

11. *On the CAMBRIAN CONGLOMERATES resting upon and in the vicinity of some PRE-CAMBRIAN ROCKS (the so-called INTRUSIVE MASSES) in ANGLESEY and CAERNARVONSHIRE.* By HENRY HICKS, M.D., F.G.S. (Read December 5, 1883.)

IN papers which I communicated to the Geological Society in 1877 and 1879, I brought forward evidence to show that some rocks in Caernarvonshire and Anglesey which were indicated on the maps of the Geological Survey as great eruptive masses intruded into strata of Cambrian and Silurian age, were really rocks of Pre-Cambrian age. I pointed out that there was the clearest evidence to show that the lowest Cambrian conglomerates known in those areas, instead of having been altered by these so-called eruptive masses, as would be inferred from the maps of the Geological Survey, repose unconformably upon the rocks composing these masses, and were mainly built up of materials derived from them by denudation. In the paper of 1877 I stated that the pebbles in the conglomerates were "usually distinctly rounded and generally imbedded in either an unaltered or semicrystalline matrix, from which they can be easily removed," and that "they were evidently in their present state, as regards consolidation, before they were cemented together to form the conglomerates, and must have been derived from rocks highly metamorphosed at that time, such rocks, indeed, as now occur immediately under them, and which, we venture to believe, belong to a Pre-Cambrian series." In the same paper I mentioned that the false appearance of being intrusive masses exhibited by these rocks and "the passage by gradual alteration mentioned by various observers, are mainly due to the fact that the matrix in the conglomerates has been derived from rocks immediately below or from similar ones, and from a slight subsequent change in the matrix, due, probably, to proximity to the intrusive dykes, aided by a readiness perhaps in the material to assume this change. This is clearly observed by watching the weathering of these conglomerates even when in direct contact with the porphyritic series; for any apparent melting-away of the hard pebble is shown not to be a fact, since on very slight weathering the pebble becomes easily separable from the matrix, and its outline is as perfect as on the day it became cemented in the mass."

Professor Bonney's very important paper (Quart. Journ. Geol. Soc. vol. xxxv. p. 309) added the necessary evidence to make these facts certain, and in it he showed also the rhyolitic character of some of the Pre-Cambrian rocks. Professor Hughes, Professor Bonney, Dr. Callaway, and Dr. Roberts have also from time to time, in different papers read before this Society and elsewhere, called attention to the same facts as are referred to above; and I should hardly have thought it necessary to bring forward this further evidence, highly conclusive as it may be, were it not that the last edition of the Geological Survey memoir relating to these areas, published in

1881, and revised, as stated therein, after the appearance of our papers, contains not only the same statements in regard to these so-called igneous masses and the strata surrounding them, but a charge is there made that we arrived at our conclusions "on purely theoretical grounds," and additional details are therefore given in support of the statements made in the previous edition. Moreover the present Director General of the Geological Survey, in his paper on the St. David's area in *Quart. Journ. Geol. Soc.* for August last, especially casts doubt on the value of the evidence adduced from conglomerates, and even quotes some of those in Anglesey in support of his view. He further reproduces his predecessor's (Sir A. Ramsay's) statement that there are no rocks of Pre-Cambrian age "in any part of the Principality."

Certainly the present Director General, in the paper referred to above, at p. 262, says—"It should be clearly understood that the conclusions to which I have come refer solely to that [the St. David's] district, and that, in the meantime, I offer no opinion regarding other so-called Pre-Cambrian areas in the Principality;" but most persons I think will agree that it is undoubtedly clear, from the paragraphs in his conclusions at pages 292 and 293, that his remarks throughout are intended to have a far more general application. At p. 292 he says—"But the same treatment which Dr. Hicks meted out to them in the St. David's area, he has consistently continued in his subsequent excursions over Wales. Having apparently convinced himself—on what grounds I have endeavoured to show—that the rocks coloured on the Survey Maps as felstone or quartz porphyry must belong to his 'Arvonian' group (that is to say, are not intrusive in the Cambrian or Lower Silurian strata, but prominences of Pre-Cambrian age), he has proceeded to apply this conviction to the Geological Survey maps all over Wales. With the most complete disregard of the evidence by which the officers of the Survey were led to regard certain rocks as intrusive, he simply turns the felstones, syenites, &c., into metamorphic and volcanic Pre-Cambrian masses." In a footnote to this paragraph he also says—"It will be a work of some labour to follow Dr. Hicks in his rapid traverses of Wales, with the view of testing his corrections of the work of his predecessors. Mr. Peach and I had time to visit a few of the areas he has renamed, and always with the same result." To show that it is absolutely necessary, in my own self-defence, that I should lay all possible evidence before the Society in regard to all the areas, to prove that I did not arrive at conclusions at variance with the views of the Geological Survey in the hasty and careless manner attributed to me in the above quotations, I need only quote one further paragraph, which concludes the first part of his paper:—"This was not the style in which the Survey Maps were constructed; nor is it the style in which they should be corrected. The intrusive character and comparatively late origin of the eruptive rocks were deliberately asserted by my colleagues after prolonged examination. Had this view been erroneous, it ought to have been disproved by a detailed review of the evidence on which it was based. I have gone fully into the asser-

tions made by Dr. Hicks himself in regard to the area of St. David's, and have proved them to be untenable. If this is the result of the critical examination of his typical Pre-Cambrian district, over which he has spent most time, I can hardly anticipate that his more rapid traverses elsewhere will, when properly tested, be found to have been more successful."

After listening to the above statements which have been made by the present Director General, I hardly need ask the Members of this Society, in whose Journal they have appeared, to consider this paper only as a first instalment of that thorough criticism of the work of the Geological Survey which is demanded in the above paragraph, and as necessary in reply to the indictment, from the only district which I have been able to reexamine since Prof. Geikie's paper appeared in the Journal.

Though the title of my paper shows that I purpose mainly to deal with evidence derived from the Cambrian Conglomerates, it is clear that it will be advantageous to refer incidentally also to any new facts obtained relating to the Pre-Cambrian rocks themselves. The rocks which we claim to be of Pre-Cambrian age have, however, been so fully described in papers by Prof. Hughes, Prof. Bonney, Dr. Callaway, and myself that it will not be necessary to do more than call attention very briefly to their characteristics. Prof. Geikie has also, in his descriptions of these rocks, included all peculiarities which have been pointed out by us as specially applicable to any of these North-Wales areas.

In the Geological Map issued with the Survey Memoir referred to, published in 1881, there is a great elongated mass coloured as "intrusive felspathic porphyry," reaching from Llanllyfni in the south of Caernarvonshire, to Bethesda in the north, a distance of about fifteen miles. It has an average width for the most part of from a mile and a half to two miles, but becomes narrower towards the north. At its south-western extremity and for a short distance along its south-eastern edge, altered Cambrian rocks are shown to be in contact with it, but at all other points ordinary Cambrian rocks. This so-called intrusive mass is stated in the index to be "chiefly of Lower Silurian age." Another mass of the so-called "intrusive felspathic porphyry" is shown to extend from Caernarvon to Bangor, a distance of about ten miles, with a width at its broadest part of rather over a mile, and narrowing towards each end. At Bangor altered Cambrian rocks are shown along its north-eastern edge; further south along the same side the ordinary Cambrian colour is given; and beyond this, to Caernarvon, Lower Silurian rocks are indicated as being in contact with the mass. Along the western edge Carboniferous rocks are shown. This mass, like the one above referred to, is marked as "chiefly of Lower Silurian age."

In Anglesey, extending from the coast south of Llanfaelog to the north-east of Llanerchymedd, there is, on the same map, a great patch coloured as granite. At its broadest part it is three miles across, and its length is about eleven miles. It is stated in the index to be "probably of Lower Silurian age." What I have main-

tained in previous papers to this Society is this, that neither of these so-called intrusive masses could possibly be of Lower Silurian age, that they could not possibly have eaten into and metamorphosed the Cambrian and Silurian rocks in their immediate vicinity, as maintained by the Surveyors, since they are truly Pre-Cambrian rocks, which were in their present condition before either the Silurian or Cambrian rocks were deposited. Where views are so diametrically opposed to one another as are those of the Surveyors to those which we have put forward, it is clear that we are bound to furnish very conclusive proofs in support of our views; and I venture to believe that from the evidence I have to bring before you in this paper, it will be allowed that the proofs are of the most conclusive character, even when tried by the most rigid tests. I have given the rough superficial areas of these rocks, as it might be supposed from some of the remarks which have been made that, as geological features, their importance is scarcely deserving of consideration. These, however, are but a few of similar areas which we claim, and when it is considered that they are now the exposed fragments only of part of that old Archæan land which extends everywhere under the newer formations, and that it is in these fragments we obtain evidence of the geological structure, the physical history, and geographical features of that primæval land, I believe the true man of science will grant that in this case the value of the inquiry cannot well be measured by the superficial area exposed now to examination.

The visit of the Geologists' Association to Bangor in the last week of July offered favourable opportunities for reexamining many of the areas previously described, and the evidence in that neighbourhood was freely exposed to the criticism of over fifty Members who were present. It was in the week subsequent to that visit, however, that, accompanied by Mr. Marr, Mr. Myers, Mr. Murray, Mr. Love, all Fellows of the Society, and by Mr. McPherson and Mr. Bartlett, and afterwards, I was able to collect the facts given in this paper, and I wish to express my obligations to those gentlemen for the very valuable assistance which they rendered me.

Hitherto, though pebbles and fragments of almost every variety of the rocks claimed by us as of Pre-Cambrian age had been occasionally observed in the Cambrian Conglomerates, no actual necessity had arisen for making a special collection, to prove their identity with the rocks immediately underlying them or in their immediate neighbourhood. The importance of making such a collection, however, became imperative after the statements of the Director General that the Conglomerate in South Wales (and according to the same reasoning in North Wales) could not possibly contain a pebble of the characteristic granite (Dimetian granitoid rock), or of the quartz-felsites or porphyries, because, as he led us to infer, they were all newer than the Cambrian rocks. Moreover if we can prove conclusively that typical Dimetian fragments, and undoubted quartz-felsites and porphyries, identical with the rocks below, do occur in the Cambrian Conglomerates, then, so far as North Wales is concerned, the Director General,

by his own statements, will be compelled to grant that our views are correct, and that he and his predecessor have been completely in the wrong in their interpretation of the geology of those areas, so far at least as the oldest rocks are concerned. The following statement occurs at p. 305 of the paper already referred to:—"There can be no doubt that conglomerates frequently mark the natural base of a series of sedimentary deposits. They do so more especially where they are formed of materials that have had an obviously local origin, and where they rest unconformably on the rocks below, from the waste of which they may have been mainly derived. In such cases they must be regarded as littoral deposits; and in this respect they possess importance from the light they throw on former geographical conditions. Of other conglomerates which possess local value as stratigraphical horizons only, he says—"Unlike the basal conglomerates just referred to, they are composed of well waterworn pebbles, for the most part comparatively small in size, derived from some distant, and in many cases, unknown source, and consisting usually of quartz, quartzite, or other exceptionally durable rocks." I accept to the fullest extent the tests suggested by the Director General in the above quotations, and I now submit the facts to the Society, feeling confident that the verdict must be in our favour. As the Director General has acknowledged that we are correct in placing the Pebidian rocks below the basal conglomerates, as a great volcanic series, though Sir A. Ramsay maintains that the oldest volcanic rocks known in Britain (as may be seen by referring to his Address as President of the British Association in 1880), of which he had any personal knowledge, are of Lower Silurian age, I will only refer to those rocks so far as it may be necessary to point out evidence of their Pre-Cambrian age, by showing the Cambrian Conglomerates resting unconformably upon them, and being here and there made up very largely from their denudation. It is more important that in this paper I should confine myself to the above-mentioned rocks, which are claimed by the Surveyors as irruptive masses of a date long posterior to the deposition of the Cambrian Conglomerates, which now surround them.

Llanfaelog, Anglesey.

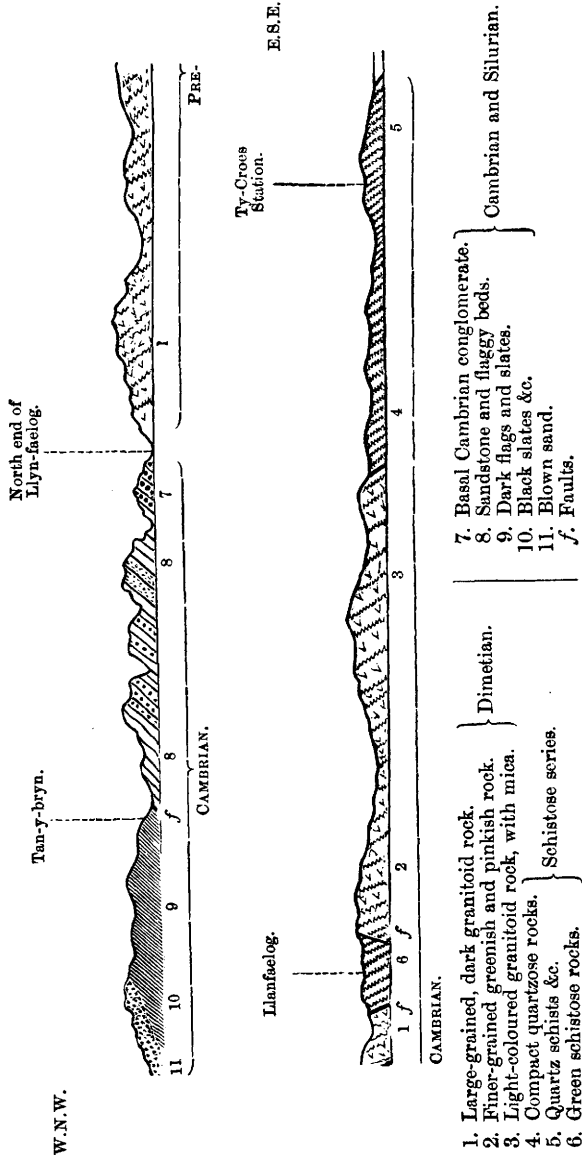
In my paper of 1879 I pointed out that the so-called intrusive granite as exhibited near Llanfaelog, in Anglesey, was almost identical in character with the Dimetian granitoid rocks at Twt Hill, Caernarvon, the so-called Rhos Hirwain syenite, and the Dimetian at St. Davids; and my views were fully confirmed by Professor Bonney's examination of the rocks in the field and under the microscope. I maintained that this so-called granite patch, instead of being, as stated by the Surveyors, composed of granite intruded into the Cambrian and Silurian rocks in Lower-Silurian time, and of metamorphosed and entangled portions of those rocks, actually consisted of the oldest rocks in Anglesey, and formed an old axis not only to the Cambrian and Silurian rocks, but even to the newer of the Pre-

Cambrian rocks. The evidences on which we based these conclusions were chiefly such as could be obtained by comparing the rocks with those found in other areas which we had examined, and by noticing carefully whether any alteration had been produced in the neighbouring rocks. We recognized that along one side the rocks were entirely unaltered, and that the material out of which the latter had been built up may have been, in part at least, derived from the denudation of the granitoid rocks; but at that time we found no fragments which could be stated definitely to have been derived from the rocks in the so-called granite patch. Moreover the actual horizon of these conglomerates and grits along the western edge had not at that time been made out; and we owe it entirely to Professor Hughes that their position as basal Cambrian Conglomerates has been clearly defined. In his excellent paper on "The Geology of Anglesey" published in 1881, he has worked out the succession of these rocks near Llanerchymedd, by fossil and stratigraphical evidence, and has proved conclusively not only that they are the basal Cambrian conglomerates and grits, but also that the Tremadoc and Arenig rocks follow them in succession. I had an opportunity of examining the sections near Llanerchymedd under Prof. Hughes's guidance, and there cannot be the shadow of a doubt that his conclusions are correct. If further evidence is necessary, it is furnished in the sections we examined to the west of Llanfaelog. In descending order are the following rocks. (See section, fig. 1.) Under the blown sand to the east of Traeth Crigyll black iron slates of true Arenig type are found, with a high dip to the north-west. At Ty-croes farm* and Tan-y-bryn, black slates and more flaggy beds are seen, still dipping to the N.W. In the depression which separates these farms from Ty-hen, the beds are not exposed, and the appearance here would rather indicate a line of fault with the loss of some of the strata. The next beds which are met with going eastward are flaggy sandstones, and these are underlain at Ty-hen by rather rough conglomerates. Between this point and the Dimetian rocks on the east shore of Llyn-faelog, a distance of about half a mile, the rocks are mainly flaggy sandstones alternating here and there with bands of conglomerate. The beds all dip towards the north-west, at an angle of from 30° to 35°. If there are no repetitions by faults, we have here a very considerable thickness of the Lower Cambrian rocks exposed. The lowest beds of the conglomerates are within 30 yards of some exposures of the granitoid rock, in the field on the east side of the lake, and I have no doubt an actual contact may be seen by the removal of some of the soil in the depression at the head of the lake. The lowest conglomerate at this point is in some respects the most interesting and important of the basal conglomerates that I have yet examined; for it shows clearly that when it was deposited the granitoid rocks immediately to the east must have been exposed, and that they formed the old shore-line on which the conglomerates were deposited. Not only is the matrix chiefly made up of an arkose material, as is some of the conglomerate at Twt Hill, Caernarvon,

* Two miles west of Ty-Croes Railway Station.

but here large fragments of undoubted Dimetian rocks occur as well-rolled pebbles, and every variety found in the underlying

Fig. 1.—Section from *Tan-y-bryn*, by *Llanfaelog*, to *Ty-Croes Railway Station*, *Anglesey*.
(Horizontal scale 6 inches to 1 mile.)



rocks may be recognized in the pebbles or fragments in the conglomerate. I have had several of these pebbles cut, and also some
Q. J. G. S. No. 157.

of the granitoid rocks from below. These have been submitted to Prof. Bonney for examination with the microscope, see his Notes 1-6, pp. 201-203, and his conclusions agree entirely with mine, that the pebbles are identical with the rocks below, that the peculiarities exhibited by the granitoid rocks of the ridge are shown equally clearly in the pebbles, and that it is evident the granitoid rocks were much in the condition in which they are now found before the fragments now lying in the conglomerate were broken off from the original mass*. Even superficially these pebbles show evidences of this fact. The crushed appearance exhibited by the parent rock is equally clear in the pebble; and that infiltration of a green material along the joints, so commonly found in the Dimetian, had taken place in Pre-Cambrian time, is made certain from finding that it is equally abundant in the fragments.

Subsequent crushing is occasionally indicated by fracture-lines across the pebbles, usually filled by quartz; but these lines are quite independent of the indications of the original crushing, which seems to have affected the whole structure of the rocks even to a point only revealed under the microscope. It has been frequently stated that the quartz in the Dimetian has a dirty appearance, and that this is due to an immense number of inclusions, chiefly of vesicles arranged in well-marked lines. These vesicles are supposed to indicate that the quartz was formed in the presence of abundant vapours. This view of their origin is now so universally accepted that I fear it will be considered rank heresy even to suggest an additional cause. Still, after a prolonged study of a large series of slides made from the Dimetian rocks and also from the older gneisses of Scotland, in which the vesicles occur in equal profusion, I must confess that the above view does not appear to me to be sufficiently satisfactory to account for their unusual abundance, or for the condition generally of the quartz in the old rocks. We know that these rocks have been crushed to a microscopical degree, and that this has allowed infiltration to take place to such an extent that the majority of the minerals have undergone a process of decomposition. One result of these decompositions would be that liquids with powerful solvent properties would be produced, which by a kind of capillary action would pass along the minutest fissures and so attack the quartz and cause decay. The quartz shows abundant evidence of having been broken up, and the fragments are frequently separated by the deposition of secondary minerals. The lines of fracture are also traceable from one fragment to another by thin strings of these secondary minerals; and it is an important fact also that occasionally these strings are seen to connect lines of vesicles in different fragments. The

* As it is a matter of great importance that no possible doubt should exist as to the identity of the pebbles in the conglomerate with the rocks below, Prof. Bonney took the precaution to examine all the slides submitted to him, distinguished by numbers only, before looking at the rock-specimens, and it is undoubtedly a highly satisfactory proof of the great value of the microscope in these inquiries that the results required no modification in any of the main facts when it was found from what areas the specimens had been obtained. In several of the slides also there was no evidence to guide him as to whether they had been cut actually from the parent rock or from a pebble.

majority of the lines extend to the edges of the quartz fragments, but others appear sealed up. The latter may have originally been lines of fracture which have been closed up by a secondary deposition of quartz. The vesicles of vapours and liquids would naturally be arranged in rows if along fissures, but not necessarily so if they were original inclusions. These lines of vesicles therefore may be the result of infiltration. A rock of so old a date as the Dimetian has suffered many great changes since it was first formed, and it may have even been several times under the influence of heated waters and vapours. The false schistosity exhibited by the more massive portions of the Dimetian may be chiefly due to this crushed character, and to the abundance of the green mineral along the joints, sometimes present in such proportions as to give the rock a *pseudo-brecciated* appearance. The secret why this old granitoid rock is useless for building- and other purposes, may be found in its crushed character; but I am inclined to think that it is also partially due to its being, as I have lately maintained, a metamorphic rock, and not, as I formerly supposed, an igneous rock of Pre-Cambrian age. It varies so much in character at different horizons here, as at St. David's, Rhos Hirwain, and Twt Hill, that it seems more natural to regard it as originally a deposited rock, like the older gneisses of Scotland and Canada, than as an igneous rock. It is, however, now so completely crystalline that its origin even, as in the case of the massive gneisses, can only be a matter of conjecture. It seems that for the present, therefore, we cannot do better than be satisfied with the critical opinion of the late Mr. Tawney, who devoted much time to the examination of the Dimetian rocks, when he says, in a paper published last February in the *Geological Magazine* (p. 67), "The constitution of the rock, however, is against its being igneous, and its great variability within short distances also."

About the centre of the Dimetian axis there are some green schistose rocks, which I believe are much newer than the Dimetian, and either folded or faulted in at this point. In the railway-cutting it appears as if, with the exception of the rocks above mentioned, we had an ascending section towards Ty-Croes Station, as explained in my former paper. The Dimetian at the east end of the cutting is lighter in colour than that towards the west, and it contains a certain proportion of a silvery mica. Beyond this are the compact quartzose rocks which we classed as belonging to the *hälléfinta* series, and these are followed by the quartz-schists and the chloritic schistose rocks so common in Anglesey. Dr. Callaway, in his paper, placed the granitoid rocks above the schists and compact quartzose rocks; but in this I feel confident he is in error, and that my original view as to the order of succession here is in the main correct. Fragments of almost every variety of the rocks in this section, besides those of the Dimetian already referred to (see Prof. Bonney's note 8, p. 203), occur in the conglomerates; therefore the evidence that all the metamorphic schists in Anglesey are of Pre-Cambrian age is abundantly clear. Fragments of the various schists have been frequently mentioned by other authors as occurring in conglomerates in Anglesey; and Prof. Hughes states in his paper,

at p. 22, that the Llanerchymedd conglomerates vary "according to the character of the underlying rocks," and contain "bands composed chiefly of white quartz with occasional fragments of jasper, quartzite, schists, &c., and some beds of large felsite pebbles." Sir A. Ramsay also, at p. 247 of vol. iii. of the Memoirs of the Geological Survey, gives a list of fragments found in the conglomerates in the north-west of Anglesey; but immediately afterwards says that they could not have been derived from the Anglesey rocks themselves, as it would be evident on reflection that such could not be the case, "the metamorphism of the Anglesey rocks having taken place after the deposition of the Lower Silurian strata." Our contention, on the other hand, is that the fragments of granitoid and compact quartzose rocks, and the chloritic and mica-schists &c., are identical with rocks in Anglesey which now underlie the conglomerates in which they are included; and hence that these rocks, instead of being metamorphosed "after the deposition of the Lower Silurian strata," were in their present condition even before the Cambrian rocks were deposited, and are therefore clearly to be classed as of Pre-Cambrian age. The average test, as applied to the conglomerates of St. David's by Prof. Geikie, could be used here greatly to our advantage; for instead of quartz pebbles and quartzites forming, as he claimed they did there, over 90 per cent., we may safely say that rocks of undoubted local origin form here more than 90 per cent. of the fragments. It must be understood, however, that as we consider the basal conglomerates to have been deposited along old shores, the percentage of any special rocks must vary much even within very limited distances. This must always be the case with basal beds where the rocks which are being denuded vary in their character, and when currents and other influences affect the drift of the shingle. Nothing can be more fallacious, therefore, than to select pieces of conglomerates from one or two points, and make the average of the pebbles in these applicable to a whole district.

Bangor and Caernarvon.

The conglomerates in contact with and lying directly along the east side of the ridge, composed of granitoid rocks and quartz felsites, which extends from Caernarvon to Bangor, have been so frequently referred to in papers by Prof. Hughes and Prof. Bonney that very little need be added concerning them. The evidence as to their having been derived by denudation from those rocks has been accumulating every year since the first papers on these rocks by Prof. Hughes and myself were read. An unusually good exposure, however, of the quartz-felsite conglomerate at the east entrance of the west tunnel, is now being made in consequence of excavations for widening the siding room. The pebbles here are of very large size, and particularly well rounded, and all the varieties exhibited by the underlying quartz-felsites may be found*. Fragments of the

* These quartz-felsites have been shown by Prof. Bonney to be true rhyolites, and were so indicated by him in his appendix to Prof. Hughes's paper read Dec. 1877.

Pebidian (Bangor) beds are also plentiful, and it is interesting to note that here, as in South Wales, the porcellanites of that series are found in exactly the same condition in which they now occur in the beds in the neighbourhood. This, to my mind, proves conclusively that the change in the Pebidian rocks had taken place to the extent now observed before the basal Cambrian conglomerates were deposited upon the Pebidian rocks, as these porcellanites are undoubtedly rocks of detrital, and not of volcanic origin. Specimens Nos. 13 and 14, described by Prof. Bonney (p. 205), are from the conglomerates on the shore of the Menai Straits, south of Garth Ferry, and they are interesting in showing that the spherulitic quartz-porphyrines here, as at St. David's, formed a part of the Pre-Cambrian ridge*. I did not happen to meet with any typical fragments of the Dimetian at Bangor, but in the conglomerates at Dinas Dinorwig, east of Llanddeiniolen (see Section, fig. 2), which is about halfway between Bangor and Caernarvon, I was fortunate enough to meet with many pebbles of most typical Dimetian. These conglomerates are mentioned by Sir A. Ramsay as among the lowest Cambrian beds of the district, therefore the evidence of their position is not disputed. Two of these pebbles, Nos. 10 and 11, are described by Prof. Bonney (p. 204) †. The other fragments in this conglomerate are mainly quartz-felsites as at Llanddeiniolen, where they rest directly on the quartz-felsites (Dinorwig beds of Prof. Hughes). In the Cambrian conglomerates, about a mile further south, on the road to Pont Rothell, I also found fragments of the typical Twt Hill (Dimetian) rock (no. 9, p. 203), and the associated fragments were again like those of Dinas Dinorwig and Llanddeiniolen. The Cambrian conglomerates on both sides of the quartz-felsites of Llyn Padarn were described in my former paper, and specimens deposited in the Society's Museum. Further examination of these conglomerates has proved conclusively, as I had previously stated, that they are mainly derived from the quartz-felsite ridge. I examined the conglomerates at Bettws-Garmon, about four miles south of Llyn Padarn, on the east side of the ridge, and here also the pebbles were mainly quartz-felsites and fragments of Pebidian rocks. I also reexamined the great conglomerate at Moel Tryfaen, and in this I found bits of Dimetian as well as the usual fragments which have been described as characteristic of this basal conglomerate. The masses of Pebidian rocks in this conglomerate are very large, some of the porcellanites being from 8 to 10 inches across. The felsite pebbles are also of large size. This conglomerate is undoubtedly the

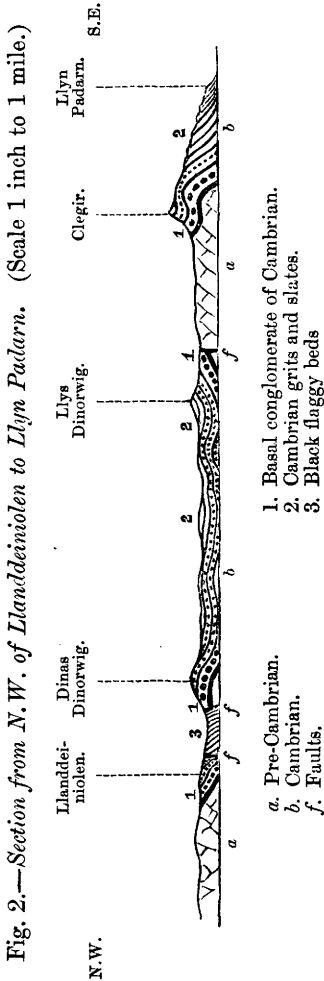
* In the discussion on Prof. Geikie's paper Mr. T. Davies mentioned that large pebbles of the well-known spherulitic quartz-felsite exposed in the Church-school quarry at St David's occurred in the specimen of the Cambrian conglomerate which I had some years previously presented to the British Museum. These quartz-felsites at St. David's are stated by Prof. Geikie in his paper to be peripheral quartz-porphyrines to what he calls the mass of intrusive granite (Dimetian), and are therefore claimed to be very much newer than the Cambrian conglomerates, which actually contain the rolled fragments of the rocks themselves!

† Prof. Bonney has described in a previous paper a fragment of Dimetian from the Llyn Padarn Conglomerate. See *Quart. Journ. Geol. Soc.* vol. xxxv. p. 316.

basal conglomerate, from its position under the lowest purple slates, as worked in the Alexandra quarry, in the district. The conglomerate is marked as altered Cambrian in the Survey maps. I examined the conglomerate also on the west side of the ridge about Glyn-Llifon, and there also recognized clearly that the conglomerates were mainly the result of the denudation of the Peibidian and quartzfelsite rocks of the area, with occasional fragments of Dimetian.

That there may be no possibility of doubt as to the meaning of the interpretation given by the Surveyors in their latest remarks on the so-called intrusive masses marked on their maps which we claim to be of Pre-Cambrian age in Caernarvonshire, I quote the following explicit passage from the last edition of the Survey Memoir, vol. iii. p. 200 (1881):—"On Twt Hill the rock consists of a mixture of felspar and quartz, forming a distinct binary compound such as was once called granitella, and is now often called aplite or granulite. But for the absence of mica it would be a true granite.

"Near Brithdir, a mile and a half south of Menai Bridge, the continuation of the crystalline mass is a purple quartz-porphry, and nearer the bridge a quartz-porphry much resembling that of Llyn Padarn in the pass of Llanberis. Between these points and Caernarvon, though much of it is a quartz-porphry, it is not always easy to give it a definite name; for though still composed of felspar and quartz, it sometimes passes into a rudely foliated rock rising here and there in bosses through the glacial debris that fills the hollow. And yet though it never perhaps deserves the name of gneiss, to me it sometimes conveys the impression of stratified rocks in a very advanced stage



of metamorphism, which for the most part may have originally consisted of the Cambrian strata that lie between Bangor and Doldeilo, and perhaps of some of the Silurian strata that border it from Doldeilo to Caernarvon. This may possibly be explained on the

hypothesis of the metamorphic alteration of the stratified rocks in part, as at Twt Hill, beyond the point of fusion, and while the whole lay deeply buried under overlying strata during part of the Lower Silurian epoch. When compared with the porphyry of Llyn Padarn, it often exhibits more free silica, and in lithological character, as a whole, it may be said sometimes to come between the quartz-porphyry of Llyn Padarn and the imperfect granitic rocks of Anglesea."

Conclusions.

As fragments of the Twt Hill and Anglesey (Dimetian) rocks, and of the typical quartz-porphyrines and quartz-felsites mentioned in the foregoing quotation, have been discovered in abundance in the basal conglomerates of the Cambrian, in the immediate vicinity of those rocks, there cannot remain, at least to my mind, the shadow of a doubt that those rocks in the condition in which they are now found in those areas were there in Pre-Cambrian times; and therefore that the views of the Surveyors of their being metamorphosed Cambrian and Silurian strata, or intrusions posterior to the deposition of those strata, are most erroneous.

Finally I must state that I am truly sorry that I have been compelled to draw further attention to so many points which I cannot characterize otherwise than as serious blots on the maps of the Geological Survey. It must, however, be borne in mind that much of the *older* work of the Survey was done before the great importance of the microscope as an aid in the study of rocks was recognized.

I have been driven to do this because in the Memoir referred to we are charged with claiming these rocks as Pre-Cambrian on "purely theoretical grounds" (p. 199); and also because in the attack made by the present Director General of the Survey on my St. David's work he has obliquely attacked also my work in North Wales. I shall shortly have very much to say on the main questions, where they refer specially to St. David's. But as I have not had an opportunity of revisiting that district since the publication of the paper in the Journal, I thought it advisable to lose no time in bringing these facts before the Society from the only areas I have since been able to reexamine. In self-defence I have had to show that work to which others as well as myself have devoted years of study in the field, and with aids which recent scientific knowledge has suggested, has a good and solid foundation, and that it has not been built up like a house of cards to be demolished by the first storm of opposition. Moreover, if the work has cost us so much labour, we can hardly be expected to allow these rocks and the names we have suggested for their definition, which have, to our minds, meanings of some importance, to be so easily "dropped out of geological literature"—as it has been suggested they should be by the present Director General of the Geological Survey.

For the Discussion on this paper, see p. 207.