalk and Hibernian Greensand formations were shown to be the great water-bearing rocks of Ulster, as evidenced by the large number of perennial springs along their outcrop. The geological basin of the Cainozoic in the counties of Antrim and

[1] Read before the British Association, Dublin, in Section C, August 19, 1878.

Londonderry was clearly demonstrative from the heights of the outcrop of the Chalk, up to elevations of a thousand feet; and its occurrence inside the basin, at Templepatrick and other places, was proof of its continuity below the basaltic plateau at a low level. The water, being held under hydrostatic pressure in the Cretaceous beds underlying impervious clays of the Lias or Keuper marls, required only to be tapped by boring through the overlying sheet of basalt to yield a practically inexhaustible supply of pure and wholesome water. The districts most favourably situated for thus yielding water supplies by boring were near Ballymena, Ballymoney, Coleraine, Antrim, etc. The author stated that for most localities the requisite depth to meet the Chalk could be readily calculated. He also enumerated the other water-bearing strata existing in the same sections, as at the lithomarge bed of the Iron-ore measures, and at the lower lithomarge bed, and also at the surface of the basalt if under a considerable head of drift. The author strongly advocated the adoption of boring for water supplies for certain districts in Ulster, as that system had been so advantageously adopted in England.

VII.—The Progress of the Geological Survey of Ireland.[1] By Professor E. Hull, M.A., F.R.S., Director of the Geological Survey.

PROFESSOR HULL gave a short account of the progress of the Geological Survey of Ireland from its commencement in 1832, under the late General Portlock, R.E., down to the present day, stating that the whole country south of a line drawn roughly from Larne on the coast of Antrim to Sligo had been surveyed, while 160 Sheets of the Geological Map, on a scale of one inch to the statute mile, had been published. Along with these had also been issued 78 separate Explanatory Memoirs describing the structure and palæontology of 126 Sheets. It had been found necessary to revise the geology of the Leinster and Tipperary Coal-fields, the Carboniferous trap rock of the County Limerick, and the South-East portion of the country, including parts of Wicklow and Wexford. The Coal-fields of the North of Ireland had also been surveyed and published in maps both on the 6-inch and 1-inch scales; and it was also intended that the districts of the County Antrim containing pyrolitic iron-ores should be illustrated by maps on both scales. The district still remaining to be examined included the greater portions of Donegal, Tyrone, Fermanagh, Sligo, and Antrim. Professor Hull entered into a brief description of the geology of the various parts of Ireland.

VIII.—On 'Hullite,' a hitherto undescribed Mineral.[1] By E. T. Hardman, F.C.S.

THE author stated that this mineral occurs in abundance at Carnmoney Hill, near Belfast, in the basalt forming the neck of a Miocene volcano. It has never been described before or analyzed,

[1] Read before Section C, Dublin, 20th August, 1878.

and has been referred to in the Survey maps and labelled in the Survey collections as obsidian, doubtless from its black colour and waxy lustre. In physical character it somewhat agrees with the *Chlorophæite of Maculloch, but is entirely different in composition,* which more resembles that of Delessite. From this, however, it differs essentially in colour, hardness, streak, and specific gravity, but it appears on the whole to belong to the ferruginous chlorite group. Physical characters—Colour, velvet black; hardness, 2; brittle; lustre, waxy to dull; very slightly affected by acids; occurs at Carnmoney and Shane's Castle, near Lough Neagh. The chemical composition of the mineral was given, and compared with those of Delessite and Chlorophæite. Its most remarkable characteristics are its low specific gravity and its resistance to the blow-pipe—both curious points, considering the large quantity of iron it contains. The author proposed to call the mineral Hullite, after Professor Hull, in commemoration of the valuable work he has done in elucidating the microscopic mineralogy of the basalts of Ireland. Professor Hull has examined the microscopic structure of the mineral, and of the rock in which it occurs, and has described the appearance presented by the mineral. Under the microscope it is of an amber brown colour, nearly opaque. It permeates the whole rock, filling the interstices, and inclosing the other minerals. It appears very much to assume the character of chlorite, and is undoubtedly a distinct mineral, and not a product of alteration.

IX.—On the Age of the Crystalline Rocks of Donegal.[1] By Professor W. King, D. Sc.

THE author said that the Crystalline Rocks of Donegal had been carefully studied, both in their petrological and geographical features, by Hampton, Scott, Harte, Griffith, Jukes, Blake, Harkness, and others; but among them some authors had succeeded in determining their geological age by means of fossils. It was true that the limestones in the Innis lower barony, in the northern part of the county, contained bodies which had been suspected to be the remains of corals, but it was to be regretted that none of these bodies, so far as is known, possessed sufficient evidence to enable palæontologists to offer a decided opinion as to their nature. Having been lately in Donegal, besides examining their mineral and structural character, he embraced the opportunity of endeavouring to find if any of the rocks occurring in this county, especially the Innis Lower Limestones, contained fossils. In the south coast division of Donegal, between Lough Foyle and Lough Swilly, where the least altered rocks prevailed, some of the limestones had apparently undergone so little alteration that it might be expected that they would retain the remains of any organisms originally inclosed in them. The bodies taken for fossils and corals consisted generally of white calcite, and they were occasionally found of a cylindrical shape, with what appeared to be internal radiating plates

[1] Read before Section C, Dublin, August 21, 1878.

Notwithstanding that the contrary had been expressed, he could not but strongly suspect that they were actually the remains of large corals. He had, however, succeeded in obtaining some true fossils from portions of the Innis Lower Limestone, that had scarcely undergone any change. He had not had time to examine them as closely as he would have wished, but they appeared to be Caradoc Bryozoa from the schists of Donegal. This was the first example, as far as he could ascertain, of an undoubted fossil having been detected in these limestones. The fact may be taken as evidence that these deposits and their argillaceous and siliceous masses are of Lower Silurian age, and it seems highly probable that the more intensely metamorphosed rocks in the north-west division of Donegal belong to the same geological period.

X.—The Origin and Succession of the Crystalline Rocks.[1] By Prof. T. Sterry Hunt, LL.D., F.R.S.

As a preliminary to a statement of the results of many years of study of the crystalline rocks in North America, the author proceeded to consider the question of their origin, which is still a subject of debate between Plutonists and Neptunists. The crystalline silicate rocks naturally divide themselves into three groups—namely, those indigenous stratified formations which have been called primitive, or primary; those masses to which, from their relations to contiguous rocks, geologists assign an exotic origin, and, in accordance with a generally accepted theory, have agreed to call igneous or plutonic; and a third and distinct group of rock-masses which, though like the last, clearly posterior to those encasing them, are now, by most geologists, admitted to be of aqueous origin. This third group includes metalliferous lodes, and various other crystalline veinstones, and is conveniently designated endogenous. It is not always easy to distinguish between the rocks of these three groups; there are not wanting those who have assigned an igneous origin to metalliferous lodes, and many still confound endogenous granitic veins with the mineralogically similar plutonic granites. In like manner, the distinction between the latter and the stratified granitoid gneisses is frequently not very apparent. That the movement of flow in extravasated plutonic rocks may give to the constituent minerals a stratiform arrangement, is a fact of which both exotic granites and doleritic dykes and masses afford illustrations. Moreover, the arrangement due to successive depositions upon the walls of a fissure may give to an endogenous mass a structure which simulates that of a sedimentary rock, and imparting to granitic veinstones a resemblance to gneiss; while a laminated structure sometimes results from the arrangement of the crystals developed in a cooling mass. Hence there are not wanting those who include under the head of plutonic rocks not only the clearly marked exotic granites, dolerites and diorites, but the granitoid gneisses, the massive bedded greenstones, and likewise the more schistose rocks with which these gneisses and greenstones are often so intimately associated that

[1] Read before the British Association, Section C, Dublin, August 19, 1878.

it is difficult to separate them. According to those who hold this plutonic view the crystalline rocks represent the igneous crust of the globe, and their frequent stratiform structure is due to agencies in great part anterior to the production of sedimentary rocks. In opposition to this view is that of the Neptunist, who, starting from the fact that the elements of an aqueous sediment may through the action of chemical and crystallogenic forces, pass into new combinations and acquire a new structure, argues not only that all indigenous crystalline rocks have had an aqueous origin, but that the exotic masses themselves represent the last stages in this process of alteration or metamorphosis of sedimentary beds.

Further inquiry into the chemical and lithological composition of the crystalline rocks, however, brings to light difficulties in the way of both of these hypotheses. To begin with the Plutonist view, volcanic rocks, both ancient and modern, are more or less nearly related in composition to the gneisses and the stratified greenstones, but we seek in vain among undoubted volcanic or igneous rocks for the chemical representatives of the masses of serpentine, olivine, steatite, chlorite, quartzite, magnetite, oligist, and limestone, which appear in the primary formations, and have, all of them, by geologists of the school in question, been regarded as of igneous or plutonic origin. To account for the presence of such rocks among the more or less felspathic aggregates—chiefly gneisses and greenstones, which make up the greater portion of the crystalline formations—three hypotheses have been imagined by Plutonists. According to the first of these, the earth's interior is a reservoir, from which at times have been ejected not only basic and acidic felspathic rocks, but molten masses of olivine, iron-oxide, quartz, and limestone. Other geologists of this school have sought to account for the presence of some of these exceptional rocks by a process of so-called segregation, which would assimilate them to endogenous masses. The chemical and geognostical difficulties in the way of both of these hypotheses have, however, led to their general rejection for the third, which supposes these rocks to have been formed by a subsequent local alteration of portions of the ordinary plutonic rocks. From acknowledged cases of alteration or replacement in mineral species, which result in pseudomorphs, and from the more frequent cases of envelopment and isomorphism which have been taken for examples of pseudomorphism, it was argued that many species are capable of being changed into others by the loss or addition of certain elements, so that the resulting body often contains no portion of its original constituents. Extending this view from single crystals to rock masses, it was maintained that different portions of an igneous or plutonic formation, whether basic or acidic, might be transformed into serpentine, chlorite, or limestone. Those changes were supposed to depend on the action of water, which, aided by heat, was regarded as the efficient agent in the local alterations of plutonic rocks. At the same time, the adjacent sedimentary strata were supposed to share in these changes, thus giving rise to what have been called contact formations. In their latest form these doctrines have been well set forth by Von Lasaulx and by Knop. This third hypothesis then proposes to account for the presence of various exceptional varieties of rock among ordinary plutonic formations, by supposing that limited portions of these have at different times been the subject of very unlike chemical processes, resulting in their complete change into new forms of rock by what has been called pseudomorphic alteration, or metamorphosis. As, however, such a conversion involves a change not only of form, but of substance, it has been more properly designated a metasomatosis.

We have next to consider the Neptunean views as ordinarily expounded. This, while it accounts by sedimentation for the stratiform arrangement of the crystalline rocks, and explains the existence therein of beds of iron ores and limestones, still presents many of the difficulties which are encountered in the Plutonist view. If, as most Neptunists maintain, the great crystalline series have been derived from the alteration of uncrystalline ones, which were not only similar to those of Palæozoic and more recent times, but are, in fact, portions of those which in adjacent regions are still known to us in their original unchanged condition, how are we to explain the genesis of the felspathic and hornblendic rocks which predominate in these crystalline formations? The sandstones and shales from which in this view they are supposed to be formed could never by themselves give rise to the rocks in question, since they are deficient in the alkalies, and to a greater or less extent in the other bases required for the production of the constituent silicates. To explain their origin, therefore, it becomes necessary to admit the introduction of these various bases from without, and to suppose a series of metasomatic processes more wonderful than those imagined by the Plutonist. The latter, by his hypothesis, has already at hand felspathic and hornblendic rocks, which are to be the subject of metasomatosis, while the Neptunist has only the products of their decay. In either hypothesis, we have to account for the presence in the primary formations of beds and interstratified masses of a great number of exceptional silicated rocks, very distinct in composition from any mechanically-formed sediments, including not only silicates like serpentine, olivine, steatite, chlorite, pinite, garnet, epidote, and hornblende, but of pure orthoclase, as well as of triclinic felspar. Each of these species would require for its production from any ordinary igneous or aqueous rock a separate and independent metasomatic process, involving the addition of certain elements, and the abstraction of others, until the whole heterogeneous crystalline series was complete. The author illustrated these views by examples from recent writers, and concluded that the hypothesis of metasomatosis, as maintained both by Plutonists and Neptunists, supposes the operation in solid rocks of processes of circulation, absorption, elimination, selection, and aggregation scarcely to be equalled in the economy of highly-organized beings, and not easily imagined in the masses of the mineral kingdom. Certain geologists suppose the existence of two classes of crystalline stratified rocks, the one Neptunean, and consisting of altered portions of Palæozoic or more recent sediments; and the other—more ancient —which may be either Neptunean or Plutonic in origin. The history of geology gives many examples of crystalline formations which have been in turn assigned to various geological horizons, from the Cainozoic to the base of the Palæozoic, but have since been found to belong to a pre-Palæozoic period. In the opinion of the author, we have no good and sufficient reason for believing in the present existence of any uncrystalline representative of these crystalline formations, or of any such formation which is not pre-Silurian, if not pre-Cambrian, in age. There are, however, many examples of local alterations of later sediments by hydro-thermal action, which has developed in these many crystalline minerals identical with those found in the more ancient rocks.

The advocates of the Neptunean hypothesis have, for the most part, sought for the origin of the crystalline rocks in sediments of a later date, of which the uncrystalline representatives are still to be found. There are, however, reasons for believing that in Eozoic, or pre-Cambrian times, there prevailed chemical activities dependent upon greater subterranean temperature, different atmospheric conditions, and abundance of thermal waters, and that under these circumstances were deposited the materials for the crystalline rocks. There have not been wanting those who have sought in similar hypothetical conditions for the origin of these rocks. De la Beche, in 1834, imagined them to be chemical deposits due to the action of the heated ocean upon the earth's primeval crust before the dawn of life. The author's researches into the composition and structure of the crystalline rocks, conjoined with his studies of the chemistry of natural waters, led him, in 1860, to reject the hitherto received view of the epigenic or metasomatic origin of serpentine, steatite, chlorite, and similar rocks, and to maintain their derivation from silicates formed by chemical processes and deposited in the water of lakes or seas. This view he soon after extended to the various other exceptional rocks found in crystalline formations which it was, in 1864, asserted had been "formed by a crystalline molecular re-arrangement of silicates generated by chemical process in waters at the earth's surface." In elucidation of this view the author referred to the insoluble silicates now separated in the evaporation of many natural waters, to the formation from the earliest times to the present of deposits of serpentine, sepiolite, glauconite, and of aluminous silicates allied to chlorite, which are found either forming beds or filling the cavities of various marine organic forms, from the foraminifers of to-day to the crinoids of Palæozoic time, and the *Eozoon* of the Laurentian. The formation in modern times of crystalline zeolites and quartz in thermal waters was also cited in illustration of this view of the generation of various mineral silicates by causes now in operation which, it is believed, were far more active in Eozoic times. This was not, as had been already suggested by others, a process confined to a seething primeval ocean before the advent of life, but was continued through long ages under varying chemical conditions, and was contemporaneous with the deposition of successive strata of limestone and detrital matters. The argillaceous portions of these, it is conceived, may have taken part in the reactions with thermal waters. We have thus, in the opinion of the author, a reasonable mode of accounting for the origin of the various rocks of the crystalline formations, and a consistent and complete Neptunean theory which does not involve the aid of metasomatosis. It has, since it was proposed eighteen years ago, met with the approval of many whose studies have made them the fittest judges of its reasonableness. Among those who have either formally given their adhesion to it, or have enunciated similar views, may be mentioned the names of Delesse, Renard, Gümbel, Credner, Alphonse, Favre, and Gastaldi.

The chemical activities concerned in the production of the various silicates have doubtless suffered gradual change and diminution through the successive ages of Eozoic time, from which have resulted mineralogical and lithological differences in the crystalline terranes. Each of these includes quartzites and limestones, in which latter certain silicates, such as serpentine, hornblende, and micas, are occasionally found. It is in those aluminiferous rocks, which are without lime or magnesia, that are seen the essential and characteristic differences dependent, as long ago pointed out by the author, upon a decrease in the proportion of alkalies. As we pass from the older to the younger of the Eozoic terranes, the felspar, orthoclase, and albite become partially or wholly replaced by silicates like muscovite, damourite and paragonite, and finally by andalusite, fibrolite, cyanite, and pyrophyllite. The author alluded briefly to the changes by which the ancient aqueous deposits were transferred into crystalline stratified rocks by what Gümbel has designated as diagenesis, as distinguished from their supposed origin by epigenesis or metasomatic change. The question of the relation of the indigenous rocks to the endogenous and exotic masses included in them was noticed, the author alluding to the hypothesis which he has elsewhere maintained that the source of all exotic or eruptive rocks is to be found in the displacement or extravasation of ancient deposits of Neptunean origin.

Coming to the second division of his subject, the author asserted that the study of the crystalline rocks of North America shows the existence of several distinct groups or terranes. The Laurentian, which is the most ancient, includes in its lower part a mass of unknown thickness of granitoid gneiss, often hornblendic (Ottowa gneiss), succeeded, perhaps unconformably, by what has been called the Grenville series, consisting of similar gneisses and hornblendic rocks, with intercalated quartzites and iron ores. These two divisions make up together the Lower Laurentian of Logan, of which the thickness in Canada may greatly exceed 20,000 feet. The Norian, which is the Upper Laurentian, or Labradorian of Logan, rests unconformably upon the Laurentian, and is remarkable for a great development of rocks composed chiefly of Labradorite, or related plagioclase felspars, which have been called Labradorite-rock, or Norite. The interstratified gneisses, quartzites, and limestones of the Norian are not unlike those of the Laurentian. This series, which abounds in great beds of titanic iron-ore, has a volume which may exceed the thickness of 10,000 feet assigned to it by Logan. The Laurentian is in many parts overlaid by the Huronian series, which is characterized by a great development of greenstones, generally hornblendic, with epidote, chlorite, steatite, serpentine, and soft hydrous mica-schists, often called talcose, besides argillites, quartzites, and limestones, generally magnesian. It abounds in metalliferous deposits, including magnetic and specular iron-ores, chrome, and sulphurets of copper, iron and nickel, and has assigned to it in different regions a thickness of from ten to twenty thousand feet.

In many parts of North America there exists a great development of rocks characterized by the predominance of orthofelsite, or petrosilex, often becoming a quartziferous porphyry. This, which is apparently the helleflinta of Sweden, was regarded as eruptive until in 1869 the author showed it to be a stratified series with some associated quartzites and schists, and then included in the lower part of the Huronian. Hitchcock, who has since studied these rocks in New Hampshire, has called them Lower Huronian. From their absence in many localities at the base of the typical Huronian, it is conjectured that they may belong to a more ancient and distinct series. The Montalban, or White Mountain series, is characterized by micaceous gneisses, generally called granites, which pass into quartzose and felspathic mica-schists, often abounding in garnets, staurolite, fibrolite and cyanite. Great masses of dark green gneissoid hornblendic rock, very distinct from the Huronian greenstones, abound in the Montalban, which also includes beds of a very peculiar olivine-rock, beside quartzites and crystalline limestones. This series abounds in endogenous granitic veins, containing muscovite, beryl, tourmaline, apatite, and oxide of tin. It probably equals the Huronian in thickness, and is supposed to overlie it. The Taconian series includes a great volume of characteristic mica-schists, often quartzose, but seldom distinctly felspathic, and frequently consisting in large part of damonite, or of pyrophyllite. Some of these, like the schists of the Montalban, include garnet and chiastolite. They are associated with quartzites, and with dolomites and limestones, all of which are also frequently micaceous. Associated with these are found serpentines and granular hornblendic rocks of a peculiar type, very unlike those of the preceding groups and much less crystalline. The quartzites are in large part detrital rocks. This series, which yields the statuary marbles of North America, has a thickness of about 5,000 feet, and is the Lower Taconic of Emmons. It is foûnd reposing alike on the Laurentian, Huronian, and Montalban, and is overlaid, in apparent unconformity, by the Upper Taconic, which is identical with the Quebec group of Logan. This, which consists of many thousand feet of sandstones and argillites, with some limestones, includes among its strata organic forms belonging to various divisions of the Cambrian up to the Arenig. The Taconian, although containing an undescribed unguloid shell, and a so-called *Scolithus*, is, by the author, considered provisionally as distinct from the Cambrian. It has yielded in Ontario, besides *Scolithus*, the *Eozoon Canadense*, and may, perhaps, be regarded as the connecting link between the Eozoic and Palæozoic ages.

The Upper Taconic, or so-called Quebec group, in Eastern North America, is separated by a stratigraphical break from the succeeding portion of the Cambrian, the Bala group (Trenton, Utica, and Lorraine); while, on the contrary, the supposed discordance in the regions just mentioned at the summit of the latter, corresponding to the division between Cambrian and Silurian in Wales, appears to have been based on a misconception. There is, however, an important palæontological break at this horizon connected with a great deposit of barren detrital rocks, which marked the close of the Cambrian period, and the author records his opinion that the name of Lower Silurian, as well as that of Siluro-Cambrian, which he, with others, has applied to the Bala or upper division of the Cambrian, is to be rejected as being historically incorrect, and as tending to perpetuate false views of the palæontological relations between these and the succeeding rocks. The early advocates in North America of the notion of the metamorphism of Palæozoic rocks taught, in the first place, the stratigraphical equivalence of the Taconic, or L. and M. Cambrian, with the U. Cambrian, and further maintained that these rocks had suffered various degrees and kinds of metamorphism, as the result of which they had assumed, in different areas, the characters of the Taconian, Montalban, Huronian, and Laurentian; the lithological differences between these several series being regarded as marks of the greater or less alteration which it was supposed these uncrystalline Cambrian sediments had undergone. Other geologists have imagined portions of these same crystalline formations in North America to be altered strata of Silurian, Devonian, and even of Triassic age. The great groups of Eozoic rocks already described constitute, however, in the author's opinion, as many great stratified series, which, before the Cambrian time, existed in their present crystalline condition, and had been successively subjected to the accidents of uplift, contortion, and denudation, so that the newer Eozoic groups were, at the beginning of the Palæozoic period, distributed irregularly over the floor of fundamental Laurentian gneiss. These various crystalline groups are found, with a singular persistence and uniformity of ethnological character, from Alabama to Newfoundland, along the Atlantic belt, and thence westward through Canada, to the great lakes, and beyond, in the vast region of the Cordilleras to the Pacific slope. The author had some years since pointed out the remarkable similarity between the various crystalline groups of North America and the crystalline rocks of the British Islands, and had lately been able, by new observations, to confirm his conclusions. Among the crystalline formations of Donegal he had indicated representatives of Laurentian, Montalban, and Huronian, and the latter he had recently observed largely developed in Argyleshire and Perthshire. To the Huronian, also, he refers the green schists of Anglesea and Carnarvonshire, in both of which regions the orthofelsite, or helleflinta series at the base of the Huronian (the so-called porphyries), and likewise the more ancient gneisses, are well represented. He would, however, leave this subject to his friend, Dr. Henry Hicks, who has so happily mastered the obscure problems of the pre-Cambrian geology of Wales. The studies of Gastaldi and others enable us to assert that similar series of ancient rocks occur in the same order in the Alps; and we infer that the chemical and physical conditions which presided over the production of the crystalline stratified rocks were world-wide.

XI.—British Association for the Advancement of Science, Forty-eighth Meeting, Dublin, August 14th, 1878.

A.—Titles of Papers Read in Section C. (Geology).

President.—John Evans, D.C.L., F.R.S.

The President's Address. (See p. 411.)

Prof. E. Hull, F.R.S.—Sketch of the Geology of the Environs of Dublin. (See p. 457.)

J. Nolan, M.R.I.A.—On the Ancient Volcanic Districts of Slieve Gullion. (See p. 445)

W. Mattieu Williams, F.R.A.S., F.C.S.—Notes on the Glaciation of Ireland and the Tradition of Lough Lurgan.

W. H. Baily, M.R.I.A., F.G.S.—Notice of some additional Labyrinthodont Amphibia and Fish from the Coals of Jarrow Colliery, near Castlecomer, Co. Kilkenny.

W. Pengelly, F.R.S.—On the Exploration of Kent's Cave. Fourteenth Report.

R. H. Tiddeman, M.A., F.G.S.—Sixth Report on the Victoria Cave, Settle.

Prof. Alexander Macalister, M.D.—Report on Fermanagh Caves.

C. E. De Rance, F.G.S.—Fourth Report of Committee on Underground Waters. (See p. 462.)

W. Pengelly, F.R.S.—On the relative Ages of the Raised Beaches and Submerged Forests of Torbay.

Isaac Roberts, F.G.S.—Experiments on Filtration of Sea Water through Triassic Sandstone.

V. Ball, M.A.—On a new Geological Map of India.

Prof. W. C. Williamson, F.R.S.—On the Supposed Radiolarians of the Coal-measures. (See p. 461.)

The President.—On some Fossils from the Northampton Sands.

W. H. Baily, F.G.S.—On some Irish Fossils.

J. Nolan, M.R.I.A.—On the Metamorphic and Intrusive Rocks of Tyrone.

T. Sterry Hunt, F.R.S.—On the Origin and Succession of the Crystalline Rocks. (See p. 466.)

H. Hicks, M.D.—On some new pre-Cambrian Areas in Wales. (See p. 460.)

W. Williams.—On the *Cervus megaceros*.

W. A. Traill.—The Rocks of Ulster as a source of Water Supply. (See p. 463.)

https://doi.org/10.1017/S0016756800151027 Published online by Cambridge University Press

J. W. Davis.—On the Occurrence of certain Fish Remains in the Coal-measures, and the evidence they afford of the freshwater origin of the Coal-measures.

G. A. Lebour.—On the Discovery of Marine Shells in the Gannister Beds of Northumberland.

R. A. C. Godwin-Austen.—Report on proposed Kentish Explorations.

W. Jolly, H.M.I.S.—Report on Fossils of the N. W. Highlands of Scotland.

E. T. Hardman, F.C.S.—On the Influence of Strike on the Physical Features of Ireland.

E. T. Hardman, F.C.S.—On *Hullite*; a hitherto undescribed Mineral, with Notes on the Microscopic Appearances, by *Prof. Hull, F.R.S.* (See p. 464.)

Prof. Hull, F.R.S.—On the Progress of the Geological Survey of Ireland. (See p. 464.)

Rev. H. W. Crosskey.—Report of the Committee on Erratic Blocks.

Dr. T. Sterry Hunt, F.R.S.—On the Geological Relations of the Atmosphere.

Prof. Herschel.—Report of Committee on the Conductivity of Rocks.

Prof. W. King, D.Sc.—On the Age of the Crystalline Rocks of Donegal. (See p. 465.)

Prof. E. D. Cope.—On the Saurians of the Dakota Cretaceous Rocks of Colorado.

Prof. James Nicol, F.R.S.E.—On some New Fossils, *Eribollia Mackayi*, from the Quartzites of Loch Eriboll and other parts of the Western Highlands of Scotland.

Alphonse Gages, M.R.I.A.—On the Influence that Microscopic Vegetable Organisms have on the Production of Hydrated Iron Ores.

Prof. O'Reilly, M.R.I.A.—On the Correlation of Lines of Direction on the Globe, and particularly on Coast Lines.

Rev. Prof. Haughton, M.D., F.R.S.—On the Earth's Axis.

Rev. Maxwell H. Close, F.G.S.—Concerning the Extent of Geological Time. (See p. 450.)

C. E. De Rance, F.G.S., and *Captain R. A. Feilden, R.A.*—Geological Results of the late British Arctic Expedition.

B.—Titles of Papers, Bearing upon Geology, Read in other Sections.

Joseph Lucas.—On the Hydrogeological Survey of England. (*Section G.*)

Sir Victor Brooke, Bart.—On certain Osteological Characters in the *Cervidæ* and their probable bearings on the past History of the Group. (*Section D.*)

W. Morris.—On the Temperature of the Earth within. (*Section A.*)

Prof. Henry Hennessy.—On the Limits of Hypotheses regarding the Physical Properties of the Matter of the Interior of the Earth. (*Section A.*)

I. Roberts.—The Filtration of Salt from Sea Water into Wells in the Trias Sandstone. (*Section G.*)