GEOLOGY AT THE BRITISH ASSOCIATION.

SO far as Section C was concerned, the Bristol meeting of the British Association was decidedly successful. The attendance at the sectional meetings was above the average, and the interest well sustained, a larger proportion than usual of the papers and reports being of a character to give rise to discussions on broad general principles, for which these occasions are pre-eminently adapted.

In some cases these discussions were curtailed from lack of time, and there was a little discontent among the more steadfast adherents to the indoor work of the meeting that the whole of the papers should have been crowded into four days, and the Saturday and Wednesday half-day sessions dispensed with. But in a region so rich in geological interest it was desirable that every opportunity for outdoor investigation should be given to the members of the Section, especially as the weather during the meeting was singularly favourable for field-work. The popularity of the short afternoon excursions arranged for Friday, Monday and Tuesday, under the leadership of Prof. C. Lloyd Morgan and Mr. H. Pentecost, to classical sections in the vicinity of Bristol, proved that to the visiting geologists the chance of inspecting the best exposures under competent guidance was at least of equal importance to the indoor proceedings. These afternoon excursions have, during the last three or four years, become an important feature in the arrangements of the Section, and though it has been sometimes objected that they are detrimental to the attendance indoors during the later stages of the daily session, it is doubtful whether such be really the case. The difficulty of holding together an audience of notable dimensions when the sitting of the Section is prolonged late into the afternoon was felt at these meetings long before the institution of the short excursions.

The papers and reports submitted to the Section are too numerous for adequate mention, and special reference can only be made here to such as possessed wide interest or led to much debate. As frequently happens, some of the papers containing the most solid and original work attracted the least discussion.

At the opening day of the sectional meeting, after the presidential address, Prof. C. Lloyd Morgan gave a clear general account of the more interesting features of the local geology, dealing especially with the places to be visited during the excursions. The lantern slides by which this address was illustrated were unfortunately almost invisible owing to the insufficient darkening of the room.

Mr. E. Wethered followed with a paper on "The building of the Clifton rocks," in which he contended for the importance of certain micro-organisms in the formation of the local limestones. These "incrusting organisms," along with other forms which he described, all hitherto usually held to be of inorganic origin, are regarded by Mr. Wethered as organic growths, to which in some cases the structure of the limestone is due; and these he considers to be serviceable aids in identifying the strata. At a later session Mr. Wethered brought forward a second paper on "The work of incrusting organisms in the formation of limestone," in which he urged the claims of Girvanella and allied forms in the production of the oolitic structure in Jurassic rocks. Both papers were illustrated by beautiful lantern slides of rock-slices prepared by the author. These papers gave rise to lively discussions, in which by some speakers the organic origin of some of the structures was strenuously denied; in his able reply, Mr. Wethered claimed that a thorough investigation of his slides by a committee of experts would convert the partial recognition which his views had already won into a thorough-going acceptance of all his conclusions.

Mr. A. Strahan brought before the meeting an account of the results of the revision of the South Wales Coal-field by the Geological Survey, showing the great advances which have been made in our knowledge of the structure of this important area, and the methods adopted for representing the new information upon the maps.

In a paper on "The comparative action of sub-aërial and submarine agents in rock decomposition," Mr. T. H. Holland, of the Geological Survey of India, drew attention to the wide-reaching difference between the manner of decomposition of the crystalline and igneous rocks in Southern India and in Europe, especially in the degree of hydration of the minerals. This difference, he thought, might be due to the absence of submarine action in the central portion of Southern India during the later geological periods, so that the rocks have been affected only by sub-aërial weathering, and deeper portions of the earth's crust have, by long denudation, been exposed at the surface than in Europe.

Friday's session was opened by a suggestive discourse by Prof. O. C. Marsh, on "The comparative value of different kinds of fossils in determining geological age," in which the claims of the vertebrates, wherever they existed, were pressed as being the best for the purpose. As a side-issue, Prof. Marsh drew renewed attention to the Jurassic affinities of the English Wealden fauna, so that his paper provided almost unlimited scope for discussion. Most of the speakers on the subject, while acknowledging that the main point of Prof. Marsh's contention might be theoretically correct, dwelt upon the practical difficulties to the field-geologist in the collection and determination of vertebrate remains, and urged that this must prevent these fossils being used for zonal purposes except in rare instances. Another paper which provoked an interesting discussion was that of Prof. J. F. Blake, on "Aggregate deposits and their relation to zones." The author proposes the term "aggregate deposits" for strata in which fossils characterising more than one zone occur together in the same rock-band. He considers that in such deposits the fossils do not lie in their natural position, but have been swept together tumultuously by strong currents. In the debate on this paper, while general approval of the term "aggregate" was expressed, there was mudh difference of opinion as to the manner in which such deposits had accumulated, and it was suggested that Prof. Blake had included strata of diverse origin in his proposed classification.

The two papers contributed by Mr. T. Groom, on "The age and geological structure of the Malvern and Abberley Ranges," were good examples of careful stratigraphical investigation, and were well received. Mr. Groom's conclusions are that the Malvern axis was not an island in Cambrian and Silurian seas as generally supposed, but that it was elevated chiefly by Upper Palæozoic crustal movements and its folds belong to the Great Hercynian system formed towards the close of the Carboniferous Period. At the same session Mr. E. Greenly announced the discovery of Arenig shales beneath the Carboniferous rocks near the Menai Bridge, and in another paper described a clear case of boulder-uplift at Llandegfan, Menai Straits, where a train of blocks has been raised about 300 feet in the distance of one mile. Mr. Greenly also called attention to the impending destruction by quarrying operations of the most important portion of the drift section of Moel Tryfaen, and his suggestion that a committee should be appointed for the purpose of securing, while there was yet time, photographic and other records of this celebrated section was at once acted upon, and a small grant was obtained to cover the expenses.

In his paper on "The age and origin of the granite of Dartmoor, and its relations to the adjoining strata," Mr. A. Somervail put forward the view that the intrusion of the granite in question took place after the folding of the Lower Culm strata, but before the Upper Culm series was deposited. In the discussion, while the importance of Mr. Somervail's conclusions was acknowledged, the speakers generally expressed themselves unable to form an opinion until the fuller details of the sections on which the author based his views should be published.

The first paper taken on Monday was that of Mr. R. Etheridge, on "The relation and extension of the Franco-Belgian Coal-field to that of Kent and Somerset." After reviewing the history of the discovery of coal at the Dover boring, where it is expected that the Coal Measures will shortly be reached by the shafts now being sunk, Mr. Etheridge proceeded to discuss the general bearing of this discovery and the probable extension of the southern coal-fields under the Secondary rocks. A new section recently obtained by a deep exploratory boring at Brabourne, near Ashford, was then described, where after passing through Lower Greensand, Wealden, Portlandian, Kimeridge Clay, Corallian, Oxford Clay, Lower Oolites, and Middle and Lower Lias, red conglomerates believed by the author to be Old Red Sandstone have been encountered at a depth of 1875 feet from the surface. The Jurassic strata in this section are about 450 feet thicker than at Dover. In the discussion on this important paper, Prof. Boyd Dawkins and Mr. W. Whitaker both expressed doubts whether the Old Red Sandstone age of the lowest portion of the Brabourne section could be considered sufficiently established; and the former speaker stated that he fully expected some of the Kentish borings would draw blank, but others would succeed, and all would supply valuable in-

formation. Sir John Evans called attention to the fact that in one section in Belgium, where the Palæozoic strata were extremely folded, Coal Measures had been met with beneath a wedge of Old Red Sandstone. Mr. E. Wethered suggested that the Coal Measures showed a tendency to become less and less productive when traced eastward from the South Wales basin; and Prof. Louis asked how the supposed horizontality of the Dover Coal Measures could be explained, while in their supposed prolongation in Belgium they were so greatly disturbed. Mr. Etheridge, in concluding the discussion, thought there could be no doubt that the bottom rock at Brabourne was Old Red Sandstone, and remarked on the evidence now forthcoming for the continuous underground extension of this formation from Bristol across the south of England, under London and parts of Kent, into Belgium.

The next paper was that of Dr. Marsden Manson, of Sacramento, Cal., on "The laws of climatic evolution"—a highly speculative attempt to explain the Glacial Period as a critical and unique stage in the evolution of this and other planets when the climate passed from "internal" to "external" control. According to Dr. Manson, the climatal conditions of all times preceding the Glacial Period were determined by planetary heat, and were independent of latitude; but the dissipation of the continuous cloud-envelope, through the loss of the planetary heat by which it had been sustained, brought about a new set of conditions. After a Glacial Period, due to the more rapid cooling of the land than the sea, a gradual rise of temperature along with a zonal distribution of climate would occur, through the trapping of solar heat by the lower layers of the atmosphere. This latest of the many ingenious attempts which have been made, on both sides of the Atlantic, to explain the Glacial Period was admirably presented by the author to a large audience, but was subjected to severe criticism in the discussion, the general feeling being that such speculations scarcely fell within the scope of Section C.

Prof. E. Hull brought before the meeting a wide subject of more tangible character, in a paper on "The sub-oceanic physical features of the North Atlantic." By tracing out the depth-contours of the Admiralty Charts, Prof. Hull showed that the British and continental submarine platform breaks off abruptly in a "Grand Escarpment" at depths varying from 100 to 250 fathoms. This escarpment, from 6000 to 7000 feet high, is, according to Prof. Hull, indented by deep bays and old river-channels, the latter, almost cañon-like in places, often prolongations of the river valleys of the existing land. These and other submarine features lead him to agree with Spencer and Upham that the whole area of the North Atlantic to a depth of 10,000 feet was a land surface at a very recent period, and that the conditions of the Glacial Epoch may be thus explained. This paper was followed by another on the same subject by the President of the Section, in which it was shown that the exaggeration of the vertical scale made Prof. Hull's diagrams misleading as to the slopes of the supposed escarpments and submerged river-valleys; and evidence was adduced to prove that extensive earth-movements were frequently in progress on the edge of the continental platform. Hence, it was urged, the features to which Prof. Hull had called attention might possibly be due to subterranean causes, a view which was shared by several speakers in the subsequent debate.

On the subject of earth-movement, Prof. J. Milne presented the report of the Committee for Seismological Investigation; and Mr. R. D. Oldham, of the Geological Survey of India, gave a lucid description, illustrated by lantern slides, of the Great Indian Earthquake of 1897. The surface indications of faulting and overthrusting which characterised this earthquake were very clearly demonstrated.

At the opening of Tuesday's meeting the President, in exhibiting a portrait of the late E. Wilson, referred feelingly to the loss which geological science had sustained by Mr. Wilson's untimely death, and other speakers bore testimony to his pains-taking and self-denying services to the Bristol Museum.

On behalf of Prof. H. F. Osborn, who had expected to attend the meeting but was at the last moment prevented, an exhibit was made of some beautiful water-colour drawings of restorations of *Brontosaurus*, *Phenacodus*, and other extinct vertebrates, executed by Mr. C. Knight for the Museum of Natural History of New York. A brisk discussion sprang up, in which Prof. H. G. Seeley, Prof. O. C. Marsh, Sir John Evans, Prof. W. Boyd Dawkins, Prof. W. J. Sollas, and others took part, as to the advisableness of giving reins to the imagination in the production of these restorations, upon which point widely diverse opinions were expressed.

There was scarcely sufficient time at this meeting to do justice to the carefully prepared paper by Mr. W. H. Wheeler on "The action of waves and tides on the movement of material on the Sea-coast." It was shown by Mr. Wheeler that the travel of shingle is not usually coincident with the prevailing winds, but is in the direction of the flood-tide, and is mainly due to wavelets set up by tidal action, whose total kinetic energy is very large.

Among the other papers brought before the Section were the following on cave exploration: by Mr. H. Bolton and the late E. Wilson, on the exploration of two caves at Uphill, Weston-super-Mare; by Rev. G. C. H. Pollen, on further exploration of the the Ty Newydd Caves; by Mr. T. Plunkett, on further exploration of the Fermanagh Caves; and the Report of the Committee on the fauna of caves near Singapore. Mr. P. M. C. Kermode, in the Report of the Committee for investigating the mode of occurrence of the Irish Elk in the Isle of Man, announced the discovery of a large and nearly complete skeleton of that animal near Peel. Mr. J. Lomas brought forward evidence in favour of the occurrence of worked flints in the Glacial deposits of Cheshire and the Isle of Man, but it was felt that further research was necessary before the author could be considered to have established his case. Mr. C. W. Andrews gave an account of the discovery of a portion of the skeleton of a huge Dinosaur in the Oxford Clay of Northampton. Papers were also contributed by Mr. J. R. Dakyns on the probable source of the upper Felsitic lava of Snowdon; by Mr. H. B. Woodward on arborescent Carboniferous Limestone from near Bristol; and by Mr. W. L. Addison and Mr. L. J. Spencer on crystallographic and mineralogical subjects. Several of the Reports of Committees possessed matter of much interest, especially that presented by Prof. A. P. Coleman on the Interglacial deposits near Toronto (where fresh facts of importance have been gained by excavations), and that of Prof. P. F. Kendall on Erratic Blocks; while the Committee for collecting Geological Photographs, that on Fossil Phyllopoda, and that on Life-zones in British Carboniferous rocks were all able to report steady progress in their investigations. New committees were formed and grants obtained to investigate the caves at Uphill and at Ty Newydd, and as already mentioned to preserve photographic and other records of the Moel Tryfaen section; and most of the old committees connected with this Section were re-appointed.

PHOSPHORESCENCE.[1]

IT is not possible in one lecture on phosphorescence to give any historical sketch which shall do justice to the work of those who have made a study of the phenomena. In a list of the names of the many who have enriched the subject with facts and with theories, those of Becquerel, of Stokes, and of Crookes stand out most prominently. Any attempt to make a sketch of our knowledge of phosphorescence and fluorescence must be to a very large extent an adaptation of the work and of the views of these masters.

The phenomena themselves may be divided into two main classes—those in which the evolution of light is associated with chemical change, and those in which there is no evidence of such direct alteration. In the first class the commonest instances are connected with the process of oxidation. Examples of this kind are numerous. It is hardly possible to take any very easily oxidisable substance and to fail to get some evolution of light. Phosphorus, sodium and potassium, ether, many aldehydes, and a host of organic compounds may be cited as instances. The experimental illustrations of these are not, however, suited to an audience of more than a very few. The same may be said of the examples of animal and vegetable phosphorescence. It is proposed, therefore, to deal more especially with the second class, and to limit the experiments to the cases where the light given out is visible and not of such a character as to necessitate the use of a photographic plate. This evolution of light may occur in varying conditions. In instances such as solutions of quinine and fluorescein and many solids, of which thallene is a good example, the duration of the phosphorescence is so short that it may be said to last only while

[1] A discourse delivered before the British Association on September 12, by Mr. Herbert Jackson.