noticed upon the broken bit of pottery what looks very like a worn-out inscription in Roman capital letters. This is best seen with a pocket lens. The bit of jet (?) may be jet or coal ; I am not competent to give an opinion. The fragments of flint are all artificial. Among them is the base (showing the bulb of percussion) of a worked flake. These flint-flakes were used down into the iron age, and we have here another proof of the fact. The bone scoop sent by Mr. Smyth is, from the character of the texture or structure of the bone, altered by exposure and time, as it is unquestionably older than the apple-scoops which schoolboys made in the present century, and which it closely resembles. I have another like it, from the Lough Revel Crannog, Co. Antrim, with cobalt patina. This from Rathcoursey (Carrigagower) is ornamented, and the flint arrow-head found there is small, beautifully chipped, and of the scarce and deeply indented type. The iron nail is very curious, with a head like a horse nail.

## NOTICES OF MEMOIRS.

British Association Reports. Abstracts of Papers read before Section C. (Geology) Swansea.

### I.—On the Action of Carbonic Acid on Limestone.

By Professor Boyd Dawkins, F.R.S.

CAVES in the limestone are to be looked upon as subterranean watercourses, which are produced partly by the dissolving action of the carbonic acid in the rain-water, and partly by the mechanical action of the streams flowing through them. The insoluble carbonate of lime in the rock is changed into the soluble bi-carbonate and carried away in solution. The additional atom of carbonic acid, however, is in a condition of unstable chemical combination, and if it be removed either by evaporation or by the action of the free current of air, the insoluble carbonate of lime at once is deposited. Hence it is that some caverns have their walls covered with a drapery of stalagmite and the little straw-like pendants from the roof formed round the edges of each drop gradually become developed into columns of various sizes. The stalagmitic pedestals also rise from the floor where a line of drops falls from the roof and ultimately unite with the column let down from above. On the surface, too, of the pools an ice-like sheet of stalagmite gradually shoots across from the sides, and sometimes where the water is still covers the whole surface. Admirable illustrations of all these processes are to be seen in the caves of Pembrokeshire, and especially in the Fairy Cave on Caldy Island.

The rate of the accumulation of carbonate of lime depending primarily upon the access of water and the free access of air, both being variable, varies in different places. Sometimes it is very swift, as for example in the Ingleborough Cave, where a series of observations by Professor Phillips, Mr. Farrar, and myself extending over the years from 1845 to 1873 give the annual rate at ·2946 inch. It is obvious, therefore, that all speculations as to the

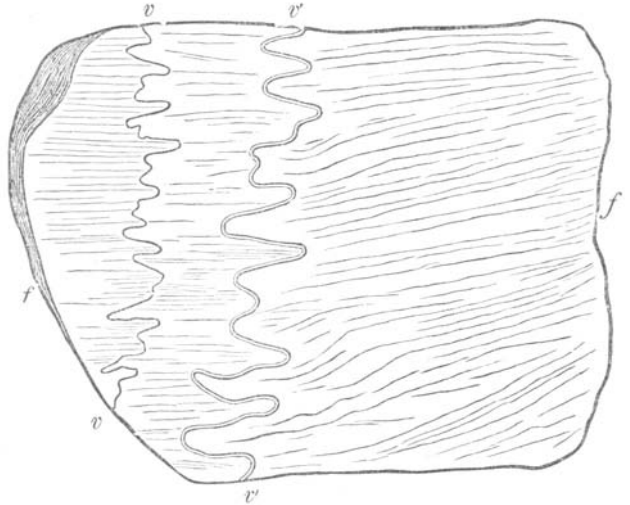
antiquity of deposits in particular cases based on the view that the accumulation is very slow, are without value.

The mountain limestone ravines and passes are to be viewed in the main as caverns formed in the manner above stated, which have lost their roofs by the various sub-aerial agents which are ever at work attacking the surface of the limestone. If any of these be examined, it will be seen that the tributary caves open on their sides, and in some cases the ravine itself is abruptly terminated by a cavern.

## II.—On a Fragment of Mica Schist.

By Professor W. J. Sollas, M.A., F.R.S.E., F.G.S.

THE author called attention to some appearances presented by a fragment of mica schist, pointed out to him by Prof. William Ramsay, Ph.D., while walking on the beach at Bodö, Norway. It is a tabular fragment, showing fine foliation-laminæ, and traversed by two undulating veins of quartz, the undulations are very high and narrow, eight complete ones occurring along a distance of ten inches in a straight line.




Face of Fragment of Mica-Schist, Bodö, Norway.

*f f* planes of foliation. *v v* and *v' v'* folded veins of quartz, crossing the planes of foliation. (Scale $\frac{1}{4}$.)

The planes of foliation correspond to the bedding in the rocks of the neighbourhood (amongst which this same phenomenon was afterwards noticed). The folded quartz vein was at one time straight and cut across the foliæ at right angles; the folding must have been accomplished by compression of the schist at right angles to its foliæ, and by measuring the length of the quartz vein between two points along its undulations (26 inches) and also directly along its path

(10 inches) one finds the amount of compression which has taken place (13 : 5). The argument is the same as that used by Dr. Sorby for the bed of quartzite folded in the slate of Devonshire.

## III.—On the Island of Torghatten.

By Professor W. J. Sollas, M.A., F.R.S.E., F.G.S.

THE author described the results of a visit which he made to this island in July, 1880. The platform from which the peak of the island rises is a narrow plain of marine denudation, produced when the island was submerged 375 feet below its present level. The tunnel which traverses it is a sea-cave excavated between two master-joints. The floor of the cave is covered with angular blocks of gneiss, which have fallen from the roof since the elevation of the cave-floor above the sea-level; the blocks have fallen far more rapidly at the entrances of the cave than in the interior, and, as a consequence, the roof rises from the middle towards each end of the tunnel, and so does the angular debris, which thus forms at each entrance a vast sloping mound. The vast quantity of fallen material is an interesting indication of what has been accomplished by simple mechanical disintegration since the island was raised above the 375 feet level. The joints are the most important factors in denudation; excepting moutonnéed faces, the author considers most of the bare rock faces which constitute the surface of Northern Norway are merely exposed joint planes. He has seen joints in the same rock, and having the same direction, extending from a few feet to over a thousand, and surface features in parallelism with them from a facet not a yard across to precipices over a 1000 feet high.

## IV.—On the Hiatus said to have been found in the Rocks of West Cork.

By G. H. Kinahan, M.R.I.A.,
President of the Royal Geological Society of Ireland.

THE paper was commenced by a table of the different classifications of the Cork Rocks.

| Griffith. | Jukes. | Hull. |
|---|---|---|
| Carboniferous Slate. | Carboniferous Slate. | Carboniferous Slate. |
| | | Coomhoola Grits. |
| Yellow Sandstone. | Upper Old Red Sandstone. | Kiltorcan Beds. |
| Old Red Sandstone. | Lower Old Red Sandstone. | Glengariff Beds |
| Silurian. | Glengariff Grits. | (Silurian.) |

From the table it is apparent that although using different group-names Griffith's and Jukes' classifications are essentially similar, while Prof. Hull's classification is materially different from both; although by adopting for his new groups, names very similar to those of Jukes, a careless reader might suppose his classification was similar to that of Jukes and Griffith.

The paper went on to point out that the supposed hiatus rested on

the conclusions of Prof. Hull, which the author reviewed in order. First, that the hiatus and unconformability, it was understood, were supported by the observations of Messrs. O'Kelly and McHenry at Kenmare and Glengariff Bays; but one of these geologists, however, contradicts this, while the second declines to give an opinion. The second, referred to well-known unconformabilities outside the limits of the typical West Cork rocks; these on account of the places in which they occur, the author was of opinion did not favour the idea of a hiatus. The third was a statement that the plotting on the maps of the Geological Survey proved an unconformability; the lines, however, to which Prof. Hull was supposed to have referred are only the conventional lines in common use to indicate folds and flexures in contorted areas; and are fully explained in the sections of Jukes and his assistants. The fourth is, that there are abrupt changes in the rocks forming Prof. Hull's different groups—this, however, was shown to be improbable, as the Carboniferous Slate of Griffith graduates so imperceptibly into his Yellow Sandstone, and the latter into his Old Red Sandstone (the upper member of Prof. Hull's "Glengariff Beds"), that the respective boundaries adopted on the Government maps are arbitrary, and depend solely on the colours of certain beds.

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## V.—The Old Red Sandstone of the North of Ireland.

By G. H. Kinahan, M.R.I.A.,

President Royal Geological Society of Ireland.

In the Geol. Mag. for August, 1880, page 381, appears the abstract of a paper "On the Old Red Sandstone of the North of Ireland," by Mr. F. Nolan (read before the Geological Society of London, June 23rd, 1880). In this communication my classification is cautiously acknowledged, although when I first published it in my preface to the Geology of Ireland, Prof. Hull, in criticising it in the Geological Magazine, brought forward most ingenious evidence to show that I was mistaken.

According to the published Map of the Pomeroy District (Ireland, Sheet 34), the Old Red Sandstone of Shanmaghry, two miles S.E. of Pomeroy, not only rests on the fossiliferous Pomeroy rocks, but graduates into them. I, however, would suggest that the position of the boundary is inaccurate, and that the Old Red Sandstone extends a little farther north into the townland of Aghafad, its base being a friable red conglomerate that rests unconformably on the fossiliferous beds a little to the north of it.

I cannot understand on what reasoning it has been assumed that the "Kiltorcan beds" of Professor Hull, which are said to be the equivalents of Griffith's "Yellow Sandstone," can be supposed to be absent in the North of Ireland. They were found there years ago by Griffith and others; and there are good exposures, in different

places in Tyrone, Fermanagh, etc., of rocks lithologically identical with those in the Kiltorcan district, Co. Kilkenny; while these rocks, and also those at Kiltorcan, have similar relations to the Carboniferous Limestone. Furthermore, it is stated in the abstract referred to that the Upper Conglomerates are supposed to represent "the Upper Old Red Sandstone of Waterford," yet Haughton, Baily, and others, years ago, proved that the Upper Old Red Sandstone of Waterford contains a like assemblage of fossils to those at Kiltorcan, Co. Kilkenny. This is a paradox that needs explanation.

As the Carboniferous Slate of Cork County is the equivalent of the Carboniferous Limestone and its associated sandstones and shales, the Calp sandstones of Ulster must necessarily in part represent the Carboniferous Slate; but it is erroneous to state they are the equivalents of it or of the Coomhoola Grits, especially the latter, as those who are acquainted with the geology of West Cork are aware that the last-mentioned name was applied by Jukes to groups of grits that may occur on different horizons in the Carboniferous Slate.

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## VI.—Note on the Range of the Lower Tertiaries of East Suffolk.

By W. H. Dalton, F.G.S., of H.M. Geological Survey.

THE Crags and Drifts of East Suffolk prevent more than an approximate delineation of the outcrop of the Chalk from beneath the Lower Tertiaries.

The London-clay disappears from the surface a little west of Orford; but the deep boring at Sir E. Lacon's Brewery in Yarmouth, made in 1840, passed through 170 feet of estuarine deposits, and then no less than 305 feet of London-clay and 51 of Reading beds, before reaching the Chalk. There could therefore be hardly a doubt of the continuity of the Eocene beds between Orford and Yarmouth, although their boundary-line might be for some part of its length outside of the present coast: indeed, in published maps, most of the interval is coloured as Chalk.

The inhabitants of Suffolk are, however, awaking to the disadvantages of a water-supply derived from ponds and sewage-tainted sands, and consequently Artesian wells, carried down into the Chalk, are increasing in number.

The accounts of these wells (which will duly appear in the Memoirs of the Geological Survey) give the following indications of the position of the outcrop of the Chalk:—

At Easton Park, Framlingham, Beccles, and Norwich, the Chalk is covered directly by Crag or Drift.

At Woodbridge, Saxmundham, Bramfield, and Yarmouth, a greater or less thickness of Lower Tertiary beds is present, and their boundary is probably three or four miles in and from these points.

At Hoxne, a few feet of 'green clay' lying directly on the Chalk may possibly be an outlier of the Reading beds.

The Lower Tertiaries, thus outlined, possess no special interest,

except that, being impervious clays, they cut off impure surface waters, and are easier to bore through than the loose sands, etc., overlying them.

The plane of the Chalk surface, whether under or beyond the Lower Tertiaries, is sufficiently uniform to render calculation of its depth in any part of the district an easy process. In the Bramfield boring, the latest of the series, the Chalk was reached at 48 feet below the ordnance datum, calculation from the three nearest points —Beccles, Framlingham, and Saxmundham—indicating 52½ feet.

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## VII.—On some Pre-Cambrian Rocks in the Harlech Mountains, Merionethshire.

By Henry Hicks, M.D., F.G.S.

DURING an excursion into the Harlech Mountains in the summer of last year, I recognized, near the centre of the well-known anticlinal of Cambrian rocks, another group of rocks, which appeared to me to underlie the former, and to be part of a pre-existing formation. On further examination I noticed also that many of the fragments in the conglomerates at the base of the Harlech Grits seemed to be identical with the rocks below, and to have been derived from some such pre-existing group. Subsequent microscopical examination of some of the fragments, and of the underlying rocks, tended strongly to confirm this view. In order, however, to satisfy myself more fully on this point, I revisited the area this summer, accompanied by my friends, Prof. Hughes, Mr. Tawney, and Dr. R. D. Roberts, and the result has been to entirely confirm my previous conclusions. This discovery is of considerable importance, as it enables us to compare the thickness of the Cambrian rocks of North Wales more satisfactorily than has been hitherto possible with those of South Wales, and to realize more clearly the early physical conditions of the areas. Hitherto it seemed doubtful what the actual thickness of the Harlech Group could be, and very different estimates have been given. It now becomes possible to give a perfectly correct estimate, and it is satisfactory to find that it approximates far more nearly with that made out in other Welsh areas, than was previously supposed.

The points where these older rocks come to the surface mainly occur along a line running nearly due N. and S. from Llyn-Cwmmynach to about two miles to the S.W. of Trawsfynnyd. Along this line the anticlinal is much broken, and denudation has taken place to a very considerable extent. It is mainly in consequence of this that the Pre-Cambrian rocks are exposed. The so-called intrusive felstones marked here on the Survey Maps are part of the Pre-Cambrian group, and are not intrusive in the Harlech rocks. They are highly felsitic rocks, for the most part a metamorphic series of schists, alternating with harder felsitic bands, probably originally felsitic ashes. They alternate with bands of purplish slates, which I once supposed might have been dropped amongst them by faults, but which I now think also belong to the Pre-

Cambrian group, as in the Pebidian rocks at St. Davids, and elsewhere. There are also some other exposures of the Pre-Cambrian rocks in the adjoining areas, and one very interesting section was carefully examined by Prof. Hughes and myself, to the east of the Trawsfynnydd road, between Caean Cochion and Penmaen, where the Cambrian conglomerates could be seen resting unconformably upon the older series, and large masses of the latter found plentifully in the conglomerates.

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## VIII.—On the Sandstones and Grits of the Lower and Middle Series of the Bristol Coal-field.

By Edward Wethered, F.G.S.

THE Bristol Coal-field is noted for its series of grits and sandstones, and these probably have their equivalents, in the South Wales and Forest of Dean Coal-fields, as well as in that of Somersetshire. They serve as stratigraphical landmarks; and it was the object of the paper (1) to compare the grits of the above Coal-field with one another, with a view of ascertaining whether there were distinguishing features which might enable them to be respectively determined, and assist in correlation. (2) To examine the chemical and physical conditions. (3) To note changes which occur when rocks are in contact with carbonaceous matter. The first point raised was the application of the term grit and sandstone. The author confirmed the statement of Mr. Sorby, in his presidential address to the Geological Society in 1880, to the effect that the Carboniferous Sandstones were composed of angular grains. Of those examined by the author, the grains of the Millstone Grit were the least angular. It was also pointed out, that as rocks show such variation of coarseness in the same deposit, this could not be taken into consideration as a test for grit. It was therefore suggested that the term grit should be confined to those rocks which show angularity of grains, irrespective of coarseness; and the term sandstone to those which are composed of rounded grains (*i.e.* from which the angularity has been removed). In any case, the term grit must be more generally applied to Carboniferous rocks than has been the case hitherto.

Reference was then made to 'duns,' which was defined as those Carboniferous beds intermediate between grit or sandstone and clay. In mining operations, where the 'driving' of branches was by contract, questions arose between employer and employed, in the case of 'hard duns,' as to whether it is 'stone' or 'duns,' double price being paid for driving in the former. It was also important for geological purposes, in the construction of sections, that there should be an easy and ready test for this determination. The author suggested that the scratching of glass would be a suitable one, which would represent a hardness of 7 for rock which scratches glass.

The chief deposits of rock in the Coal-field were then referred to in ascending order, commencing with the Millstone Grit. Several samples of this, taken from Brandon Hill, gave from 97·4 to 98·5 per cent. of silica. In places it is used for brick-making, being

mixed with the other material to increase the proportion of silica. It was pointed out that there were other beds higher up in the Coal-measures which would do equally well, and in some cases better. for this purpose. The paper next referred to the 'Pennant Grit.' There is considerable difficulty in defining the limits of this deposit, but it was certainly not 2000 feet thick, as some authors had stated. The paper places the thickness at about 970 feet; but the middle or Pennant series of Coal-measures, so called on account of the Pennant being so extensively developed in this division, was about 2000 feet thick, and this, probably, was the origin of the mistake regarding the thickness of the Pennant.

The 970 feet of rock above referred to as the Pennant grit, was only entitled to that name as a local distinction. It was nothing more than an extraordinary development of a local measure grit: the 'Dexall grit,' of the lower series, for instance, was quite as much a 'Pennant,' if that term is to distinguish a certain class of rock.

After a careful examination of the rocks of the Coal-field, the author had come to the conclusion that, owing to the great similarity of Carboniferous arenaceous rocks occurring at different horizons, there was risk of serious error, in relying upon them for correlation or as stratigraphical landmarks. The proportion of silica could be sometimes used as a guide in determining one from another, but little reliance could be placed on it over a large area, as so many beds contained nearly the same amount.

The author's analysis showed the first 50 feet of the Pennant to contain 90 per cent. of silica; but after this, for a considerable thickness, 'good Pennant' varied from 84 to 89 per cent. in the proportion of silica contained in it.

The paper then referred to changes in the Carboniferous rocks, when in contact with carbonaceous matter. The author found that the per-centage of alumina increased, and this mostly as a silicate. By comparing the analysis of duns and shale from the district with that of the rocks, the same constituents were found to be present, the great difference being in the greater proportion of alumina in duns and shale. As a rule, the latter beds were to be found near coal; but in cases where rock followed, the author found that as it neared the coal it became more fissile and argillaceous.

This change was ascribed to the action of carbonic acid gas, generated by decomposing vegetation on silicates. The analysis of the rocks given showed them to have been formed from the denudation of older silicate rocks, and the action of carbonic acid on such sediment would be to readily decompose all silicates with the exception of silicate of alumina, which would thus increase in proportion to the whole, and give rise to beds of the composition of duns and shale.[1] To this cause the author attributed the formation of the latter deposits, and contended that although they may occur apart from carbonaceous matter, there is no proof that it was never present, and that it may not have been destroyed by decomposition.

[1] The writer is not now dealing with the hydrocarbons which shales sometimes contain.