

ABOUT THIS SERIES

Based on original research, these illustrated studies will describe the mineral districts of Mid-Wales, with accounts of more than a hundred mines of silver, lead, copper and zinc which in their day formed a very important industry.

Explanations of machinery and techniques will also be included, with details of present day remains and guides to the industrial archaeology of the sites.

The series will interest growing numbers of students who find attraction in the many facets of British metal mining and its antiquity.

- Part 1 Cardiganshire—South of Devil's Bridge
- Part 2 Cardiganshire—The Rheidol to Goginan
- Part 3 Cardiganshire—North of Goginan
- Part 4 West Montgomeryshire
- Part 5 Aberdovey, Dinas Mawddwy and Llangynog.

(Parts 3-5 are in preparation)

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The Old Metal Mines of Mid-Wales

Part 2 Cardiganshire—The Rheidol to Goginan

DAVID E. BICK

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Front cover : Nantyrarian mine, near Goginan, Aberystwyth
(By courtesy of Mr. A. Bebb)

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WILLIAM

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INTRODUCTION

The A.44, one of the great high roads to Cardiganshire, enters the county over the shoulder of Plynlimmon and thence descends by degrees to Ponterwyd, Goginan and Aberystwyth. From Ponterwyd an alternative route runs parallel to the Rheidol via Devil's Bridge and one or other of these roads passes within a mile or two of every working described in this volume.

Though more prolific in mines, the region was less productive than that already covered to the south. However it was as anciently wrought and in the Goginan vicinity long esteemed for silver. Ample evidence remains of the 'Old Mens' activities and there is plenty to occupy the industrial archaeologist.

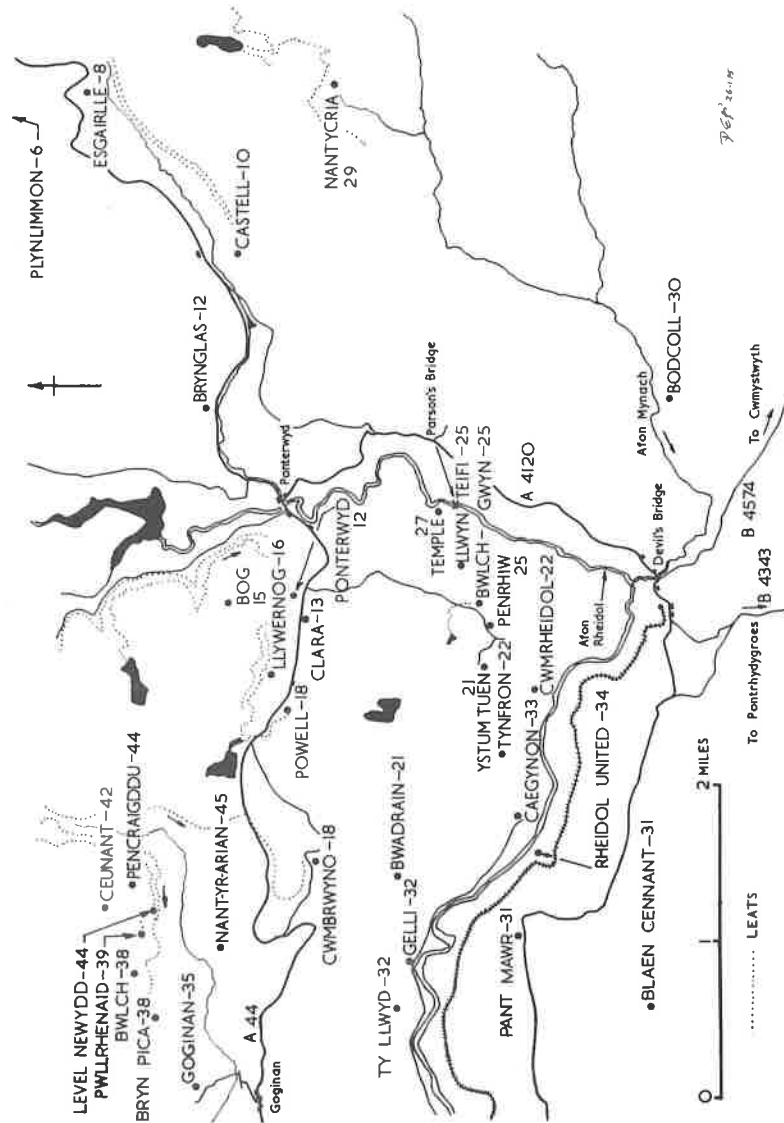
Under Sir Humphrey Mackworth and William Waller, the Governor and Company of Mine Adventurers worked the area on a considerable scale in the 18th century and towards the end of their tenure some of the mines were examined by Lewis Morris in his capacity of Surveyor to the Treasury. Both Waller and Morris made sketch plans of the mines, the former for promotional purposes and the latter to assist the Crown over the question of mineral rights in its battles with local landowners. As we shall discover later, these neglected plans are nowadays of great significance—to compare them on site with features still clearly to be seen is somehow to annihilate the passage of centuries.

At a later period the region suffered worst than most at the hands of unscrupulous promoters whose object consisted of floating companies for quick profit by sharepushing and in consequence, scores of ephemeral ventures arose, with frequent re-namings that are the historian's despair. Under more honest management, the development of Mid-Wales might have followed a very different course.

The area is covered by Ordnance 2½ inch maps SN 67, 68, 77 and 78 which are ideal for all who wish to go up into the hills to see the mines for themselves, and to taste in a practical and effective way something of how the miners lived.

Finally a plea for preservation. At a time when industrial archaeology is becoming recognised as an important and rewarding study in its own right, the evidence itself is being swept away at an increasing rate—in North Wales alone, several fine Cornish engine houses have been wantonly demolished within the last few years. Though a case can be made out for removing waste dumps of negligible mineral content for hard core and other purposes, the wholesale levelling of buildings, wheelpits, dressing floors, leats, adits and other surface features is quite another matter. These are worthy of much respect; once obliterated, their testimony and the last visible links with another world are lost forever.

Let us hope that an official policy can be quickly formulated in this matter.



THE MINES DESCRIBED

The first to attract our attention is **PLYNLIMMON** (795856) to which a long and rough cart track ascends from Eisteddfa Gurig. Within the shadow of the highest mountain in Mid-Wales, its situation at 1800 ft above sea level is bleak in the extreme, with shocking weather for much of the year. Even so, drought often brought the water-powered machinery to a stand, so that one way or another the elements played havoc with operations both above ground and below. Under such conditions a considerable output of lead ore (3270 tons) was nevertheless achieved.*

The mine commenced production in 1866, after a working miner found solid galena about 3 inches wide in the stream. Results were immediate and highly promising; the adit penetrated 155 fathoms in good ore and when a new company took possession in 1870, about 1000 tons had already been sold, with one foot of galena still showing in the 12 fathom level. A new 50 ft diameter water wheel started work on 26th October 1870 and the old 40 ft wheel thenceforth served for crushing and drawing. But water supplies proved so unreliable that within a year an 18 inch horizontal steam engine costing £700 was installed and connected by gearing to the pumping wheel.

Captain John Garland succeeded John Paull as manager in February 1873—a position which the latter was no doubt glad enough to relinquish. In addition to the shortage of power, great difficulty persisted in attracting labour to so desolate a spot, where the lack of a nearby public house presented 'a grievous fault in the eyes of the miners'.

At the 1875 A.G.M. it was admitted that the steam engine had proved totally useless, having almost shaken the pumping wheel to pieces, and in the October a breakage occurred in the line of flat rods to the new shaft (sunk on rising ground to the east). Hardly was this repaired when the balance bob broke in two. However these setbacks were minor compared to lack of water for pumping, and for long periods flooding rendered the bottoms unworkable.

Although £38,000 of ore had been raised by the end of 1876, Plynlimmon still failed to pay costs and a new concern took over in the following year. Previously the winzes below the 24 fathom level were drained by the primitive expedient of man power, which was soon replaced by a system of wire ropes from the 50 ft wheel to pumps via the adit. Further troubles included the bursting of the reservoir in December 1876. But by now, lead prices were on the verge of decline, and twelve years of struggle ended in 1878 when the 36 fathom level turned out poorer than expected.

*In general, the ore production figures quoted in Parts 1-4 date from commencement of official returns in 1845, as given by O. T. Jones.



Plynlimmon
A view of the mine from the pumping waterwheel pit

Photo : Tim Curr

In spite of the record, Plynlimmon revived a few years later and yielded 195 tons of ore between 1887 and 1891. Apart from a little further work in 1895 it has lain dormant ever since.

Today the dumps (still with good specimens of galena) point like some giant finger down the valley, with the shafts, tramroads and wheelpits forming their own memorial to one of the most discouraging mine sites in Wales.

The next few mines all lie within a stone's throw of the road to Aberystwyth and the workings of **ESGAIRLLE** (792828) actually pass beneath it. Several lodes were exploited here by means of Old Engine Shaft above the road and Eliza's Shaft on the lower slopes, into which several adits were also driven. The mine lays claim to antiquity because bucking stones for dressing ore have been found in old surface workings.

More recently, Esgairlle was developing on a small scale in 1846 and came into production in 1850. At a shareholders' meeting in November 1853 held at the offices of Mr. T. P. Thomas of Old Broad Street, the Chairman expressed hopes of shortly declaring a dividend. He reported that Engine Shaft was down to the 30 fathom level with work progressing on three lodes. At surface, nine good houses were completed at Eisteddfa Gurig* and at the mine was 'a carpenter's shop, count house, smithy, 40 ft waterwheel, a splendid crusher, drawing machine and crushing house, and a 25 ft waterwheel complete for pumping. There were also various dressing machines 'all charged and paid for'.

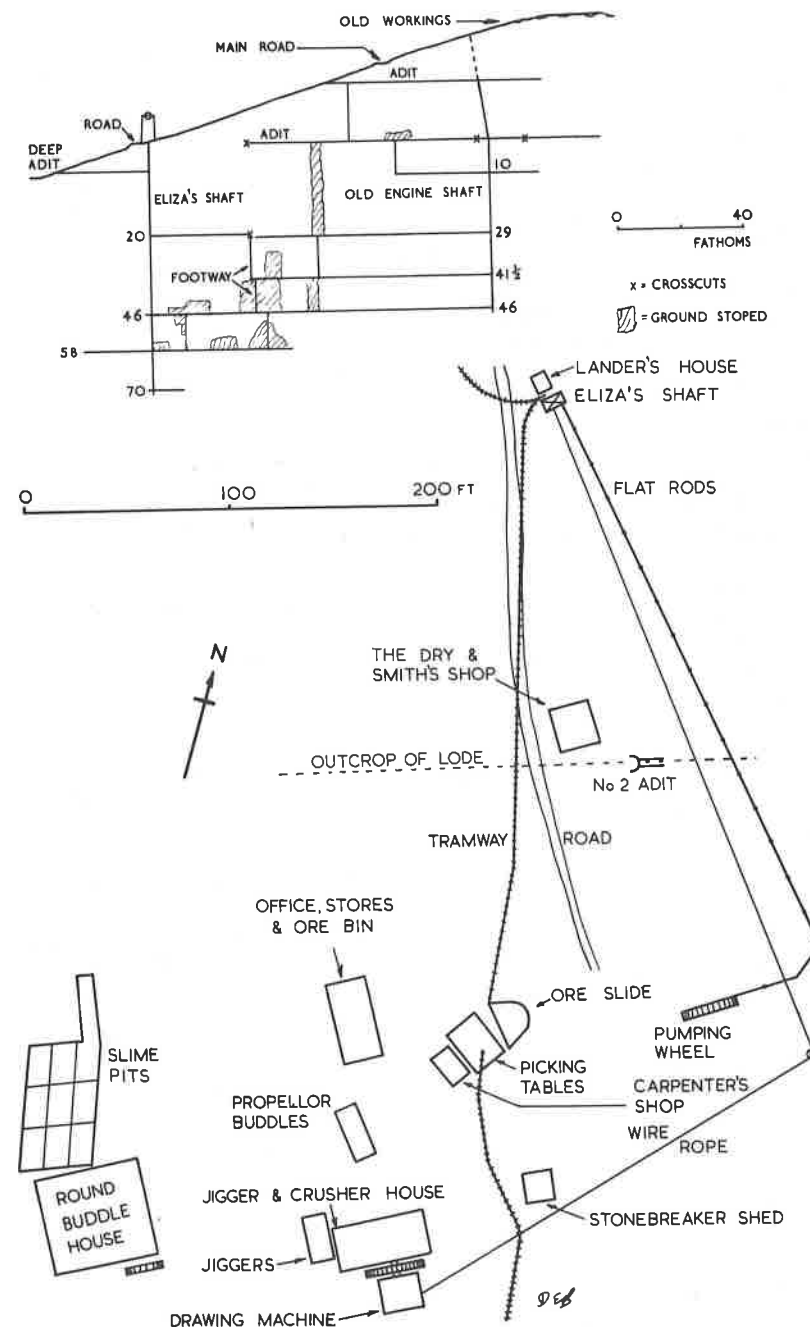
But in spite of a promising start, output soon ceased and the mine was auctioned by T. P. Thomas himself in January 1856*. It only resumed with any continuity when the Esgairlle Silver-lead Mining Company took over in 1870, one of the first actions being to commence sinking Eliza's Shaft.

This was a time when the astonishing success of the Van Mine near Llanidloes provided an inspiration to British mining and also an opportunity that unscrupulous promoters quickly seized. In 1873 an ostensibly new concern, the Great West Van Mining Company, acquired Esgairlle and claimed quite erroneously, that the property lay on the Van lode. The strategy proved so effective that this mediocre mine changed hands for the ridiculous figure of £40,000—the very sum for which Van itself had been offered and refused only a few years before.

*In two facing rows, these forgotten dwellings survive as farm buildings close against the main road.

Opposite : Esgairlle.

N.L.W.
Most of the surface features can still be made out. The mine is best approached via the minor road up the valley.



The new company sank both shafts to the 46 fathom level but results proved very disappointing; in 1878 the mine was again sold though for only £2,050. Production continued intermittently until 1892 and in the last couple of years 30 or 40 men were employed.

From an output point of view, Esgairlle's earlier years were best, amounting to 1255 tons of lead ore before the Great West Van swindle and only 813 tons after.

Across a watersplash just below Dyffryn Castell Hotel lies **CASTELL** or **WEST ESGAIRLLE** (775813). This shallow mine exploited the powerful lode that extends as far as the Vale of Rheidol, and was being opened for blende by Thomas Bonsall in 1785; it had however, probably closed by 1803, when the thriving South Wales ironworks had attracted nearly every Cardiganshire miner.

During a re-working in 1856, Nicholas Ennor favoured Castell with a passing glance during his annual tour of mines likely to interest investors. Writing to the *Mining Journal* he ridiculed the management for erecting a waterwheel 'so high on the hill as to be unable to obtain sufficient water to turn it'. This drew a strong retort and explanations from Captain Lester, who also stated that the wheel was for a crusher 18 fathoms north of Engine Shaft, with a pumping and drawing wheel to be placed between. Nevertheless, Ennor judged correctly, for in November 1856 the property complete with 30 ft x 4 ft waterwheel came up for sale, being optimistically described as 'in perfect working order and offering to capitalists an opportunity seldom to be met with'. The auctioneer was T. P. Thomas.

The mine reopened again on several occasions, the longest run being from 1898 to 1908. The present crusher house with its lofty tapering walls was erected in 1898 by Captain J. Owen for the New Castell Mines Ltd., and the fine wheelpit alongside (43 ft x 5 ft) may date from this period. Castell produced over 5000 tons of blende and a little galena.

Behind the crusher house and guarded by a fence are huge opencut workings, to the west of which is Engine Shaft with walls of the balance pit. Towards the crusher house is a hollow that no doubt contained Captain Lester's wheel, but of his pumping and drawing wheelpit there is no trace—probably it was never built.



Opposite. A general view of Castell, showing the engine shaft and balance pit. Beyond the fence is the likely site of Captain Lester's wheel, with the 1898 crusher house in the background. There are extensive opencut workings to the right of the picture.

A mile west of Castell and north of the river is **BRYNGLAS** (753815) which was first worked about 1745 when some poor miners sank a shaft a few fathoms onto a solid rib of galena 5 ins thick. Several lodes occur here and at later dates five or six adits were driven to intersect them, some from close beside the main road. The mine was active for a few years after 1855 and in 1860, 32 tons of lead ore were sold; but only a few months afterwards the following sale notice in the *Mining Journal* announced the venture's demise.

'The above mine has been worked by the present proprietors for nearly three years, and the machinery for pumping, crushing, and dressing the ore is of the very best description, and in perfect working order.

Upwards of £5000 has been expended in the erection of the machinery and the development of the mine. The shaft is sunk 26 fms. In the level in the bottom of the lode is worth from 15 to 20 cwt. per fm. The lode in the 20 fm. level is also worth from 15 to 20 cwt. per fm. There is an abundant supply of water, and the royalty is moderate.—For further particulars, apply to the Secretary, at the offices, Claremont Hill, Shrewsbury.

This however was not quite the end of Brynglas, for an attempt at promotion occurred in 1879 when it was claimed that a company of farmers and tradesmen had earlier sold 3114 tons of rich silver-lead ore from the mine. But nothing materialized beyond a fresh coat of paint on the waterwheel.

Remnants at Brynglas include the wheelpit near the river opposite a small car park, and the leat which can be followed along the hillside.

Beyond Ponterwyd the road to Aberystwyth runs close to Afon Llywernog and watercourses that fed the mines in the valley stand out high on the north side, like the parallel roads of Glen Roy.

The mines were mainly active in the last century and suffered considerably at the hands of share pushing speculators whose phoenix-like promotions sprang up every few years. Perhaps for this reason none achieved more than a very limited success. The first is **PONTERWYD** (741807), a poor mine, little more than a trial, just north of the road. For a short time it was also known as **CALIFORNIA of WALES**—a reflection of the euphoria sweeping the Old World after fabulous gold discoveries in the New*. A 32 ft waterwheel for pumping was erected near the turning to Ystum Tuen and commenced work on 10th September 1853. It was connected to two shafts by long runs of flat rods crossing the main road (see plan); the pitwork and rods had been derived from the bog mine which was then lying idle†.

*Arising from this, a gold mining mania swept England and Wales (see G. W. Hall *The Gold Mines of Merioneth* 1975). Numerous tottering enterprises including Ponterwyd submitted samples for analysis but with no lasting consequences—most of the claimed results were fraudulent.

†About 1860, travellers on the Aberystwyth road passed beneath at least four runs of flat rods—at Esgairlle, Brynglas and two at Ponterwyd.

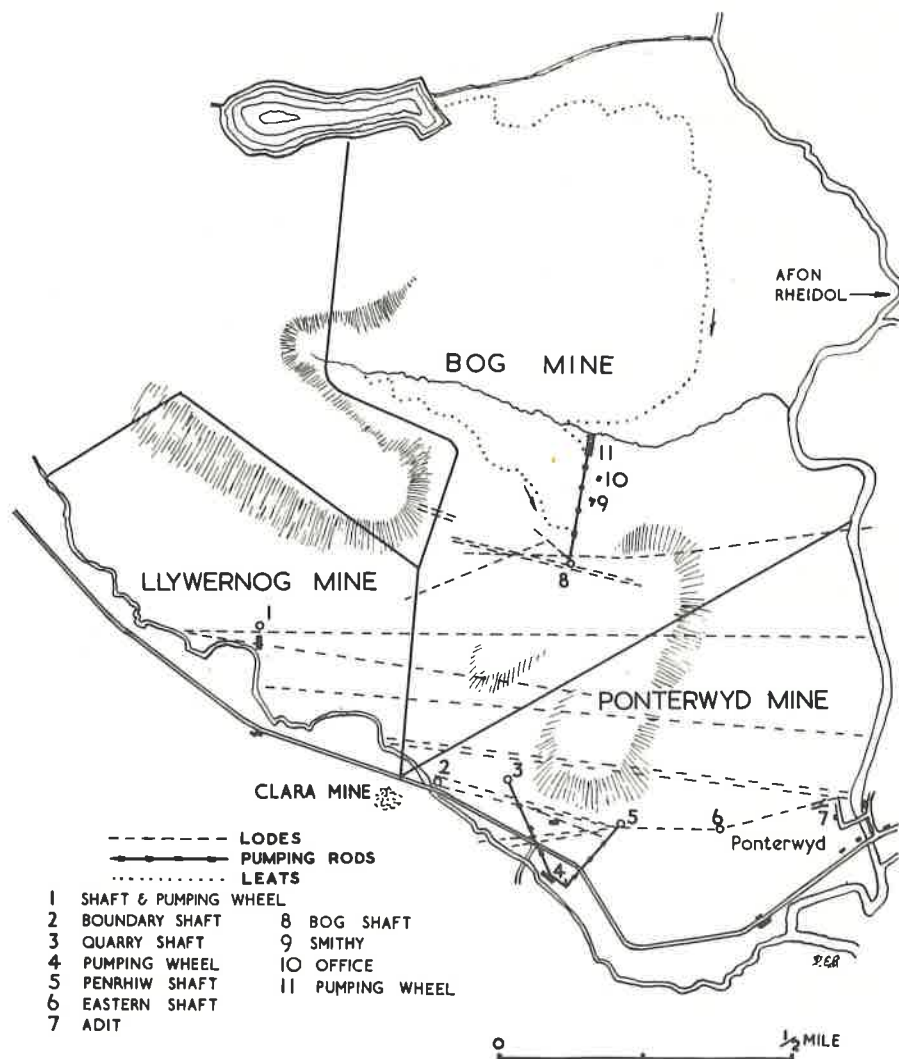
MINING IN CARDIGANSHIRE.—In the neighbourhood of Aberystwith the mines continue to work with great activity; at the California of Wales, or the Ponterwyd Silver-Lead Mine, the operations are being carried out with spirit, under the management of Capt. J. Paull. The western and middle engine-shafts are both commanded by a splendid water-wheel; the western shaft is sunk between two fine-looking lodes, being the same as the adjoining mine, Cwm Bruno, from which considerable returns are now being made, both these lodes will be cut in the 24 fm. level in the course of a few days at Ponterwyd, the result of which is being looked forward to with great interest; these lodes, were seen at surface, produced a good pile of ore in cutting down the shaft. There are also three other large lodes laid open, running through the entire length of the sett, a distance of two miles, containing lead up to the surface, and in places where opened on showing a course of ore 1 ft. wide, solid lead, and within 4 yards from grass: these and other proved lodes form a junction in this property, 30 feet wide, one splendid mass of gossan, carbonate of lime, and lead ore. These lodes are laid down in the Geological Survey, and are to be seen at the Museum in Jermyn-street, proving this junction to be the centre or heart of all the mineral veins in the principality of Wales. Levels are also being driven which will cut all the lodes in the sett, and unwater the mine to a depth of 110 fms. There are about 20 tons of lead at surface, which will shortly be increased, and regular samplings continued. The mine has been inspected by the first agents of the day, who fully confirm the favourable opinion hitherto expressed, that this mine presents more than ordinary prospects of making a lasting and dividend mine. There has been a good demand for shares during the week, at 6s. per share, but few sellers under 10s., which price, no doubt, they will soon reach. This mine is situated on the main road from Aberystwith to Gloucester, and in the immediate neighbourhood of Goginan, Cwm Bruno, Lisburne, and other mines returning large quantities of lead ore.

An example of share-pushing promotional literature from the columns of the Mining Journal.

In 1858 the Llywernog United Silver-Lead Mining Co. amalgamated the three mines of Llywernog, Bog and Ponterwyd, and at this period the pumping shafts were down to the 22 fathom levels. From 1861 to 63 Ponterwyd became part of Clara United with J. B. Balcombe as Managing Director. Production figures are unknown, but must have been quite negligible judging from reports in the *Mining Journal*.

Across the road from Ponterwyd and on the same lode is **CLARA** (737806) another small mine where in February 1854 a new engine shaft was down 17 fathoms with nine men sinking. Preparations were in hand to transfer the pitwork from the old shaft, and a new wheelpit was in course of construction.

In 1861 Clara United took over, and by 1867 the engine shaft had reached 44 ft below the 50 fathom level. According to the agent, the lode in the latter was deranged and changing its underlie, and the sinkers had encountered very hard ground. Nevertheless Clara's best years, such as they were, lay ahead with 80 tons of lead ore returned in 1871/2; this being almost a half of the mine's total output. The mine closed in 1882.



Llywernog United Mines, 1858

Based on a plan issued with the company prospectus. Most of the surface features are still clearly evident. The pumping wheel pit (4) is in a plantation near the turning to Ystum Tuen.

N.L.W.

A little to the north, **BOG** or **CRAIGNANT BACH** (738813) occupies a position near the summit of Mynydd Ponterwyd. It was discovered by one W. Lewis about 1830 and was worked to just below adit (10 fathoms) by Job Sheldon. In the 1840's John Taylor & Sons sank the mine 30 or 40 fathoms deeper on a good shoot of ore with pumping effected by flat rods and a waterwheel as shown opposite. In 1858 it was again active above adit as part of Llywernog United.

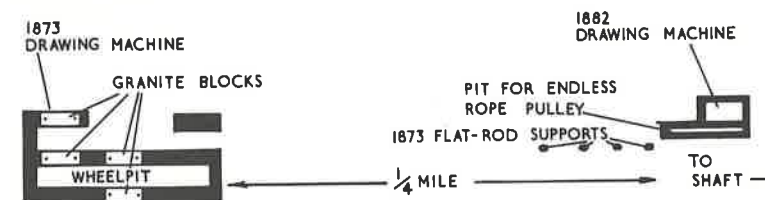
The workings reopened as Cardigan Old Bog in 1872 with James Overton as manager, and a new lode 15 fathoms to the south revealed some good ore in a shaft sunk 9 fathoms upon it. The company erected an iron waterwheel (33 ft x 3 1/2 ft) for pumping and drawing, and it commenced work on 7th March 1873. It was situated well beyond sight of the mine to the south-west and the wheelpit with massive granite bearers is still visible from the main road. Unfortunately the company collapsed a little later without gaining the lowest levels, and all equipment came up for auction including 'T bob balances, pullies, standards, 440 yards of iron rope and 25 fathoms of 6 inch pumps'.

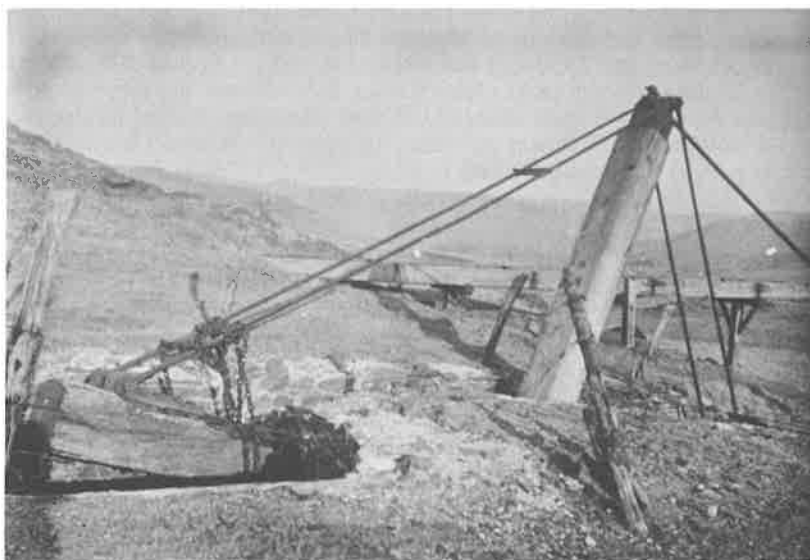
But the failure did not deter the Craignant Bach company from securing the lease in 1882 at a time when lead prices were at their lowest for 50 years. In this attempt both pumping and drawing were effected by wire ropes, the cable for working the drawing machine was 3/4 ins diameter and ran continuously with presumably a clutch at the machine itself. 50 yds beyond, the shaft was fitted out with a skip road for raising ore.

By the October a pit for a 40 ft waterwheel was well under construction but the purpose and even the site of this project is obscure. A month afterwards, when Bog had been forked to the 24 fathom level and progress appeared very satisfactory, the agent revealed that the equipment could not withstand the strain of another lift of pumps. Faced with such a predicament the management lost heart and Bog very soon closed for the last time. It was indeed a sad commentary that neither company had been able to reach the old bottoms; far less to carry out any serious new developments.

1542 tons of lead ore were recorded, probably largely from the Taylor period, and 703 tons of blende.

This mine well repays a visit from the industrial archaeologist. Both wheelpits and the drawing machine foundations survive as well as indications of the courses taken by flat rods and cables that worked at various times. (See drawing below).

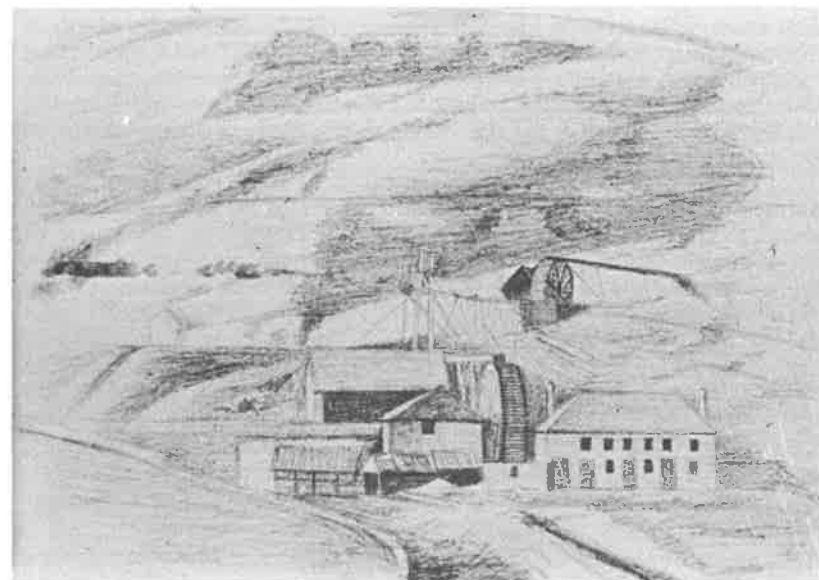




Llywernog G. Bramall.
A pre-war view of the engine shaft and balance bob, and the wooden launder conveying water to the wheel.

On the same lode and close to the main road is **LLYWERNOG** (733809) which now provides the site of the recently opened Mining and Folk Museum. Lewis Morris leased a mine of this name in 1756, probably for prospecting purposes only, and in 1810 the Cardiganshire historian S. R. Meyrick* observed that two mines called Llywernog were then operating in the vale, one by Sir Thomas Bonsall and the other by William Poole. He went on to say that 'they were discovered about 40 years ago but were so overpowered by water that they could not be worked. However an engine [waterwheel] has been erected on each mine and the water cleared off. They consist of lead ore; quartz and black jack or zink ore'. Poole's mine is apparently the one later known as Llywernog whilst Bonsall's working probably equates with Powell mine across the road. Bonsall's operations consisted of deep opencuts '28 yards long in good ore' with 50 men employed, but the venture had closed by 1813.

*Meyrick's comments on the county's mines were mis-quoted by Robert Hunt in his *Notices of the History of the Lead Mines in Cardiganshire* M.G.S. 1848. Unfortunately this well known memoir contains many inaccuracies.



Llywernog N.L.W.
The mine in its working days, showing an upper waterwheel for operating a drawing machine in the shed alongside.†

Subsequently Llywernog attracted little attention until the early 1840's when the Francises were looking for ventures to promote, not least to create jobs for several unemployed members of the family. It was then held by Robert Dunkin of Llanelly and a company named Rheidol United Mines was proposed to manage the mine in association with Rhiwrugos and Nantglas, the latter two being several miles away. George Francis jnr. was to act as manager with Absalom Francis of Flintshire a visiting director*. However, it is doubtful whether much was done, for when in 1858 the Llywernog United prospectus appeared, the depth was only 30 fathoms from surface. Little output followed this later attempt though better results attended a reopening by the Clara company; returns of ore were maintained for the next 14 years during which time a depth of 72 fathoms was reached.

†I am indebted to Amina Chatwin for drawing my attention to this illustration.

*The Mining Company of Ireland had recently dismissed George Francis jnr. and concerning this, a delightful passage occurs in one of Absalom's letters—'I rather think his father has puffed him a little for he told me that Mr. Taylor says that he was as good a man as I was'.

The state of the mine in March 1864 was given in a report by Matthew Francis who referred to a depth of 40 fathoms with a 40 ft × 4 ft waterwheel for pumping and crushing. In order to release enough power to enable the wheel also to drive a drawing machine, Francis advised gearing down the crushing machine 2:1,—he did not record how output was to be maintained!

Though steam engines were later installed at Llywernog and Powell, running costs were prohibitive and several mines in the area banded together to construct a long leat from north of Ponterwyd, the course of which is clearly shown on the 2½ inch Ordnance map. Full advantage was taken by erecting a new 50 ft × 3½ ft wheel at Llywernog which according to Peter Lloyd Harvey, the founder and director of the museum, was provided by the well known firm of John Mills, Llanidloes, in 1875. Mining came to a virtual end in 1878, for attempts at revival by the Scottish Cardigan Mines Ltd. in 1907 lasted only a few years with no output resulting. As for the 50 ft wheel, after its working life ceased, this fine example survived in full view of the main road until the 1950's at a time when the history of mining was an interest shared by the very few*. Those who sensed a certain symbolism in the scene will find it fitting that this of all sites has been chosen for a museum.

Most of the Llywernog ore came from the intersection of two lodes. One of these in striking towards the main road enters the **POWELL** mine (728808) the early history of which has already been mentioned. One of the shafts is close beside the main road, with other workings on the hillside to the south. In 1868 the mine was operating as Powell United, with a 'splendid oscillating engine' running at 55 lbs pressure for pumping, drawing and crushing.

Steam however, became merely a stand-by after construction of the new leats and erection of a 45 ft waterwheel in March 1874. The mine was then known as Powell Consolidated, with Captain Nicholas Bray in command. It finally closed in the 1890's having attained a depth of 80 fathoms, with workings on several lodes.

At various times Powell and Llywernog operated together, and the total production of the two mines amounted to 3813 tons of lead ore with 560 tons of blende.

Westwards from Powell and within another watershed lies **CWMBRWYNO** (714805). Lewis Morris recorded lead ore here, but no serious attempts at mining were made until a century later when two brothers named Evans drove a shallow adit and sold several hundred tons of ore.

John Taylor & Sons came into possession in 1849 or 50 and to provide power constructed a long leat from large storage pounds to the north†.

*A photograph of the wheel is reproduced in Part 1.

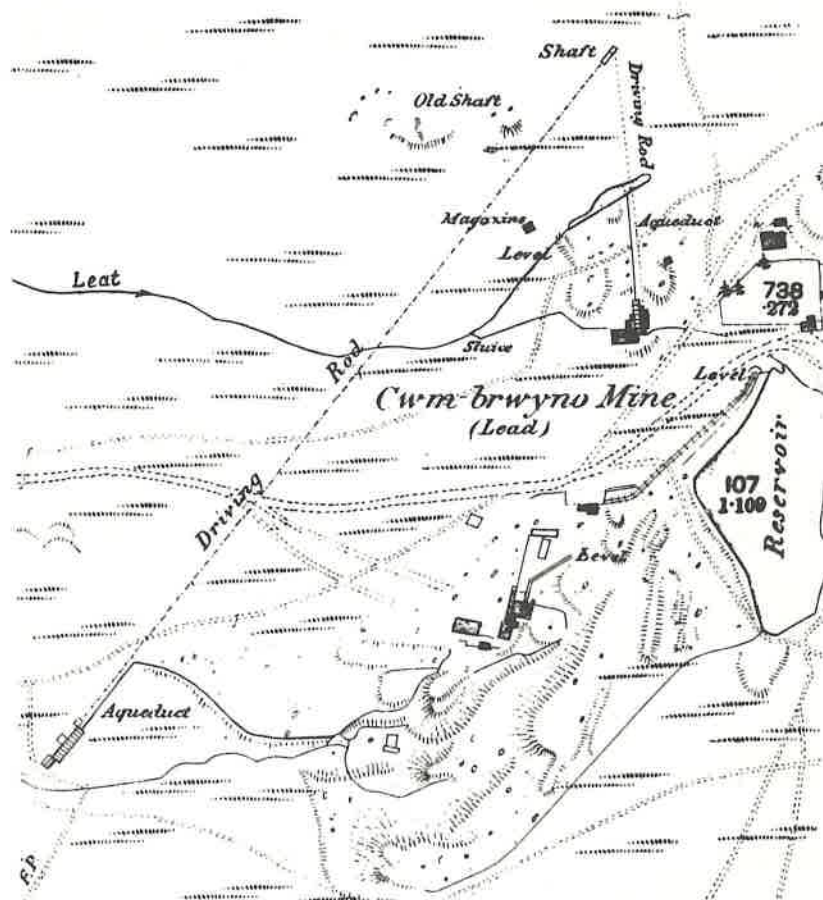
†The leat is visible above the road west of Llywernog (718812). An iron pipe that conducted the water under the road still protrudes above the verges.

Dressing floors were established at the mouth of an intermediate adit, and a much longer and deeper adit was eventually driven from east of the main road at Cwmbwyno Bridge. The mine rapidly became very profitable. When relinquished in 1866, Taylor's Shaft had been sunk to the 92 fathom level with the orebody largely cleaned out above.

Nevertheless in the following year the Cefn Brwyno Mining Company with £15,000 capital was floated, having J. H. Murchison as secretary and



Cwmbwyno. The pit of the waterwheel for driving the crushing machine. Note the massive holding-down studs.



Cwmbrwyno. 25 in Ordnance Survey, 1887. Interesting features can be found along the course of the 'Driving Rod' including 2 ins diameter wrought-iron lengths abandoned on the hillside, and remnants of a tunnel under the road.

In order from top to bottom were the drawing, crushing and pumping wheels; all three wheelpits survive. Evan's adit is shown near the magazine.

Captain James Paull of Goginan as manager. It was intended to work a north lode that had been partially wrought at deep adit level, but results were disappointing. In 1879 another new concern, the Cwm Brwyno Lead Mining Company, came into possession with double the capital and on the mine were two crushing mills and four large waterwheels (one of 48 ft diameter) together with five smaller wheels at the dressing floors. The prospectus informed potential investors that 'the directors have much pleasure in stating that the mine is rapidly improving in value' and to bolster their claim a rosy report by Absalom Francis was appended. Unfortunately, the reality of the situation was very different. According to contemporary manuscript records, most of the machinery is worn out and underground the mine had suffered from ill-management for many years. However, enough money materialised to enable the venture to proceed. In 1888 the last lead ore returns brought the total to just over 6000 tons.

To the south, on a marshy plateau high above the Rheidol, is **BWADRAIN** (712797). Absalom Francis relates that it commenced about 1838, the deepest shaft eventually being sunk to 65 fathoms. To develop the mine a large waterwheel was erected in the valley at the site of the present Rheidol Power Station Reception Centre and its motion reached the pumps via a long line of flat rods up the mountainside—one of many instances, noted elsewhere, of remarkable feats of 19th century engineering. Surprisingly in such a situation, a deep adit was never attempted. The mine sold 1744 tons of lead ore between 1867 and 1876.

From Bwadrain a narrow lane leads to the hamlet of Ystum Tuen, which forms the centre of a long-wrought group of interconnected workings on the powerful Castell lode and its branches. The area is isolated, being absolutely cut off to the south and east by the Rheidol Gorge 800 ft below.

In order the mines are **YSTUM TUEN**, **PENRHIW**, **BWLCHGWYN** and **LLWYNTIEFI**, all of which are subjected to a bewildering sequence of amalgamations and managements that can only be partially dealt with here.

YSTUM TUEN* (733788) the oldest, was taken over by William Waller for the Governor and Company of Mine Adventurers in 1705, and is our first encounter with that remarkable concern†. Though eventually becoming one of the company's more successful undertakings, Ystum Tuen got off to a poor start because of remoteness from its smelting works and wharves at Garreg (696970). However, following a brief closure, operations continued till 1727. After this, the workings remained drowned until 1746, when a Flintshire company sank a vertical whim shaft to intersect the lode in the deepest bottoms.

*I have encountered at least ten other spellings viz: Estentein, Nanteos papers; Estymtean, Estymteon, Smyth; Estimtean, Istimtean, Istymtean, Ystimtean, Waller; Ystum Tuan, Morris; Ystum Tyhen, Francis; Ystum Tuen, Meyrick.

†A chapter will be devoted to Waller and the Mine Adventurers in Part 3.

Opposite: Waller's description of Ystum Tuen. The map is really a combined plan and section. Below, Morris's section drawn 40 years later, makes an interesting comparison (N.L.W.).

Untypically of Mid-Wales, the ore contained much iron pyrites (then termed marcasite) and Lewis Morris's account of its treatment is worth quoting. 'There is a vast Quantity of Marcasite in this work, and it shoots into Chrystals of Copperas by the very heat of ye Sun, but it is of very little value here being so far from the Sea. The waste of this mine is worked over and over to profit Every eight or ten years, the Marcasite being dissolved by the Rains and Heat of the Sun Suffers the Ore to be disengaged - -'.

In 1806 Ystum Tuen was being worked by Sir Thomas Bonsall, but shortage of water for pumping and dressing presented a great drawback, making a deep drainage adit from the Rheidol a very desirable objective. This important step was begun about 1824 by Thomas Alderson who with his brother George expended much capital in the area*. Unfortunately within ten years the Aldersons' affairs had descended to bankruptcy, leaving the fruits of their labours to others.

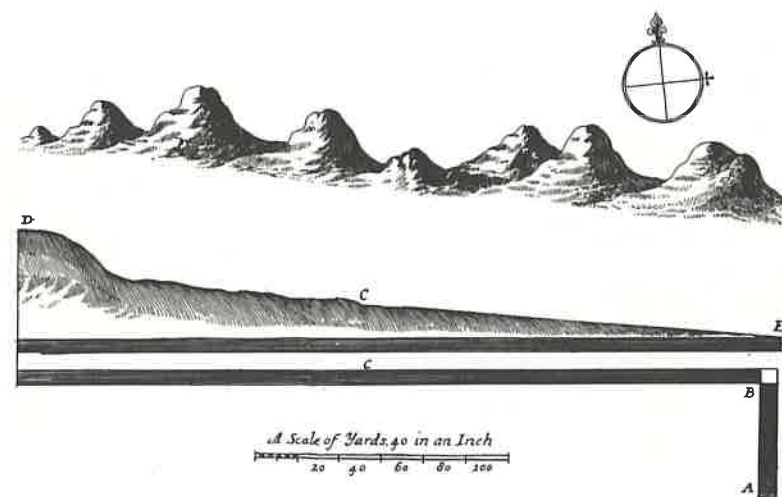
In 1844 Ystum Tuen, Penrhiw and Gwaithgoch were taken up by the Taylors as the Nanteos mines, but their interest in the area was short-lived. From this period, the history of Ystum Tuen revolved around Alderson's adit which had cut the lode 234 fathoms from daylight, at a depth of 78 fathoms. The ore was trammed out for dressing at adit mouth and water to operate the plant came via a long leat high on the hillside from the Afon Tuen below Penrhiw farm. After 1874 a still deeper adit was driven to cut the lode at 118 fathoms from surface.

Mining of the Ystum Tuen lodes revived between 1900 and 1912 with dressing floors situated below Alderson's level at **CWM RHEIDOL** (730783). Substantial amounts of blende were raised, some of which came from the **TYNFRON** levels half a mile to the west by means of a tramway. A steep aerial ropeway carried the concentrates to the Vale of Rheidol railway and power for the dressing plant was provided by a turbine. The timber aqueduct that conveyed water to the latter still spans the river a short distance upstream and vivid ochre colours in the dumps testify to the iron content of the lode.

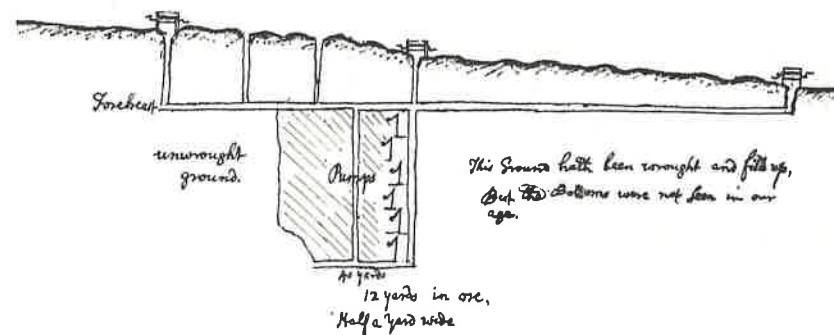
But it is at old Ystum Tuen where the most historic remains are to be seen. Close to a fence near the middle of the mine is the whim shaft of 1746, and nearby are hummocks where the sulphurous ores were leached. At the eastern end of the opencuts, Waller's 1705 cross-cut adit can be made out as a long hollow extending into a field. We are looking back two or three centuries and change comes slowly in these timeless hills.

*Anderson clearly did not wish to aim too deep under the old bottoms for his adit commenced well above the valley floor—perhaps reflecting the belief that Cardiganshire ore died out in depth.

A Mapp of y Lead Mines of Ystymtean.

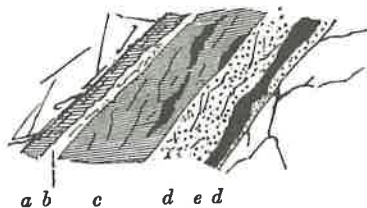


A The Beginning of the Adit. B Where it cuts into the Vein. E The North Vein. C Where we now are driving in the Sun Vein; and have already open'd Thirty Three Yards in Ore, all measures from a Foot to Two Foot wide; but the last Eight Yards at C is above a Yard wide in good Ore, and grows wider as we drive Westward, and is there Eighteen Yards deep, and a fine feeding ground to D; and there we have a Level of Fifty Yards deep, and a good feeding Ground for above Eight Hundred Yards more, being all Bog, and Watery Grounds, where Five Veins run, and never fail of being rich in Ore; - -





Cwmrheidol. Remains of the crushing mill with the river in the background. The Vale of Rheidol Railway and dumps from Rheidol United can be seen on the far hillside.



a Copper pyrites. *b* Quartz. *c* Blende. *d* Pyrites. *e* Galena.
The structure of the lode at Tynfron. M.G.S. 1848

Immediately east of the village is Penrhiw and across the Afon Tuen lies Bwlchgwyn with Llwynteifi beyond—a trio that in the last century sometimes worked as one. In its early days **PENRHIW** (737787) was apparently known as Penyberth, and was active before **BWLCHGWYN** (739789) which itself was revealed by working miners about 1735.

Bwlchgwyn, originally called **Gwaith Newydd Ystum Tuen**, (Ystum Tuen New Works) soon attracted a great deal of attention. 'This mine', observed Morris 'hath the Prospect of a Great Work, having a fine range of Ground to the Eastward, and is wrought with very Small Expense, there being hardly any Powder used. The vein in the Bottoms is from 12 to 18 Inches wide and the Ore is found in Soughs in good Quantities, mixed with a kind of dirty clay'. Morris also referred to ancient workings on a north lode to which Powell was bringing up a long adit; the latter probably began near the bridge over Afon Tuen, though nothing shows of it now.*

Arising from the Bwlchgwyn discovery a critical lawsuit arose between Thomas Powell of Nanteos and the Crown as to ownership, which Powell eventually won†.

On higher ground beyond Bwlchgwyn and encompassing the shallow pass that leads to the Rheidol was **LLWYNTTEIFI** (741790). This worked from an adit commencing in the Bwlchgwyn sett and in the 18th century several branches of the main lode were mined, with extensive stoping below adit.

In 1845 the three mines were held by Messrs Parry and Atwood, who began the formidable task of a deep adit into Llwynteifi from the Rheidol gorge—a venture that was never completed. At Penrhiw there was a 40 ft waterwheel for pumping and another for drawing and crushing, whilst Bwlchgwyn Engine Shaft had been sunk 40 fathoms. Penrhiw worked from an engine shaft 20 fathoms west of the Bwlchgwyn boundary but only the 16 fathom level had been driven to any extent.

In spite of a fine reservoir a mile to the north-east, water shortage held up development very seriously, to the extent that from May to November 1855 the wheels hardly turned at all. However after April 1856, pumping requirements greatly diminished on extension of Alderson's level from Ystum Tuen into Penrhiw; it broke through 6 ft below the 46 fathom level and at the same time greatly improved the ventilation through the whole workings. The two mines were then known as Nanteos and Penrhiw and remained so until the company collapsed in 1863.

*Morris, by the way, firmly believed in knockers or subterranean spirits which 'have a language which we don't as yet thoroughly understand, but as we understand Dumb Men by Motions, we hope to come to it by and by: We only know they are our very good friends, and have actually discover's us hidden Treasures'.

†Nanteos Mansion (621786) the ancestral home of the Powells, is open to the public during summer months.

Under the title **Nanteos Consols**, Bwlchgwyn and Penrhiw were inspected in 1870 by Richard Williams who gloomily reported that in the latter mine, the lode was failing with less galena and more pyrites in the deeper workings. 'I do find' he wrote, 'that the large quantities of ore said to have been discovered left standing by former workers were entirely unfounded - - - I am forced to the conclusion that it is one of those unfortunate undertakings which may be said almost too good to abandon and yet too poor to work'. The two continued for a few years after 1872 as the Aberystwyth Mines and after several further reopenings, ceased production in 1917.

Taken as a group, Ystum Tuen, Penrhiw, Bwlchgwyn and Llwynteifi raised over 15,000 tons of galena and blende, and also 3864 tons of pyrites.

As to present-day remains at the three latter mines, Penrhiw engine shaft collar stands high above its surroundings and a masonry 'tunnel' leading into it no doubt held a balance-bob for the pumps. Behind is a wheelpit (36 ft x 5½ ft) and crusher house, though the orientation of the timber flooring suggests to us that the two were not connected. A little to the east the Bwlchgwyn sett is entered and opposite the terrace of miners'



Penrhiw Engine Shaft. Looking towards Bwlchgwyn and Llwynteifi from inside the masonry tunnel, Note the abandoned row of miners' cottages on the left.

cottages another crusher house and wheelpit is situated below an oreslide and the engine shaft. At Llwynteifi, the ground rises rapidly past a small reservoir before descending to the Rheidol; shafts, adits and numerous grassed-over surface workings dating from Morris's time can be traced as far as the eastern slopes.

Though beautiful or even spectacular terrain often surrounds the metal mines of Wales, its presence nowhere more hindered the miner than at **TEMPLE*** (749793). The mine occupies part of the Llwynteifi sett a stone's throw above Parson's Bridge in the Rheidol Gorge, and exploited a lode south of the main Castell-Caegynon lode by means of three adits driven westwards. It was worked by the Temple Lead Mining Company from 1876 to 1881 and by Cardigan United† in 1886/7, under Absalom Francis as agent.

To provide power the first company cut a leat out of the solid rock of the gorge, and for nearly half of the total 1¼ miles it had to be built up from 1½ inch pitchpine supported by iron rods. A 40 ft x 4 ft waterwheel was installed outside the middle and deep adits and its duties comprised pumping an underground shaft to the 20 fathom level via flat rods, working a compressor for rock drills and powering a drawing machine. The latter wound ore from the shaft and operated an inclined tramway at the surface via pulleys and 400 fathoms of steel rope.

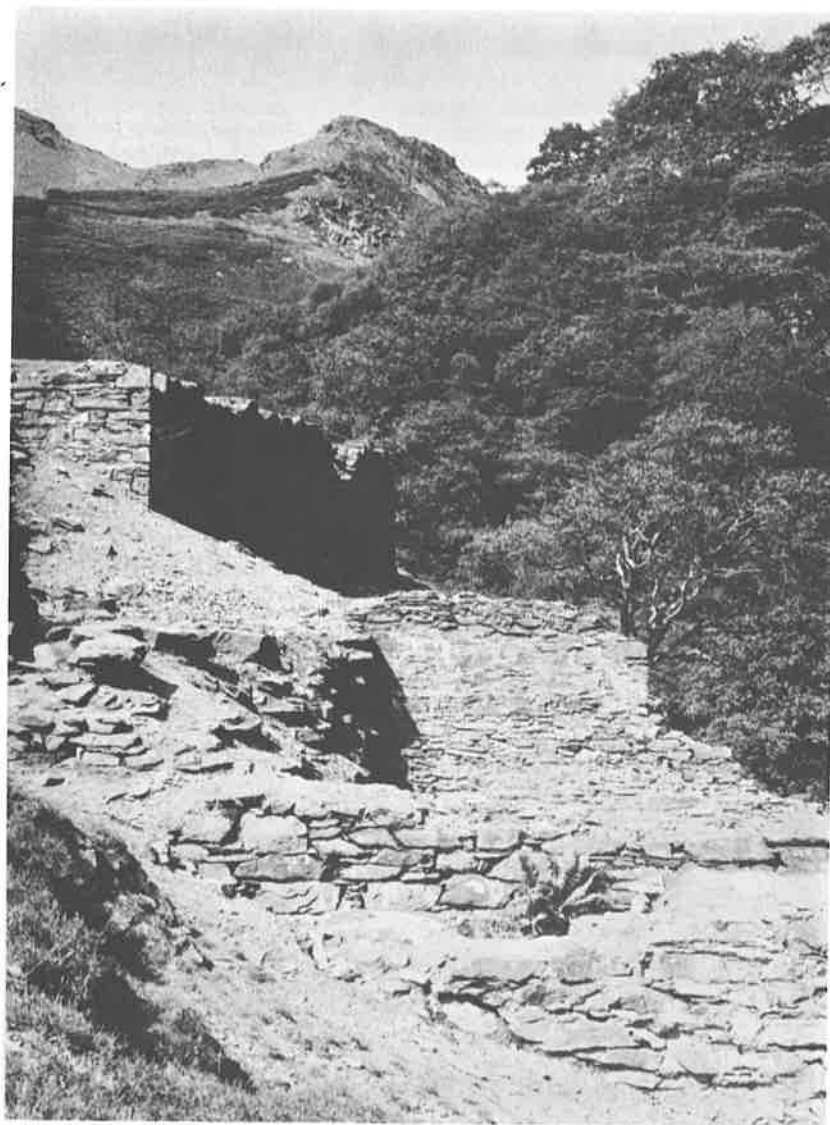
A little downstream at the dressing floors, a 30 ft x 4 ft waterwheel was coupled to a Blake stone crusher and 24 ins diameter rolls, and a 14 ft wheel drove the dressing machinery. To aid transport of ore and materials the tramway incline ascended several hundred feet to meet a cart track that followed a circuitous route to Bwlchgwyn.

After about 50 fathoms drivage, the middle and deep adits came into good ore and over 100 tons of galena were sold in 1881 together with 22 tons of blende; but after this encouraging start the lode petered out both in length and depth. Attempts to locate payable ore by crosscutting north to the Castell lode were equally disappointing. A few years later Cardigan United drained the mine and sank Rawcliff's Shaft close to the river upstream of the pumping wheel to a depth of 15 fathoms, also with the intention of crosscutting to the Castell lode. The sole output of this venture was 3 tons of lead ore derived from the old workings.

The most impressive remnant at Temple is the massive and awesome pumping wheelpit rising sheer out of the river, with a network of foundation walls alongside that once supported the compressor and drawing machine. The dressing floors are also worth seeing but in any event, a walk there is worth the effort for the scenery alone.

*My thanks are due to Peter Lloyd Harvey for information on this mine.

†Mining companies were often suffixed 'United', and if the names remind us of football, the association is appropriate for mining shares were in many respects the 'pools' of the 19th century.



Temple. The pit for the crushing machine wheel is in the foreground, with two masonry ore slides in heavy shadow. There are also fine remains of two circular buddles.

Hidden in a mountain ravine east of Ysppytt Cynfyn and the least accessible mine in this volume, is **NANTYCRIA** (792803). Lewis Morris referred to it as an ancient drowned lead mine of about fifty yards long; he tried to reopen it for the Crown between 1747 and 1751, but opposition from William Powell and others brought the attempt to a close.

In spite of the geography, Nantycrria soon became renowned for blende and yielded good quantities under Job Sheldon in the early 1800's. Forty years later Crockfords the gaming people employed 50 men there, and were reputed to have made high profits from an ore price of only £2 per ton f.o.b. at Aberystwyth.

In 1849, Nicholas Ennor and Captain J. H. Hitchins the discoverer of Devon Great Consols, examined Nanterria for the Cardiganshire Crown Mines Company. Though discrepancies arose as to the adits driven into the eastern hillside (Hitchins observed four, Ennor only three) these two worthies agreed that workings extended 15 fathoms below the deep adit, whilst under the western hill they reported another adit adjacent to extensive old men's workings. Excellent prospects were concluded but nevertheless the company (which also held Esgair Mwyn) failed to market any ore.

In the latter half of the century Nantycrria reopened on several occasions and in 1874 Absalom Francis considered the lode to be the best filled with mineral that he had seen in the county—in places exceeding 8 ft wide, nearly solid in blende and galena.



a blende, *b* galena, *c* quartz.

The structure of the lode at Nantycrria.

M.G.S. 1848

Three large ponds of about 20 acres provided water power via a series of leats, one of which continued past the mine at about 1650 ft O.D. and discharged over a brow in order to augment supplies to Castell mine. This feature is shown on the 1:25,000 Ordnance map at grid reference 781797.

Nantycria's recorded output has amounted to 6000 tons of blende and about 900 tons of galena. Nowadays, short of a long walk, access to the site involves the use of forestry roads for which permission must be obtained from the Forestry Commission, Victoria House, Aberystwyth.

To the south-west, the watershed of Afon Mynach contains several small and isolated mines, all now submerged in conifers excepting **BODCOLL** (759769) to which a rough track leads from the B 4574 road $\frac{1}{2}$ mile above Devil's Bridge. The workings date from the 18th century and consist of shafts and several adits on two parallel lodes south of the river, one of which in 1854 was described as '6 to 9 ft wide, principally composed of quartz, gossan, mundic [iron pyrites] and copper ore, intermixed with good quality lead ore'.

In 1851 when operating as the South Wales Mining Co., some quite ungently activities ensued; according to the agent, Lewis Pugh of Aberystwyth was illegally conducting his own operations in the middle of the sett and had found some very rich ore. Captain Barbery the manager, was thereupon instructed to sink a shaft close to Pugh's works, and by means of 'perseverance and a little force' countered the latter's best attempts to impede progress. In the September, the new shaft was daily expected to cut the lode, but nevertheless no ore reached market either in that year or the next. Bodcoll did not in fact turn to any account until about 1870 when the deep adit was pushed east into a good body of ore, and a deeper level was commenced from beside the present trackway. Several hundred tons of galena were raised. In 1954 the entrance to the latter level comprised a splendid masonry portal almost of railway tunnel proportions, with a stone tablet inscribed 'R. Girdwood Esq. 1872'. The whole has since been quite obliterated, apparently during construction of the trackway to the forestry area. On higher ground, other adits are still in evidence, together with remains of a dressing floor.

Journeying to the next mine, we pass through Devil's Bridge* and it is worth recalling that the village did not exist in the 1820's when lead smelting works thrived close by. They were established by the Aldersons for their Cwmystwyth ore and coal was employed as fuel. Westgarth Forster†, a great authority on lead mining in the North of England and a close friend of Sir George Alderson made various suggestions for improvements, but it appears without much success since the hearths were eventually fired by peat. The works closed in 1834.

Unfortunately, the railway has obscured the site though a substantial masonry flue is revealed in a low bank at the side of the track. Nearby, one cottage remains of a terrace of four or five, and to the south-west

*At an unspecified mine near here, Greg & Lettsom recorded brilliant translucent hair-brown crystals of Pyromorphite in the 1850's.

†Forster spent several years in Mid-Wales and we shall encounter his activities in the Aberdovey area in Part 5.

are vestiges of an earthen dam (732768) which no doubt retained water for the works*.

North of the minor road from Capel Trisant to Llanfihangel Y Creuddyn and near the source of Nant Cennant, is **BLAENCENNANT** (697771). The lode runs almost parallel to the brook, crossing at a sharp angle, with surface trials and opencuts extending more than 500 yds. The mine was already old when leased by Taylors about 1849, but their tenure was very brief.

In the 1860's another company raised some good ore by stripping down the walls of the lode. Early in 1869 Captain Thomas Ball‡ of the Lisburne Mines made a report on the property which indicated that the old workers had gone down 20 fathoms below adit, and at the eastern end Taylors had put down a diminutive $4\frac{1}{2}$ ins pump worked from an 8 ft waterwheel by means of rods only half an inch diameter‡. The lode was $2\frac{1}{2}$ to 4 ft wide and the bottoms were then under water.

The 1881 6 in. Ordnance map shows a tramroad and line of flat rods parallel to the stream at the western end and this evidence, together with the remnants of a short leat and waste tips, implies a waterwheel for pumping and crushing. A little below the adit portal are remains of a dressing floor for hand sorting the ore, which was then trammed along the hillside and tipped into the crusher. The engine shaft is above the adit near opencut workings, and against the stream a cinder tip may indicate the use of steam power. Close to the road there is a storage pond still full of water, that once augmented the feeble resources of Nant Cennant.

Only 72 tons of lead ore and 62 tons of blende are recorded from this little mine.

By the main road north-east of Blaencennant, **PANTMAWR** (706784) followed the best speculative tradition, as these changes of name indicate¶.

Pantmawr	1857-58	Imperial	1867-70
Silver Bank	1859-61	Silver Hill Consols	1871-73
Silver Mountain	1862-66	South Rheidol	1876

One of the few voices to cry out against such unprincipled promotions was that of Henry Curwen Salmon, editor of *The Mining & Smelting Magazine* (an excellent but short-lived periodical) and it is worth recording his comments on the Silver Mountain Company's Prospectus.

*The Old Series Ordnance map shows the works and reservoir.

‡The tombstones of Ball and other Lisburne officials can be seen in Hafod Churchyard.

¶In 1953 I encountered an even smaller machine at a copper mine in Cym Prysor (SH 768395). It consisted of a hand pump worked by a crank and a long line of shafting geared up from a 7 ft waterwheel. The latter was made by Evan Jones, Carnarvon.

¶ My thanks are due to George Hall for this and much other information.

'We are scarcely surprised at the statement that, from careful surveys a rich course of ore recently intersected is estimated from 80 to 100 fathoms long, "and contains at least £30,000 worth of ore above the adit level; the amount below being incalculable." Well may Captain Tregonning, manager of the Grogwion Mines, one of the reporters on this mine, ask: Where is there in Cardiganshire such a great chance of making profits; or, where is there in this county such a long distance driven in a deep adit, on such a splendid lode? Where indeed Captain Tregonning! Captain Matthew Francis seems to be connected with this concern, which it is to be hoped will prove an exception to the other mines in this county he has been the means of bringing before the public, during the last seventeen or eighteen years, every one of which have ended in failure, - - -'

Salmon's remarks were ill received in certain quarters and he eventually found it prudent to recant.

Workings at Pantmawr were mainly effected from an adit well below the road. Alongside the latter are quarry-like opencuts that at the time of writing are fenced off due to the ground having recently subsided into old stopes. A level was eventually driven eastwards and connected with workings on the Nantglas lode, making it possible to emerge in the Rheidol Valley nearly 1000 ft below.

The total output amounted to 264 tons of lead ore.

From Pantmawr a minor road descends to Aberfrwyd and eastwards from here old lead and zinc workings honeycomb the beautiful wooded valley of the Rheidol. It was the prospect of mineral traffic which belatedly created in 1902 the interesting narrow gauge railway that climbs to Devil's Bridge, and good views of several mines are gained from its alpine course.

The first mine is **TYLLWYD** (697796) which ascends to the summit of the escarpment from behind the Rheidol Power Station Reception Centre. Lewis Morris recorded that the lode was revealed about 1742 and within a few years five adits had been driven into the hillside. These old workers removed the best ore, for although several companies tried subsequently, only a couple of hundred tons of lead ore were sold.

Beyond, where the road approaches the river, is **GELLI** or **GELLEIRIN** (703796). It was worked from several adits after discovery by Thomas Bonsall in the 1790's and it is said that he derived such profit from the undertaking as to pay for the freehold within six months. The lode was found high on the hillside, reputedly 6 ft wide in almost solid galena, and the familiar sight known as the 'Stag' is formed from the waste of these excavations. John Taylor & Sons tried Gelleirin about 1840 but the attempt soon collapsed, only 60 tons of lead ore having been raised. In 1856 it was active under Matthew Francis with a waterwheel and crusher installed, but when results failed to meet expectations, attention turned to the extensive old waste tips which were shovelled down a kind of helter-skelter to the mill for treatment. This was supposed to have been a very lucrative exercise. In 1863 Captain Northey was in charge; by that time work had been resumed underground and there were fourteen people employed on the dressing floors. Altogether 706 tons of lead ore were recorded.

Further east again is **CAEGYNON** (718784), also an old work. About 1850 Absalom Francis promoted a company to develop the mine and at the end of 1853 Engine Shaft had reached 10 fathoms below adit. A 25 ft waterwheel had just been erected for pumping and driving a 30 inch crushing mill, and an old 20 ft wheel was being harnessed to a drawing machine. Good ore was reported west of the shaft but from December 1854 to January 1855 inclusive, only 1½ tons were sold. At a general meeting, Francis attributed this to inclement weather, adding that 'in the scale of working this mine will give as good profits as any mine in Cardiganshire, - - - and I entertain no doubts of good results in future'. Nevertheless, the meeting must have been disquieted to read in another column that both he and his brother Matthew had forfeited 100 shares through non-payment of calls.

At this time, efforts were also made to exploit supposed deposits of gold bearing gossan—sure signs of no lead ore—but as at Ponterwyd, nothing came of it although trials purported to indicate over 2 ozs per ton.

About 100 ft above the road the engine shaft was sunk between two lodes, the southernmost having been discovered, so Absalom tells us, in cutting foundations for the wheelpits. Working intermittently, Caegynon returned 371 tons of lead ore and 700 tons of blende between 1853 and 1875.

Opposite Caegynon on the south side of the valley, woods climb nearly a thousand feet to the plateau above, and hide a confusion of shafts, adits and open-workings that mark the remnants of several old mines. The



Caegynon. A cluster of mine buildings. Above the dumps at the western end is an old adit, from which a steep path ascends to further adits and the engine shaft.

latter sometimes operated together and at times individually, the area being usually grouped under the collective title of **RHEIDOL UNITED** (710786-715782). O. T. Jones referred to at least five sets of workings on four different lodes, named from north to south, Gwaithgoch, Nantglas, Rhiwrugos and Allt Ddu. Mining here dates from ancient times and some of the old stopes barely exceed a foot in width.

In the 1840's and 1850's Gwaithgoch was active under John Taylor & Sons as part of the Nanteos Mines which as we have seen, also comprised Ystum Tuen and Penrhiw. In December 1853 during one of the Rheidol United amalgamations, Captain Henry Francis reported that the top level at Rhiwrugos 'had reached a lode of spar and clay about 18 inches wide, very rich and promising'. The deep level cross-cut at Nantglas was soon expected to reach the Foxpath lode and the Nantglas deep adit driving west on the lode was said to be daily improving. Sales of lead ore began in 1855 and a tramway nearly a half a mile in length was laid to the dressing floors from Nantglas Engine Shaft. Several thousand tons of blende were sold between 1859 and 1861.

Captain Richard Ridge was in charge in 1863 by which time the tramway seems to have gone out of use; ore was carried by two pack horses to the floors where twenty women and boys worked, the former being paid a shilling (5p) a day and the latter, 8d or 10d. The floors were roofed over and protected from the weather—a feature that was then considered to be worthy of particular mention. The deepest adit was claimed to be about 160 fathoms below surface and 300 fathoms long; one of the deepest in Mid-Wales.

In July 1863, Ridge attended a Royal Commission into the working conditions of miners (from which we have already quoted in Part 1) and his evidence provides a shocking insight into the industry as it existed a century ago. An extract is given below.

Are you acquainted with other mines in this district?—Yes, I have inspected the South Lisburne Mine. [See Part 1, pg. 34]

Is it well ventilated?—It is only middling.

Do they adopt any artificial means there?—They are just like we are, pushing on; they ought to have air; it is a mine which will not pay its way, and they are trying to keep down the expense, and in the end it is the worse for all.

In your opinion, is that generally the case in the smaller mines in this district?—It is generally the case throughout the district; if you get a man to tell you the truth you will find it is the case everywhere.

The poverty of a mine prevents the adventurers working properly?—Yes.

Do the men suffer from working?—Yes; I have been underground this morning in some of our levels. When you go in about 20 or 30 fathoms, you will perceive a smell which will almost knock you back, a nasty, filthy, bad smell; that is what kills the miners.

How does it affect them?—It affects their lungs.

At what age do they die from it?—Generally about 25 or 30, or something like that. When a miner gets up about 40 years of age he is not worth the snap of a finger.

Ten years later some of the Rheidol United adits were being cleared out and surveyed by Absalom Francis and during the first World War a little ore was raised at Erwtomau where adits into the vein can be seen near the railway. Further up, on the course of the lode, are extensive opencut workings. As a whole these mines never prospered, at least in relatively recent times, returning only about 5000 tons of blende and 900 tons of galena.

The best approach to Rheidol United is via the footbridge near the fish ladder at Rheidol Falls. The remains of two fine masonry ore slides face the river, but below them the dressing floors have been reclaimed as pasture. A little to the east is Gwaithgoch deep adit from which trams conveyed ore directly to the slides, and below is a wheelpit and walls of a crusher house. On the same horizon as the adit, a level path leading towards the east was probably once the tramway to Nantglas or later, the pack horse trail of Captain Ridge.

Leaving Rheidol United, the next area to be covered is best reached by retracting to Capel Bangor and thence travelling up the main road to Goginan*. The village owes its origins to the nearby mine of the same name which was quite the most important of an historic group prized for its high silver content. All were active in the hands of the Company of Mine Adventurers before 1708, and some originated long before.

GOGINAN (692817) where Roman coins have been found, was worked for silver by Sir Hugh Myddelton about 1620 and by Thomas Bushell in the 1640's, the latter deriving great wealth from the undertaking. When in 1700 the Mine Adventurers under Mackworth and William Waller began large scale developments, one of their first objectives was Goginan. Waller commenced by driving a level under the old stopes. 'It proves a glorious work' he wrote to Mackworth in 1706, 'I doubt not but it will be shortly as wide as the Old Man† had it, which was six or seven foot'. Three months later he reported 'the up forehead in Goginian the last Thursday was a yard wide full of small sparks of ore'. However, by 1710 only 20 tons had been raised, though production seems later to have improved since the company still held Goginan in 1744.

A further important stage came with the arrival of John Taylor & Sons into Cardiganshire in 1834. Their reopening of the Lisburne mines proved so lucrative that attention quickly turned to other prospects including Goginan, which was then in the hands of an Aberystwyth solicitor named Samuel Hughes. Though for many years previously the mine had revealed little of its old form (the ex-lessee‡ actually offering to carry on his back to Aberystwyth all the ore that might be raised) the Taylors nevertheless felt

*The Druid Inn at Goginan deserves a mention as the scene of the discovery some years ago of Captain Matthew Francis's personal papers; they are deposited in the National Library of Wales.

†This is perhaps the earliest recorded use of the term 'the Old Man'.

‡Absalom Francis in his *History of the Cardiganshire Mines* infers the lessee was a Mr. Evans of the Ponterwyd (George Borrow) Hotel.

that something remained to be done. In July 1836 a 21 year lease was drawn up and under Captain James Davey the task of clearing the adit began. The latter had been driven as deep as possible from the Afon Melindwr and very probably dated from the 17th century. Its goal appears never to have been achieved, for in August 1837 Absalom Francis of Flintshire was urging his nephew Matthew Francis to 'drive on and rise against the old bottoms'.

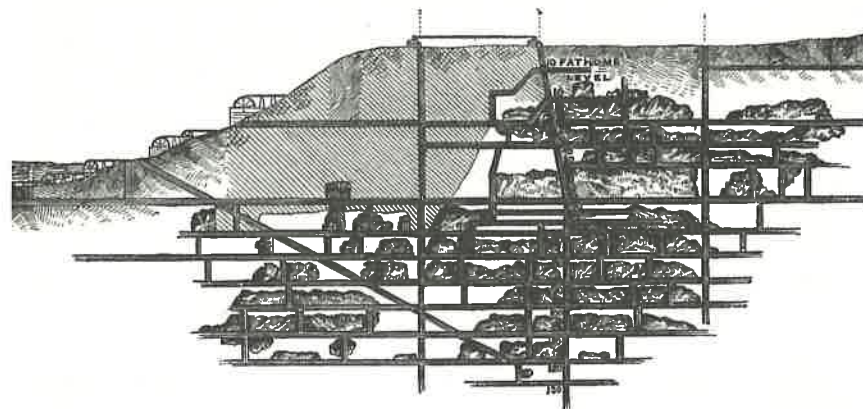
Plans took shape in March 1840 for 100 tons per month output and drawings were prepared for a 20 in rotative steam engine for crushing and stamping. With regard to the mine itself, an unusual feature was the conception of an inclined shaft or plane as a walkway for the miners instead of ladders, and to provide a means for drawing up the mine trams, thus avoiding the use of kibbles. John Taylor jnr. took a close interest in the scheme. 'About your Inclined Plane & wheel for it', he wrote to Matthew Francis, 'Be pleased to furnish me with a fuller Description of it than you have done—you say it will be only 38 fms long & at an angle of 28°—with the horizon, or as nearly possible 3 feet in a fm—with all due deference this is rather too steep—please also say whether you intend to have 1 or 2 lines of rails so as to avail yourself of the weight of the descending waggon----.'

The incline was eventually powered with a 36 ft x 3 ft waterwheel which also drove a crusher placed just behind the portal. The rate of progress at Goginan can be gauged from the following letter to Taylor, written by Francis a few weeks later; 'Since my last report a Steam Engine has been erected for Crushing & Stamping, a 45 ft Wheel for pumping, and a 12 ft Wheel for Stamping. Francis Shaft has been made good to the Deep Level and is now cleared about 9 ft below it, Taylor's Shaft has been communicated from surface to the Deep Adit and about a month more is requisite to secure it and get our pitwork for draining under the Adit level connected through it with the Water Wheel. Gilbertson's Shaft is sinking from the surface and Rising from the Deep Adit.

An inclined Plane has been laid out from the surface for the convenience of better landing the stuff which will be completed in 4 months time'. Francis however, did not remain much longer in charge; he was dismissed in July 1842 though he continued to reside at Goginan village on and off for many years, together with others of the family.*

Development advanced so rapidly that when the Geological Survey paid a visit in 1846/7, twelve waterwheels (the sole source of power) were at work, Taylors Shaft was down to the 110 fathom level and 400 men were employed. From inauspicious beginnings 11,246 tons of ore had been raised in only ten years, and the mine had become the brightest star in Taylor's Mid-Wales firmament. Two years later £5 shares were fetching £250 and some £40,000 profit had accrued from an outlay of only £500.

*For details of the Francis family and their relationships with the Taylors, see Part 1.



A section of Goginan, about 1850. From right to left the shafts are Incline Shaft, Francis's, Taylor's and Gilbertson's. The shallow adit or 26 fathom level (still visible) was driven before Waller's time.



The portal of Taylor's inclined shaft, 1974. Monuments such as this are worthy of protection and restoration.

But by this time output was already declining and determined efforts to locate new orebodies met with only partial success. By 1852, when Taylor's Shaft had reached its ultimate depth of 142 fathoms, production had fallen to barely a third and in 1863 only 50 men were at work. Goginan struggled on for another 20 years with little real prospect that its old form might be restored. Nevertheless when closure came, the record was an honourable one—25,000 tons of lead ore had been produced since 1837 together with some half-million ounces of silver. Waller's 'glorious work' had vindicated itself at last.

For the industrial archaeologist, this celebrated mine is nowadays an anticlimax. Whereas a few years ago every surface feature could still be made out, bulldozers have since levelled the site and apart from Taylor's inclined plane which has been mercifully spared, little remains to detain him.*

Behind Goginan the lode outcrop rises rapidly and was tried at **BRYNPICA** (698822 ?) by sinking a shaft in Myddelton's time. According to Waller it was 18 yds deep with a firm rib of ore 18 ins wide, and about 1700 he began a long adit to come 30 yds below the old workings. No ore however, had been raised by 1708.

The Brynpica sett was again at work in the 1850's when Taylors pushed forward the Goginan adit and simultaneously deepened the shaft; the two intersected at about 105 fathoms from surface and a good deal of ore resulted, being credited to Goginan. The adit was continued a total distance of 790 fathoms as far as the Bwlch boundary. Here, Taylors sank another shaft (Boundary Shaft) on the highest point of the outcrop, but it did not descend to adit. Again, a certain amount of ore was raised. A large waterwheel fed by long wooden launders and situated midway between the two shafts served for pumping and drawing.

As to the location of Waller's workings, we are guided by a 1708 report quoting the level as 372 yds long with seven shafts sunk, the deepest being 17 fathoms. Good ore had been raised in a cross cut 3 yds from surface. The adit probably began in a dingle (694820) and water welling up in a field (697821) may indicate the cross cut. Grassy tips opposite Goginan Fach probably denote some of the shafts.

East of Brynpica where the road reaches its highest point close to Boundary Shaft, the main Goginan lode and a branch lode cross into **BWLCH** or **BWLCH CWMERVIN** (703823)—a mine which in Waller's day was known as Cwmervin†.

About 1705 the Mine Adventurers were driving the adit westwards on the branch lode and had intentions of cross-cutting south to the main lode, the course of which is marked by numerous pits and trenches beside the old mountain road to Pwllrheniad and Pencraigddu. However by 1708 no ore had been sold in spite of 164 fathoms of drivage.

*An 1840's surface plan of the mine is reproduced in W. J. Lewis *Lead Mining in Wales* 1967, Pg. 348.

†I thank Mrs. Mary Tucker for help with this and other mines.

In mid-1840's, Bwlch had only reached 15 fathoms below adit and was producing a leisurely 40 or 50 tons of ore annually, aided by a 40 ft wheel for crushing. This was a period when Matthew Francis after his recent dismissal by the Taylors, had turned attention to promoting mining ventures either directly or by consulting for other concerns. Advertised by the wonderful success of the Lisburne mines and Goginan, and aided by the submission of diplomatic and usually favourable reports, Francis's services were in considerable demand. Such an occupation called for extensive travelling, even as far as the Continent, and often led to neglect of pressing matters nearer home. Being so close to Goginan, Bwlch provided an obvious target and his efforts culminated in the formation of Bwlch Consolidated Mines in 1847 of which he became general manager, with James Davey as mine captain.

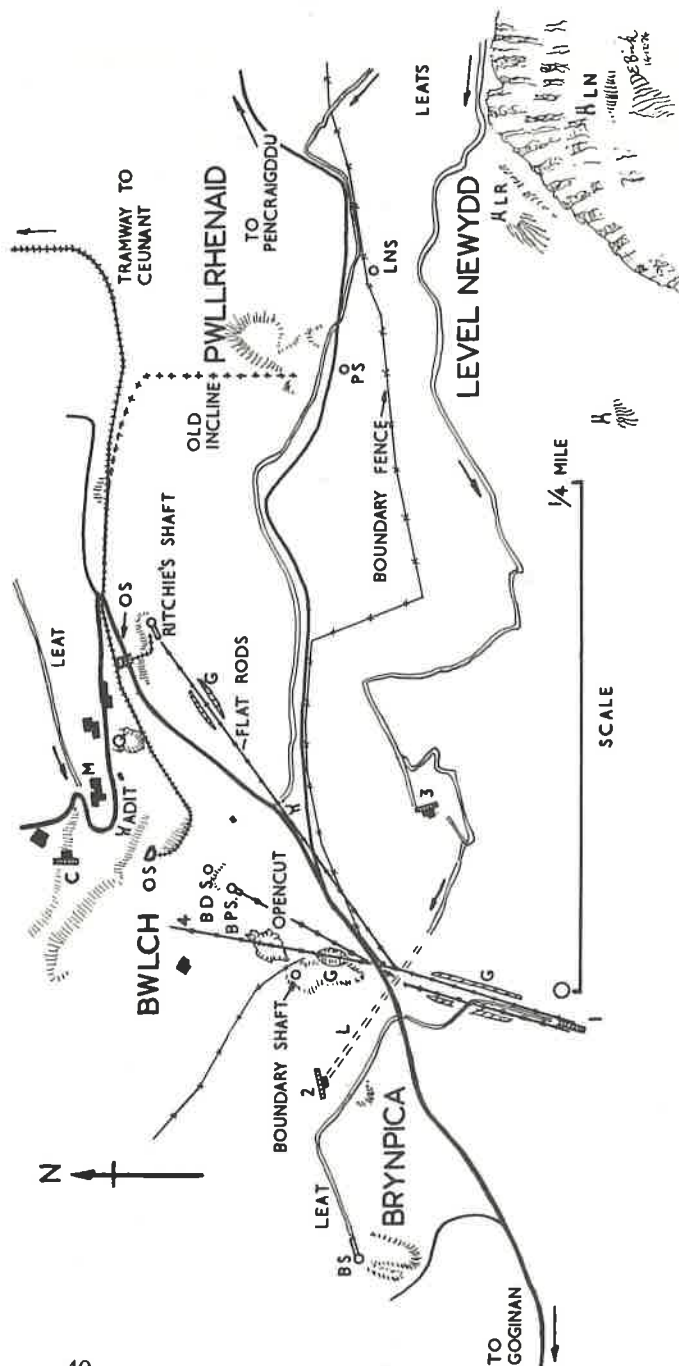
The first task was to provide water power. This involved negotiations with the Taylors to utilize the Goginan leat which ran from Blaen Melindwr Pool (715836) on high ground bordering the two setts. A 50 ft × 4 ft wheel was completed on 10th June 1848 with a long line of flat rods running over the mountain to Engine Shaft, and after a brief but costly trial with a high pressure steam whim in 1849, a 40 ft × 3½ ft waterwheel was also installed for working a drawing machine*.

These operations incurred a heavy expense and there were long delays in erecting a new crushing mill due to Harvey's of Hayle refusing to dispatch castings without prior payment. Meanwhile though the 55 fathom level had been reached, output fell from 635 tons in 1849 to 205 tons in 1852, so that after a promising start fortunes were now taking a downward spiral with not even sufficient cash in hand to meet the Goginan water rent. Early in 1853—somewhat late in the day—Francis offered the mine as a going concern to John Taylor & Sons for £8000 but on receiving a stern rebuff the management had little alternative except to continue.

James Davey was thereupon dismissed in favour of Captain William Tregoning and in addition a new board of directors decided to entirely abandon the existing workings and to concentrate upon another part of the sett a quarter of a mile to the east. This was also one of Waller's ventures, worked from a shaft on the mountain and known as **PWLLRHENAID** or **BWLCHRHENAID** (706823). The Taylors had previously exploited the lode at depth from an adit called Level Newydd (New Level) driven from the south, and the two workings were connected underground by winzes.

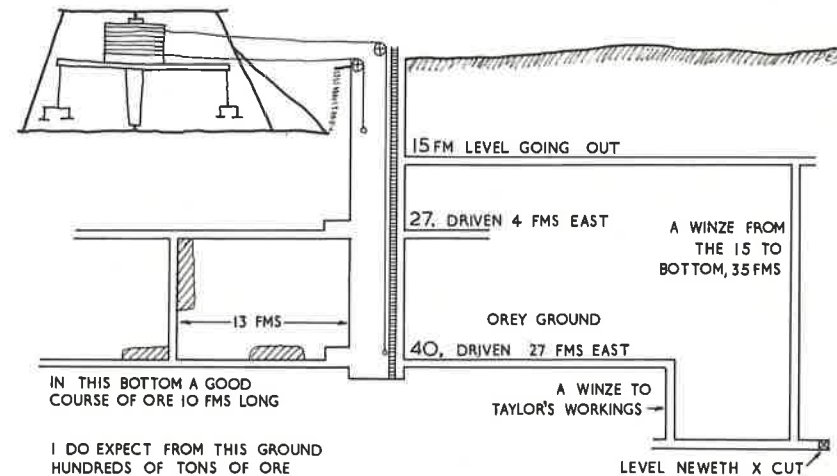
In the new attempt, after a preliminary sorting the ore was taken to the Bwlch dressing floors via an inclined plane and tramway. Some very rich patches were discovered but no dividends accrued and in April 1856 the

*High on the horizon, these two big wheels together with the Brynpica wheel and its long high channel of launders, must have presented a splendid spectacle from the Aberystwyth road—different from the vista today.



- | | | |
|--------------------------|-------------------------|------------------------|
| 1 Bwlch pumping wheel | BS Brynpica shaft | M Manager's house |
| 2 Brynpica pumping wheel | BDS Bwlch drawing shaft | OS Ore slide |
| 3 Bwlch drawing wheel | BPS Bwlch pumping shaft | PS Pwllrhenaidd shaft |
| 4 Flat rods to plunger | C Crusher | Q Quarry |
| | | LR Level Reich |
| | | LN Level Newydd (adit) |
| | | LNS Level Newydd shaft |
| | | G Gully for flat rods |
| | | L Launder |

THE BWLCH AREA IN THE 1880's.
(South of the boundary fence is now afforested)



Pwllrhenaidd
A section based on a sketch by Tregoning dated August 1854. The horse whim circle is still visible behind the shaft.

N.L.W.

Captain Nicholas Bray in February 1878. At the first General Meeting it was reported that the big pumping wheel had been repaired and 'one line of pump rods 160 fathoms long to the old Engine Shaft with pulleys stands and travellers and with bob stands, is in effect entirely new work; another line of rods over a quarter of a mile in length with new pulley stands has been completed to Ritchie's Shaft. The old drawing machine has been replaced by a new one on the most modern and effective principle - - - A new wire rope over 300 fathoms long with pulleys and stands is connected with this machine and the whole works admirably'.

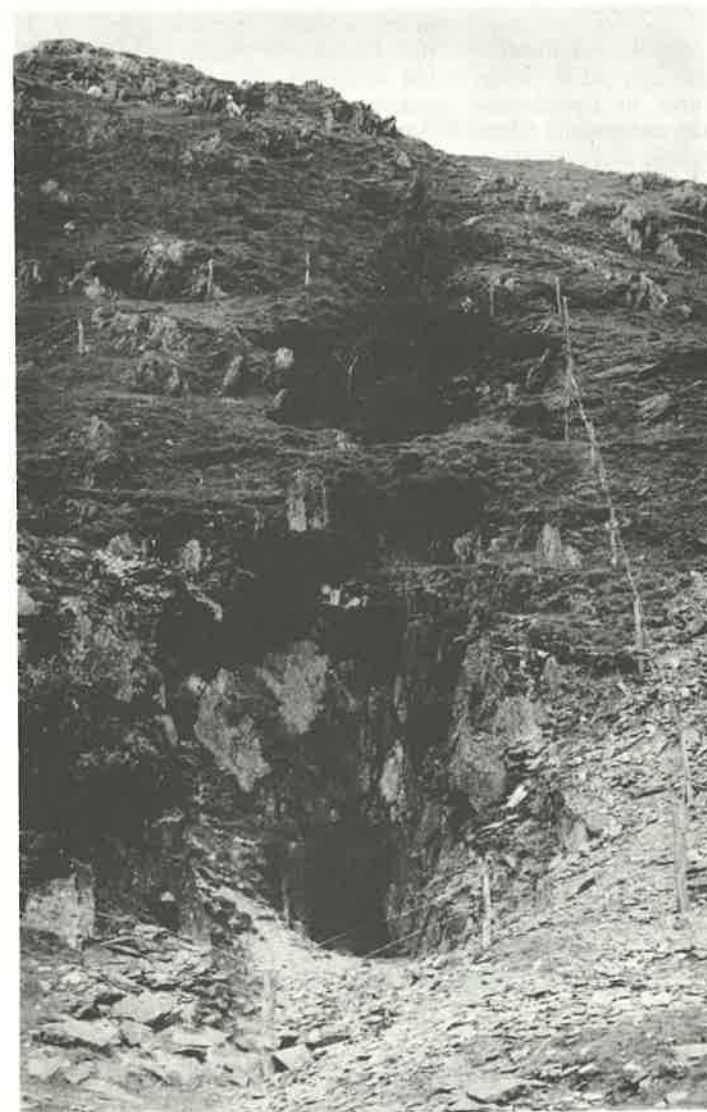
Good ore was reported in the 60 fathom level east of Ritchie's Shaft, which was sinking to the 100.

The machinery however, was generally showing its age and the severe winter of 1878/9 proved too much for the old 50 ft wheel. It finally collapsed under superincumbent masses of ice and a replacement began work on 23rd July 1879. In 1880 the 30 ft crushing wheel gave way to a secondhand 40 ft x 5 ft wheel from Eaglebrook mine and the new 50 ft wheel was burdened with a third line of rods 140 fathoms long to operate 'a 24 inch plunger'. This device was probably a pump to recirculate water for dressing purposes.

Unfortunately progress below ground lagged behind activities above. By 1883 a few hundred tons of ore had been gleaned from old workings but sinking the old Engine Shaft to the 100, and Ritchie's to the 112 had brought no returns whatever. Indeed, Bwlch United served merely to illustrate the folly of reopening old and worn out mines without sufficient resources for proper development, and the inevitable demise followed in 1884. It was regrettable that at no time was the Goginan deep adit extended, thus saving the entire cost of pumping and also providing a good chance of new discoveries. Altogether Bwlch sold 7750 tons of lead ore, of which about 1100 tons came from Pwllrhenaid.

There are many interesting features at the site including the Engine Shaft with pump rods in view; at Ritchie's Shaft a tramway led via a bridge across the road to an ore slide, still extant, from whence the ore dropped into trams on the Pwllrhenaid railway. The long lines of flat rods indicated by gullies and stumps of wooden stands can also be made out together with the course taken to the enigmatic 24 inch plunger. Submerged in trees, the 50 ft wheelpit is nonetheless very impressive though only one wall remains. Impenetrable forestry has defeated my efforts to locate with certainty the 40 ft drawing wheel pit, though a heap of stones in a clearing may well denote its sole remains.

On the same run of lodes is CAENANT or CEUNANT (708827) where several adits enter the rocky mountainside and stopes ascend up to daylight. The best years of this old mine dated from before the 19th Century. It was well under adit in the 1740's with men working three pumps one above the other. In 1849 the Bwlch company found a little ore and one or two attempts have subsequently been made, including extending the above-mentioned tramway to the mine, but without much success.



Ceunant. Ancient workings on the lode. The ground has been stoped completely away inside the level.

A little beyond Pwllrheniad where the forestry plantation approaches the old road is **LEVEL NEWYDD** (708822). The shaft, now run in, lies just inside the fence which divided the two setts. According to O. T. Jones, sinking commenced about 1863 down to an adit known as Level Reich and thence through old workings to the 70 fathom level. The latter was driven west almost to Pwllrheniad workings which were then drowned and potentially dangerous. About 300 tons of lead ore were raised.

Beyond the shaft the lode continues for some distance just within the plantation where numerous old surface workings are heavily obscured. Here, the ground rises steeply, levelling out where the wood ceases. From this point further ancient trials lead to **PENCRAIGDDU** (711824), the lode dividing into two parts some 200 yds before the main workings. Pencraigddu is yet another Waller mine and was at one time highly esteemed for silver—Lewis Morris spoke of it in the same breath as such renowned sources as Goginan, Darren and Cwmswmlog. Its situation is grand in the extreme and affords superb views from seemingly the very roof of Cardiganshire; in fact the altitude is not half that of Plynlimmon.

The Mine Adventurers took up the lease about 1701 at a reputed price of £1000 and Waller began by driving a long adit on the lode towards a swampy plateau. In common with the philosophy of the time, he considered boggy ground as a sure receptacle of mineral treasures and we have it on Morris's authority that 'a great body of ore' was indeed discovered on the spot. This would have been between 1710 and 1720. In the 1740's Waller's son Charles was chief manager and Pencraigddu still yielded a profit. Morris considered that a deep adit was much to be advised 'which may be had Several Hundreds of Yards in depth and not a Quarter of a mile distant from the mine. Such another Situation for a Grand Work', he concluded 'is hardly to be seen in Great Britain'.

Accompanying his writings, Morris included a sketch plan (not reproduced here) which is of great interest; the features are clearly visible over two hundred years later, including the course of the two levels mentioned in Waller's description*. Morris' recommendations however, were never followed up. Apart from a little work by the Bwlch company in 1848-9, and again some years later when ore raised by a horse whim was carted to Llawrcwmbach (707854) for dressing, the mine has laid unproductive ever since. Its deepest workings are only 12 fathoms under adit so that Pencraigddu has never been properly tried in spite of the good fortunes of its contemporaries in their later years.

*Hitherto it has been presumed that the adit which Waller stated would come 32 fathoms under the bog is the one commencing in the deep valley to the east (714824). But I consider there is closer agreement with these early accounts by assuming that Waller's level was driven easterly on the lode.

This is confirmed by a report laid before the Company of Mine Adventurers in 1708 stating that the level was 300 yds long with 11 shafts, the foremost being 22 fathoms deep. It was still however, short of its goal. These shafts are probably identifiable with the above-mentioned ancient trials. It is possible that the entrance to the level is none other than **Level Reich**—Waller having driven east on reaching the lode; later workers driving west.

The last working to be described is **NANTYRARIAN** (705814) at the head of a narrow lane from Goginan. This small mine is supposedly very ancient, stone hammers having been found there. In modern times two lodes were tried but only 9 tons of lead ore sold, in 1882. Under the Silver Stream Mining Co., an attempted revival took place in the early 1900's, with John Owen as agent.

The picture of the engine shaft reproduced on the front cover probably dates from the latter period. It is difficult to reconcile with the present scene due to scrub and undergrowth, though 60 yards upstream a fine wheelpit (43 ft x 5 ft) with balance pit hewn from solid rock is easily visible. Alongside is the drawing machine pit, complete with timber foundations and bolts. At the shaft a little yellow copper ore shows on the dumps whilst beyond is another wheelpit (33 ft 6 in x 4 ft 8 in) with remains of a crusher house and two grassgrown bases of round buddles—the whole somehow forming a sad conclusion to those proud hopes evinced in the photograph.



N.L.W.

THE CRUSHING MILL

Like the great waterwheel that drove it, the crushing mill is now a thing of the past and not a single example survives *in situ* within these islands to represent this once important and elegant machine. Fortunately the buildings are still quite common and much is to be gleaned from an examination of their crumbling walls. But before taking a closer look, perhaps a word of introduction is necessary.

It is easily forgotten that nature herself, by the wonderful creation of mineral lodes, was the first and greatest concentrator, but nevertheless the miner usually had to contend with much useless gangue interspersed with the valuable constituent. The removal of this unwanted material was known as 'dressing'. Originally, the first stage in the process consisted of breaking down the ore manually, and this tedious method endured at least in part, till the end of the last century. In Wales, the physical labour was lessened by the introduction of the well known stamp battery not later than the mid 17th century, but by the 1830's stamps themselves were being challenged by the crushing rolls which better suited the lead and copper ores of the Principality.

The device was brought to Flintshire by John Taylor and in a few years had spread to most larger mines. Its virtue lay in reducing the ore to the size of small gravel which was ideal for subsequent dressing operations; although a certain amount of fine material inevitably resulted, the proportion was much less than with the stamp battery.

As in every great innovation, simplicity was the hallmark of the crusher, and it is a matter of regret that so little is known of its origins. The appellation 'Cornish rolls' has often been applied to the machine, and some authorities have indeed ascribed it to the Duchy, perhaps from the following implicit remarks by Robert Hunt. 'Among other inventions applicable to mining Taylor introduced the crushing mill in 1806 at the Crowndale copper mines near Tavistock - - - Mr. Taylor took two lengths of cast-iron pipe of 16 or 18 inches diameter and made these serve as cylinders or rolls'*.

However, in 1848 W. W. Smyth† referred to the North of England as the birthplace of crushing rolls and many years before, in 1821, Westgarth Forster‡ described an elaborate form used in the Pennines having three pairs of rolls, one for coarse and two for finer grinding. He talked of this as having been introduced 'within the last 25 years'. Further, in evidence before the Children's Employment Commission of 1842, Dr. Michell spoke of the introduction of crushing mills to the north 'about 40 years ago'. Hence there is strong evidence to support Smyth's claim.

*Robert Hunt *British Mining* 1887 Pg. 693.

†Smith W. W. *Memoirs of the Geological Survey Vol. II pt. II* 1848 Pg. 676.

‡Westgarth Forster *Section of the Strata* 1821 Pg. 355.

As to the machine itself, the mechanism resembled the domestic mangle turned upon its side, and reference to the illustrations will make the operation clear. One roll was driven directly from a waterwheel, the second being mounted on slidable bearings to permit separation in the event of any tough material arriving via the feed. In some versions the second roll was driven by gears but in others it merely revolved in sympathy with the incoming charge. Opinions differed as to the better method, though the latter had many adherents in Wales.

The rolls, of hard white cast iron, were urged together by a heavy weight suspended on the end of a long horizontal arm that usually projected outside the building. Being keyed to the shafts, they could be replaced when worn down, though the operation was a lengthy and difficult one requiring considerable skill.

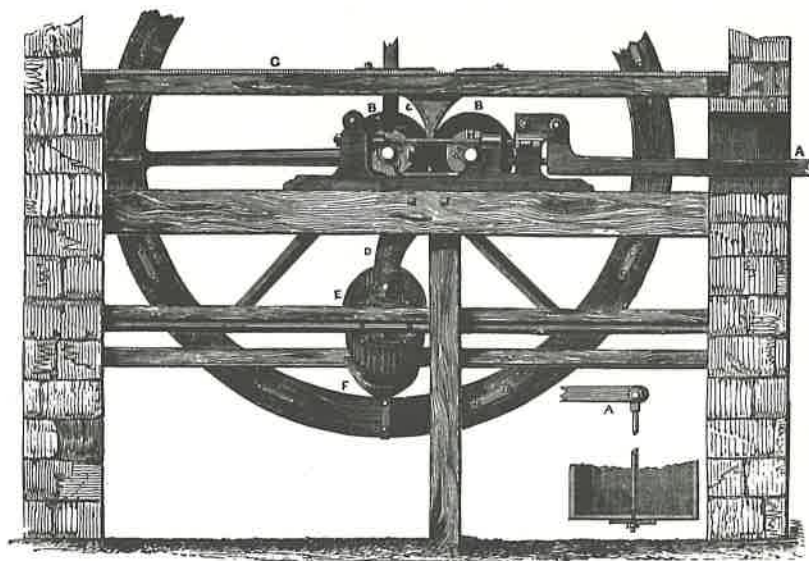
A valuable refinement was the rotating sifter or trommel, in conjunction with the raff wheel; the sifter separated any large lumps of ore passing through the rolls and the raff wheel returned them into the feed—an early instance of automatic recirculation. This feature apparently originated after 1821.

Over the years many attempts were made to further improve the crushing machine and it is a tribute to the inventor that few succeeded. The most important advance stemmed from the commercial availability of india rubber in the 1870's. Working in compression, this material very effectively replaced the long arm and suspended weight as a means of forcing the rolls together; relieved of such large inertias, they could thus exceed the old leisurely speed of 4 or 5 rpm with a consequent increase in throughput. However, this came too late for general application in Mid-Wales.

Rolls could not tolerate feed larger than about 1½ inch cube, and notwithstanding the introduction of the Blake stone crusher from America about 1862, the primitive method of hand breaking lingered on, perhaps because of the opportunity so presented for a rough hand-sorting of the ore.

Nowadays, though the crushing machine, the stamp battery, the waterwheel and the beam engine have vanished from the mining scene, it is worth remembering that of these four leviathans, the crushing machine alone was not so much superseded by other methods, as ignored by a new technology of ore dressing where its product was simply no longer required*.

*Ironically, the principle has recently revived as the latest thing in laboratory rock crushing devices.

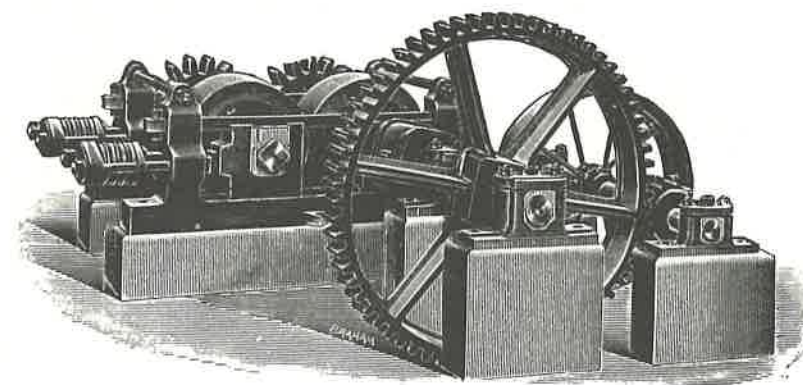
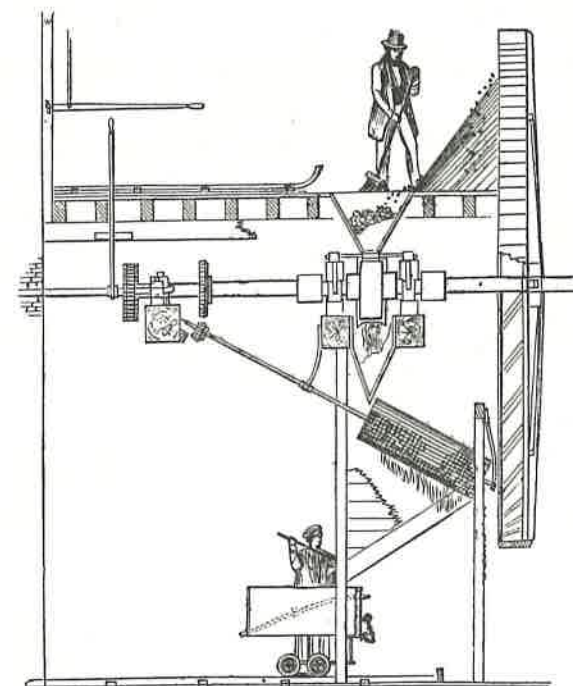


The above illustration of a mid-19th century crushing mill is derived from Phillips and Darlington *Records of Mining & Metallurgy*. Note the lever arm A, rolls B, sifter E, raff wheel F, rails for incoming trams G. The buildings were very robust to withstand vibration and often had staircases as in Cornish engine houses.

Opposite is a transverse view from Pepper's *Playbook of Metals* with below, a 'high speed' mill with geared rolls taken from E. H. Davies *Machinery for Metalliferous Mines*.

Size of Rolls (ins.)	Weight (tons)	Capacity (tons/hr.)	Horse Power	Price £
30 x 16	8 $\frac{1}{2}$	4.5	14	135
27 x 16	6 $\frac{1}{2}$	3.5	12	124
24 x 14	4 $\frac{1}{2}$	2.6	10	110
22 x 14	3 $\frac{3}{4}$	2.0	8	95
20 x 14	2 $\frac{1}{4}$	1.6	6	68

'Off the Shelf' crushing rolls as supplied by Greens of Aberystwyth in the 1880's.'



SOME CRUSHING MILLS AT WELSH MINES IN THE MID-19th CENTURY†

(In ascending order of diameter)

Mine	Rolls		Lever Arm		Sifter		Dia. of Raff Wheel	Waterwheel	
	Dia.	Length	Suspended wt. (cwt.)	Force on rolls (cwt.)	Holes per sq. inch	R.P.M.		Speed Dia. ft./sec.	R.P.M.*
Minera	14	14	8	73	9	48	10	18	5
Llandudno	18	15	8	61	Flat Sifter	48	Jacob's ladder	30	5.3
Lisburne	18	16	16	169	30	25	16	36	9½
Cwmbrwyno	20	13	7	84	27½	16	14	36	9½
Lisburne	27	15	20	180	30	16	16	30	9½
Lisburne	27	15	20	224	30	12	16	30	9½
Cwmervin	27	14	20	293	30	9	16	34	9
Cwmystwyth	27	14	10	78	24	9	16	20	3½
Cwmystwyth	27	14	10	85	24	9	16	22	4½
Cwmwmlog	30	18	18	207	45	16	16	40	12½
Goginan	30	14	40	390	36	9	16	32	9
									5.4

(Arm dimensions in inches, wheel diameters in feet)

*Speed calculated from the two preceding columns. Comparison with the rolls R.P.M. gives an idea whether the waterwheel drove directly, or by gears.

† This table is derived from Phillips and Darlington *Records of Mining and Metallurgy* 1857. The original was reproduced unacknowledged, in several mining textbooks as late as 1890, by which time it was hopelessly out of date.

APPENDIX INDUSTRIAL ARCHAEOLOGY—SUBSTANTIAL REMNANTS

Notes : Some sites are on private property and prior permission to view should be obtained. Rights of way are shown on the new 'one inch' Ordnance maps.

Open shafts and workings are potentially dangerous and should never be approached too closely.

In addition to details given below, shafts, adits and leats are visible at nearly every mine.

Mine	Grid Ref.	Page	Wheel -pit(s)	Crusher House	Tram -way	Open-cuts	Buddle	Ore Slide	Remarks
Plynlimmon	795856	6	P. C.		*	*		*	
Esgairlle	792828	8				*	*	*	Plan. Pg. 9
Castell	775813	10	PC	*		*	*		
Bog	738814	15	PW. P			*			Plan. Pg. 14
Llywernog	732809	16							Site of Mining Museum
Cwm Brwyno	714805	18	P. C. W.			*			Plan. Pg. 20
Ystum Tuen	733787	21				*			Plan. Pg. 23
Penrhiw	737787	25	?	*					
Bwlchgwyn	739789	25	PWC?	*		*		*	Miners' cottages
Temple	748793	27	PW. C.	*	*		*	*	
Blaencennant	696771	31				*			
Rheidol United	711785	34	C	*	*	*		*	
Goginan	692817	35							Taylor's Inclined Plane
Bwlch	703823	38	P		*	*	*	*	Plan. Pg. 40
Pwllrhenaidd	706823	39			*				Horse Whim Circle
Pencraigddu	711824	44							Horse Whim Circle
Nantyrarian	705814	45	PW. C.	*				*	

Key to wheelpit column : wheels used for the following purposes.

P	=	Pumping
W	=	Winding (Drawing)
C	=	Crushing
PW	=	Pumping and winding
PWC	=	Pumping, winding and crushing
PC	=	Pumping and crushing.

GLOSSARY

ADIT	A tunnel driven into a hillside for access and drainage.
BLENDE	The common ore of zinc, usually with a semi-metallic blue/brown lustre. Contains up to 67% zinc, 33% sulphur, plus iron as an impurity.
BUDDLE	A machine for separating finely crushed ore from gangue.
CROSS-CUT	A level or adit driven in order to cut a lode.
DRAWING MACHINE	The old term for a winding engine (see also Whim).
DRESSING	The process of removing waste material and gangue from the crude or 'undressed' ore.
ENGINE SHAFT	A shaft fitted with pumping equipment.
GALENA	The common ore of lead, distinguished by its great density and silvery metallic lustre when freshly broken. The external colour is light grey after long exposure. 86% lead, 14% sulphur.
GANGUE	The ore matrix, often comprising fragments of rock cemented with quartz, calcite, etc.
GOSSAN	The weathered upper part of a lode.
KIBBLE	A barrel-shaped vessel of iron or wood in which ore was raised.
LEVEL	A tunnel or gallery, usually on the course of a lode.
LODE or VEIN	Mineralized ground containing ore usually in company with valueless material, e.g. rock, quartz, etc. (see Gangue). Lodes are often nearly vertical, 20 or 30 feet wide, and can extend for miles.
OPENCUTS	Quarry-like excavations on the lode, often long, narrow and deep, and dating from ancient times.
ORE SLIDE	A semi-circular bin built of stone for storing undressed ore.
QUARTZ	Silicon dioxide. A glassy appearance if pure; more usually milk-white.
RISE	An underground shaft driven upwards.
SETT	An area of land taken for mining purposes.
STOPE	The working chambers or cavities in a mine created by removal of ore.
WHIM	A large windlass worked by horses, steam or water power for winding ore (see also 'Drawing machine').
WINZE	An underground shaft excavated downwards.

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