Chapter 36 The metalliferous mines of Parys Mountain

Introductory

Parys Mountain, which is 480 feet in height and about a mile and a half in length, is one of the nine isolated hills that are enumerated on p. 781. For many miles around it can be distinguished from. the neighbouring heights of Nebo and Eilian by the old engine-house and windmill that still stand upon its summit (Plate 60).<ref>The highest point is close to the old engine-house.</ref> Its western and northern parts are now green and beautiful; but all the higher and central portions are one of the most utter desolations imaginable. A hundred and fifty years of mining have covered them, even to the summit, with huge piles of debris (seen in the upper part of (Plate 60)), which, acid with slowly oxidising sulphides, refuse to support so much as a blade of vegetation, and remain as barren as when first thrown out, gradually changing from dull-green to brown as the atmospheric waters act upon them. Here and there, knobs of rock emerge, rusty-coloured like the rest, and in the midst are the two great open pits, 100 or more feet in depth- and a third of a mile in united length. The views from the summit of this wilderness, over either the green southern lands or the blue northern sea, are contrasts in colour not readily forgotten. As the mines are at present being worked by a solution-process, the hill is now nearly deserted, the buildings are crumbling to ruin, and the whole place is as silent as it is desolate.

Its geology has been dealt with in Chapters 14, 15, 17, 18, and 19. To briefly recapitulate, the rocks of which it is composed are Ordovician and Silurian shales, with a sill of felsite several hundred feet in thickness at or near the junction, the structure being that of a deep isoclinal infold (Figure 213), (Figure 214), bounded and traversed by thrusts which are ancillary to the great Carmel Head thrust-plane. All the rocks are, in varying degrees (sometimes excessively), silicified, micacised, and pyritised; and the lodes are not fissure-veins, but zones of maximum chalcopyritisation. These mineral changes took place partly during, but chiefly just after, the great Post-Silurian earth-movements.

History of the mines

The name 'Parys' (also borne by a farm on the northern slopes) is doubtfully said<ref>The suggestion that Parys' merely stands for Parry's' may surely be dismissed. In such case we should not have had Mynydd Parys' but 'Mynydd Parys', as in such cases as 'Bwrdd Arthur', 'Carnedd Llewelyn', 'Tyddyn Philip', and even such a hybridism as 'Tyddyn-soldier'.</ref> to have been conferred after one Robert Paris, who was Chamberlain of Chester and North Wales in the reign of King Henry IV. In the oldest documents, however, the hill is called 'Mynydd y Trysglwyn' (a name which survives in a farm on the southern side), and, under that title, was reckoned among the estates of the princes in records of the seventh century.

There is no documentary evidence of metals having been worked at Parys Mountain in ancient times, but the circumstances of the discovery that was eventually made leave little doubt of there having been some such workings. Moreover, a local belief survived that, at some early period, the rock was heated by brushwood fires and then split by throwing water on it. Pigs of copper of Roman type have been found at Trysglwyn, as well as at some other places in Anglesey, and a cake (now preserved at Mostyn) stamped 'Socio Romae' is stated to have been disinterred at Aberffraw. Mr. Neil Baynes, after an exhaustive examination of the evidence, considers it almost certain that copper was obtained at Parys in the Roman, and probably even in the Early Bronze and Iron periods. No works appear to have been undertaken between the Roman period and the eighteenth century; but old rumours and traditions hung about the hill, and it is said that a pool of copper-water' (probably at the sources of the stream afterwards called the. Afon-goch, where water. finding its way down the pitch of the infold would be very likely to rise in springs) was known to the inhabitants.

The circumstances which eventually led to the discovery of the ores were somewhat romantic. Persuaded, apparently, that the ancient traditions could not be baseless, an Anglesey landowner, Sir Nicholas Bayley (an ancestor of the Marquises of Anglesey), began to make explorations in 1757, but without success. In 1762 there landed in the Island 'one Alexander Frazier' (a scion of the famous house of Lovat), who, according to some accounts, travelled in quest of mines', but who, according to local tradition, had fled from Scotland on account of some charge of manslaughter. Crossing the Irish Sea in a small boat, he was overtaken by a storm and wrecked upon the northern coast, but succeeded in escaping. Thence he made his way to Parys Mountain, where by some means he convinced himself both of the presence and importance of the ore-deposits. Being protected by Sir Nicholas Bayley, he incited his friend to a fresh and better-directed effort, in the course of which ore was found, so that this Highland refugee was the real discoverer of the famous mine. Water, however, broke in. and put an end to the work. Then, in 1764, 'Roe and Co. of Macclesfield', described by Lentin<ref>For this author see pp. 22, 29.</ref> as 'a company of smelters', applied to Sir Nicholas Bayley for a 21-years' lease of an abandoned lead-mine at Penrhyn-du in Carnarvonshire; and he agreed, on condition that they should also take Parys Mountain, and keep a certain number of men at work there during the whole term of years. This condition was considered most unreasonable, but as Bayley with stiffneckedness insisted thereon ' (' weil Bayley mit einer Hartnäkigkeit darauf bestand'), was complied with, and in the year 1765 six men and a manager were sent.

A shaft was sunk, at a spot 800 yards east of the place known as 'The Golden Venture' (p. 833) (which would be in the Silurian shale at the east end of the infold) because of a spring which was thought to 'issue from mineral'. It was on the strike of the Great Lode, and copper was again found, but in small quantity, decreasing downwards, and there was so much difficulty with the water (which was doubtless passing that way down the pitch) that the shaft had to be abandoned. Other places were then tried, but with no better success. As a last resort, the manager decided to sink at three points along a north and south line across the middle of the hill. Work was begun at the highest of these points on the second of March, 1768, a day long afterwards observed as a festival; and no sooner had seven feet of cover, it is said, been lifted than ore was struck, and in large quantity. They had come, indeed, upon 'The Great Lode'.

Its magnitude was quickly realised, and a period of extraordinary activity began. From a fishing village, Amlwch became a com: mercial town; the haven was enlarged as much as possible, and was even then so crowded that ships had to wait at Holyhead for days before they could be admitted. A wide road was also made from the mines to the port, 'probably' remarks Lentin, 'the most costly in the world, being made throughout of hard lead ores, which were not then thought worth the smelting' In a few years the Parys mines became the most productive in Europe, delivering 3,000 tons of metallic copper yearly, and employing more than 1,500 men.<ref>The aggregate produce of all the mines of Cornwall being then 4,434 tone.</ref>

To-day, an occasional cart may be met upon the 'costly' road, a schooner or two are usually to be seen discharging general cargo at the port, the mines are silent and deserted, and of many of the calcincries and sorting-houses one can only just make out the foundations and the ground-plan.

The history, as well as the discovery, of the mines is not without some romantic and fantastic episodes. The original company were dispossessed of half of the mine by one Edward Hughes, described by Lentin as a country-preacher, who put in a claim on account of his ownership, through his wife's dowry, of some rather barren land which he had been using as summer-pasture for a few sheep and for his pony. His claim had to be admitted, and he stepped, accordingly, into a great fortune. Later on the two companies were amalgamated. The two great 'open-works', known locally as the 'Great' and the 'Hillside' Opencasts, but called in this book the 'West Pit' and the 'East Pit' (p. 480) because the local names are not used upon the maps, that are so striking a feature of the mine (Plate 60) came to be made as follows. The Great Lode was at first worked by means of a crowd of separate shafts (several hundreds of which were sunk in a single year) and then by underground levels; but finding that they could not obtain a renewal of the lease, the company began to cut away the easily accessible ore that had been left for pillars. Then came a great collapse of roof, and this led to the decision, in which they were followed by the other mine, to do away at once with roof and pillars, and open the workings to the sky. The early difficulties due to flooding were overcome. But iron pumps could not be employed on account of the acidity of the waters. Recourse was therefore had to massive wooden pumps, drilled on the spot out of the cores of great oak trunks, a few of which are still to be seen at the yard on the hill. The pumping was done by wind-power, which indeed, on such a spot as the summit of Parys, can rarely have failed, as anyone who has had many years' experience of the climate of Anglesey will but too readily realise. The windmill continued to be used, to economise fuel, for many years after steam pumps were introduced.

The approaching exhaustion of the Great Lode led to exploration of the other southern lodes; but a new- epoch of prosperity, second only to the original one, was inaugurated by the finding (at what date is not precisely known, the old records being vague, but apparently about 80 or 90 years ago) of the northern lodes, of which the best one, the 'North

Discovery' Lode, was far richer in proportion than the Great Lode, though composed of more refractory material, and more difficult of access. These lodes in turn became exhausted, and solid mining on any considerable scale came to an end about 30 years ago. A little later on it was considered worth while to have some of the old spoil-banks picked over; and the peat of the bogs along the Afon-goch was burnt and. copper extracted from the ashes; but though the process was very cheap the yield was small. Exploration, however, has been made periodically; besides which a good deal of 'bluestone' has been, and still is, raised from time to time.

Large parts of some of the more refractory lodes are still untouched. Whether they can be worked with advantage depends upon their depth, refractoriness, and amenability to smelting, in relation, of course, to the demand for copper; and is a rather complex economical question. Work of some kind or other, however, never seems to have been interrupted, and is still steadily, if quietly, proceeding. The present treatment of the mine is described on pp. 842–3.

Extent of the mine

The deepest workings are those on the 'Gwen' shaft, a little to the north of the 'M' of 'Mountain', which go down to 570 feet below sea-level. The mouth of the Cairns'' shaft is on the summit of the hill, 480 feet above the sea, so that the total vertical extent of the mine is 1,050 feet. Its horizontal extent is nearly a mile and a half from west to east, and about a third of a mile from north to south; while the aggregate length of the old subterranean levels amounts to several miles. In the days of the separate ownerships the western part was called 'Parys Mine', the eastern part 'Mona Mine', the workings at the extreme west end of the hill being known as 'Morfa-du Mine'.<ref>Morfa-du Mine' is engraved by mistake at the east end of the hill on the .0004 maps.</ref>

The ores

The metallic ores which are found on any considerable scale are Pyrite (*i.e.,* 'iron pyrites'), Chalcopyrite (*i.e.,* 'copper pyrites'), Chalcocite (Cu_2S), Blende, and Galena. The two last, however, do not occur in workable quantity as distinct and individualised minerals distinguishable by the naked eye, but intimately intergrown in an ore locally known as 'Bluestone'.

Chalcopyrite and 'Bluestone' are, indeed, the two really im- portant ores of the hill. It will be observed that all these ores are sulphides.<ref>They should be compared with those found in the pyrite-deposits of Rio Tinto, Rammelaberg, and other places, descriptions of which may be found in Beyschlag, Vogt, and Krusch's great work on Ore Deposits.</ref>

The pyrite and chalcopyrite occur in a matrix of quartz, in which are generally also a little haematite, chlorite, and a few other minerals. The pyrite is, even when closely crowded, idiomorphic;<ref>*i.e.,* developing its own crystalline form.</ref> but the chalcopyrite occurs in allotriomorphic<ref>*i.e.,* unable to develop its own crystalline form, but having outlines determined by its neighbours.</ref> aggregates of irregular form, and appears to be later than the pyrite. The quartz of the matrix rarely develops idiomorphic, or even large allotriomorphic crystals like those of ordinary veins, but is apt to be rather fine, with a granular aspect' not unlike that of a quartzite. Large idiomorphic crystals, indeed, are seldom to be seen in the Parys ores, probably from the fact that they are impregnations, not 'comby lodes' deposited on the cheeks of open fissures.

'Bluestone' is a dark bluish-grey material, very heavy, granular, and rather fine in texture. Tracts of fine pyrite and chalcopyrite can be seen among the grey body, which is lit up with innumerable little flashes from some brilliant metallic-looking glance'. Sometimes blende can be detected with the hand-lens, and in powder under the microscope is seen to be abundant. Two typical bluestones, supplied by the captain of the mine, Mr. Hughes, have been sliced (E9421) [SH 441 904]–(E9422) [SH 441 904]. Dr. H. H. Thomas describes them as follows: 'The main mass of the ore consists of a deep-yellow zinc-blende which appeal's, with the quartz, to be the earliest-formed portion of the lode. The blende is much fissured, and traversed by a network of minute cracks which carry chalcocite, galena, and pyrite'. It would appear that the introduction of the galena and pyrite followed that of the chalcocite. The mineral which I take to be chalcocite has a characteristic blue tarnish and shows well in the hand-specimen. It has been tested for copper and sulphur'. Bluestone is, therefore, an intimate intergrowth of pyrite, chalcopyrite, chalcocite, blende, and galena, with a little quartz, in varying proportions. Its complexity has -been a serious hindrance to smelting.

Most of the following analyses give less copper than the sliced specimens would, as those are so full of chalcocite.

	I	II	III	IV	V	VI
Pb	14.46	11 to 13	14 to 15	1.00	15	10
Cu	2.13	0.5 to 1	2	3.80	6.26	4.41
Zn	27.89	30 to 32	30 to 33	12.21	1.20	
Fe	11.45	14 to 16		10.33	26.25	23.80
S	29.05	24 to 26		18.40	27.05	23.75
MgO					90	1.10
SiO_2	14.47	16 to 18		53.65	37.15	45.24
O				61	1.04	1.60
Total	99.45			100.00	100.00	100.00
	per ton	per ton	per ton	per ton	per ton	per ton
Ag	6oz. 15dwt.	10 to 14oz.	8 to 10oz.	5oz.	2oz. 10dwt.	3oz. 7dwt.12gr.
Au	traces	2 to 3dwt.	2dwt.	1dwt. 12gr.	1dwt. 12gr.	2dwt.

I. Bluestone Old analysis, by Claudet.

II. Bluestone. Anal. C. H. Hills of the Amlwch Chemical Works.

III. Bluestone. Anal. not named.

IV. Approaching a bluestone. Anal. Johnson & Sons, 23, Cross Street, London, E.C. 'O' includes traces of As and Mn. Blackrock shaft.

V. Probably pyrite, chalcopyrite, and quartz. Anal. Johnson & Sons. 'O' includes trace of Mn and Bi. Gwen shaft.

VI. Probably quartz with pyrite, chalcopyrite, and chlorite. Anal. Johnson & Sons. 'O' includes traces of Mn and Zn. Quarry shaft.

Nos. III–VI were kindly supplied by Mr. Fanning-Evans. No specimens of the analysed ores have been preserved.

The genetic relations of the several ores and minerals might perhaps be made out by examination of a well-selected suite of slides. But as most of the specimens would have to be taken from the old spoil-banks (hardly any sulphide but pyrite remaining in the open pits), the positions in the lodes from which they came could not be ascertained, which would be a serious obstacle.

Silica — Finally, the vast accumulations of silica (pp. 562–3) call for a brief consideration, as they may prove, some day, to be of some importance. They fall under three heads: the silicified shale, the silicified felsite, and the quartz-rock of the Careg-y-doll Lode (p. 834). Partial analyses of some of them will be found on pp. 563–4, though much higher silica-percentages could be obtained. The drawback to all of them is the presence of sulphides, for though pyrite-free specimens can easily be selected, yet masses quarried on the large scale could not be expected to be free from that mineral. The silicified shale is indeed known to the miners as 'bluestone-ground'. If, however, any process is ever devised for which a small quantity of sulphide is no serious objection, then an almost unlimited supply of siliceous material could easily be obtained from Parys Mountain.

The lodes

The general geological relations of these have been described on p. 564. They vary a good deal in character, some being much more definite than others, the quartz-pyrite lodes much more so than the bluestone lodes. In magnitude they also differ, both from one another and in different parts of the course of each. One of them is a mile in length, with a maximum width of 70 feet. With regard to their vertical extent, some have been followed to a depth of 900 feet, others have quite a moderate depth. Some die out downwards, others upwards; two or three are known to have outcropped upon the surface. They dip usually a little west of north at about 45°, the dip ranging, however, from 25° to 60°. The nature of their contents will be described below, so far as it is known; but the underground workings are now so encrusted with mud and salts that little can be gathered from them, and the descriptions given here are based for the most part upon examination of the old 'dumps' or spoil-banks<ref>The material that came from all the different lodes was kindly shown me by Mr. Hughes, the captain of the mine. It could not have been identified without such aid; but the positions of pure material from single lodes, and also the names of the principal shafts, have now been set down upon the .0004 maps.</ref> (which consist, of course, of the less cupriferous material), 'upon what can be seen in the pits or open-casts', and upon the few natural outcrops; combined with old published accounts, and with local information. The southern and western group were largely bluestone, the northern and eastern, quartz-pyrite-chalcopyrite impregnations. Almost the whole outcrop of those which lay within the Silurian shale was covered (p. 749) by a 20-foot sheet of boulder-clay.

Twelve lodes in all are laid down upon the plans, and their outcrops (or positions of outcrop in the case of those which do not actually reach the surface, protracted from their dips) have been, through the kindness of the manager, Mr. Fanning-Evans, reduced upon the .0004 and smaller maps<ref>There are, he says, some slight errors in the angles on these plans.</ref>. They are:

The Great or Open-Cast Lode

The Clay Shaft Lode

The Black Rock Lode

The Golden Venture Lode

The Careg-y-doll Lode

The South Branch Lode

The North Discovery Lode

The North Branch Lode

Charlotte's Lode

The Great Cross-Course

The Careg-y-doll

Cross-Course.

Morfa-du Lode

Other names are sometimes locally applied to particular portions of them; and some smaller strings and bunches are also known to the miners. The main lodes are arranged here, in a general way, in order from south to north. They fall into certain natural groups. The Clay Shaft, Black Rock, and Golden Venture appear to be subordinate to, perhaps connected with, the Great Lode. The North and South Branch are certainly connected with the North Discovery, and so apparently is Charlotte's Lode. The Careg-y-doll appears to stand by itself and have special characters of its own.

The Cross-Courses are connected with small faults. Morfa-du Lode, far away below the western escarpment, is isolated. The adit and another level have been driven through the northern dip-slope of the hill, but no more lodes were met with.

The Great or Open-Cast Lode

No plans of this (of any value) are preserved, and the cupriferous portions have been worked entirely away; but from the descriptions that exist, from what can still be seen in the 'open-casts', and from the spoil-banks, it is possible to get some idea of this once-famous deposit. The two great 'Open-Casts', referred to here as (p. 480) the 'West Pit' (Plate 60) and the 'East Pit', occupy the positions of two enormous aggregates or bunches, which, after the collapse of the underground workings described by Lentin, were quarried away in the open air. The two pits, which are only 30 yards apart, have a combined length along the strike of 620 yards, with an area of about 12 acres, and are f7oin 110 to 140 feet in depth, their floors being some 300 feet above sea-level. The lode, moreover, extended further downwards, and was mined below the floors of the pits, but (though said to be better there in quality) wedged out rapidly when followed down. It also descended at both ends, at the same time dying out into a complex of small veins. At a moderate estimate, its total content cannot have been less than 90,000,000 cubic feet. The northern walls of the pits coincide, in a general way, with the northern margin of the Silurian shales, though the workings were, in some parts, carried back into the felsite, in the schistose parts of which (called 'Careg-y-grogan', the 'shelly rock'), especially between the Cross-Courses, many good kernels of chalcopyrite were found. The southern limb of the felsite was not reached, so that the lode lay almost wholly within the Llandovery shales.

The whole seems to have become exhausted about a hundred years ago. It was not rich, the yield being only from 3 to 5 per cent. of metallic copper, but being so large, and so easily accessible, there was practically for a while no limit to the output, and the value of the metal annually sold exceeded for many years £500,000.

There is said to have been a sort of rough order in the arrangement of the ores, pyrite on the north, chalcopyrite in the middle, and bluestone on the south, though no part was free from pyrite. The chalcopyrite and bluestone have been worked away so completely that it is difficult now to find even specimens of them on the crags. But large quantities of pyrite remain, especially in the western pit, and from a study of these a general picture of the Great Lode may be formed. The best localities are the stack ' of silicified shale at the old engine-house in the middle of the West Pit (seen in (Plate 50)), and the foot of the cliff to the north of this, just at the junction of the felsite and the shale. The mode of occurrence is the same in both cases. In rock that is more or less pyritised throughout, are great lenticular or ellipsoidal, overlapping aggregates, elongated along the strike, of pyrite cubes that are so closely crowded as to leave barely matrix enough' to bind them together. They are not sharply defined, but send out many strings along the strike, and veins across it, seeking out especially such planes of cleavage or schistosity as remain unhealed ' by the silicification. In the felsite, the bending schistose portions around the harder cores are densely studded with pyrite, destroying all the smoothness of the old shear-planes, and sometimes almost entirely replacing the fissile seams. Here and there a little chalcopyrite can be seen, but very little. The lode itself, it is evident, was a series of such aggregates, the bluestone zone (which is said to have varied from a few inches to 50 or 60 feet in width) having been a range of impregnations of similar form. Further, though the dip is high, the outcrop is as much as 300 feet in width, and yet there is no sign of incipient upward thinning. Manifestly, therefore, all the upper parts, perhaps half the original extent of the lode, have been swept away by denudation. Were these parts of the same nature as those which survived? There is reason to suspect (p. 838) that they were not, but that they contained large quantities of galena together with some of the sulphides of arsenic.

The matrix of the aggregates, both in the pits and on the spoil-banks, is quartz, not coarse with conchoidal fracture like most vein-quartz, but granular, and decidedly fine, also very free from chlorite. Specimens can be obtained upon the older heaps, from which almost all the pyrite has decayed, and which are now a sort of trellis-work of sub-translucent quartz, pierced with square holes in all directions, but just strong enough to hold together. Here and there, thin strings of ordinary vein-quartz cut it, and these are usually much freer from the sulphides. There is abundant silicified shale (some of which is granular and seems to approach to the nature of a 'bluestone'), but this must not be regarded as lode-stuff, being evidently the separating rock. On the spoil-banks chalcopyrite can be seen much more often than in the pits, some blocks being quite rich (though never like those from the North Discovery Lode). Blende also is not uncommon, as little, well formed, honey-coloured crystals, in veins and druses lined with comby quartz. In the pits, especially the East Pit, it may often be found *in situ* as cherry-coloured patches, about the size and thickness of a sixpence, on the joints of the silicified shale. No crystals of note are to be seen, the largest, usually of pyrite, very seldom attaining an eighth of an inch along the cube-edge.

In favourable weather, crystals of several sulphates effloresce upon the crags. Mr. Griffith J. Williams has found a fibrous modification of alum; while a pale-green, often almost colourless substance, which is very common, was found by Mr. J. O. Hughes to be ferrous sulphate with a little ferric sulphate, but only a trace of copper. Closely associated with this, and manifestly its oxidation-product, is a substance corresponding to the account given of the mineral analysed by Prof.

Church (p. 33), which he describes as orange-coloured, ochreous, crystalline, and apparently isometric. He found it to be a basic ferric sulphate, and assigned to it the formula—

$$\begin{matrix} Fe^{iii} \\ \\ H_4 \end{matrix} \begin{cases} O_5 \\ SO_4 \\ (OH)_4 \end{cases} 4aq.$$

It is, he adds, nearly identical with the Glockerite of Naumann, but with four molecules of water-of-crystallisation instead of two. For reference, therefore, it may (p. 568) be termed Hydro-Glockerite. The small proportion of copper in these efflorescences is remarkable, but large crystalline aggregates of copper sulphate have been, and appear to be still, met with upon the walls of the underground workings.

To sum up, we must think of the 'Great Lode' as a pair of huge groups of lenticular aggregates or impregnations, lying in more or less silicified and pyritised shale. Those along a southern zone, 50 or 60 feet in width, were bluestone. The rest were finely granular quartz, impregnated along the margin of the felsite, and for a varying distance to the south, with pyrite, but over the greater part of its extent with chalcopyrite also.

The Clay Shaft Lode

This is given a width of 54 feet in the sections at the East Pit, but is said to have thickened to 140 feet on a dip of about 25°, from which it would seem to have consisted of bunches or swellings. According to the plans, it would emerge in both the pits, but nothing can be seen of it there now, and there is little doubt that its upper parts were worked entirely away. Bluestone seems to have been its principal ore, but chalcopyrite is said to have been obtained as well. On the spoil-bank little can be seen but silicified shale with bands of pyrite, just as in the East Pit. Its upper parts are described (p. 837) as deeply decomposed, which may account for its absence from the pits, as the decayed material would be readily worked away.

The Black Rock Lode

The relations of this appear to have been the same as those of the Clay Shaft Lode. The two lodes are said to have come together as 'bluestone' at the 'Bluestone Shaft'; and therefore, as Hunt refers to this as the richest of the tributary or subordinate parts' of the Great Lode (upon which mining was begun when that began to fail), it is evident that all three were in some way connected. The material at the spoil-bank is chiefly silicified shale, with nests and veins of pyrite, and some of chalcopyrite and blende, but very little venous quartz. More blende is to be seen here than at any other spoil-bank, not like the cherry-coloured patches, but honey-coloured and in little veins, and it is quite as plentiful as the chalcopyrite. Some of the material approaches 'bluestone' in texture. The lode appears to have been a string of bluestone aggregates in silicified shale, with a little chalcopyrite, and to have been very ill-defined upon its margins, the bluestone fading off into 'bluestone-ground'.

The Golden Venture Lode

This is the only lode shown within the felsite. It is said not to have been very rich, and to have died out downwards at about 180 feet. No outcrop can be seen, though rock is visible just to the east of its line of strike. A small open-cast' in the felsite, which is close by, seems to have been connected with it, but protraction from the plans would place the outcrop a few yards to the north. Schistose felsite is seen at the shaft's mouth, but the spoil-bank of the lode itself consists chiefly of venous quartz, some horny-looking, but most of it rather finely granular. Pyrite abounds in the quartz, but chalcopyrite, is also to be seen, some aggregates being quite rich.

The Careg-y-doll Lode

This great lode has a range of nearly a mile, from the Corwas thrust-plane, about two-thirds of a mile west of Pensarn, to near the summit of the Rhosybol road, and maintains a thickness of some 60 or 70 feet throughout a great part of its course, but thins, rather rapidly, to six feet at its eastern end. It lies in the Ordovician shales, on the north side of the north limb of the felsite (Figure 214), from which it is said to be separated by a small but varying width of shale, and has an average dip of 45°. It appears to have been worked at a great depth below the Gwen shaft'. At both the Cross-Courses it is cut and shifted. Near the summit of the hill, 133 to 230 yards east-north-east of the windmill, is a great boss of quartz-rock known as the Careg-y-doll ('the crag of the toll-taking'). When the protractions from the plans were laid down upon the maps, it became evident that this, as well as a number of other exposures of quartz-rock between the Great Cross-Course and the east end of the hill, could be no other than outcrops of the Careg-y-doll Lode, in which identification Mr. Hughes, the captain of the mine, concurred, adding that the character of the material of the boss was that of the lode as known to him in the underground workings. The width of these outcrops also agrees with the measurements of thickness given by Phillips and the Messrs. Fanning-Evans. The sections of the Mona Mine, it is true, show the lode dying out upwards in a number of thin strings, and do not give it more than 30 feet, but they are said to show only its more cupriferous, and ignore its barren portions.

At the west end of the hill, north of the 'u' of 'goleu', are some exposures of a wide band of quartz-rock, rising at one place into a great white knob, whose ice-worn summit (p. 746), shining in the sun, is a conspicuous object for several miles. The stratigraphical difficulties of its position have been a good deal discussed, and, certainly, it is not a. sedimentary quartzite. But it has all the peculiarities (described below) of the Careg-y-doll boss and lode, it lies close to the junction of the felsite with the Ordovician shales, and is without doubt an outcrop of the same or of a precisely similar lode. It has the north and south strike of that portion of the hill, but must thin rapidly in both directions, as there is no room for it between the felsite and main body of the shale at short distances away. Levels are said to have been driven underneath it. Whether it be a separate segregation on the same horizon as the Careg-y-doll lode, or a portion of that lode cut off by late movements, is not at present known.

All these outcrops, and also the great spoil-banks of the Henry's Shaft, have the same general characters. The body of the lode is a. very hard quartz-rock, rather fine, and frequently simulating a sedimentary quartzite. Under the microscope, however, there is not the least sign of clastic texture, all the quartz being granular, with interlocking junctions, often, indeed, hypidiomorphic, sometimes even with an approach to a spherulitic arrangement. In the field, curious wandering banded structures are conspicuous, especially on the clean ice-worn summit of the western boss; and drusy cavities are very common. Underground, enormous empty vughs are said to have been met with, one of them being no less than 24 feet in height; 'magic caverns, that when entered with a candle, display a scene of intense brilliancy'. Remains of shale, and sometimes, apparently, of schistose felsite more or less silicified, are enclosed within the quartz-rock. The general body of quartz is more uniform than in the other siliceous lodes, and, in the spoil-banks, pale green with disseminated chlorite. Pyrite in small cubes is always present, but not in great quantity, except in some curving seams of the Careg-y-doll crag, which divide the rock into rude lenticles. On the outcrops it is represented only by cubic cavities, often filled with limonite. In the same way, the small druses of the surface may be accounted for by the decay of pyrite and chlorite. But what the minerals can have been whose removal gave rise to the great subterranean caverns is not easy to understand. Knots and strings of chalcopyrite can be found in the spoil-banks, but not so large or so concentrated as in the others. Some good bunches have been found in it, but the lode is not a rich one, its average being put at 2.5 to 3.0 per cent., and the matrix is very hard. Large masses of it still remain unworked.

Charlotte's Lode

With this is included what is by the miners called the 'Marquis Lode' at the east end, but an interval is shown on the plans, though no displacement is represented at the Careg-y-doll Cross-Course. It is said to die out upwards (Figure 214), and shale can be seen at the surface where its outcrop would be according to protraction.

It is on the strike of the North Discovery Lode, and is said to have been rich, but the material is quite different, much of what can be seen upon the spoil-bank being a fine hornstone, sometimes evenly bedded, and very much like the silicified shale, rather sparsely studded with pyrite. Other blocks have a little venous quartz with chlorite as a binding to dense aggregates of pyrite, along with which are similar aggregates of chalcopyrite. But there is not much of such quartz, and a general picture of the lode is not easy to arrive at.

The North Discovery Lode

This, by far the richest in the mountain, has been worked entirely away, scarcely so much as 'scrapings', it is said, remaining some 30 years ago. It bore as much as 20 to 25 per cent., and the total value of the output has been estimated at more than £1,000,000. The description is more like that of a true fissure-vein than any other in the mines, for it is said to have had well-defined foot and hanging walls, to have dipped north at 60° (cutting, apparently, the Careg-y-doll Lode on its way), and to have been about eight or ten feet wide. On the plans it is shown as beginning a few yards west of the Great Cross-Course, and running as far as the Rhosybol road, a distance of rather more than quarter of a mile. No outcrops can be seen, but the ground is heavily laden with spoil-banks. It is said that the shoot of ore dipped west at '1 in 2', from which it would appear that the richest parts were elongated concentrations whose major axes had an inclination parallel to the strike.

The spoil-banks are even now the richest that are to be seen upon the hill, in spite of having been picked over some 25 years ago, when they yielded 3.5 to 5.5 per cent. Consistently with the comparative definiteness of the general relations of this deposit, the spoil-bank material is decidedly less impregnation-like than usual. There is a good matrix of quartz, rather coarse and venous in aspect, not simulating a quartzite as does that of the Careg-y-doll. In this is chlorite, sometimes so abundant as to suggest that silicified diabase may enter into the composition of the lode, especially as a few small basic sills crop out along the line of strike. Here and there, notwithstanding the generally venous aspect of the material, are surviving flakes of shale, silicified and chloritised.

Some exceptional blocks contain a hard haematite. Pyrite is generally present, but is not dominant as in the other lodes. Chalcopyrite is, even in this refuse, quite common; almost any block one breaks contains a little, and some, that have a peculiar rusty crust, are brilliant with it, in aggregates an inch or two across.

The North and South Branch Lodes were off-shoots of The North Discovery Lode, and are said to have had the same general character. Between the North Discovery group and the Careg-y-doll zone there were only some small strings of quartz with a little chalcopyrite, blende, and galena, the whole being of no great value.

The Cross-courses

Both from plans and outcrops it is evident that these run along north-and-south faults with downthrows to the west. Where they cut the Careg-y-doll Lode, the displacements of the faults are, at the Careg-y-doll Cross-Course about 150, and at the Great' Cross-Course only about 100 feet, but a considerable deflection of the strike is produced at the latter. The Careg-y-doll Cross-Course is represented as narrow, and nothing more is known but that it contained a band of ore, presumably chalcopyrite. The descriptions given of the Great Cross-Course, also called 'The Flucan' (a term applied elsewhere to a metalliferous breccia), are perplexing, and do not agree, either with the small displacement of its fault, or with what is to be seen on the ground. It is said by Phillips to have been a breccia of the adjacent rocks, no less than 60 feet wide, and is represented as 80 feet wide at the north wall of the West Pit. No such breccia can, however, be seen upon the cliff (which is shown in (Plate 50)), and even the displacement of the fault has died away. Nothing is to be detected but some rather folded sericitic shale, with the schistose felsite overlying it, and the boundary not appreciably shifted. There has been a heavy rock-fall at the place, and such breccia as may exist must be concealed by that. On the south cliff the silicified shale is undisturbed. Most likely the explanation is that there is a considerable wrench, developing a small fault, that dies out southward, along which there is a little breccia, with a parallel zone of pyritisation, attaining a width of 60 or 80 feet in places. it is described as resembling, in a general way, the Great Lode. There are no recognisable spoil-banks.

Morfa-du Lode

This lies at the western extremity of the mountain, running from north to south between the great quartz-knob and the chapel (pp. 458–9), in the Phyllograptus shales below the felsite, and is said to dip westward. It is a bluestone lode, and the spoil- banks are chiefly modified shale. Much bluestone, with a rough, russet crust is (in 1912) lying near the shafts, the lode having been worked, at intervals, for a considerable time, down to a few years ago. The modified material, unlike the indurated 'bluestone-ground', is rather soft, and it is evident that the Morfa-du bluestone, though a mineralised, is not a silicified shale. There is also a little quartz-pyrite ore. Pyrite and chalcopyrite are frequent in the bluestone, but blende is not conspicuous. A rather coarse variety is frequent, which is brilliant with a 'glance' that appears to be chiefly chalcocite.

The workings are said to be shallow, and the lode a series of ill-defined impregnations like most of the bluestone lodes.

Primary ore-zones

From these accounts it will be seen that in one or two cases there are some signs of primary ore-zones, but the old records are vague.

In the North Discovery Lode they indicate a rude vertical succession among the several sulphides, dipping at about 27°, which, as we shall presently see, cannot be other than primary. In the Great Lode, the only order of which we have direct information is horizontal; pyrite, chalcopyrite, and bluestone succeeding each other from north to south, from which it would appear that all these ores must be original, not secondary, products. Moreover, it will appear that there is indirect evidence that they were once overlain by a primary zone rich in argentiferous galena, with considerable quantities of some arsenical ore.

Gossan

The product known locally as 'gossan' we have found (pp. 564–5) to be really a ferrified boulder-clay. Access has (since the remark on p. 564 was printed) been obtained to more of the old records, from which it is evident that a considerable amount of true gossan was developed, though only, so far as is known, upon the southern lodes.

Clay Shaft Lode — The bluestone of this (and to a less extent, apparently, of the Black Rock) lode was much decomposed in its upper part to a dull grey clay, the body of which would seem to have been a residuum of partly mineralised shale. In the opinion of Hunt, its copper, zinc, and iron had been removed by weathering, being oxidised to sulphates, all of which would be. soluble, its lead, whose sulphate would be insoluble, remaining behind. Manifestly this clay was a true gossan after bluestone; and the downward improvement of both these lodes may therefore be regarded as developments of secondary depth-zones.

The Great Lode — Nothing that could be described as true gossan seems to remain in the pits to-day; but fpom the old accounts given by Pennant and Lentin, mineralogically vague though they often are, there is no doubt that considerable developments of true gossan, some of which have a genetic interest, existed upon this lode.

Several varieties are described by them. Pennant states that 'above the copper ore, and not more than three-quarters of a yard below the common soil, is a bed of yellowish greasy clay, containing lead ore, and yielding 600 to 1,000 lbs. per ton', which, however, was difficult to smelt, so that some 8,000 tons were thrown on to the banks. A loose dark purplish earth' is also said to have yielded well. The others are described by Lentin. One of them, tough, white, and somewhat greasy, contained reniform aggregates of barytes. Close to the surface, on the northern side, was a yellowish green 'lead-earth' (perhaps identical with Pennant's clay'), containing white 'Bleiglaskrystallen', and sometimes crystals of sulphur, in a very brittle quartz. This earth is said to have been so extremely volatile that it could not be smelted, which suggests that it must have contained a high proportion of arsenic. Little, if any, deeper, at the opening of the mines, was found a 20-foot mass (which died out downwards), consisting partly of melaconite, partly of tetrahedrite (whose presence confirms the suggestion that the volatility of the aforesaid 'earth' was due to arsenic); while, in a similar position, occurred leaf-like and moss-like aggregates of metallic copper. Pyromorphite also seems (p. 839) to have been present. Perhaps the most interesting is an accumulation, found in the middle of the lode, at a depth of about 70 feet, described as brown, porous, and friable, in which were crystals of a Silberhaltigen Bleiglas', whose form, colour, fracture, and percentage-composition all agree with those of anglesite. It will be observed that several of the substances mentioned are well-known gossan-products; and also that lead, with its tendency to form an insoluble sulphate, had become concentrated in these gossans. In fact, such large quantities of lead sulphate seem out of all proportion to the moderate amounts of lead sulphide found in the early explorations of this lode, and can hardly have been derived therefrom. May we not ascribe them to downward percolation from the vanished upper portions, long ago (p. 831) swept away by denudation? we may, then the phenomena just considered seem to point to those upper portions having been comparatively rich in argentiferous lead, as well as in arsenic.

The Northern Lodes — On the corresponding parts of these, nothing of the kind seems to have been met with. Some of the natural outcrops of the Careg-y-doll Lode still remain to us, and certainly there is no true gossan upon them. Its absence from all but the southern lodes may be ascribed to a combination of causes. The hill has been (p. 746) severely glaciated, and incoherent matter like that of a decomposing ore could hardly fail to be swept away by the onset of the ice from all its northern and upper parts, whereas the southern lodes emerged under the sheltered lee of steep escarpments, positions like thosewhere we have already found (p. 702) that similar decayed matter has been able to survive. But it is quite likely that the northern lodes never developed more than very small quantities of true gossan. Their sulphides are disseminated throughout a matrix of granular quartz, protected by which encasement their decomposition would be very slow. It is, indeed, to the great quartz-reef of the Careg-y-doll and to the silicification of the felsite that Parys Mountain owes its survival as a monadnock (p. 781), which of itself indicates that any development of true gossan upon such masses must always have been trifling. Nor can any secondary enrichment have taken place in lodes of this kind, so that any ore-zones in them of which there are indications must have been primary.

Date of the gossans — We happen to have information (pp. 567, 602, 629) that the Careg-y-doll and Great Lodes (with, probably, therefore, most of those that are not still buried) were laid bare for a while in early Carboniferous times. They may then have developed some gossan, but as they were (p. 627) undergoing severe erosion, it was probably removed as fast as it was developed. No gossan-minerals have been found in the boulders of the Lligwy Bay conglomerate. The lodes then received a protective cover of Carboniferous deposits, under which they remained for a very long time. Even if exposed in the course of Triassic denudation, the climate can hardly have been conducive to decay. But from the evidence adduced in Chapters 33–34 it will be seen that prolonged exposure to sub-aerial weathering is unlikely to have begun before the Tertiary period. On the other hand, from the severe glaciation of the gossan-less northern, and the protective sheet of boulder-clay spread out upon the gossan-bearing southern lodes, it appears that the effects of Post-Glacial weathering have been insignificant. We must look, therefore, to some portion of Tertiary time. Now we have (p. 785) seen reason to believe that locally very deep decay of even the ordinary rocks of the Island was going on during the Pliocene epoch. To its long-continued genial climate, accordingly, beneath whose influence metallic sulphides would still more easily succumb, we may with probability ascribe the development of these gossans.

Anglesite

As this mineral received its name from the Island, its mode of occurrence and origin therein, as well as the history of its discovery, will be of interest to students of the geology of Anglesey.

The first mention of the natural sulphate of lead appears to be that of Monnet in his "Nouveau Systême de Minéralogie" (1779), in which work, under the name of Vitriol de Plomb, he describes the sulphate as a white decomposition product of galena. The first record of the crystallised mineral to which the name Anglesite was afterwards applied appears in Bergmann's "Sciagraphia Regni Mineralis " (1782) as Plumbum acido mineralisatum. In the French translation of this work, "Manuel du Minéralogiste ou Scigraphie du Règne Minéral" (1792), the mineral is mentioned as having been found in considerable quantity at Parys Mine, Anglesea, by Dr. Withering, who proposed to undertake a more detailed analysis than had hitherto been made. The same work states that the crystals are modified "octahedra" and are exceedingly regular in form, that they appear to be very pure, are white in colour, and have a ferruginous gangue. A little later Richard Kirwan in his "Elements of Mineralogy" (1796, 2nd Ed.) says "I found these Crystals thickly disseminated in a reddish brown mass of Ore sent to me from Anglesea, accompanied with a number of brownish red Crystals, irreducible by the blowpipe tho' easily fusible. These I did not thoroughly examine, but suspect them to be Phosphorated Lead and Iron". Repeated references are made by the earlier mineralogists, such as H. W. Phillips, Mohs, Naumann, and others, to the natural sulphate, but Beudant in his "Traite elementaire de Mineralogie" (1824, 2nd Ed. 1832) first describes this mineral under its now usually accepted name of Anglesite, naming the species after the Island of Anglesey in which it was first discovered. Beudant may therefore be regarded as the founder of the species. He quotes also what is probably the earliest complete analysis, which is set out below.<ref>For the foregoing history of the discovery of Anglesite I am indebted to the kindness of my friend Dr. H. H. Thomas.</ref>

Analysis by Klaproth:	
Acide sulphurique	24.8

Protoxide de plomb	71.0
Eau	2.0
Oxide de fer	1.0

The loss in this analysis may perhaps be accounted for by barium or arsenic. Though Klaproth does not appear to have separated silver, Lentin's account leaves no doubt of the presence of that metal. Anglesite is now quite a rare mineral in Part's Mountain, though crystals may still be found here and there on the crags of the great pits; but when first discovered it was evidently abundant.

From the descriptions quoted on p. 838, it is clear that what we may call the type-specimens were obtained from the gossans of the Great Lode, wherein it would appear to have been an oxidation-product of argentiferous galena that has been removed by denudation. In the gossans of the Clay Shaft Lode it was manifestly a residuum, derived from oxidation of the galena that occurs in the network of minute veinlets by which the bluestones are everywhere penetrated in all directions.

Treatment

Early methods

Chalcopyrite — From various indirect allusions, and from the silence of Lentin, it would appear that the only ore which received any treatment on the spot was chalcopyrite. To obtain it, blasting was freely resorted to; but while in the lower depths it was attacked in the usual manner, the crags of the great open pits were quarried by men who were lowered by windlasses, and worked suspended in mid-air. As soon as it was raised it was broken up with hammers on iron anvils into pieces about the size of a fist; an operation which was performed by women and children, armed with iron gloves! In fact, 'Morwynion y Parys' (the 'maidens of Parys') were famous all over the district, and are still remembered by the older inhabitants of the north of Anglesey. After having been freed as far as possible from quartz, ferro-pyrite, and other minerals, it was roasted. In the first days of the mines, great heaps are said to have been 'calcined' in the open air, a method which, crude though it seems, has been employed at various places in early times. Lentin, however, about 1798, describes the process as being carried on in kilns or furnaces, the older ones being rectangular buildings of stone and lime, 70 feet in length, between each pair of which was a smaller condensing-chamber wherein the sulphur crystallized. Coal was arranged in brick channels at intervals (which also served to maintain a draught) and then the whole was filled in from above with ore, upon which was built a sloping roof of 'Schiefersteinen' (probably the Hartfell green shales, which have been quarried a good deal close to the mines) cemented with lime. The coal was lighted on the windward side, and the process, which once started needed no fresh fuel to keep it going, went on for five or six weeks, after which the kiln had to be cleared out and refilled. At the time of Lentin's visit, however, these rectangular kilns were being abandoned in favour of conical ones 27 feet high, standing over a chamber eight feet deep, into which, at intervals, the roasted lower layers of ore (10 tons of which were delivered by each kiln every week) were allowed to fall, fresh ore being then introduced at the top of the cone. The process was thus made continuous, and the fuel needed reduced merely to a single initial supply, because (one old writer explains) of the ore's own phlogiston'. Lentin says that, when he was there, 45 such kilns were already working, and more about to be built. He tells his countrymen that the methods in question were greatly superior to those then in use in Germany. It will readily be believed, however, that sulphur-dioxide and sulphuric acid escaped in such quantity as to destroy vegetation all over the hill for many years, even the northern dip-slopes having been in a barren condition as lately as 1877. There were kilns about the Port as well, and little crystals of selenite may still be found in sheltered nooks among the rocks, products of the sulphuric acid.

The poorer ores, after being roasted, were placed in shallow brick tanks, long ranges of which, remaining to this day, are shown even on the one-inch map, and allowed to stand in water for 12 or 16 hours, after which they were taken out and broken to pieces about the size of a walnut by other companies of 'the maidens of Parys'. The waters were led into a large basin and allowed to deposit their sediment, whence the clear sulphate-soltrtions were conducted into another suite of tanks, where the copper was precipitated by metallic iron, the remainder of the process being essentially the same as that which is described below, save that the ferrous sulphate seems in those days to have been run off as waste. It found its way into the sea at Traeth Dulas, the stream depositing ferric hydrate (from atmospheric oxidation) all along its course, whence it was appropriately called the Afon-goch<ref>'Red River'. compare the term ' Rio Tinto'.</ref>, a name which it still retains upon the one-inch maps. Lentin, who recommends this process also to his countrymen, states that, so far as he was aware, precipitation was not being employed at any other mine in Europe, but adds that, according to Schluter, it had been practised in ancient times in the Unter-harz. The method appears, however, to have been known for more than 100 years at Hern-grunI in Hungary; and also, for a long time, in Wicklow.

The roasted chalcopyrite of all qualities, whether direct from the kiln or after passing through the tanks, was sent to Liverpool in a fleet of sailing-ships varying in size from 80 to 300 tons, all of which were owned by servants of the companies. Thence it was taken in canal-barges to Ravenhead and Stanley, 12 miles away, where the products of both mines were smelted.<ref>The smelting, as well as all the foregoing processes, are described in great detail by Lentin.</ref>

Other ores — The gossan-minerals brought out in the early days of the mines are said by Lentin and Pennant to have been thrown away, many hundreds of tons lying about in all directions. Bluestone and other complex ores were, however, being raised in the latter part of the eighteenth century, and have been worked at intervals ever since. In their smelting special arts were needed, and they have always been sent to Swansea to be dealt with.

By-products — Besides the copper and other metals, with the crystalline sulphur of the kilns, there were several other products. Chemical works were established at the Port, in which alums, with sulphates of zinc, iron, and copper, as well as a certain amount of sulphuric acid, were prepared. It will be observed that all of these by-products were sulphates.

Present methods

The mines are now being worked almost entirely by solution and precipitation processes. Water is pumped up to the top of the hill, and allowed to flow into, and remain for some time in the old workings, the mine being flooded up to about the deepest parts of the floor of the West Pit, that is to about 300 feet above sea-level. There the free atmospheric oxygen which it contains acts upon the finely disseminated sulphides, and the metals are therefore extracted in the condition of soluble sulphates. All the waters are now brought out upon the northern slope (so that the erstwhile Afon-goch is recovering its natural tint), and led through a long series of tanks at Dyffryn-adda, which is at 178 feet above the sea. The mixed sulphates (which are acid) are then treated with scrap-iron, and copper is precipitated, the iron (which is scraped, and turned over and over until it disappears) going into solution:

$CuSO_4 + Fe = Cu + FeSO_4$.

The copper is obtained as a fine crystalline powder (E11401) [SH 450 906], distinctly red in reflected light. Mixed with it are various impurities from the tanks, and the yield of pure metallic copper from the 'precipitate' is about 60 per cent.

The ferrous sulphate is oxidised, in the open air by being pumped up to an artificial wooden waterfall by the shallow pool called Llyn Llaethdy, into which it falls, and is allowed to remain some time-

$12\ FeSO_4 + 6O + 2\ H_2O = 4\ Fe_2(SO_4)_3 + 2\ Fe_2O_3\ H_2O$

and the process can be repeated by reducing the ferric sulphate with scrap-iron:

$Fe_2(SO_4)_3 + Fe = 3\ FeSO_4$

which can be again oxidised. The ferric hydrate thus obtained acts as a purifier of coal-gas, but seems now to be used chiefly for the preparation of ferric-oxide colours. All these processes are comparatively inexpensive. Along their course, the waters deposit still more ochre, and, passing out at Porth Offeiriad, often in part also at Amlwch Port, colour the sea light yellow for some distance from the shore. Considerable quantities of sulphuric acid probably pass out with them, which, so far, it has not been found practicable to reclaim. The equations given above take no account of basic ferric sulphates, yet it is certain that such must appear at some stage of the process, for they are known to be produced in the course of the atmospheric oxidation of ferrous sulphate. Also, as anhydrous ferric sulphate, $Fe_2(SO_4)_3$, is almost insoluble in water, all the ferric sulphates which develop in this process must be expected to be hydrous. One such, indeed, the natural product which we have (p. 832) termed Hydro-glockerite, has been already proved in Parys Mountain, and it is at once basic and hydrous.

Output

Continuous records of output are not to be had, but the following figures have been obtained:

		Tons
Annual output of Metallic Copper	1773 to 1785	3,000
Annual output of Metallic Copper	in 1795	2,000
Annual output of Metallic Copper	1817	350
Annual output of Metallic Copper	1826	758

Decline again followed, but there must have been another great rise, for the North Discovery Lode began to be worked about that time. No records of its maximum output or of its decline have been obtained. Nor are there any records of the early outputs of bluestone.

The output in 1912 was as follows:

Copper Precipitate	150 tons = £7,000 (nearly)
Ochre	close on 700 tons = 1,400 (nearly)
Bluestone	rather more than 600 tons = 1,200
	£9,600

Conclusion

Such are the once-famous mines of Parys Mountain. The great days of their prosperity have long been over, leaving to the district, as Lady Boston sadly remarks, 'an aftermath of poverty'. There seems, however, no reason why the present prudent and unobtrusive methods should not be carried on successfully for many years to come. Their graptolite-fauna, vulcanism, tectonics, and meta-somatism have now invested these mines with remarkable scientific interest, while interest of another kind cannot fail to be aroused alike by their fantastic past and their present desolation.

(Plate 60) Parys Mountain, the West Pit looking towards the summit. Silurian Shale, Silicified Shale, Felsite, Boulder-clay, and Spoil-banks.

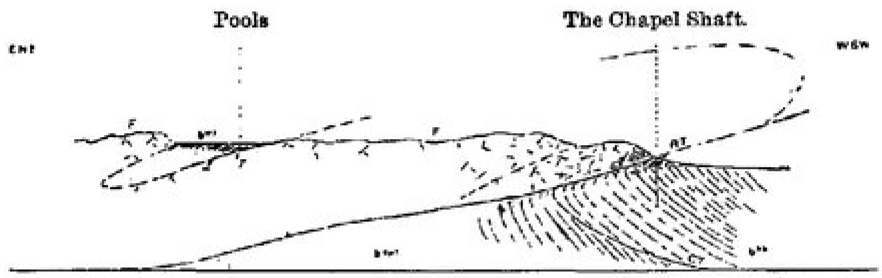
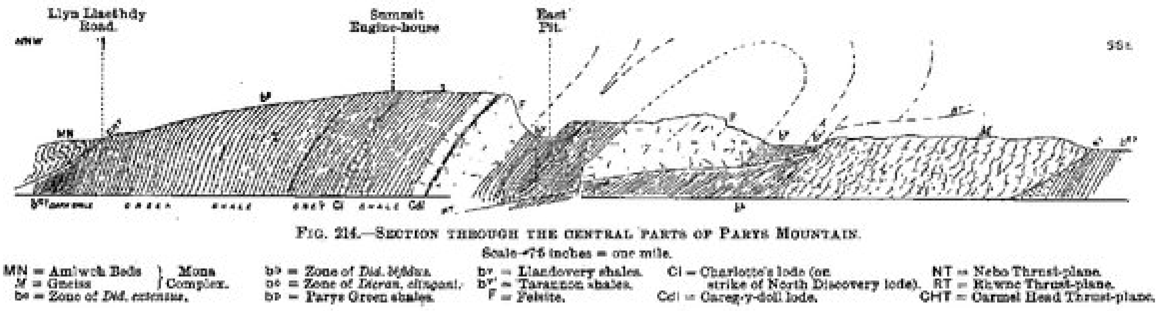


FIG. 213.—SECTION THROUGH THE WEST END OF PARYS MOUNTAIN.
Scale—eight inches = one mile.

bhb = *Phyllograptus* and adjacent Shales. bcp = Hartfell Shales. bv = Llandovery Shales.
F = Felsite. CT = Chapel Thrust-plane. RT = Rhwnc Thrust-plane.

(Figure 213) Section through the west end of Parys Mountain. Scale eight inches = one mile. bhb = Phyllograptus and adjacent Shales. bcp = Hartfell Shales. bv = Llandovery Shales F = Felsite. CT = Chapel Thrust-plane. RT = Rhwnc Thrust-plane.



(Figure 214) Section through the central parts of Parys Mountain. Scale 7.5 inches = one mile. MN = Amlwch Beds, Mona Complex, M=Gneiss, Mona Complex Be = Zone of Did. extensus. bb = Zone of Did. bifidus. bc = Zone of Dicran. clingani.. bp = Parys Green shales. bv = Llandovery Shales. bv■ = Tarannon shales. F = Felsite. Cl = Charlotte's Lode (on strike of north discovery lode) Cdl = Careg-y-doll lode. NT = Nebo Thrust-plane. RT = Rhwnc Thrust-plane. CHT = Carmel Head Thrust-plane.

(Plate 50) The Menaian Platform and the Bodafon monadnock. From the roadside at Mynydd-mwyn-mawr, Llanerchymedd.