

exception (which could not be called a true metamorphic gneiss as the felspar was provided ready made), I do not think that any beds belonging to the slaty series of the Himalaya have been converted into gneiss; whether they could be is a matter to be decided by chemical analysis.

NOTICES OF MEMOIRS.

I.—BRITISH ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE.
FIFTY-SEVENTH MEETING, MANCHESTER, 1887.

SECTION C.—GEOLOGY.

President: HENRY WOODWARD, LL.D., F.R.S., F.G.S.

Titles of Papers Read September 1st to 7th, 1887.

1. Address by the President.
2. *Prof. W. Boyd Dawkins*.—On the Geography of the British Isles in the Carboniferous Period.
3. *Prof. W. Boyd Dawkins*.—On the Structure of the Millstone Grit of the Pennine Chain.
4. *Mark Stirrup*.—Foreign Boulders from Coal Seams.
5. *Dr. G. J. Hinde*.—On the Organic Origin of the Chert in the Carboniferous Limestone Series of Ireland, and its similarity to that in the corresponding strata of North Wales and Yorkshire.
6. *Robert Law and James Horsfall*.—On the Discovery of Carboniferous Fossils in a Conglomerate at Moughton Fell, near Settle, Yorkshire.
7. *Dr. H. Crosskey*.—Report on the Erratic Blocks of England, Wales, and Ireland.
8. *Prof. E. Hull*.—Note on a few of the many remarkable Boulder Stones to be found along the Eastern Margin of the Wicklow Mountains.
9. *Prof. H. Curvill Lewis*.—The Terminal Moraines of the great Glaciers of England.
10. *Prof. H. C. Lewis*.—On some important Extra-Morainic Lakes in England, North America, and elsewhere, during the period of Maximum Glaciation; and on the Origin of Extra-Morainic Boulder Clay.
11. *Hugh Miller*.—A comparative study of the Boulder Clay in the Glaciated Districts of Europe—Britain, Norway, Switzerland, Low Germany, and the Pyrenees.
12. *Dr. H. Hicks*.—Report on the Cae Gwynn Cave, North Wales.
13. *J. W. Davis*.—On an Ancient Sea-Beach near Bridlington, containing Mammalian Remains.
14. *Dr. H. Woodward*.—On the Discovery of a Larval Cockroach, *Etblattina Peachii* (H. Woodw.), from the Coal-Measures of Kilmaurs, Ayrshire.
15. *Dr. H. Woodward*.—On a new form of *Eurypterus* from the Lower Carboniferous Shales, Glencartholme, Eskdale, Scotland.

16. *Dr. H. Woodward.*—On a new Trilobite (*Conocoryphe*) from the Upper Green Slates, Penrhyn Quarry, near Bangor.
17. *Prof. T. Rupert Jones.*—Report on the Fossil Phyllopoda of the Palæozoic Rocks.
18. *Prof. H. G. Seeley.*—Evidence on the Mode of Development of the young of *Plesiosaurus*.
19. *Prof. H. G. Seeley.*—On the reputed Clavicles and Inter-Clavicles of *Iguanodon*.
20. *Prof. H. G. Seeley.*—On *Cumnorina*, an Iguanodont Genus founded on *Iguanodon Prestwichi*, Hulke.
21. *Prof. H. G. Seeley.*—The Classification of the Dinosauria.
22. *Prof. Vilanova.*—Sur la calcedoine enhydrique et la roche dans laquelle se trouve à Salto Oriental (Uruguay) avec exhibition de l'échantillon.
23. *Prof. W. Boyd Dawkins.*—On the Schists of the Isle of Man.
24. *Prof. G. A. Lebour.*—On Thimolite and Jarrowite.
25. *W. W. Watts.*—A Shropshire Picrite.
26. *Vaughan Cornish and Percy F. Kendall.*—On the Mineralogical Constitution of Calcareous Organisms.
27. *Sir J. William Dawson.*—On New Facts relating to *Eozoon Canadense*.
28. *Dr. T. Sterry Hunt.*—Gastaldi on Italian Geology and the Crystalline Rocks.
29. *Dr. T. Sterry Hunt.*—Elements of Primary Geology.
30. *Prof. T. G. Bonney.*—Preliminary Note on Traverses of the Western and of the Eastern Alps, made during the summer of 1887.
31. *J. E. Marr.*—Some effects of Pressure on the Sedimentary Rocks of North Devon.
32. *Prof. J. F. Blake.*—Report on the Microscopic Structure of the Older Rocks of Anglesea.
33. *Dr. C. Callaway.*—Notes on the Origin of the Older Archæan Rocks of Malvern and Anglesea.
34. *J. J. H. Teall.*—The Origin of Banded Gneisses.
35. *Howard Fox and Alex. Somervail.*—On the occurrence of Porphyritic Structure in some rocks of the Lizard district.
36. *Prof. W. J. Sollas.*—Some Preliminary Observations on the Geology of Wicklow and Wexford.
37. *G. H. Kinahan.*—On Archæan Rocks.
38. *W. Pengelly.*—Recent Researches in Bench Cavern, Brixham, Devon.
39. *Prof. J. W. Judd.*—The Natural History of Lavas, as illustrated by the materials ejected from Krakatoa.
40. *Dr. H. J. Johnstone-Lavis.*—Report on the Volcanic Phenomena of Vesuvius and its neighbourhood.
41. *Prof. J. Milne.*—Report on the Volcanic Phenomena of Japan.
42. *Dr. T. Sterry Hunt and James Douglas.*—The Sonora Earthquake of May 3, 1887.
43. *Thos. Ward.*—The History and Cause of the Subsidences at Northwich and its neighbourhood in the Salt Districts of Cheshire.

44. *Prof. J. H. Panton*.—Places of Geological Interest on the Banks of the Saskatchewan.
45. *Rev. E. Hill*.—The Disaster at Zug, on July 5, 1887.
46. *Dr. A. Fritsch*.—On the Permian Fauna of Bohemia.
47. *Prof. W. C. Williamson*.—Report on the Carboniferous Flora of Halifax.
48. *A. Smith Woodward*.—On the Affinities of the so-called Torpedo (*Cyclobatis*, Egerton) from the Cretaceous of Mount Lebanon.
49. *Prof. J. F. Blake*.—Description of a New Star Fish from the Yorkshire Lias.
50. *C. E. De Rance*.—Report on the Underground Waters in the Permeable Formations of England.
51. *Prof. Vilanova*.—Notice du *Dinotherium*, deux especes, trouvées en Espagne.
52. *A. H. Foord*.—On the Genus *Piloceras*, Salter, as elucidated by examples lately discovered in N. America, and in Scotland.
53. *J. S. Gardner*.—Report on the Fossil Plants of the Tertiary and Secondary Beds of the United Kingdom.
54. *A. Bell*.—Report on the “Manure” Gravels of Wexford.
55. *R. G. Bell*.—The Pliocene Beds of St. Erth, Cornwall.
56. *J. S. Gardner*.—Report on the Higher Eocene Beds of the Isle of Wight.
57. *W. A. E. Ussher*.—The Triassic Rocks of West Somerset.
58. *W. A. E. Ussher*.—The Devonian Rocks of West Somerset on the Borders of the Trias.
59. *Prof. H. Carvill Lewis*.—The Matrix of the Diamond.
60. *Prof. T. G. Bonney*.—Observations on the Rounding of Pebbles by Alpine Rivers, with a Note on their Bearing upon the Origin of the Bunter Conglomerate.
61. *Prof. W. Boyd Dawkins*.—The Present State of the Channel Tunnel, and the Boring at Shakespeare’s Cliff, near Dover.
62. *Prof. Otto Torell*.—On the Extension of the Scandinavian Ice to Eastern England in the Glacial period.
63. *Prof. H. Carvill Lewis*.—On the Terminal Moraine of the Irish-Sea Glacier, near Manchester.
64. *E. P. Quinn*.—Upon a Simple Method of Projecting Microscopic Rock Sections upon the Screen, both by ordinary and by polarized light.

List of Papers bearing upon Geology read in other Sections.

SECTION A.—MATHEMATICAL AND PHYSICAL SCIENCE.

- Prof. E. Hull*.—On the Effect of Continental Lands in Altering the Level of Adjoining Oceans.
4. *C. Russell*.—On some Variations in the Level of the Water in Lake George, New South Wales.
3. *Douglas Archibald*.—The Direction of the Upper Currents over the Equator in connexion with the Krakatoa Smoke-Stream.

SECTION B.—CHEMICAL SCIENCE.

1. *W. Clarke*.—The Chemical Structure of Natural Silicates.

SECTION D.—BIOLOGY.

Discussion on the arrangement of Museums (in conjunction with Section C), Opened by Dr. H. Woodward, F.R.S., F.G.S.

SECTION E.—GEOGRAPHY.

W. Brindley.—A Visit to the Porphyry Quarries of Gebel Dukhan. Second Report of a Committee for inquiring into the depth of the permanently frozen soil in the Polar Regions.

Prof. Boyd Dawkins.—The beginning of the Geography of Great Britain.

G. Skelton Streeter.—The Ruby Mines of Burma.

Josiah Pierce, jun.—On the United States Geographical and Geological Survey.

SECTION F.—ECONOMIC SCIENCE AND STATISTICS.

W. Topley.—On the Future Production of the Precious Metals (at a Joint Meeting with Section C).

SECTION G.—MECHANICAL SCIENCE.

Jeremiah Head.—The Iron Mines of Bilbao.

F. Ransome.—Portland Cement Manufacture.

T. A. Walker.—Severn Tunnel.

SECTION H.—ANTHROPOLOGY.

Sydney B. J. Skertchly.—On the Occurrence of Stone Mortars in the Ancient (Pliocene?) River Gravels of Butte County, California. Report of the Committee on the Pre-historic Inhabitants of the British Isles.

Dr. Henry Hicks.—The Migrations of Pre-glacial Man.

Dr. H. Colley Marsh.—The Early Neolithic Floor of East Lancashire.

W. Pengelly.—On Recent Researches in Bench Cavern, Brixham, Devon.

Papers Read at the Meeting of the British Association, Manchester, in Section (C), Geology.

II.—THE PLIOCENE BEDS OF ST. ERTH, CORNWALL. By ROBERT GEORGE BELL, F.G.S.

SINCE the publication of the paper read before the Geological Society of London in February, 1886, a good deal of work relating to the geological surroundings and to the special fauna of the deposit has been undertaken. Considerable excavations were made, and much examination given to the sands and clays, with the result that the section given on p. 202, "Quarterly Journal of Geological Society," for May, 1886, was completely verified.

The clay deposit is not, however, uniformly fossiliferous, nor is it uniform in the distribution of its fossil contents as a rule. *Cerithia* are found in great numbers at the base of the blue clay, while the larger *Nassæ* and *Turritellæ* are generally distributed in that bed. A great feature of interest is the large number of the smaller species of mollusca, especially of Gasteropods, which embrace more than three-fourths of the total amount.

Of these small shells the genera *Rissoa* and *Odostomia* are the most plentiful, in species and numbers; about twenty species of the former (including the *Hydrobias*) and eighteen of the latter genus are present, some being living inhabitants of the British and Mediterranean seas, while others appear new to science, and will have to be described. The *Trochi* are nearly all extinct, three only being Crag and living forms. Of *Nassa* about eight species are present, *Nassa serrata* being by far the most common, and is nearly identical with the general form of *Nassa reticosa*, Sowerby, so plentiful in the coprolite pits of the Boyton district in Suffolk; there are also other well-known Crag species of this family.

The carnivorous Gasteropods are, however, not otherwise plentiful; one should be noticed, a large fragment of *Buccinum undatum*, but no traces of *Fusus antiquus* or *F. gracilis*; all the *Pleurotomas* are scarce except *P. brachystoma*, and there are two species of *Pisania* or *Lachesis*; all these last are southern forms.

Of the bivalves not much can be said; few species were obtained, and these mostly in a fragmentary condition. It is still a difficulty to afford an adequate explanation of this fact, for while the deposit of clay is so well calculated to preserve the shells, as shown by the perfect state of the univalves, the bivalves (if we except the oysters and some minute species) have universally suffered. Some explanation other than that of the physical character of the deposit must be sought for, and none has yet appeared sufficiently satisfying.

The opinion expressed in the earlier reports upon this deposit, as to the southern facies of its fauna, has been amply justified by fresh researches; a large quantity of the fossiliferous clay has been carefully washed and examined, and no trace of northern forms, except *Buccinum undatum*, and the two small species noticed in the paper previously referred to, has been found, while greatly increased evidence confirming what has been already said is present. Had there been any connection with northern seas or colder waters, it would be difficult to understand the entire absence of those forms of *Pleurotoma* (*Bela*) so abundant in the Boreal seas of the Crag period and the present age, as well as the equally characteristic bivalves, *Astarte* and *Cyprina*.

Some conflict of opinion exists upon the depth of water in which the St. Erth clays were deposited.

In a letter to "Nature," of August 12, 1886, a very competent authority on Pliocene phenomena, Mr. Clement Reid, F.G.S., gave it as at least forty or fifty fathoms, founding his view on the evident fact of its deposition in still water, which he maintains could not be found in a district exposed to Atlantic swells at less depth. To this the writer must take serious exception. Undoubtedly the clays exhibit an entire absence of such a disturbing cause as the influence of great wave action, but it remains to be proved that such a great depression as Mr. Reid describes did occur at the western end of Cornwall, and as far as I have been able to observe there is little indication of such a fact. Some depression, of course, must have happened, sufficient to submerge the low-lying land near St. Erth,

causing a strait or gulf, dividing the Land's End from the main eastern portion of the county.

In this shallow strait the clays and sands were deposited, and just such an assemblage of mollusca is found as will bear out this view. Scarcely any of the shells which are of living species are known to inhabit such deep water as Mr. Reid indicates, while the majority show the presence of a laminarian zone, extending to not more than fifteen fathoms. This bathymetrical range is the chosen habitat of the *Rissoæ*, who are all vegetable feeders, and of the *Nassæ*, which are predatory and always plentiful just below low-water mark; and what appears still more conclusive is the number of *Hydrobia*, which have a close connection with *Littorina* and indicate shallow depth and close proximity to shore.

It is hoped that a more detailed examination of the mullusca fauna may soon be completed, and the whole series added to the National Collection.

III.—PRELIMINARY NOTE ON TRAVERSES OF THE WESTERN AND OF THE EASTERN ALPS MADE DURING THE SUMMER OF 1887. By Prof. T. G. BONNEY, D.Sc., LL.D., F.R.S., F.G.S.

THE first traverse was made along the line of the Romanche from near Grenoble to the Col du Lautaret, and thence by Briançon over the Mont Genève and the Col de Sestrières to Pinerolo at the edge of the Italian plain. The second went from Lienz, across the central range of the Tyrol to Kitzbühel, and the rocks of this range were also investigated at other places. During both traverses the author had the advantage of the assistance of the Rev. E. Hill, who had accompanied him on a similar journey in 1885.

The results of their examination fully confirm the views already expressed by the author as to the nature and succession of the crystalline rocks of the Alps.

(1.) The lowest group consists partly of modified igneous rocks (which indeed occur at all horizons), partly of gneisses of a very ancient (Laurentian) aspect.

(2.) The next group, up to which there seems a gradual passage, consists mainly of more friable gneisses and moderately coarse mica-schists (Lepontine type). This group is commonly less fully developed in the above districts than in the Central Alps, having probably been removed by very ancient denudation.

(3.) The third group has an enormous development. It forms a large part of the Cottian and Graian Alps, and it flanks the central axis of the Eastern Alps on both sides, often passing beneath the ranges of Secondary strata, which here form the northern and southern ranges. It has been traced almost without interruption from east to west for more than fifty miles on the southern, and eighty on the northern side of the central range. It has a very close resemblance in all respects to the uppermost group of schists in the Central Alps, found to some extent in the Lepontine and yet more largely in the Pennine Alps, and the author fully agrees with the Swiss and Austrian geologists in regarding it as in the main

a prolongation of the same series. It is characterized especially by rather dark-coloured mica-schists, often calcareous, sometimes passing into fine-grained crystalline limestones, with occasional intercalated chloritic schists, especially in the lowest part, and with (rarely) quartz schists.

(4.) The Carboniferous and Secondary strata infolded or overlying in the Western Alps section, and the Palæozoic (? Silurian) and Secondary strata succeeding the metamorphic rocks in the Eastern Alps, are comparatively little altered, and are each readily to be distinguished from the above.

(5.) The succession of strata in the third group is inexplicable, unless it be due to stratification; in the second this explanation appears highly probable, and in the first not more difficult than any other.

(6.) As groups of rocks with marked lithological characters occur in like succession over a mountain chain measuring above 400 miles along the curve, and sometimes at distances of 40 miles across it; as these groups correspond with rocks recognized as Archæan elsewhere, which exhibit like characters and sometimes a like order of succession, the author thinks a classification of the Archæan rocks by their lithological characters (using the phrase in a wide sense), may ultimately prove to be possible.

(7.) The views already expressed by the author as to the distinctness of cleavage-foliation and stratification-foliation have been fully confirmed by the examination of the above districts. He believes that the failure to recognize this distinction is the cause of the contradictory statements with regard to the relation of foliation and bedding which have been made by so many excellent observers, and lies at the root of much of the confusion which exists on the subject of the so-called metamorphic rocks.

IV.—SECOND REPORT OF THE COMMITTEE, CONSISTING OF PROFESSOR T. MCK. HUGHES, DR. H. HICKS, DR. H. WOODWARD, AND MESSRS. E. B. LUXMOORE, P. P. PENNANT, EDWIN MORGAN, AND G. H. MORTON, APPOINTED FOR THE PURPOSE OF EXPLORING THE CAE GWYNN CAVE, NORTH WALES. DRAWN UP BY DR. H. HICKS, SECRETARY.

THE main object that the Committee had in view this year was to extend the excavation which had been made in front of the new entrance to the cavern, discovered last year, so that a clear section of the deposits which covered that entrance might be exposed.

Work was commenced on June 6, and continued to the 18th, when it was decided that sufficient excavation had been made, and work was for the time suspended. It was deemed advisable to postpone the shoring up of the sides and any filling in that may be required until August, so that an opportunity may be given to any one interested in the exploration to examine the section exposed. The excavation was visited daily by some members of the Committee, and all, excepting Dr. H. Woodward, were able to be present on

several occasions. The section has also been examined by Prof. Boyd Dawkins, F.R.S., Messrs. C. E. De Rance, F.G.S., R. H. Tiddeman, F.G.S., Clement Reid, F.G.S., A. O. Walker, F.L.S., H. C. Beasley, and others.

It was found necessary to remove much of the timber placed last year to support the face in front of the entrance, so that the section might be clearly exposed, and the cutting was widened here sufficiently to show a vertical face of undisturbed deposits. The timber supporting the north-east face of the cutting was allowed to remain, as that portion had been well exposed last year, and it was thought that the excavation in front and to the south-west would yield all necessary evidence without incurring that additional trouble and expense. The cutting was carried in a south-south-west direction from the mouth of the cavern, and beyond the dip in the field supposed to indicate the line of an old fence; the length from the timber on the north-east face to the commencement of the dip in the field being about 30 feet and the width varying from 5 to 10 feet; the narrowest part being at the furthest point from the cavern. In the face exposed in front of the entrance, and for a distance in the cutting from there of about 25 feet, the soil varied in depth from 18 inches to 2 feet, but at the slope supposed to indicate the line of the old fence it thickened considerably. Underlying this throughout the whole length of the cutting and in the field beyond this point, a boulder clay of reddish-brown colour was exposed. This boulder-clay contained thin seams of sand, which were traceable generally at the same horizon along the whole section.

At a depth of about 7 feet from the surface, in a continuous band of reddish sandy clay, numerous fragments of marine shells and some perfect ones were met with, and these have been recognized by Mrs. McKenny Hughes to belong to the following species, viz. *Ostrea sp.*, *Mytilus sp.*, *Nucula nucleus*, *Cardium echinatum*, *C. edule*, *Cyprina islandica*, *Astarte borealis*, *Artemis exoleta*, *Venus gallina?* *Tellina balthica*, *Psammobia ferroënsis*, *Donax?* *Mya truncata*, *Littorina sp.*, *Turritella terebra*, *Buccinum undatum*. Below the boulder-clay at a depth of about 9 feet from the surface, there was exposed some sandy gravel and fine banded sand with a total thickness of over 6 feet, and under the latter a well-defined band of finely laminated reddish clay.

Below the laminated clay the brecciated bone earth was found to extend as far as the cutting was made in front of the entrance, and also for a distance of 7 feet in a southerly direction from the entrance. This year only a few fragments of bone and bits of stalagmite were obtained from this earth, though it will be remembered that last year it yielded many teeth as well as the flint flake which was discovered near the entrance. The limestone floor under the bone earth was found to rise gradually outwards from the mouth of the cavern for some distance, forming a shallow basin-shaped space in front of the entrance. In the bone earth in this space there were several large angular blocks of limestone.

It was not thought necessary to dig down to the floor along the

whole length of the cutting, but it was traced for 7 feet in that direction by the side of the cliff against which the deposits abutted. Beyond that point the cutting was made deep enough to reach the sandy gravel under the boulder-clay, and at different parts test-holes were sunk still deeper into the gravel and sand. One hole was also sunk in the field in front of the cutting at a distance of over 35 feet from the entrance to the cavern. The deposits here were found to be similar to those in the cutting and in front of the cavern, but the depth of the soil over the boulder-clay was only from one foot to 18 inches. A very large number of smoothed and ice-scratched boulders were found, many of considerable size; the majority being fragments of Wenlock shale from the neighbourhood, and Lower Silurian rocks from the Snowdonian area. Amongst them also were fragments of granite, gneiss, quartzites, flint, diorites, basalts, Carboniferous rocks, etc.

V.—THE DISASTER AT ZUG ON JULY 5, 1887. BY THE REV. E. HILL, M.A., F.G.S., OF ST. JOHN'S COLLEGE, CAMBRIDGE.

ON July 5, 1887, at the town of Zug, in Switzerland, a portion of the shore gave way and sank into the lake. About three hours later another much larger adjacent area also suddenly subsided, so that in all an area considerably over two acres, with half of one of the principal streets, was submerged to a depth of about 20 feet. It can be seen that the subsoil consists of coarse gravel and sand, followed after a few feet by soft wet sand and fine mud. According to Professor Heim, this fine mud or sludge reaches to a depth of nearly 200 feet, and the disaster is shown to be due to a flowing out into the lake of this mobile sludge from under the superincumbent weight of buildings and firmer ground. The buildings collapsed as they sank. The catastrophe must have been long impending; the exact cause which precipitated it is indeterminate, but a low level of the lake and tremors from pile-driving for new quays are suggested as contributories. On the English coast the incessant changes of pressure from tides probably render impossible such instability of equilibrium.

REVIEWS.

THE MAMMOTH AND THE FLOOD. AN ATTEMPT TO CONFRONT THE THEORY OF UNIFORMITY WITH THE FACTS OF RECENT GEOLOGY. By HENRY H. HOWORTH, M.P., F.S.A., M.R.A.S. Svo. pp. xxxii. 464. (London, 1887, Sampson Low, Marston, Searle, and Rivington.)

THE desire to find harmony between the Geological record and the first chapter of Genesis, laudable enough when Science was in its infancy, has ceased now-a-days to cause much anxiety. Geological chronology, like human history, can only be separated into epochs that are marked by local breaks or "landmarks" in the continuity of events; so that no system of subdivision that applies to one tract of the earth's surface will be equally applicable in all countries.