The survey of the mineral wealth of this country is a great national undertaking, which has repaid its cost to the taxpayer over and over again. Facts have been recorded, a knowledge of which is vital to those concerned in the exploitation of this mineral wealth, to those dependent upon them, and to those advising them. Those who have by taxation paid the cost of this stock-taking, those who have willingly given assistance in the collection of facts, the institutions which are training those who will make use of the collected facts for further exploitation of the resources, have a right to ask that this information shall not be denied to them in order that a Treasury may make a trifling bookseller's profit or save an utterly insignificant loss.

At the close of the visit, which gave very much pleasure and instruction to the party, a very hearty vote of thanks was passed to the Director-General of the Ordnance Survey and to the various gentlemen who had placed their services so unreservedly at our disposal for the afternoon.

EXCURSION TO NORTH WALES.

JULY 28TH TO AUGUST 7TH (LONG EXCURSION), 1909.

Director: W. G. FEARNSIDES, M.A., F.G.S.

Excursion Secretary: E. MONTAG.

(*Report by* THE DIRECTOR.)

THE party, numbering 50 in all, assembled at Bala on Wednesday, July 28th, the headquarters being at the Plasgoch Hotel.

Thursday, July 29th.—The first day's excursion was arranged for the purpose of studying the stratigraphy of the Upper Cambrian rocks of the Arenig district, and of obtaining a general idea of the topography of the western slopes of Arenig Mawr. Leaving Bala at 9.30, we took train to Cwm Prysor Station, situate on the shores of Llyn Tryweryn, in the midst of one of the finest grouse moors of the country. Walking along the northern shores of the lake, we noted the characteristic openness of the mature valley up which we had come, and were almost surprised by the sudden change of scenery, as we looked over the windgay, some 200 yards beyond its head. Looking westward, across the cwm-like head of the capturing, west-flowing Afon Prysor, we noted the unrejuvenated heads of east-flowing tributaries of that river, which are still at grade with the thalweg of the Tryweryn. The topographic features of this district are of a type similar to those of the High Cup Nick district at the head of Teesdale, and are

a fine example of the working of the *Law of Unequal Slopes*. It is suggested that the Tryweryn is one of the stream-courses consequent on the uplift of the Wales-Wicklow dome, while the Prysor is one of the steep, west-flowing streams, which has worked back as a set of waterfalls or stream gorges along fault rock or soft beds, from the hollow which had been determined by the falling in of the Irish Channel. Returning from the col by the way of the southern shores of Llyn Tryweryn, the peculiarities of a drift-covered moor overlying the outcrop of shaly or slaty rock were only too prominent, and the circumstance that the boulder clay there contains far-travelled boulders from the west was noted only by a few. Nevertheless, it is a matter of some interest, and shows that here, as elsewhere, the ice drainage during the glacial period tended to re-establish older lines of consequent drainage. Crossing back to the railway below the Cwm Prysor station, it could be seen that the Tryweryn lake is held up by a drift barrier, and that the outlet of the water, in so far as it is not by springs to the west, lies over boulder clay. It is probable also that the talus "corrom"* brought in by the stream from the south is helping to maintain the drift barrier, and it is conceivable that if by a change in the vegetation of the country that corrom were to grow more rapidly, the lake would extend its area, pour its waters wholly westward over the col, and so advance the eastward migration of the main watershed of Wales by a considerable stride.

In the railway cutting, 100 yards east of the station, the composition of the boulder clay was examined in some detail, and from locally derived blocks of Dolgelly beds numerous well-preserved trilobites were obtained.

At the Nant-y-Gisfaen we left the main valley of the Tryweryn, and turned southward, to see the open section of Upper Lingula Flags there exposed. The section begins about 150 yards above the bridge and opens in the lowest beds of the *Niobe* horizon. These are grey to black rusty slates, tending to break along a bad cleavage into fragments like unforged knife-blades. They pass down into the Black Band or *Peltura*-beds, which are seen in the slate trial-hole on the left bank of the stream. Near the top of these beds Mr. Collins turned out a good tail and thorax of *Niobe homfrayi*, along with the more common *Agnostus trisectus* and *Peltura*. This discovery is important as showing the gradual replacement of the *Peltura*- by the *Niobe*-fauna before the change of lithology which is usually associated with this change of fauna had taken effect, and furnishes another argument for the retention of the *Niobe*-beds of this country within the Cambrian system. The *Orthis*-beds below the *Peltura*-horizon were examined, and soon yielded their quota of fossils,

* See Kendall and Bailey, *Trans. Roy. Soc. Edin.*, vol. xlv (1907-8), p 25.

and though the *Parabolina*-beds below them gave but small and fragmentary specimens, enough was seen to make it sure that the trilobite-bearing beds of the drift by the railway-side also belong to this horizon. The topmost Ffestiniog beds, with their thousands of *Lingulella davisii*, afforded good collecting, and the detailed determinant relationship of joints and shatter-faults to the river course across them was readily demonstrable. At the narrow gorge above the pool, where the second tributary of the Gisfaen comes in from the south-east, the hard, siliceous flags of these upper Ffestiniog beds contain rounded masses of what seems to be a much coarser grit. These boulders are usually ovoid or flattened ellipsoids, and range from an inch or two up to a foot in diameter. Their greatest elongation generally coincides with the bedding of the flags, and their exteriors are often slickensided by the crushing of their softer surroundings upon them. Under the microscope they are seen to be partly recrystallised, compact, quartzose grits, with some felspar, and many of the outlines of the original clastic particles are still observable. Strain-shadows appear in nearly all the crystal grains. When broken across the boulders are often found to be cavernous, and in the manner of breaking and in the arrangement of the hollows they have much in common with the septaria of such beds as the Kimeridge Clay. Similar grit boulders have been observed in these same Upper Ffestiniog Beds at several points on their outcrop round the Harlech dome, and at present their origin presents an unsolved problem.

The western branch of the Gisfaen was followed almost to its head. Over much of its upper course it is a strike stream, but occasionally it tumbles in small cascades over the edge of a gritty bed, and near its head exposes the outcrop of some thin dolerite sills of normal ophitic type. These sills are associated with the flattening of the dip by a broad, north-south, anticlinal fold which here crosses the district. Leaving the Gisfaen where it swings eastward, we crossed over the watershed to visit the hornblende porphyrite of the upper Lliw, and collected both granular and porphyritic varieties of this rock. In traversing this district the walking was most laborious, and the impotence of the present drainage system, and the inability of the streams to obtain sediment with which to corrade even their upper courses, among this moss and heath-clad upland, was much commented on. Skirting the northern shoulder of Moel Llyfnant, we saw sundry small exposures of Tremadoc rocks, and noted also the lines of springs and crags which mark the outcrop of the Basal Ordovician Grit. At this stage rain compelled us to seek the lower ground, and beyond noting the great screes of the Moel Llyfnant dolerite, which we had to cross, we descended the Amnodd River seeing but little. The upper valley of the Amnodd is mostly choked with drift, which, by reason of the rock-

barrier at Yr Orsedd, the débris-laden river has only been able to spread out into a well-graded boulder-strewn plain. The outcrop at the latter place is of a hard, discontinuous sill of granular andesite, and this the river has now at last broken through, along a joint. Below the hard outcrop the stream is quite at grade with the main Tryweryn, while above it the mile of boulder-strewn plain grades with the temporary level of its upper surface. The breaking through of the little gorge must, therefore, be a recent event, and it is not surprising that we find the rapids above the gorge eating back and leaving a boulder-strewn terrace with irregular rock tumps (whose surface coincides with the level of the terrace) to flank its course. Below Yr Orsedd a modern peat section, with interstratified river gravel, was examined, and an alterating succession of fen- and forest-growths was noted. Along the railway the drift section north of Waun Goch was examined, and the abundance and size of rhyolitic boulders from Snowdonia commented on, before the final adjournment to Rhyd-y-fen for shelter and tea.

Friday, July 30th.—The second day's excursion was arranged to see the character of the Tremadoc and Lower Arenig rocks, and to ascertain their influence upon the topography of the country.

Arrived at Arenig station, we took the old road westward to the point where it crosses the railway to Pont Rhyd-y-fen. From the bridge a fine view over the flat bog-land of Uwchmynydd was obtained, and it was agreed that this hollow among the hills represents a former lake. The present Tryweryn meanders across the flat and has exit over the bared dip slope of hard Upper Ashes of Arenig, but it is probable that at one time the river took its course along the steep-sided, drift-choked hollow of Pant-y-rhedyn, to the south of Foel Bodrenig. The Uwchmynydd hollow is mostly upon the outcrop of Daerfawr Shales, and may therefore well be due to the relatively rapid glacial erosion of this softer rock. The Pant-y-rhedyn depression follows the shattering of an important east-west fault.

From the railway bridge we followed the track to Amnodd Wen. Ascending the hill by Hafodty Milltirgerig, we examined first the blocks of fossiliferous Tremadoc beds (*Shumardia*-horizon) in the drift, and then the new exposures of the sett quarry now being worked in the dolerite outcrop there.

The ingress cuttings to this quarry afford a fine opportunity for seeing the sill-like character of the intrusive junction of the dolerite with the Llyfnant Flags. The marginal dolerite is rather fine-grained, and the felted arrangement of the felspar laths, which are its most prominent mineral constituent, is well seen. The parallel arrangement of these laths is maintained where, farther from the junction, the rock becomes coarser, and determines the all-important "read" of the rock. The jointing

in this quarry is most regular, and as the rock is of a rough-wearing composition, the setts obtained promise to be of very good quality. The Llyfnant shales in contact with the dolerite are appreciably altered for about two feet from the junction. Though apparently slickensided along their bedding, they have taken no cleavage. They consist of alternating shaly flags and pebbly grit-bands, and are full of worm-tracks and riddled with borings. A slab of shaly rock upon the tip contained a *Dendrograptus*, but fossils seem to be very rare. Some of the pebbly grits contain fragments of chert and pieces of rhyolite, as well as the more usual vein quartz, and one band about 5 feet below the junction with the dolerite has numerous clay or slate galls up to 4 or 5 inches in diameter. Most of these clay galls are considerably mineralised and have a well-marked system of concentric joints, which makes them break up like an onion.

The old slab quarry of Waun Goch failed to yield its *Asaphellus*, and even the stream section in *Shumardia*-shales at Amnodd Wen failed to satisfy all collectors. At the latter place fossils are abundant, but of small size, and the experience required to break them out is considerable. From Amnodd Wen we skirted below the dolerite to the stream gash, Ceunant-y-garregddu, and there examined the Tremadoc rocks at their best exposure. The section was in fine condition, and the complexities introduced by small faults and folds were evident to all. Fossils belonging to all three divisions—*Bellerophon*-beds, *Asaphellus*-flags, and *Shumardia*-shales—were collected, and fine views of the distant Snowdonian hills were obtained. From this exposure we ascended almost to the col which separates Arenig Mawr from Moel Llyfnant, and, keeping within the cwm of the Amnodd valley, avoided the peat bog which occupies its top. From an outstanding crag on the Llyfnant side a fine view along the course of the great north-south fault, which here traverses the country, was obtained. From this view-point it is evident that the Amnodd is a subsequent stream, whose valley has developed by the removal of the slaty Dolgelly and Tremadoc beds beneath the hard volcanic rocks of Arenig mountain, and that the western face of Arenig Mawr is the true escarpment of these latter rocks. The south-east flowing Erwent is also to some extent a strike stream along the crop of the Arenig series, but as its course follows rather closely the curving line of a series of faults, it is probably in part the result of the erosion of the rock shattered by them.

At present the head of the Amnodd is much more active in its erosion than is the Erwent, and a southward migration of the watershed at this col is in progress. The cwm of the Amnodd is beautifully lined with lateral and crescentic moraines formed during the late stages of a glacier which had its origin within the cwm, and it is worthy of note that the lower part of the glen

contains two parallel streams which are separated by a drift mound. During the maximum glaciation, on the other hand, ice carrying Snowdonian boulders overrode the col from north to south.

From the fault-line crag we ascended Moel Llyfnant, and examined in turn Llyfnant Flags, Henllan Ashes, Erwent Limestone, and Filtirgerrig Beds, all dipping towards us. At the northern cairn of the mountain the Henllan Ashes yielded good specimens of *Calymene parvifrons* and *Ogygia selwynii*, which it was agreed are exceedingly like the *Nesuretus ramseyensis* and *Niobe menapiensis* of the so-called Tremadoc of South Wales.

Crossing the north-west—south-east fault, we came upon the resistant rocks of the Upper Ashes of Arenig, and from the cairn had a magnificent panoramic view of the Harlech dome and its surrounding mountains from Snowdon to Plynlimmon.

We descended by way of the north-west—south-east fault to the river Erwent, and, following under the craggy outcrop of the volcanic rocks, found a steep and well graded grass slope beneath its lee. At the river level we recrossed the great north-south fault, and saw the *pot-pourri* of rock made by the confluence of these and other faults. Ascending the eastern side of the valley, we crossed a dolerite, mixed up, as usual, with the Basal Ordovician Grit, and visited the prolific exposures of the limestone of Llechwedd Erwent, with abundant *Orthis carausii* and trilobites.

Returning thence, we climbed a little higher, and skirted the outcrop of the Lower Ashes and Agglomerates round the Amnodd cwm, and descended by the fault line through the summit of Arenig Mawr to Amnodd Wen, and so by the cart road back to Rhyd-y-fen and tea.

Saturday, July 31*st.*—Dissuaded by the weather from attempting the ascent of Arenig Mawr, we decided to examine the less mountainous ground to the north of the railway.

From the Cwm Prysor station we took the road eastward to Nant-ddu. For the first half-mile only drift is seen, but after crossing a small stream the outstanding crag shows a characteristic exposure of the granular andesite which belongs to the *Niobe*-Beds of this district. Farther along the shales of the *Niobe-Beds* outcrop in the road, and at the old mine of Nant-ddu the shales of the *Dictyonema*-horizon, but with only occasional graptolites, are well exposed.

A considerable spread of the *Bellerophon*- or Nant-ddu Shales follows, topped by *Asaphellus*-Flags, and then on the brow of the hill (as seen from the Nant-ddu) the continuation of the Yr Orsedd dolerite is seen.

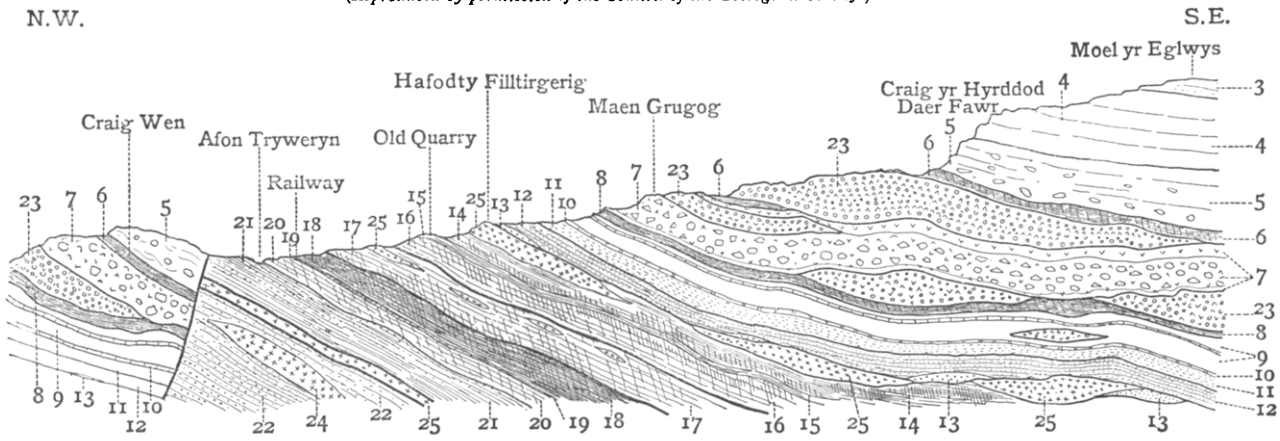
Ascending from this to Craig Henllan, the various members

of the Arenig Series are crossed in turn, but the outcrops are not satisfactory, especially in the rain, and the first rock to demand attention was the agglomerate mass of the summit.

The fretted weathering of this very coarse rock and the massive manner of its jointing were much admired, and under the lee of the summit its general suitability for making big boulders is very evident. The whole hill is a giant *roche moutonnée* glaciated from the west. Along the east side the north-south fault so often mentioned brings the soft Upper Lingula Flags to rest against the hard agglomerate, and hence, even in pre-glacial time, there must have been a steep hillside, and this, during the glaciation, was plucked back by the ice to the present outline. The late stages of the glaciation are also interesting, for Craig Henllan stands at the confluence between the rivers Tryweryn and Tai-hirion, each of which had its glacier with lateral moraines. Lateral moraines therefore flank the hill on both the southern and north-eastern sides, and, converging at an angle more acute than the round of the hill, shoot out from it and enclose the former lake and present bog of Y Gospiol. From Craig Henllan we continued northwards to the wet ground of the Daerfawr Shale outcrop, noting the intimate association of agglomerate and massive vesicular rock on the way. Then, doubling back, we gained the vast intrusion of Bryniau Poethion, whose composition and vesicular character are just like the vesicular rock among the agglomerates, but which can here be proved to transgress all the successive horizons of the Arenig series, and must therefore be intrusive. From Bryniau Poethion we crossed the morass of Nant Rhydaugloewon, with its north-east—south-west fault, and saw the Basal-grit exposures of Llechwedd Deiliog. Thence, by road and cart-track, we made our way to the sheep folds of Nant yr Olchfa, where, despite the spate, we were able to find the characteristic *Didymograptus bifidus* of the Olchfa Shales, and to see the true relations of these shales as underlying the Lower Ashes and Agglomerate of Arenig. From the Olchfa stream we descended the right bank of the Tai-hirion to the main-road bridge, and, turning east along the road, came to the Nant-yr-achub, where the oft-mentioned north-south fault brings the middle division of the Upper Ashes of Arenig to rest against the lowest Tremadoc beds. The shattering of the shales of this latter division and the fault-rock are well seen in the right bank of this stream, just above the road. At Tai-hirion we saw the *Asaphellus*-Flag quarry (Tai-hirion Beds), and thence turning north came to the pretty strike stream, Nant Rhos-ddu, where it has cleaned out its course along the shaly portion of the Olchfa Shales. The shales, which contain a Llanvirn fauna, and the overlying volcanic series were quite well seen. Returning to the main road, we followed it to Bryn-maen-llifo, and thence took the "old" road to Arenig station. It being Saturday afternoon, we took

FIG. 32.—SECTION ACROSS THE WESTERN FLANKS TO THE SUMMIT OF ARENIG FAWR.—*W. G. Fearnsides.*

(Reproduced by permission of the Council of the Geological Society.)



1. *Dicranograptus*-Shales.
2. Derfel Limestone.
3. Rhyolitic Ashes. } Upper
4. Massive Ashes. } Ashes of
5. Acid Andesitic Ashes. } Arenig.
6. Daerfawr Shales.
7. Lower Ashes and Agglomerates of Arenig.
8. Olchfa Shales.
9. Filltirgerig Beds with Ash-band.
10. Erwent Limestone.
11. Henllan Calcareous Ashes.
12. Llyfnant Flags.
13. Basal Grit.
14. Amnodd Shales.
15. Tai-Herion Flags.
16. Nant-ddu Beds, with *Dictyonema*-Band at the base.
17. *Niobe*-Beds.
18. *Peltura*-Beds.
19. *Orthis lenticularis*-Beds.
20. *Parabolina*-Beds.
21. *Lingulella*-Beds.
22. Grits and Flags of the Ffestiniog Beds.
23. Intrusions of Hypersthene Andesite.
24. Intrusions of Ophitic Andesitic Dolerite.
25. Intrusions of Hornblende-Porphyrite, etc.

the opportunity to examine the so-called "granite" road-metal quarry. The rock worked is a vesicular intrusion of hypersthene andesite of the type common to the Lower Ashes and Agglomerates of Arenig in this district. It is remarkable for the regularity and complexity of its system of jointing, and for its lack of any intrinsic parallel structure or "read." From a distance the whole mass appears to consist of hexagonal columns placed vertically, but on closer examination it is seen that the columns are four-sided, with solid angles of 65° and 115°. The columns do not break rapidly in a horizontal direction, but are slashed by two (or more) sets of joints at right angles and making angles of about 45° with the vertical. Under the microscope it is found that the rock, once probably glassy and with parallel microlites, has recrystallised with an uniform granular arrangement of micro-pœcilitic patches of felspar and quartz. The vesicles are very irregular, both in distribution and in size. Quartz and calcite are the usual in-filling materials where the rock is fresh, but many of the bubbles are empty, and some contain concentric layers of chlorite. Several of the larger vesicles were found to contain manganese carbonate along with the calcite, and in the veins, which occasionally cut the rock, this mineral is not rare. A green or yellow-green talcose mineral (a variety of epidote in skeletal crystals), pseudo-hexagonal in habit, was also collected in similar association.

From the "granite" quarry an expedition was made to the Aber Derfel gorge. The route taken was along the railway, and thence down the cascade which marks the stripped southern face of the east-west fault, through Pant-y-Rhedyn, and thence along the bed of the stream to the limestone exposure.

The Derfel stream, from its junction with the Tryweryn to the bend up to Llyn Arenig Mawr, is a longitudinal stream, developed by the destruction of the shales which overlie the Upper Ashes of Arenig along a synclinal fold. The shales, with the limestone at their base, passing down into the ashes were well exposed, and having collected a sufficiency of the usual *Orthis*, etc., we returned to Arenig station, and so by the afternoon train to Bala.

Monday, August 2nd.—Leaving Arenig station, we turned westward to Milltirgerig. Looking south through the Nant Llaith, attention was drawn to the synclinal character of the northern face of the mountain. Near at hand the upstanding crags of the "granite" quarry (Clogwyn-y-fran) to the left, and the mass of Maen Grugog to the right, are determined by the same rock series (Lower Ashes of Arenig), while in the distance Simdde-ddu and Craig-yr-hyrddod, consisting of the Upper Ashes, are similarly related. The valleys which come down to Milltirgerig are, therefore,

strike valleys, developed on the outcrop of Daerfawr Shales, and converge by reason of the pitch of the syncline.

Beyond Milltirgerig we begin to skirt the outcrop of the Lower Ashes, and so, beneath the steepest west-facing crags of Maen Grugog, came upon the exposure of the *Didymograptus bifidus* shales, here crowded with *D. indentus* var. *nanus*. *Cryptograptus* also was obtained in some abundance, and a single example of *Clinacograptus bicornis* was noticed upon one of the slabs along with this form. Following the contour above the shale exposure, we crossed to the stream which goes down to Hafodty Milltirgerig, and examined the famous *Amphyx*-bearing block of the Erwent Limestone here exposed. In the adjoining flagstone quarries of the Llyfnant Flags a few fine specimens of *Tetragraptus amii* were found, along with the common *Didymograptus deflexus*. From this point the ascent of the mountain was begun. The route taken crossed the outcrop of the Lower Agglomerates at a point where a drift bank conceals the steepness of the crags, and by keeping along the margin of the drift an easy route up to the Daerfawr Shale shelf was found. Between the drift and the solid rock there is here a sort of hollow or stream course, and the moraine on the outer wall of this consists wholly of large blocks. Similar big blocks are also seen perched upon the crags within the driftless area, and hence it is clear that the margin of the drift represents a stage in the recession of the ice, and not the limit of its maximum extension. Between the height of 1,600 and 1,800 feet a very large proportion of the stranded boulders are of foreign (Snowdonian) origin, but in the drift-covered area this predominance is not apparent. Under the western end of the crags of Craig-yr-hyrddod the Daerfawr Shales yielded a few ill-preserved graptolites. These crags, and the plateau above them right over to Gelli Deg and Simdde-ddu, are determined by the Upper Ashes of Arenig, and the culminating scarp is everywhere determined by the actinolitic or siliceous bands which appear at the top of the lower division of that group. Gaining the plateau, we followed its western margin round for about three-quarters of a mile, to the summit of Arenig Mawr, which is known as Moel-yr-eglwys. The view between the intervals of driving mist was superb. The southward continuation of the Arenig scarp is here broken by the fault (north-west—south-east) through Amnodd Wen. It is this fault which gives the mountain its twin-peak appearance from so many points of view. The southern peak is known as Craig-y-diocyn. From the summit we wandered eastward along that edge of the plateau which is not a scarp face, and in about half-a-mile came to the grassy descent of Bwlch-blaen-y-nant, a depression due to the shattering of another north-west—south-east fault (that of Y Castell), and by it descended to the steep gully of Bryn-y-dyfrgi, and so to the southern margin of Llyn Arenig Mawr.

According to the view of the Director, the summit plateau is a somewhat large and lumpy fragment of a hill belonging to the 2,000-feet pene-plain of North Wales, which, by reason of the hardness of its rocks, had not been completely base-levelled at the time of uplift. The abrupt change of slope, which we followed from the summit to the Bryn-y-dyfrgi, in his opinion, represents the backward margin of the cutting of the pre-glacial and present Dee drainage system, and its feature is largely independent of the structure of the rocks. A similar shoulder of rejuvenation extends all along the eastern slope of Arenig Mawr, but where, as along Simdde-ddu, above the lake, it is most marked, it has been exaggerated by the backward plucking of the late glaciers which occupied the cwm. Llyn Arenig Mawr is a corrie-lake, produced by glaciation and cut back into the steep dip slope of the Upper Ashes of Arenig. The cliffs of Y Castell, to the south, may be in part due to the above-mentioned fault, but the western cliffs, at the back of the lake, have no such explanation, and are the result of denudation only. The lake is probably in part a rock-basin, but its present outlet is over drift. In pre-glacial times the valley in which it lies probably opened directly eastward, by the Bleiddyn valley towards Bala Lake, but, impeded by the drift deposited along its course, the river lost its corrasive power, and by backward cutting of the Derfel valley has now beheaded it. The outflowing waters of the Llyn are therefore carried by the Derfel directly to the Tryweryn. We followed the course of the Derfel as far as the old road bridge, and thence, taking that road westward, returned to Arenig station.

THE ARANS.

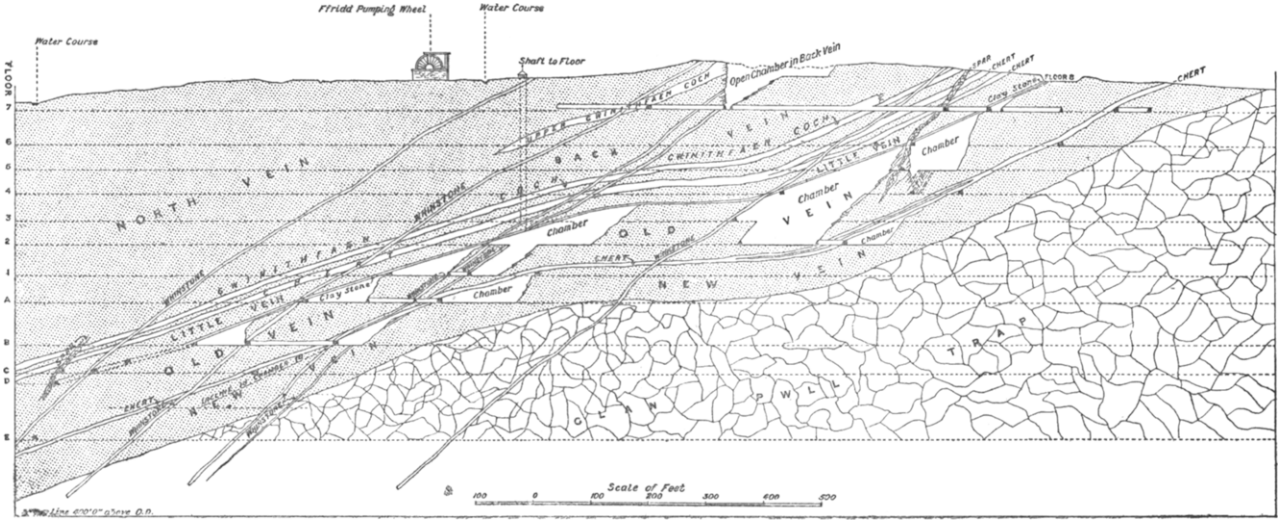
Tuesday, August 3rd.—Arrived at Drws-y-nant, we turned south, and ascended the drift bank to the base of Esgair-gawr. At this point a fine view along the Bala fault is obtained, and the difference between the topography of the Lingula Flag country of the lower slopes of the Arans and of the Ordovician volcanic rocks of the north side of the Wnion is most marked. At Esgair-gawr we entered the Ceunant-coch, and noted the *Lingula*-bearing Ffestiniog beds, dipping south-west. Then, crossing the dolerite sill, we traversed the wooded gorge, keeping near the stream so as to observe the freshness of the section and the sequence of the rocks. The rocks exposed are the sediments of the Ffestiniog and Maentwrog divisions of the Lingula Flags, which have some 30 to 40 intrusive sills from the Foel-ddu felsite mass intercalated among them. The dip is ever down stream and away from the Foel-ddu intrusion. The Ceunant-coch is the gorge of the confluent streams.

Afon-harnog and Afon-cwm-ochr, which, rejuvenated by the lowering of the thalweg of the Wnion after the Pliocene uplift, have just begun to cut back their lower courses into a series of waterfalls and rapids. The upper courses of these streams (as of all the tributaries of the major west-flowing streams of North Wales) lie through valleys which, through the long ages of Tertiary time, have well-nigh attained maturity, and which have not been affected by the rejuvenation of the pre-Glacial (Pliocene) uplift. Following the Harnog stream, we came, in about a mile, to the main mass of the rhyolite, and noted the differential crushing, almost to foliated chloritic schists, which has been suffered by the flags some 20 feet from the intrusive junction. The thermal metamorphism along the junction is not intense, and in walking over the half-mile or more of continuous felsite exposed in the Harnog and its tributary from the north of Cefn-glas, we were much struck by the uniform fine-grained texture of so large a mass of rock. Leaving the drift-filled hollow of the Harnog, we came, at about the 1,600 feet contour, to the south-eastern margin of the rhyolite and to the east-dipping Lingula Flags beyond. Maentwrog, Ffestiniog, and Dolgelly divisions were crossed in turn, and, dipping steeply at from 55° to 80° to the east, together they occupy an outcrop of about 700 yards. Crossing to the ridge above Pared-yr-ychain, we saw little of the Tremadoc rocks, which are here faulted out and replaced by a big spread of hypersthene dolerite. The lower Arenig beds are also locally pinched out, and soon we came to the crags of the massive and rather coarse agglomerates of the main andesitic volcanic series. Scrambling over the rough ground which these produce, we came upon an outcrop of shales. These soon yielded ill-preserved tuning-fork graptolites, and were identified as the Daerfawr Shales of Arenig. Their outcrop, smooth, well-graded, and often boggy, led us obliquely up the hill almost to the top of Aran Mawddwy. Leaving it, to gain the summit we had to cross the finer ashes and agglomerates above the shale horizon. These are rhyolitic, rather than andesitic, in character, and include several irregular sill-like masses of a quartz-bearing, blue, fine-grained, and very brittle rhyolite. In making the ascent of the Aran by this route we avoided the crags and cliffs which in general bound its summit-plateau. Nevertheless, it had been noticed that above the level of Cefn Glas (2,023 feet) the slope had changed from concave to convex upwards, and it was pointed out that this change might well correspond to the limits of the backward cutting of the mature Tertiary valleys into the older or 2,000-feet plateau noticed above as occurring on Arenig. On attaining the summit, it was agreed that the view southward and eastward across the sea of hill tops made it evident that the 2,000-feet peneplain

upon the slaty hills there is a very real thing indeed, and the validity of the argument for regarding the convex summits of the Arans and Arenigs as hills of hard rock rising out of it was generally accepted. Following the ridge from Aran Mawddwy to Aran Benllyn, the general character of the mountain as an escarpment of steeply dipping volcanic rocks was noted, but it was also seen that nearly all the ridges are "plagioclinal,"* and that their alignment is determined by the distribution of the joints rather than by the bedding. The frequent occurrence of wind- or snow-hollowed rock basins, with small tarns between the ridges, was also noted. The view south-eastward was magnificent, and the interest of the problems presented by the river development of that district was evident to all. The behaviour of the Cwm Groes River and its headwaters, Cwm Llwyd, attracted special notice. These are strike streams worn out along the slate outcrop just above the volcanic rocks, here probably crushed and shattered by the differential movement contemporaneous with, or subsequent to, the coming of the cleavage of the country. At one time the ridge of the Arans, rising from the 2,000-feet peneplain, must have had the rivers of its south-eastern slopes flowing in parallel courses south-eastward. These south-east flowing rivers, all except the Llaithnant in the midst, have been captured by strike streams and cut off at their heads, especially by the Cwm Llwyd and by Hencwm. Some streams have undergone a double capture. Such was the stream which came out of the cwm under Aran Benllyn, and, crossing the Bwlch Maes-yr-hir-ddyn, joined the Llaithnant, near Ty-nant. That stream suffered capture both by the Cwm Llwyd and Cwm-du, which, joining at Cwm-ffynon house, form the Cwm Groes. The ridge, Braich-yr-hwch, left between these capturing streams still retains the contour of both sides of the ancient high-level thalweg, whose grade agrees well with the level of the Bwlch Maes-yr-hir-ddyn. From the summit of Aran Benllyn we descended somewhat rapidly over the rough slopes of Creigiau Llwydion to the basal conglomerate of the volcanic series which is so well seen at Cerig Gwynion. At this point the boulders of the agglomerate range generally about 6 inches in diameter, but there are many larger ones. The boulder bed is about 20 feet thick. Crossing the Llechwedd Ieirch, towards the head of Drws-y-nant-uchaf, the ground is much drift-covered by ice from Cwm-y-dolau to the south, and neither Tremadoc rocks nor the granophyric intrusion were well seen. At the stream-head, north of Hen Ffridd, the Black Band of the Dolgelly beds was examined, and many beautiful *Agnosti*, *Sphærophthalmus* and a complete *Peltura scarabæoides* were collected. The return to Llanuwchllyn and tea was made by way of the grassy drift slopes along the Bala fault.

* Callaway, *Geol. Mag.*, 1879, p. 221.

Fig. 33.—Dip Section Showing the Slate Beds Worked in the Llechwedd Slate Quarries, Blaenau Ffestiniog.
—*Messrs. Greaves & Sons, Ltd.*



BLAENAU FFESTINIOG.

Wednesday, August 4th.—On arriving at the Great Western station we were met by our local Director, Mr. R. M. Greaves, and conducted through the grey-slate metropolis to the Llechwedd quarries. The town is built upon the upland shelf, at the head of the Dwyryd valley, at a point where the pre-Glacial rejuvenation of that valley has succeeded in affecting the thalweg almost back to the watershed attained by the mature Tertiary drainage system. The rocks seen in the road cuttings of the lower town are of Tremadoc and Arenig age, but are much altered by the metamorphism due to the adjoining Tan-y-grisiau granophyre. The crag of Garegddu is the representative of the Lower Ashes and Agglomerates of Arenig, here known as the Glan-y-pwll Trap. The valley through which the London and North-Western Railway runs is along a great north and south normal fault, the latest of all the known tectonic structures in the country, here separating the Llechwedd from the Oakley mining properties and displacing the slate beds of the latter some half-a-mile or more to the north. The slate beds of Ffestiniog are all above or in the highest beds of the Glan-y-pwll Trap. The detailed stratigraphy of these slate beds has not yet been elucidated, but it is known that the *Ogygia dilatata* (or *Buchii*), which, with *Didymograptus*, *Diplograptus dentatus*, and a *Cryptograptus*, has been found at Llyn Bowydd, belongs to a high horizon among them.

After a visit to the engine house, where water power, through the agency of Pelton wheels and dynamos, is converted to electric, the open workings and untopping operations at the surface were inspected along both strike and dip sections. The succession is as shown in the section, in which it should be noted that, in local significance, the word "vein" is used to indicate a continuous group of beds. "Trap" is an agglomerate somewhat altered by silicification and crushing, while "chert" is a finer ash, interstratified with the slate, and now recrystallised or otherwise altered until it in parts almost resembles an adinole. "Whinstone" is used for the altered andesitic dolerite dykes which follow the cleavage, and "spar" for the quartz and calcite veins which have usually the same trend. Through the Llechwedd property the beds indicated on the diagram maintain their succession pretty constantly. The thickness of the beds, however, varies from yard to yard, and the quality, either of chert, slate, or whinstone, at any point can only be ascertained by actual trial. The dip of the beds is generally about 15° to the north, that of the cleavage about 30°, but the dip of both bedding and cleavage is in some places found flattened almost to zero. The angle between bedding and cleavage is usually approximately maintained through such flattenings. (See Fig. 33.)

The method of quarrying the slate is rather like the pillar and stall method of coal mining. A tunnel is driven down the dip just under the overlying "hard," and from this, at successive vertical distances of 50 feet, strike tunnels are driven in each direction, right and left. Each 50 feet along the strike tunnels, new tunnels are driven up the dip to join the strike tunnel next higher in the series. By this means a rectangular system of tunnels is developed along dip and strike, and just under the overlying hard rock. These assure a natural circulation of air without recourse to artificial means of ventilation. The winning of the slate is undertaken along the dip tunnels, which are widened on each side from below upwards, just under the hard, until one-half the area separating the "chamber" from its neighbour has been "unroofed." When the roof is exposed the face of the slate below is worked forward, as in an open quarry, along the joints and cleavage. When the forward working of a chamber brings its roof up to the strike tunnel, driven at the level next higher in the series, the road to chambers right or left has to be suspended by a hanging bridge.

Where a single bed of slate is being worked between two hards, such a system might be extended indefinitely. In the Llechwedd Quarry the two lower veins, known as Old Vein (above) and Deep Vein (below), are worked in conjunction, and the hard bed or chert between them is left as a strut to hold apart the 240 feet-high "walls" between successive chambers. Whinstones, spars, and masses of bad slate are similarly left, and hence numerous difficulties and complications involve subsidiary and irregular chambers in the plan of the mining. Another difficulty is due to the circumstance that the strikes of bedding and cleavage are not identical, and hence, when tunnelling in slate which does not show its bedding, trial strike tunnels are apt to take a mistaken direction. The "pillaring," or direction of the second cleavage, which determines the joints best followed in quarrying, also is neither vertical nor accurately parallel to the dip, and hence men working in chambers which have no through connection have to be watched continuously if the plan of quarrying is to be kept according to the preconceived plan.

All these, and many other principles and details of the mining, were ably demonstrated to those who went below ground by Mr. R. M. Greaves and the quarry manager, Mr. Wm. Owen, and a practical point raised by the finding of a mass of cherty agglomerates at the end of a trial tunnel, in chamber E, 1,600 feet below ground, was much discussed.

Outside in the daylight the succession was examined, and the local occurrence of "posts" or strike joints, with about two feet of shattered or powdered rock between their faces, was noted. A demonstration of the power of 200 lbs. of gelignite to move rock was arranged as a part of the untopping operations.

The lunch generously provided by Messrs. Greaves and Sons was partaken of in the workmen's dining-rooms, and after it a vote of thanks to our kind hosts and leaders was proposed by the President and seconded by Mr. Fearnsides. Mr. J. E. Greaves, on behalf of the firm, briefly replied.

After lunch the slate-splitting and dressing mills were visited, and thence we made our way along the Bowydd River to Llyn Bowydd. Following thus the strike of the beds, the slight topographical significance of the hard beds which are so important in the quarrying, was amply demonstrated, and the difficulty of mapping the "veins" across the moorland recognised. From Llyn Bowydd we turned south, and, crossing the well-marked stony agglomerates above the Diphwys Casson quarry, contoured round the Craig-ddu hill to the quarry of the same name. At this high-level quarry (2,000 feet above the sea) the slate beds overlie the volcanic mass of Manod Mawr, and the cleavage now lies almost horizontal, with the bedding also but slightly inclined. The slates are here worked in the open, and the deep, circular hole, with its galleries all round, every 50 feet, is a magnificent sight. Round this quarry we were conducted by Mr. Bowton, the managing director, who later entertained us to a most excellent tea.

Cherts and whinstones are rare in this quarry, but spattering quartz-veins spoil some parts of the slate, and as in open workings all has to be cleared away, add considerably to the expense of working. The arrangement of the smaller quartz veins in the gaping joints adjoining the one hard cherty band which crosses the top of the quarry is very characteristic, and shows how successfully cherty beds can resist compression and protect their neighbours. The descent from Craig-ddu to Manod village was made by way of the inclined cable-ways which bring down the slate.

The composition of the slate rocks of Blaenau Ffestiniog has long been a matter of considerable interest to those who would discover the origin and mode of formation of these intensely cleaved rocks. By kind permission of the Slate Association of Portmadoc, I am permitted to append the following recent report of a chemical investigation of the properties of a test sample of the best Llechwedd "Old Vein" slate:

SAMPLE OF OLD VEIN SLATE.

(Analysis by Mr. Bertram Blount, F.I.C.)

	Per cent.
Silica (SiO_2)	53.92
Titanic Acid (TiO_2)	0.80
Alumina (Al_2O_3)	24.09
Ferric Oxide (Fe_2O_3)	1.87
Ferrous Oxide (FeO)	6.52
Manganous Oxide (MnO)	0.19
Lime (CaO)	0.24
Magnesia (MgO)	1.80
Potash (K_2O)	3.64
Soda (Na_2O)	0.74
Phosphoric Anhydride (P_2O_5)	0.19
Pyrites (FeS_2)	0.13
Combined Water and loss	5.87
	100.00

Absorption of Water.—A test piece was immersed in water and allowed to remain there until saturated. The quantity of water absorbed was determined and found to be—

	Per cent. by weight.
Water absorbed	0.18

Transverse Breaking Strain.—Load applied across centre. Distance between supports 22 inches.

	Dimensions. Breadth. Depth. Inches.	B D^2	Maximum Deflection Inches.	Ultimate Stress Lbs.	Stress Per B D^2
1	12×0.19	0.433	0.28	143	330
2	12×0.17	0.347	0.35	123	354

Action of Acids.—Test pieces were exposed for 12 days to the action of moist sulphurous acid. In a few isolated places small spots appeared, but the action was inconsiderable, and the slate as a whole was unattacked.

A test was also made using hydrochloric acid (10 per cent. HCl) as the corrosive agent. At the end of 12 days the slate, except for a slight greenish stain, was unaffected.

Conclusion.—The slate is of normal composition, resists the action of acids well, and has a small absorption of water and good transverse breaking strain. The trifling amount of pyrites present is of the ordinary kind, less easily oxidisable than marcasite.

FURTHER SAMPLES.

(Analysis by Mr. William Macnab, F.I.C.

	Old Vein.	New Vein.	North Vein.
	Per cent.	Per cent.	Per cent.
Silica (SiO_2)	55.25	53.40	55.75
Alumina (Al_2O_3)	24.60	26.67 } 80.7	26.20
Iron Oxide (Fe_2O_3)	10.40	9.53	10.00
Lime (CaO)	1.00	0.90	0.86
Magnesia (MgO)	2.09	1.85	1.77
Loss on Ignition	4.62	4.47	4.77
Alkalies (etc.)	2.04	3.18	0.65
	100.00	100.00	100.00

TAN-Y-BWLCH.

Thursday, August 5th.—On August 5th the Headquarters were transferred to the "Oakley Arms," Tan-y-bwlch. The hotel is built upon an outcrop of the upper beds of the Ffestiniog (Middle Lingula Flags) series. Leaving the hotel, we took the footpath to Dduallt, and by a well-graded ascent gradually traversed the outcrop of the Dolgelly beds and their attendant sills of spherulitic felsite, and gained the upland plateau. Following the railway, we passed the Dduallt station, and, crossing the outcrop of the Tremadoc beds along their dip, soon came to the entrance of the tunnel by which the railway traverses the outcrop of the Tan-y-grisiau granophyre. Leaving the railway at this point, we first followed the old surface tramroad, and then skirted the workings of the disused Moelwyn Copper Mine, and began the ascent of the mountain by way of Nant-ddu. The bleached and spotted character of the hornstones, which have been formed by the alteration of the Tremadoc Slates, by the granophyre, were duly noted, and the arrangement of certain mineral banding along the lines of former sealed-up joints and cleavage also received attention. After crossing the quartzite which forms the local base of the Ordovician, we turned north, and picked our way among the crags into the valley of the Afon Stwlan. Ascending by this stream, we crossed the outcrop of the flinty ashes of Careg-flaen-llyn, and had lunch upon the shores of the lake Llyn Stwlan, which lies behind this exposure. Llyn Stwlan is a normal corrie lake, with its surface about 1,600 feet above the sea, and appears to occupy a well-defined rock basin which has been scooped out in the softer slaty rocks which lie between the lower and upper agglomerate series of the Moelwyn.

From the northern shores of the lake we made the ascent of the Moelwyn Mawr, 2,527 feet, directly, traversing successively the craggy slopes of upper agglomerates and the grass slopes of the slates above them on the way. At the summit climatic conditions were most favourable, and the panoramic view obtained unusually fine. The "hollow-chested" giants of Snowdonia were seen in all their splendour, and the details of the sculpture accomplished by ice, upon them and upon the hills around us, were most clearly seen.*

From the summit we descended by the north-west arête, and then, skirting southwards round the hill sides, crossed the dolerite exposure to the Pant Mawr slate quarry. The quarry was worked in beds immediately overlying the upper agglomerate series. In the midst of this agglomerate, at Creseiliau Dwon, occur certain slaty beds, and from these a considerable suite of brachiopods, corals, bryozoa, and some fragmentary trilobites were collected. The horizon is at present indeterminate, but the fauna appears to belong to the shelly facies of the Middle, rather than either the Lower or the Upper Ordovician. From the fossil locality we followed the old tramroad across the screes of agglomerate from Craig Ysgafn to Bwlch Stwlan, and, continuing through the col, contoured round the Stwlan cwm to the "old levels" of the Moelwyn slate quarry, between the upper and lower agglomerate series, from which graptolites of Arenig age have been collected. From the slate working we ascended a narrow fault-gully to the peaty upland which forms the summit plateau of Moelwyn Bach. This plateau appears to be an outlying remnant of the 2,000-feet plateau which we noted upon Arenig and to the south of the Aran range, and the descent from it into the river- or ice-worn valleys of the present cycle of upland denudation is most abrupt.

The descent to Tan-y-bwlch was made by a direct route past Llyn-y-garnedd and by way of the agglomerate neck which pierces the Tremadoc slates about half-a-mile north of Tan-y-bwlch station. The crushed and faulted character of certain of the slate and agglomerate beds at the base of the Ordovician volcanic series attracted much attention.

Friday, August 6th.—The second day of the Tan-y-bwlch excursion was devoted to an examination of the Tan-y-grisiau granophyre intrusion, and of the rocks in contact with that mass. Leaving the hotel, we took the road along the north side of the Dwyryd alluvium to the old bridge, Pont Dol-y-moch. This road cuts obliquely across the strike of the Ffestiniog beds to lower and lower beds. Crossing the bridge, we joined the main road south of the river, and, proceeding to Pont Tal-y-bont, examined the surfaces of Maentwrog beds which are exposed in the cuttings of its approach. The Ceunant Cynfal, over which the latter bridge is built, is a fine

See Davis, W. M., *Quart. Journ. Geol. Soc.*, vol. lxv (1909), p. 281.

example of a stream whose thalweg has just arrived at the state of adjustment with the main Dwyryd, but whose sides still bear evidence of extreme youth. At Pont Rhyd-y-sarn we recrossed the main valley, and immediately afterwards also crossed the Afon Goedol by a foot-bridge. The Goedol flows in a very young and picturesque gorge-like valley, which is possibly of late glacial origin, and may be due to the diversion of the Ceunant Sych by the moraines at Cymeran-uchaf. After crossing the gorge we took the footpath towards Dduallt station, and ascended obliquely across the rough scars of the Ffestiniog grits and grauwackes, taking the opportunity to collect specimens of the abundant *Lingulella davisii* on the way. Nearing the station, we passed on to the Dolgelly beds, and examined an old lead mine, which was worked in veins traversing an intrusion of granular felsite. Between this mine and the railway the outcrop of Tremadoc rocks begins, but as these are here wholly within the aureole of metamorphism of the granophyre, little could be made out. The actual margin of the granophyre was found just above the south entrance to the railway tunnel, and the complexities of its windings were followed eastward to the cliffs which overlook the Goedol gorge at Bryn Melyn. The junction along this line is a transgressive one, and the variation of the metamorphic changes which affect successive members of the Dolgelly and Tremadoc beds is most interesting. In some beds the interveining of slate and granite is extremely intimate, and for a thickness of a few inches from the junction recrystallisation is so complete as to suggest a partial fusion of the sedimentary rock.

From the cliffs overlooking Bryn Melyn we contoured round over the main granophyre outcrop to the intake-reservoir of the Electric Power Generating Station, and, crossing the Afon Goedol by way of the reservoir dam, joined again the main road to Tan-y-grisiau.

Passing through the village, we observed the well-known spotted slates, with cordierite, and saw how these slates, while retaining their distortion, have, by metamorphism, lost their cleavage. From the village we proceeded to the quarry which is being actively worked for setts and road stone by the Ffestiniog Granite Company, Ltd., in the southern slopes of Cefn Bychan. The rock quarried adjoins the margin of the granophyre, and is somewhat peculiar. The actual marginal belt is too full of xenolithic heathen to be of much value, and it may well be that the shapeless patches of a dark-looking, pseudo-ophitic, spherulitic chlorite, which give the rock quarried its characteristic speckled appearance, represent fragments of the country rock more completely assimilated. The rock is well jointed and comes away in rather small blocks. It has, however, a good "read," and cuts sharply under the hammer. Its property of maintaining a rough surface as it wears is likely to make it very useful for road-making. The

"peculiar mineral" which occurs in narrow, pegmatite-like veins along certain master joints is now recognised as orthite, and was collected by the members in considerable quantity.

From the quarry we returned to take tea in the garden of the village post office, and then, proceeding to the narrow-gauge railway station, returned to Tan-y-bwlch by train.

Saturday, August 7th.—The last day's excursion was devoted to the low ground adjoining the estuary of the Glaslyn. Leaving the hotel in carriages, we drove along the Portmadoc road as far as Minffordd station. Thence, by way of the Cambrian railway line, we crossed to the Runcorn Granite Company's quarry, which is worked in a large quartz-dolerite sill on the southern flank of Garth Hill. This rock, with its attendant felspathic aplites and pegmatoid augite-felspar veins, we examined in detail, and characters common to it and to the post-cleavage (Carboniferous?) intrusions of St. David's Head, and the post-Carboniferous sills of Scotland and the North of England, were commented on by several observers. The mass of bastard rock which divides the two working faces of the quarry was also examined. It is the same dolerite, altered by shearing along a tear-fault, and has in many places become almost a quartz-chlorite schist. The baked sedimentary rock below the sill did not yield us its famous *Angelina*, but it was thought that the concretionary structures and the jointing bear evidence that, though the rock has lost its cleavage, the baking has not completely obliterated the traces of the distortion which must have accompanied that cleavage.

From the quarry we proceeded to Plas Newydd, and there collected numerous drawn-out specimens of *Angelina sedgwickii* from the Tremadoc slates exposed below the dolerite. Thence, by devious paths, we came to the basal Ordovician grit exposures of Ty-obry, and beyond the farm-house collected numerous specimens of *Climacograptus scharenbergi* (zone of *Nemagraptus gracilis*) close down upon that grit. The possible circumstances which could account for the absence of Arenig rocks at this point were discussed, and it was agreed that a strike fault affords the only satisfactory explanation. Such a strike fault has since been proved in a trench which has been dug for the purpose. Following the strike of the slates above the grit, we came to the mass of agglomerates which overlooks the Ty-obry farm, and thence, in about half-a-mile, to the Penrhyndeudraeth-Aberglaslyn road, noting the effect of several other strike faults as we went along. The distant views of Snowdon obtained along this route were much admired. At the foot of the Penrhyndeudraeth hill we turned from the main road and examined the tip-heap from the copper mine. Here most of the material is a

* J. V. Elsden, *Quart Journ. Geol. Soc.*, 1908, p. 273

pale flaggy rock, which, though not exposed at the surface, supplies the country rock in which the underground explorations after copper have been worked. On the tip-heap from the main quarry no identifiable fossils have yet been recognised, but from the adit which has recently been driven in from the foot of the hill, farther to the north-east, numerous good specimens of *Didymograptus nicholsoni* and several branching graptolites, indicative of a horizon about the middle of the Arenig Series, have been obtained from a very similar type of rock. The waste heap from the adit was examined, and yielded a considerable variety both of graptolites and mineralogical specimens.

From the copper mine we returned to the main road, and, there meeting the carriages, drove along the edge of the Traeth Mawr alluvium to Aberglaslyn and Bethgelert, where we had tea at the Goat Hotel. Returning, we drove as far as the foot of the hill at Llanfrothen, and thence walked over, by the village of Rhyd back to Tan-y-bwlch. The scenery along this route is magnificent, but much more field work will have to be done before the details of the beauty of the area can receive a geological interpretation.

EXCURSION TO GLEN PARVA AND CROFT (NEAR LEICESTER).

THURSDAY, SEPTEMBER 2ND, 1909.

Directors: W. KEAY and E. LOWE, F.G.S.

Excursion Secretary: A. C. YOUNG.

(*Report by* W. KEAY.)

GLEN PARVA.

ADVANTAGE was taken of the cheap excursion to Leicester leaving St. Pancras at 10.6. On arrival at South Wigston Station from Leicester at 1.9 p.m., the party, numbering 21, proceeded to the brickyard at Glen Parva, a distance of rather less than half-a-mile.

Fine weather prevailed, and this magnificent section of the whole of the Rhætic Series was examined under conditions of comparative comfort.

Standing on the eastern side of the clay pit, and looking westwards, the pit presents a face about 70 feet in depth.

On the top, and immediately overlying the bluish shales of the Upper Rhætic Series, is a reddish boulder clay, containing pebbles, Lias fragments, and a few boulders of syenite. Flints are extremely rare.