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REPORT ON THE PRE-RECLAMATION ARCHAEOLOGICAL SURVEY AND EXCAVATIONS OF THE CYFFTY MINE COMPLEX, LLANRWST



Gwynedd Archaeological Trust Ltd

Ymddiriedolaeth Archaeolegol Gwynedd Cyf

REPORT ON THE PRE-RECLAMATION ARCHAEOLOGICAL SURVEY AND EXCAVATIONS OF THE CYFFTY MINE COMPLEX, LLANRWST.

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INTRODUCTION

In 1990 the Snowdonia National Park Authority (SNP) commissioned a programme of reclamation at the Hafna-Nant Uchaf and Cyffty mine sites. A preliminary contract was completed prior to the commissioning of archaeological work. The second contract related to the making safe and sealing of open mine shafts and adits, diverting water courses away from toxic waste material and the consolidation of standing structures.

The SNP commissioned the Gwynedd Archaeological Trust Ltd. (GAT) for the following programme of archaeological work, starting in August of 1991;

(i) Western Shaft. (SH 7709 5874) To record by survey and photographs the area around Western Shaft in current state. To clear debris from the shaft head and record the balance bob and winch pit with drawn, written and photographic records. This was achieved and an isometric reconstruction of the beam mechanism has been produced from these records;

(ii) Engine Shaft (SH 7722 5885). To record possible existing shaft head masonry and to maintain watching brief during any further clearance. There was little to record before exploratory excavation was carried out by the Contractor to ascertain the location of the shafthead below the existing ground surface;

(iii) Crusher house. (SH 7722 5888). To record the building as it stands, using drawn, written and photographic records. This was achieved, and reconstruction elevation drawings produced from the records;

(iv) Forge, storeroom and adjoining areas. (SH 7720 5886) To record the building as it stands and to clear debris off the floors and record new details. To excavate and record timber buddle pit. This was achieved, the buddle pit proving to be well preserved and worthy of detailed recording, taking more time than was originally envisaged;

(v) Waterwheel pit and late dressing floors in centre of site. (SH 7716 5881). To record the structures as they stand, particularly the wooden structure and and concrete buddle pit. The wooden structure has been recorded photographically but the extra time spent on the wooden buddle prevented clearance and detailed drawn records of this feature. The machine house and concrete buddle have been fully recorded;

(vi) Waterwheel pit 3 and adjacent structure (SH 7711 5877). To plan and record as it stands, achieved;

(vii) Spoil heaps. To record in plan and with written and photographic records the surviving extent, plan and spoil size differentiation between the spoil heaps. This has been achieved, with surface analysis of the spoil compared to the findings of the Environmental Advisory Unit of Liverpool University contained in the consultants report;

(viii) Other shafts. To be recorded before and during contract work. There were no visible features recorded at any of the shafts other than Western (C7) prior to contract works. Ginging in the top of pulley shaft (C2) was photographed during works.

METHODOLOGY

(i) Drawn records. Ground plans and elevations were produced at a scale of 1:50 and 1:20, and detail added on at a scale of 1:10 where necessary. A limited number of reconstruction drawings have been produced from these records. The plans were annotated to complete a written record.

(ii) Photography. Monochrome prints, colour slides and a limited number of colour prints were taken for all the features surveyed. Monochrome prints taken using a shift lens, to compensate



Fig. 1 Location of Cyffty Lead Mine and related surface features. Courtesy of R.W. Vernon



Fig. 2 Plan of surviving surface features and detail plan location.





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for parallax, have been used to supplement elevation drawings in producing reconstructions.

(iii) Surveying. The eastern spoil and features within it were surveyed using a total station and easyCAD software, and a detailed contour plan and ground model were produced. Around 1500 spot levels were taken in an area of less than 1 hectare, ensuring minor features were included. The position of major features such as buildings and shafts already surveyed by Parkman were not re-surveyed.

(iv) Excavation. The wooden buddle pit (BP1) was excavated by GAT and 2 labourers from Jones Bros of Ruthin by hand over 4 days and a machine was used to clear away the spoil and level the surrounding area. The buddle was planned at a scale of 1:20, with individual planks and nails measured in. The wooden base of a jig or sorting area was also uncovered and recorded between BP1 and the Crusher house. Debris from the floor of the forge was cleared and the floors recorded on the ground plan already produced. Debris was cleared from the beam in Western shaft to allow detailed records to be made.

HISTORICAL SUMMARY

A brief history of Cyffty Mine.

The Cyffty (or Pencraig Mine as it was formerly known) lies on the western side of the Gwydyr Forest at a height of about 750 to 800 ft above sea level.

The main surface features of the mine lie adjacent to a minor road about one mile to the west of Llyn Sarnau.

The mine worked the WSW/ENE trending Principal Load from two main shafts. The western shaft on the western end of the site, was the main pumping shaft, and the Engine or Winding shaft at the eastern end was the main drawing shaft. Adjacent to both shafts lie dressing floors and features associated with pumping.

The earliest record of mining at Cyffty can be found in a plan of the Pencraig area dated May 1787, upon which one shaft is shown on the north side of the road. It seems that at this time, the minor road ran down through the small valley in which the mine lies. A later undated plan refers to the area as Llidiart y Gwynt and names the shaft as Davies shaft along side which lies a smithy. The smithy may have been incorporated into the row of cottages which lie at a similar position relative to the Engine Shaft.

However serious mining at Cyffty did not commence until the 1840's when the Principal Lode was examined by a group of Mine Adventurers. By 1859, the sett was leased to the Mineral Company of Wales. Their actions met with modest success when 200 tons of lead ore was raised.

By 1851, the Pencraig Lead Mining Company owned the mine and sinking of the two main shafts was commenced. In addition, an adit level was driven from a point on the west side of the sett. A plan of land leased to the company exists in the Porth yr Aur Manuscripts at Bangor University. It shows that the pumps for the two shafts were operated by a single waterwheel located between the shafts, the pit for which can still be seen. The Shallow Adit, or 11 yds level had at this time been partially driven and it seems reasonable to believe that earliest lead production was from this adit. Highest production in a single year during this period was 60 tons 4 cwt in 1857. However, by 1859 the mining was at a standstill.

September 1860 heralded the floating of the Pencraig United Lead Mining Company Limited, who leased much of the land as far east as Llyn Sarnau. However lack of water to the waterwheels (which were used for both pumping and ore dressing) meant that there were periods when the mine was standing. The water supply from the adjacent Llyn Tyn y Myndd was inadequate in the summer months so the company negotiated to buy additional water from the adjacent Coed Mawr and Ffridd Mines. The Bod leat which supplied water to these mines from

Llyn Bodgynedd to the north of Cyffty ran through the Cyffty site. However the meagre amount that Cyffty was allowed to have was still insufficient, and by 1865 the company had gone into liquidation having only produced a total of 77 tons of lead ore.

In 1866, the new owners of Cyffty, the Caernarvonshire Consolidated Lead Mining Company Limited overcame the control of water problem by amalgamating Cyffty with the Coed Mawr Pool and Ffridd Mines. At Cyffty, two waterwheels were erected for pumping and crushing, and their wheelpits are still discernible. Despite the company's optimism only 19.5 tons of ore was raised at Cyffty.

The Bryn Llugwy Lead Mining Company Limited took over the three mines in 1870 with the same optimism. However they only lasted one year having merely raised 40 tons of ore.

Thomas Goddard, a local miner, leased Cyffty for a short period from 1871 to 1877 and during this period raised up to 30 tons of ore per annum. Goddard worked several mines on the Gwydyr Estate, more notably those in the Gerionydd area. Having turned the mine into a potentially viable concern he sold his interests to the Bettws y Coed Lead Mining Association Limited to work the mine. This company motivated more by mining than sharedealing had their offices in Devon. They decided to purchase a steam engine primarily for drawing ore, but also to assist in other operations during periods of drought. Steam power was introduced at several mines in the 1870s due to the railway reaching Llanrwst allowing coal to be obtained cheaply. The company's efforts led to success, for during this period, Cyffty produced 144 tons in 1880. Success was short lived as the days when lead ore commanded high prices were in the decline, and mining was to cease one year later.

Following the collapse of the Bettws y Coed Lead Mining Association, the mine went through phases of being worked until its ultimate closure in the early 1920's. During this period it changed its name to Cyffty Consolidated. The only real attempt to revive it as a going concern happened in 1899 when the Cyffty Lead Mining Company Limited acquired the lease. An inventory dated 1899 lists all machinery and equipment very much as left by the Bettws y Coed Lead Mining Association. The Cyffty Company did manage to achieve an output of 115 tones in 1901.

It is not known with certainty as to when the new dressing plant was built just to the east of Western Shaft. It may have been erected by the Cyffty Company but more likely by the following company, the Great Challinor Mines Limited who acquired the lease in 1913.

Geological Survey in their Mineral Resources Memoirs dating from the early 1920's states that the dressing plant at Cyffty was as follows:-

"Masson Jaw Crusher, rolls, trommels, jigs and buddles. Power is derived from steam, and water from Llyn Ty'n y Mynydd operating a 35ft waterwheel."

Output figures do not exist for the period of the Great War and other information is scant from this period to when the mine was flooded to adit in 1922.

From 1915 onwards limited mining took place, but by this time Cyffty was being treated as a transferable asset rather than a going mining concern. In 1915, it was owned by the Mineral Oil and General Exploration Company. In 1917 by the Consolidated Investment Guarantee Trust Limited and during the period when it was allowed to flood to adit, by the Metallurgical and Mining Syndicate Limited. Some ore was raised in this period. Up to 30 to 32 men were employed between 1918 to 1920 when 35 tons of ore was dressed. This ore was probably raised from the upper levels, for it had been recognised that the lead ore was giving way to iron pyrites with depth. This was to be endorsed some 40 years later when Parc Mine underworked Cyffty.

SITE LOCATION.

The Cyffty or Pencraig mine (NGR SH 772589) is situated to the west of Nant Bwlch yr Haiarn within the Gwydyr Forest some 3 km north-west of Betws y Coed at an altitude of about 240 m OD (Fig. 1). The site lies immediately south of an unclassified road running from the "Ugly House" on the A5 west of Betws y Coed, north-eastwards before joining the B5016 to the south-west of Llanrwst. The area is owned and managed by the Forestry Commission and is within the Snowdonia National Park.

The appearance of the site has undergone periodic change since its closure in the 1920's. In the 1950's remaining viable ore deposits, recovered from earlier operations at surface were removed to Parc Mine for processing. During the 1960's the building complex associated with Engine Shaft were demolished. In the 1970's the site was tidied up and sections of the remaining derelict buildings were partially consolidated. A roofed shelter and lengths of low walling were also constructed at this time, further detracting from the original appearance of the site from the time of its abandonment.

The mine workings are stretched over an area of some 15 hectares on the Principal Lode, orientated east-west, while the mine buildings are located within an area 250 m east-west by about 60 m north-south, bounded to the south and west by private grazing and to the north and east by the road and forestry plantation. A reservoir to the north of the road used to supply a small rock-cut dam serving the works (Fig. 3).

For the purposes of this report the site has been divided into four areas, from east to west, The Engine Shaft and crusher house, the mine waste, the machine house and Western Shaft (Fig. 2).

DESCRIPTION OF FEATURES

THE ENGINE SHAFT (SH 7722 5885)

The main winding shaft at the Cyffty Mine was the Engine shaft, situated on levelled ground above and east of the crusher house. Power to the shaft was originally generated by waterwheel and carried by flatrods from WP3 and WP2 respectively which were shared with the Western Shaft. In 1878 this method was superceded by the installation of a coal fired steam engine housed to the east of the shafthead. Winding in the shaft before this date was apparently generated by a horse whim located on the east side of the shaft head. The steam engine at Engine Shaft may have replaced the location of an earlier engine close to Western Shaft, and like the horse whim, illustrated in contemporary documents dated to 1851.

The shafthead complex was demolished and levelled in 1966, infilling and sealing the shaft in the process. The original layout of the complex can still be appreciated superficially from the Tidmarsh painting of 1884 and a series of photographs by Robert.T. Clough taken in the 1940s. Without these little, if any, valid interpretation could be made of the original arrangements on this part of the site.

The 1914 OS map marks the presence of an L shaped section of walling west of the Engine Shaft and such a wall is clearly shown on the Clough photographs. This wall apparently served to retain or face the ground through and upon which the shafthead layout was situated. This juxtaposition suggests that the ground level below the wall to the west was comparable with that of the upper floor of the crusher house to which it most probably gave access, and could have served as a sorting floor prior to crushing.

The photograph also shows what appears to be a portal in the wall which most likely gave access to the balance bob arm immediately west of the shaft head (R.W.Vernon. comm.) An alternative possibility is that this may have accessed a short level through which raised ore was transferred

to the sorting floor. This area was almost completely obliterated when the site was levelled. Attempts during the contract to locate the shaft to facilitate the installation of a concrete cap have proved inconclusive, although in the process several features of archaeological interest were revealed.

Two $(2.1 \times 1.9 \times 1.4m)$ conglomerate lumps consisting of mortar, brick and rock were identified as being the displaced foundations for the wooden headframe which were originally set into the ground astride the shaft. One was rather amorphous suggesting that it had been formed in a prepared setting in the ground around the upright timber. The other appeared to have been enclosed by shuttering and this may have been due to its proximity to or incorporation within other structural elements. Remains of the timbers were visible in both, being 0.32m (1ft) square.

Two short, previously damaged, stretches of mortared walling were visible at surface in the approximate location of the shaft. Mechanical and subsequent manual clearance revealed these to be part of the housing for the balance bob fulcrum, located in the neck of the shaft some 2.0 m below the modern ground surface. It is this location that was probably served by the arched portal described above. The east end of the feature was destroyed and any direct relationship between its location and the infilled and obliterated shaft is unclear. The feature contained the remains of three mounting beams set onto concrete ledges and anchored by iron bolts. These closely resembled the fixtures seen at the base of the single arm bob pit located at the western end of water-wheel pit 2 in the centre of the site. The actual depth of the feature was not revealed although the surviving fixtures were recorded in some detail (Figs 4 and 5).



Fig. 4 Detail plan of surviving features in balance bob pit, Engine Shaft.

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Fig. 5 Section through balance bob pit. Engine Shaft

THE CRUSHER HOUSE AND WHEELPIT (WP1) (SH 7722 5888) (Fig. 6, 7a and 7b)

Below the site of the Engine House, to the west, are the remains of a small, roughly square 2 storey building incorporating a wheel pit that once housed crushing machinery and a 25 foot waterwheel respectively (WP1). The wheel and the machinery that it once powered have since been removed. Unlike the wheel in WP2, the wheel serving the Crusher House was removed prior to 1940 as a contemporary photograph by Robert T. Clough demonstrates.

The wheel was breast shot via a launder carrying water from a specially constructed header reservoir that can be traced on the north side of the modern road. Immediately below this feature a rock cut culvert indicates the outlet for the water supply that was controlled by a simple sluice gate. Water from the Crusher House wheel pit (WP1) was channelled away to a small triangular shaped resevoir (R.W.V. comm.) 80 m to the south and re-used by a larger 35 foot wheel (WP2) in the centre of the study area.

Wheel pit 1 and the Crusher house appear to be of a single main phase of construction, probably dating to the early 1860's when the mine amalgamated with Coed Mawr Pool and Ffridd Mines, located approximately 1 km to the east.

It was not possible, during the present works, to establish the exact location or nature of the ground upon which the Crusher House and wheelpit had been built. The surviving structure may occupy the site of features associated with an earlier phase in the ore processing system.



Fig. 6 Location plan of Crusher House and associated surviving features related to ore processing.

Features of the surviving structures.

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The only door giving access to the ground floor of the crusher is approached by a bedrock plateau, 9 m long and 2 m wide, standing proud of the modern ground surface and bounded on its north side by a substantial dry-stone wall linking the crusher complex to the forge building. This appearance is deceptive as at least three constructional phases are represented in the immediate area. The linking wall is the latest major building phase, abutting the crusher and respecting the northern edge of the wooden round buddle. The wall retains, on its north side, infill that forms a trackway, on average 2 m wide. This trackway may have replaced an earlier means of access from Engine Shaft to the centre of the site, and Western Shaft. The wall, however, overlies the northern edge of the buddle and is not shown in the Tidmarsh painting of the 1870's and suggests the presence of an earlier wall or slope further to the north.

The wall and retained material may also now obscure a more extensive area of levelled ground representing an earlier dressing floor over which the crusher house was constructed.

The crusher house measures 6.5 by 6.25 m (21ft x 20ft 6in) externally and 5.5 by 4.8 metres (18ft x 15ft 6in) internally. The maximum height of the walls would have been around 6.3 metres (20ft).

Little can be discerned today of the arrangement of any features that would have existed on the upper floor of the building, and much of the masonry has now collapsed. The upper floor was supported by wooden beams resting on a bench recessed 3.0 m (9ft 9in) above the ground floor.

The recess, still visible on three sides of the interior, is 0.16 m (5 in) wide resulting in the walls of the ground floor being correspondingly thicker than those of the top floor. Larger wooden beams would have supported a Roller Crusher (see reconstructed elevation and section).

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The north wall of the ground floor contains a fireplace, raised 0.50 m (1ft 6in) above floor level and a flue that presumably ran through the wall to a chimney stack, although such a feature is not illustrated in the watercolour studies by Tidmarsh done in 1884. The chimney stack of the building located between the Engine House and the road is not shown on the Tidmarsh watercolour but such a feature existed by 1940 and is shown on a photograph taken then.





Fig. 7b Reconstructed section through Crusher House and Wheelpit showing surviving internal features.

In addition to the door, another opening was located in the same wall 1 m (3 ft 3in) above the floor, and measures 1.5m (4ft) wide and 0.9m (3ft) high, faced in red brick. This was not simply a window; the Tidmarsh painting shows the weight arms from the Roller Crusher inside the building protruding through this opening.(R.W.V. comm.) Much of the floor remains covered in debris and little could be discerned of any floor mountings or fittings save that some parts of the floor were boarded whilst the majority was of concrete.

Along the base of the south wall (the north side of wheelpit 1) there are three openings into the wheelpit itself. These would have given access to the adjustment points on the beam anchors supporting the wheel.

THE ROUND BUDDLE (SH 7721 5887) (Fig. 8,9 and 10)

Immediately west of the Crusher House was an area likely to be disturbed by the removal of a modern wall. It is an area depicted on the Tidmarsh watercolour of 1884 and which included the round buddle amongst other features. The only surface trace of the buddle was the top 0.1 m of an arc of partially decayed, vertical wooden staves in an upright position amidst of a thick patch of juncus grass. A section was cut across this arc to reveal an uneven layer of poor topsoil 0.02 - 0.10 m deep below which was a 0.35 - 45 m of highly mottled grey, green-grey and orange lenses sitting in uneven wavy layers of fine tailings. Towards the base of these layers was a bright rusty orange layer, 0.02 - 0.10 m deep of tailings on a uniform layer of grey tailings c. 0.05 m thick, under which was the natural grey subsoil. There were two finds from the fill, a rectangular plank of unknown function, 0.45 m by 0.35 m and 0.02 m thick, lying off-centre and 0.3 m below the surface, and an iron spatula.

A trench was excavated from the north side of the staves to the wall joining the crusher house and forge complex. The trench aimed to establish the stratigraphic relationship of the various features. A plank floor was revealed radiating from the staves and ending just short of the wall. It was apparent that the vertical staves formed the central hub of a round buddle and the plank floor the outer element. This related to the dimensions and location of the round buddle shown on the 1914 1:2500 OS map. The whole buddle was emptied of tailings infill by shovel, to reveal the stone enclosing wall, the plank floor and a drain in the western side. The buddle comprised a low circular wall, 7.3 m diameter, enclosing a central hub from which planking extended radially to the wall. The spoil from the excavation was removed by machine and the area around the buddle levelled. This action unexpectedly revealed an area of wooden planking between the buddle and the Crusher House. This is probably the remains of a floor or sorting area associated with the site of a jig. (R.W.V. comm.) The Tidmarsh painting shows a wooden box structure that is likely to be a jig existing in this area although the juxtaposition is a little vague. The jig served to separate ore and gangue of different specific gravities after crushing by a means of agitation in water and graded sieving.

The outside of the round buddle was formed by a low stone wall which survived to the height of about 0.35 m (1ft 1in) and varied in width between 0.4 m (1ft 3in) and 0.7 m (2ft 3in). The outer face is only visible for about two thirds of the circumference as the north side is scarped into an area of outcropping bedrock. The wall is best preserved on the north, due in part to the existence of a later boundary wall between the crusher and the forge, which both respects and sits upon the edge of the buddle wall. The masonry of the buddle wall consists of slabs of local shale of various sizes ranging from 0.1 x 0.1 x 0.02 m (4in x 4in x 3/4in) and 0.35 x 0.35 x 0.08 m (1ft 1in x 1ft 1in x 3in). The wall was carefully built to provide a relatively smooth inner face. The lime mortar used in the wall had become yellow and powdery. There was no evidence that the wall had ever been capped with mortar and may originally have been slightly higher (Fig.8).

The floor of the buddle was supported by and attached to three concentric timber rings. The innermost of these was critical to the strength and symmetry of the buddle for as this formed the base upon which the central hub element was constructed. The inner ring is actually two rings, one above the other, each composed of six separate curving timbers of irregular length. The direction of the grain in the timbers indicated that these components had been sawn to shape rather than bent. The larger, lower ring had an external diameter of 2.5 m (7ft 6in) and the timbers measured 0.038 deep by 0.14 m wide (1.5in by 5.5in). The upper ring, which provided a fixing point for the vertical staves, had an external diameter of 2.35 m and the timbers measured 0.038 deep by 0.07 m wide (1.5in by 2.75in). The rings were held together by iron nails 0.05 m (2in) long, driven down through the upper ring.





The vertical staves forming the uprights were attached by similar length nails to the outer face of the upper ring. Out of an estimated 55 staves, 12 survived *in situ*. The staves measured 0.145 by 0.055 m (5.75 by 2in) around and were 0.3 m (1ft 1in) long, representing the original height of the hub sides. The staves were inclined from the vertical by 5 degrees towards the centre of the hub. The top end of the staves would have originally been held fast by another timber ring frame. The position of this is indicated by a band of discolouration around the inside top of the staves resulting from the disintegration of iron nails that once secured the frame.



Fig. 9 Detail of construction of central hub support, staves and floor.

The floor was built of 81 tapering planks, 1.85 m (6ft) long, radiating from the hub and with outer edges cut to fit the shape of individual stones in the wall. The planks sloped down from the hub to the wall at an angle of 4 degrees. The width of the planks ranged between 0.03 m and 0.1m (1.25in and 4in) at the hub end and between 0.2 m and 0.23 m (8in - 9in) at the wall end. The timber floor was not disturbed but one loose plank was raised to reveal two concentric rings of supporting timbers onto which the planks had been nailed. The thin end of the planks rested on the lower central ring abutting the upright staves of the hub. The middle and outer rings of timber supports had a diameter of around 4.0 m (13ft) and 5.95 m (19ft 6in) respectively. About 550 nails were used in the buddle floor. The north quadrant of the floor displayed the remains of pitch coating, which was to protect the floor and to allow the water and ore to run easily over the timber.



Fig. 10 Detail of wooded buddle plank floor.

The Launder

The water supply to the buddle was taken from a leat above the trackway to the north, and was culverted under the wall retaining the trackway. Water was delivered to the centre of the buddle from a launder adjacent to the Crusher House. Two planks that may be part of a launder or trough survived at the base of the wall, adjacent to the bedrock plateau leading to the crusher house.

The Tidmarsh watercolour of 1884 shows the buddle with a trough running towards the centre of the hub, above which appears to be the drive to the hub, eminating from the Crusher House waterwheel. The trough would have carried a mixture of ore and water in the form of a coarse slime to the buddle from the Crusher House and jig.

The Sluice

The buddle was drained via a sluice on the western side opening into a covered launder which was traced for a distance of about 2 m. The sluice gate was formed by two upright wooden posts, 0.25 m apart, set on the inside of the buddle wall and surviving to about the same height. An iron plate, 0.2 m by 0.4 m, found in the waste infill may have been a part of the sluice gate.

The drain trough was constructed in wooden sections; the outlet section was 1.2 m long from the sluice gate and 0.3 m wide and 0.25 m high. It was made of of complete planks on the base and sides, and covered with six shorter sections 0.2 m long, probably to facilitate the removal of obstructions and waste during processing.

The outlet trough was connected to the drain proper by a supporting plank lying beneath both; it was not possible to investigate the nature of the join as, on conservation grounds, the drain was not dismantled. The drain trough was narrower than the outlet trough, about 0.15 m wide and 0.2 m high. The construction was also different, being of four planks of equal length joined to form a covered trough. The drainage trough was at an angle to and not parallel with the outlet trough. It is possible that the water was directed into one or more slime tanks to allow the ore carried in suspension to settle. The trough was backfilled immediately after recording because of its fragile condition.

THE WOODEN FLOOR or JIG BASE. (SH 7721 5888) (Fig. 11)

The planking that comprised this feature was buried under 0.7 m of tailings abutting the bedrock plateau west of the crusher (Fig. 6, Detail Fig. 11). It is associated and contemporary with the operation of the Crusher House and the buddle between which it is situated. Constructional details are based solely on surface observation after the timbers were revealed and cleaned.



Fig. 11 Plan of surviving plank floor associated with location of Jig.

The surviving remains of the feature comprise 17 separate planks mounted onto 3 narrow crossbeams, average 0.07m (2.5in) square. About 80% of the estimated floor area has survived, with at least two planks on the south side missing. The planks do not appear to be of uniform size and there is no indication that they were coated with pitch or anything else. Planks 5 and 6 may indicate that the floor was repaired and that planks 1 to 4 were originally the same length as planks 7 to 10.

The east end of the feature was 2.7 m (9ft) west of the crusher house wall and the buddle extended 6.1 m (20ft) toward the round buddle, with a maximum width of 1.8 m (6ft). The floor was essentially flat and located outside of the north-east edge of the floor, and partially recessed

into the outcropping bedrock behind, was the remains of a square-cut timber upright or post, 0.67 \times 0.13 \times 0.13 m (2ft lin \times 5in \times 5in). The post may have once been instrumental in supporting the timber sides of a structure of which the surviving planking was the base or floor. It is reasonable to associate these remains with the location of a jig. Water used in the jigging process could have been derived from what may be an enclosed wooden launder that can be seen on the north and west exterior walls of the Crusher House in the Tidmarsh painting.

The built up ground between the east end of the jig base and the crusher house wall, some 2.7 m to the east, was not excavated. This represents an accumulation of waste material that originally became trapped between the wooden east side of the jig and the west wall of the Crusher. This has survived partly in isolation and appears to have been revetted on its west side in more recent times.

The lack of surviving timber other than that of the floor suggests that the structure was demolished some time after it fell into dis-use. Some time after this a layer of tailings accumulated over the floor surface.

The position of the jig base in relation to the round buddle trough, and the fact that both appear to have been constructed at a corresponding level serves to demonstrate that both processes were employed during a contemporary period.

THE FORGE COMPLEX (7720 5886) (Fig. 12)

The forge complex consists of one rectangular building divided into two rooms, the forge and stores, and a smaller square building, the office, abutting the west gable (Fig 12). The total area covered by the three units is 14.5 m (4ft 6in) by 4.75 m (15ft 6in).

THE FORGE AND STORE (Location - Fig.2)

The forge building measures 9.25 m (30ft 4in) by 3.6 m (11ft 10in) internally, covering an area of 33.3 square metres or 360 square feet and is divided into two by a wall 0.9 m high (3ft) which has been re-constructed recently. The forge is the smaller room, measuring 4.2 by 3.6 m (13ft 9in by 11ft 10in) and occupies the east end of the building, whilst the store measures 4.5 m by 3.6 m (14ft 9in by 11ft 10in).

The walls of the building vary in thickness between 0.65 m (2ft 2in) at the east end to 0.5 m (1ft 7in) at the west end. The east gable survives to a height of 3 m (9ft 10in), although the walls on average survive to a height of 1.5 - 2 m (4ft 10in - 6ft 6in). The inner face of the north wall of the building appears to have been reconstructed in the 1970's as the stone is very irregularly coursed and there is no mortar in the construction. As this wall revets the trackway to a depth of nearly 2m it seems likely that this action has subsequently preserved the rest of the building. Original masonry is best seen in the east gable, where it is more or less regularly coursed with large flat stones, interspersed with smaller stones. The masonry has been pointed on both sides, although some parts of this this may have been done in the 1970's. On the inner face of the east gable, to the north of the chimney breast, the mortar is pink and fire-crazed, suggesting that this mortar may have been present when the hearth was still in use. One obvious part of the 1970's scheme is the capping of walls with a rough mortar using tailings as a base. This seems to have been effective as a temporary measure to check the destruction of the building, particularly on low walls that invite clambering. The doors were in the south side of the building. The entrance to the forge is 0.95 m wide (3ft 1in) and appears to be original, being of solid construction with an iron door post or hinge mount on the west side. The narrower entrance to the store is 0.75 m wide (2ft 5in), and is in its original location, although the whole of the wall to the west up to the corner appears to be of recent construction.





Fig. 12 Reconstructed elevation and section of forge complex and plan of surviving features.

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Features Within the Forge

The east end of the forge was the "business end", incorporating the flue, furnace/hearth, chimney and anvil mount. The flue is a 0.2 m (8in) square gap running through the wall and supported by a lintel. The air was probably directed southwards once it came through onto the furnace base to go into the hearth from the side. The chimney is not complete and the precise arrangement is not clear, although an iron hood covering the hearth can be envisaged. The chimney was stone-built up to roof height, and the shaft was of brick. The shaft has fallen off the gable into the building as a single lump measuring 0.5 m (1ft7in) square and 0.7 m (2ft 3in) long. The hearth was built on a brick base in the south-east corner of the room. The hearth measures 2.3 m (7ft 6in) along the gable by 1.25 m (4ft 1in) and is 4 bricks high (0.5 m or 1ft 8in), on top of which is a layer of large elongate stones, forming the surface on which coke was placed. A low wooden anvil mount with a diameter of 0.45 m (1ft 6in) survives in the centre of the remaining available floor space.

The forge was cleared of vegetation and debris but was not otherwise excavated. The floor was of compacted natural sub-soil and not brick or stone as in the other buildings. A wooden structure 1.75 by 0.4 m (4ft by 1ft 4in) was partially uncovered lying at the base of the north wall, and may be the remains of a quenching trough, and a rectangular mortar spread 3.5 m x 0.85 m (5ft 9in by 2ft 9in) was observed between the hearth base and the anyil mount.

Features Within The Store

The store was internally accessed from the forge via an entrance 1.1 m (3ft7in) wide in the southwest corner of the forge, and externally by a reconstructed entrance in the south wall. A wooden doorpost survives on the north side of the internal entrance. The store was cleared of debris to reveal a red brick and stone flag floor surviving over about one third of its total area. The brick floor was most complete in the north-west quadrant, where the brick size averaged 8 cm by 22 cm (8.5 by 3in). Where the original stone floor was best preserved, in the south-west half of the building, a small area of brick floor had been inserted, perhaps as a repair. An isolated area of smaller flagstones survived in the north-east corner of the building. An iron pin of unknown use was observed towards the base of the centre of the west gable wall.

THE OFFICE

The small square office building abutts the west gable of the store and measures 3.2 m by 3 m (10ft 6in by 9ft 10in). The single entrance, 1.2 m (4ft) wide, is at the east end of the south wall, with a wood doorpost on the east side. There is a fireplace 0.95 m (3ft) wide and 0.5 m (1ft 8in) deep built slightly off-centre in the west gable wall. A brick floor survives over the north half of the building, with larger bricks employed than in the store (0.24 by 0.12 m or 4.75in by 9.5in). There is some suggestion of internal rendering in the building, which is compatible with the function of the site managers office.

THE MACHINE HOUSE (SH 7715 5881) (Location Fig. 2)

The machine house, part of the latest dressing plant on the site, is a small yet complex structure with prominent machine mountings and wheel recesses though unfortunately with no surviving trace of the actual mechanisms.

Immediately west of the machine house were the dressing floors which it would have served. The Geological Survey in their Mineral Resources Memoirs of the 1920's list several components of the dressing plant, namely a Masson Jaw Crusher, rolls, trommels, jigs and buddles. Few of these features have survived to the present day and some items would have been removed after the closure of the mine. Little remains above the modern ground surface and no excavation was carried out in this area, and the exact location of many of the listed features is unknown. At the western end of the dressing floors a raised wooden tramway was constructed to carry away discarded material, which was subsequently dumped between the dressing floors and Western Shaft. The alignment of this feature is still discernable from the remains of several 'A' shaped stanchions, partially buried in waste material.

The building today is a square, three-sided open structure (5.2 by 4 m) with a large central pillar and a smaller side pillar occupying the open face (Fig. 13).

The Tidmarsh watercolour of 1884 shows wheelpit 2 (WP2) after it had superceeded WP3 but before the machine house was built. The position of WP2 was such that it could serve both Western Shaft and Engine Shaft, and as such the alignment remained unaltered. Therefore, when the machine house was built there was a limit as to where it would fit most efficiently to continue to serve both shafts economically. An area of bedrock to the north of WP2 had to be quarried level in order to achieve this, and the machine house was built on and up to the bedrock face.

A photograph taken in about 1940 by Robert T. Clough shows the machine house and WP2 with waterwheel *in situ*, the concrete buddle in the foreground and the engine house in the background. In the photograph the machine house does not appear radically different from today, although the buttress and the side pillar are both built to the maximum height of the walls and central pillar. The photograph also shows the partially surviving remains of what appear to be jig frames, made of timber, located between the buddle and the machine house. At the time the jigs first installed and in operation, during the early part of the twentieth century, both they and other items of dressing machinery would have been enclosed by sheds constructed of wood and corrugated iron. The location of such a feature is recorded on the 1914 Edition O.S. Map. Traces of wooden framework belonging to these features are still visible through the modern ground surface.

The south wall of the machine house is parallel with WP2 and would have been the sole access for any transmitting of power between the waterwheel and the mechanisms within the building. The wall, 6.2 m (20ft 4in) long internally and 0.55 m (1ft 9in) wide, survives to a maximum height of 3.5 m (11ft 6in). There is a single brick-dressed entrance 0.8 m (2ft 7in) wide, slightly off-centre towards the east end of the wall, the arch of which has since collapsed, leaving the original height uncertain. Between the entrance and the south-east corner of the building is a brick-dressed opening 0.8 m (2ft 7in) wide, the sill of which is 0.25 m (10in) above ground level and wooden lintel 1.3 m (4ft 3in). The entrance almost certainly belongs to the first phase of the building while the other opening belongs to phase 2. The other main features of the wall are 2 adjuster sockets 0.95 m (3ft) above ground level, 0.2 m (8in) wide, 0.35 m (14in) deep and 0.2 m (8in) high, located to the west of the entrance. The sockets are 1.3 m (4ft 3in) apart and sitting directly above them and connecting the two is a beam tied into the construction of the wall. The adjuster sockets are at the base of vertical plank shutters that once held the beam anchors at the top of the wall, and were to allow their adjustment and removal. A shutter socket 0.2 m square (8in) was also observed in the top of the wall in the south-east corner of the building, although there was no trace of a corresponding adjuster socket in the wall, suggesting that the socket belonged to phase 1 and became obsolete when the building was altered. The nature of any fittings associated with these features is unknown.

The east wall is 4 m (13 ft) long, 0.65 m (2ft) wide, and stands to a height of 3.3 m (10ft 10in). A brick-lined recess was built flush against the south wall, 0.35 m (14in) wide and 0.2 m (8in) deep, from ground level to a height of 1.3 m (4ft 3in), which may have housed the arc of a pulley or fly-wheel. There is a brick-dressed window 2.4 m (7ft 10in) from the south-east corner which is 1 m (3ft 3in) wide with a sill 0.8 m (2ft 7in) above ground level.

The north wall is 5.2 m (17ft) long, 0.6 m (2ft) wide and survives to a maximum height of 1.8 m (6ft). The wall appears to have been built against the bedrock face which was a result of the initial levelling of the building site. In the north-east corner is a recess 0.7 m (2ft 3in) wide cut back 1.25 m (4ft) into the bedrock face, above which is a wood lintel. The recess is probably



Fig. 13a South facing internal elevation of Wheelpit 2. Fig. 13b Plan of surviving strutures and features Machine House and Wheelpit 2

connected with phase 2 and is best interpreted as an engine or machine and drive wheel/drum mount. There is an adjuster socket 0.95 m (3ft) from the west end of the wall, which is 0.25 m (10ft) wide, 0.35m (14ft) deep and 0.9 m (2ft 11in) above ground level, above which is a beam tied into the wall, and associated with phase 1. Sitting on top of bedrock and abutting the north face of the wall is a buttress 2.2 m (7ft 2in) long and 0.85 m (2ft 9in) wide, which survives to a height of about 1.5 m (5ft), although originally stood to the same height as the walls.

The central pillar is 2.3 m (7ft 6in) long and 1.4 m (4ft 6in) wide and survives to its original height of 3.3 m (10ft 9in). The front of the pillar is in line with, and slightly closer to the north wall but set back 0.9 m (3ft) from the south wall. The pillar has red-brick angle quoins and 2 adjuster sockets on the west face and 2 on the east face, with a locking beam running across the top of each pair. The sockets are 0.25 m (10ft) wide, 0.4 m (1ft 4in deep and 0.8 m (2ft 7in) above ground level. Above the sockets wooden shuttering enclosed iron anchor rods that had become exposed due to collapse in the south-west corner. The mountings relate to phase 1 and may have held an overhead wheel or drum. Running lengthways in a recess down the centre of the top of the pillar are 2 iron plates or runners, which were probably to guide cable from an overhead wheel. This arrangement was probably powered by an engine and superceded the wheel drive from WP2.





Halfway between the central pillar and the south wall is a narrower pillar 2.3 m (7ft 6in) long and 0.7 m (2ft 3in) wide, surviving to a height of 0.75 m (2ft 5in), although originally it stood as high as the central pillar. The face of the pillar is in line with the end of the south wall and therefore stands in front of the central pillar. There is a gap of 0.4 m (1ft 3in) on either side of the pillar, presumably for cables to pass through. This gap appears to correspond to the width of the wheel recess in the east wall.

On the north side of the central pillar is a low, rectangular concrete block 1.25 m (4ft) by 0.6 m (2ft) and 0.4 m (1ft 3in) high. The block abutts the central pillar but stands proud of it, coming in line with the side pillar and the south wall. On either side of the block wooden rails 1 m (3ft 3in) long and 0.08 m wide (3in) wide were mounted onto recesses. The function of this block, and to which phase it belongs is unclear.

WATERWHEEL PIT 2 (WP2) (SH 7716 5881)

Wheelpit 2, 4 m south-east of the machine house, measures 11.8 m (38ft 8in) long, 1.2 m (4ft) wide and 3.5 m deep, although it was originally about 5.5 m (18ft) deep. The wheelpit housed a wheel with a diameter of 35ft (10.7 m) and was constructed to supercede and improve upon the functions originally fulfilled by WP3. This waterwheel is listed as part of the dressing plant machinery at Cyffty in the Mineral Resources Memoirs of the Geological Survey dating from the 1920's, although the main function of the wheel was to provide power to the pump rods at both Engine and Western Shafts. The wheel was breast-shot, and water was carried to it, via a wooden launder, from a small resevoir situated 25 m to the north. The resevoir was fed by water from WP 1, next to the Crusher House.

On either side of the wheelpit are four iron anchor rods, centrally placed, 1 m (3ft 3in) apart, with corresponding adjuster sockets 0.4 m square (1ft 3in) 3 m (9ft 1in) below ground surface (Fig.13a).

Abutting the wheel pit to the west is a smaller pit, stone faced internally, 5.2 m (17ft) long and 2m (6ft 6in) wide. At the base of this feature could be discerned the wooden beams and iron fixtures for the attachment of a sweep arm, which would have transmitted the motion from the cam on the waterwheel to the flatrods serving Western Shaft. The ground surface to the north of the pit had been levelled and a revetment built to retain the flat surface.



Fig. 15 Reconstruction of power transferral from waterwheel to flat rods (not to scale).

A second, smaller, sweep arm pit, 2 m x 2m (6ft 6in square) of similar construction is located at the east, outer end of the wheelpit. The feature was overgrown and partially infilled with rubble at the time of recording and was not, therefore, investigated further.

THE CONCRETE BUDDLE

This feature was an integral part of the late dressing floor associated with the Machine House to the west.

The concrete buddle pit survives as a low semi-circular concrete-lined pit surrounded by a low brick wall. It is 12 m (39ft) west of the large machine house and 35 m (115ft) east of the small machine house. The western half of the buddle has been destroyed, probably incidentally when the spoil to the south and west was removed in the 1950's to be taken to Parc Mine for reprocessing. The diameter of the buddle measures 5.2 m (17ft) externally and 4.75 m internally (15ft 7in) (Fig. 16).





The buddle was built directly onto dark greyish-brown processing waste, as was the wooden buddle (BP1) to the east. Above the spoil is a single course of bricks, forming a floor, with a second course added in the centre to strengthen a central concrete hub. The hub is 1.45 m (4ft 7in) in diameter and 0.22 m (8.5in) high at its outer edge and holds an iron mounting rod 0.035 m (13/8in) in diameter by 0.8 m (2ft 7in) high. The hub slopes down from its centre at an angle of 7 degrees or about 1 in 8. The floor of the buddle is strengthened and made smooth with a layer of concrete 0.03 m (1.25 in) thick sitting on the brick floor. The floor slopes downwards from the hub to the enclosing wall at an angle of 2 degrees or about 1 in 28.

The surviving enclosing wall is 0.28 m (11in) high and 0.22 m (8.5in) wide, and is built of a double layer of bricks, four courses high. The inner skin is of solid single bricks and forms a relatively smooth face, while the outer skin is more roughly made using both whole and half bricks. The wall may have been consolidated in the 1970's tidying scheme, but it is not possible to confirm this. The ends of the semi-circular surviving wall are squared, with no uneven brickwork, which suggests that either they have been rebuilt or that there was a drain at one or both of these points and functioning in a similar way to the BP1 drain.

A photograph by Robert T Clough taken about 1940 shows the concrete buddle in the foreground with the machine house, wheelpit 2 and engine shaft in the background (Williams, C.J., 1980, plate 48). The photograph shows that the ground level was at the top of the buddle wall, and that a single wooden launder approached from the north and extended to the concrete hub, supplying the buddle with a mixture of ore and water.

THE WATERWHEEL PIT and SMALL BUILDING (SH 7711 5877) (Fig. 18)

Forty metres north-east of Western Shaft are the remains of a small sub-rectangular singlestoried building and a 27 foot long waterwheel pit (WP3). These, along with the Forge and Smithy below Engine Shaft, are probably the earliest upstanding structures surviving within the complex.

DOCUMENTARY EVIDENCE

The waterwheel, the earliest on the site, provided power to flatrods used for pumping at both Western and Engine Shafts and was apparently in operation by 1851 when scale plans and sections of existing and proposed workings, including the location of surface features was produced by the Pencraig Lead Mining Company. These plans and sections are contained within the Porth yr Aur Manuscripts held at UCNW Bangor, and provide a useful illustrative record from which to compare and interpret the surviving features at ground level today (see Fig. 17). In addition to the waterwheel pit (WP3) three other structures are indicated, in close proximity, at the western end of the site. Described from east to west these are a small, single floored building and a slightly larger two floored building, both apparently to the south of the line of flatrods. A chimney is also shown, approximately 30ft high, to the west of the wheelpit, and collectively the complex is labelled 'Water Wheel & Steam Engine'. The relative positions of the surviving identifiable structures indicated seem accurate, and based on this it would seem that the lower floor of the two storey building has survived. No trace of another building or a chimney survive above the modern ground surface. It is possible that the surviving building is the remains of an early Engine House.

The area around the surviving structures is also shown on the 1914 edition 1/2500 Ordnance Survey map. Only the wheelpit and the single square structure are indicated, and it would seem that any other buildings did not survive to that time. The map also shows a raised area stretching from Western Shaft to WP2, probably representing the original extent of the spoil removed in the 1950's. This action could have also removed any surviving traces of structures although there are none marked the the 1914 map. The water was probably carried to the breast-shot wheel on an overhead launder similar to that of WP2 featured on the H.E. Tidmarsh watercolour of 1884.



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THE SQUARE STRUCTURE (SH 7712 5876) (Fig. 18)

The structure as it stands today is a small unprepossessing building slightly longer than wide, with low walls that show little evidence of regular coursing. There is a single entrance 0.8 m (2ft 7in) wide in the north-east wall and a floor composed of refractory brick. Internally the building measures 2.65 m (8ft 8in) NW-SE by 2.45 m (8ft) NW-SE, giving an area of 6.5 square m or about 70 square feet. The walls survive to a maximum height of 1.75 m (5ft 8in) and width of 0.65 m (2ft 2in) in the south corner, though averaging about 0.75 m (2ft 6in) high and 0.5 m (1ft 7in) wide. The south-west wall originally had a central entrance 1.45 m wide (4ft 8in), subsequently blocked. The location of an entrance on the south-west side is consistent with the illustration on the contemporary section drawing. Likewise, the width of the surviving original walling suggests that it could have easily supported an upper storey.

Slightly off-centre in the blocked-off wall there is a beam 0.12 m (4.5in) thick running through the wall at an internal height of 1.15 m (3ft 9in), above which is an uneven shelf running the length of the blocking. The shelf appears to be the base of an aperture that was centrally divided. A beam runs vertically through an external recess on the west side of the blocking, which may have been part of the original fixtures.

The south and west corners of the building have stressed quoins and the walls are generally more evenly coursed, with larger and more regular masonry than exists for the rest of the building, which has low, randomly coursed, and only partially rendered drystone walls.

The present appearance, ie that of a poorly built structure is misleading, and the building was once more solidly and squarely built. It seems likely that the north-west and south-east walls were rebuilt when the south-west entrance was blocked up. The function of the structure is also likely to have changed at the same time as these changes took place, and the height of the structure may have been reduced correspondingly.

The present entrance into the structure is through the north-east wall, which in turn is seen to abutt the north-west and south-east walls. The construction of this section of walling and the position of the entrance may be the product of the works carried out in the 1970's.

The floor is made from red/dark-brown refractory bricks 0.24 m by 0.12 m (9.5in by 4.75in), though they are not visible in the south-west third of the building because of vegetation and rubble. It is not clear whether the floor was part of the first or second phase of use, and the only comparable floor within the mine is found in the office of the forge complex, with which it may be contemporary.

To the east and south the building is abutted by spoil on average 0.5 m deep. This has been retained by an arc of dressed drystone revetment wall, consisting of large, roughly dressed blocks two to three courses high. This may be part of the original masonry of the square structure. This may have utilised collapsed masonry originally from the square structure itself, and may conceal features associated with the earliest function of the structure and the site as a whole.

THE EARLY WATERWHEEL PIT (SH 7711 5877) (Fig. 18)

Waterwheel pit 3 is one of the earliest features to survive on the site and dates from the first half of the nineteenth century. Investigation demonstrated certain constructional details to be diagnostically different from those seen in the other two, later wheelpits on the site.

The wheelpit is situated 1.5 m south and west of the square structure and is 8.3 m long (27ft 3in) by 1.4 m wide (4ft 8in) and 2.2 m (7ft 3in) deep. The parallel side walls are of massive, square dressed masonry construction, and have been built up to and around two square sectioned, iron beam anchors on each side, 3 m (9ft 1in) from the south-west end, 3.4 m (11ft 2in) apart and 1.9m (6ft 3in) from the northeast end. In wheel pits 1 and 2 the beam anchors are encased by wooden shutters, allowing them to be tightened or removed.

The end walls too, are of a different construction, being more roughly built of smaller drystone



Fig. 18 Wheelpit W3 and associated structure - Plan of surviving structural features

blocks and not at right-angles to the side walls, which they abutt. The character of the end walls and the fact that the machine anchors are not central to the side walls, as one might expect suggests, that originally the side walls extended 1 m - 1.2 m (3ft 7in) further at the north-east end, which would increase the size to about 9.5 m (31ft).

If the assumption is made that the diameter of the waterwheel is 3ft smaller than the length of the pit, then this would lead to the conclusion that a larger 28ft wheel was replaced by a 25ft wheel. One possibility is that the original wheel was removed to wheelpit 2 which replaced wheelpit 3. The side walls of wheel pit 3 were originally 1 - 2 m (3ft - 6ft 6in) higher than they are today based on these estimates.

WESTERN SHAFT (C7) (Figs. 19 and 20)

The Western Shaft and its associated spoil - now considerably reduced from its 1914 extent - is a dominant feature at the south-west end of the study area. Waste rock, excavated from the shaft as it was sunk, was dumped around the shaft head, thus raising the ground level and requiring the shaft head to be extended upwards. Little or no other rock or ore was brought to surface via Western Shaft, the sole purpose of which was to provide linkage and power to operate underground pumps for de-watering the workings.

The Shaft links from Cyffty 10 fathom level to Parc Mine No. 2, and relates to the later period of working at Parc, when areas of the abandoned Cyffty workings were re-opened. These later operations no longer relied on pumping from the surface as water was now able to flow through to Parc No.3 level, the main drainage adit for the workings. Western Shaft has remained open since the closure of the mine in the 1920's but ground erosion has caused some movement and collapse of the upper part of the ginging in the neck of the shaft itself.





Power was transmitted originally to the shaft by flat rods, supported by wooden stanchions. The lower part of some stanchions still survive, indicating the alignment of the flatrods. Power was initially generated by a 25ft breast shot waterwheel (WP3) located some 50 m to the north-east. The wheel was later replaced by a larger, and more efficient, 35ft water wheel (WP 2). This is located a further 60 m north-east and utilised the existing flatrod alignment to both Western and Engine Shafts.

The appearance of the Western Shaft complex has come about from the dumping and consolidation of waste produced by the sinking of the shaft. By increasing the height of the shafthead level a more energy-efficient horizontal alignment was created for the flatrods operating from the 35ft wheel (WP2), constructed at this time, and the pumping mechanism (see Fig. 17).

The 1884 watercolour by H.E.Tidmarsh shows the 35ft wheel (WP2) disused and standing in isolation. Four metres north-west of WP2 another structure survives and the 1914 OS map describes an alignment of flatrods running from it to Western Shaft. Did this later addition replace WP2 in supplying power for pumping to the shaft and was it standing by 1884? Perhaps it was simply the result mis-iterpretation by the Ordnance Survey.

Archaeological investigations were carried out between the shaft head and the balance bob pit in advance of shaft head reconstruction and grating. Details of the beam arm and other associated features were recorded.

Excavation revealed the beam arm to be at an angle of about 10 degrees, inclined towards the shaft. This was the direct consequence of the counter balance weight and housing having been cut away and the subsequent removal of the salvageable metal components of the fulcrum. During consolidation in the 1960s the slope was levelled out by placing large rocks across the open side of the shafthead and infilling behind it to provide a platform over which successive wall collapses and other debris had accumulated. This formed the bulk of the overburden removed by excavation.

The wooden beam arm proved to be in reasonable condition although the wooden mounting beams on which it had once pivotted were in an advanced state of decay. The beam arm originally operated in a narrow masonry trench some 0.52 m wide. The depth of the trench would have been about 2.5 m deep allowing the beam to move approximately 20 degrees each side of horizontal. The beam arm was constructed of two large timbers of differing, lengths placed one above the other, sandwiched between two planks on each side. Iron fixtures for the fulcrum went through the upper timber only and the whole was surrounded on three sides by iron brackets, the bolt on the upper plate being missing.

The beam arm was pivotted between two fixed beams of similar width sitting on stone benches built in the sides of the beam trench. The fixed beams were set on a mortar bed and had been levelled carefully using wooden wedges inserted under the beams. The beams, mounted securely over smaller cross beams, were fixed in place by adjustable iron rods anchored to large beams incorporated into the masonry of the trench about 1.5m below. Axe and saw marks show how a large part of the beam on the north side of the pit had been removed.

The beam arm was still connected to the vertical pumping rod and the method of attachment was recorded. There was no evidence for the method by which the flat rod assembly connected to the fulcrum or to the elbow formed between the beam arm and the pumping rods. Direct evidence of the nature of the fulcrum did not survive but the locating points on the beams suggest it was a simple pivot (but see Fig. 22).

There was ample evidence of heavy greasing having been carried out around the pivot, indicated by the amount of oily residue found on both the surface of the beams and impregnating the surrounding compacted ground surface.

A simple recess in the walling or revetting on the north side of the pit may have been a seat for maintainance staff.







Fig. 21 Western Shaft - axonometric drawing of surviving components of timber pump arm and mountings on south side of beam pit.





Evidence for the exact arrangement of power transfer to the pumping arm from the flatrods is absent, although the remains of the final stanchion in the line to the shaft are still visible, above and east of the balance weight pit next to what may be a drystone buttress.

Either side of the shafthead, yet at different levels, are the settings for a pair of shear legs from which maintainance equipment and additional pumping rods could be lowered.

West of the shaft head are the remains of a working floor that once supported an engine and winch for servicing the shaft (see Fig. 19). The winch may well have been used for lowering the pumps when Cyffty was being de-watered by workings in the Parc Mine in the 1950's. A pump was removed from this shaft in the 1970's and is now on display at the Llewernog Lead Mining Museum near Aberystwyth (R.W. Vernon). The winch engine was removed in the late 1960's (S. Sheltinga, pers. comm.)

THE MINE WASTE AREA

The spoil area is roughly triangular covering about 0.6 hectares, bounded to the north by the wall built in the 1970's (now demolished in the current contract), to the east and south by a stock fence and to the west by a low line of modern walling (see Fig.23a) These are of course completely artificial boundaries. The mine waste area, including the area between the wall and the road, was surveyed with a total station, and samples selected from the various tips.

The spoil is visible as three distinct heaps separated by two watercourses which still have the remains of stone facing in places, and which are assumed to be contemporary with the workings, though possibly consolidated in the 1970's tidying scheme. Towards the south end of the larger, east watercourse a slab caps the revetted leat, which could indicate either the original construction of the whole leat, or alternatively could be the remains of a small footbridge. On the east side of the spoil area a third stone-lined water course disappears through the fence and into the field. It was not possible to trace it further in the field. The location of this watercourse may in part be attributed to the location of a shallow adit, known as the 11 yards level, that used to access Engine Shaft from this approximate position. This level was at least in partial service by 1851 and it is likely that much of the earliest lead production was from here. The exact location of this portal is now unknown, and the area is obscured by mine processing waste.

Two flat-rod stanchions survive on the western heap, and a third at the top of the larger watercourse. The flat rods could have supplied power from either WP 2 or WP 3 to engine shaft.

The spoil is largely intact - although there has been weathering by wind and water which has led to finer material being washed over larger areas than it originally covered. This was seen in the shallow depths of surface material recorded in the trial pits by the EAU (see below). The erosion has taken place as there is no ground cover other than a small patch of gorse in the extreme south east sector, which itself has allowed the spoil to be recorded.

Surface sampling

The spoil was described in the field according to its colour, size, shape and distribution. A 0.5 kg. sample was collected of each type for more detailed description. The samples were dampened before colour description using a Munsell colour chart. Where possible the samples have been related to the trial pits recorded by the EAU, although the varied nature of the waste does not allow close comparison. Note also that most trial pits (TP) record a surface layer 0.05 - 0.15 m thick, which in most cases corresponds with GAT samples. The spoil types are listed below according to size and an interpretation is offered as to their origins. A separate report on the samples is being commissionedfrom University College of North Wales, Bangor.

There were nine types of waste material identified, and these are listed below.

Type 1. Very dark greyish brown (2.5YR 3/2), 35% very angular fine pebbles, 35% very angular



Fig. 23a Location of spoil tip area Fig. 23b Detail contour plan of surviving spoil tips as they appeared before reclamation in October 1991.

coarse pebbles, and 30% very angular cobbles of Ordovician shale (maximum diameter 200 mm). These occur on the eastern hillock from the site of the shallow adit south to the fence corner.

Interpretation: The large size and angular shape indicates that the spoil is waste or deads, a result of cutting through sterile rock to reach the lode, and contains no ore.



Fig. 24 Distribution of spoil types and location of trial pits and sampling areas

Type 2. Light yellowish brown (2.5YR 6/4) angular/sub-angular coarse pebbles and cobbles (75% 50-100 mm) of 90% quartz/10% Ordovician shale. The spoil has become exposed through the erosion of the western slope of the middle hillock by prevailing winds. It appears to have originally been sealed by 5 and 6.

Type 3. Light olive brown (2.5YR 4/2), 90% sub-rounded coarse pebbles of quartz and Ordovician shale (80% 20-80mm), 10% coarse sand.

TP2 recorded yellow-grey coarse quartz and shale mine waste, 90% ranging between 10 and 100mm. The trial pit was 2 m deep, and no other material was recorded

Interpretation: Spoil types 2 and 3 are probably the waste from bucking and hand sorting, processes to remove stone with low or no ore content before processing by crushing machinery.

Type 4. Dark greyish brown (2.5YR 4/2), 35% coarse sand, 35% sub-angular fine pebbles and 30% sub-angular medium pebbles of Ordovician shale. The spoil occurs at the extreme south of the site and is dissected by the middle watercourse.

- TP3 0 0.15 m brown soil and mine waste
 - 0.15 1.8 m yellow grey crushed gravels to 30mm diameter]
 - 1.8 2.0 m rusty-orange mine waste of quartz and shale to 150 mm diameter.

The material was very loose and the pit had to be abandoned when the walls collapsed.

Interpretation: This well mixed spoil was probably waste from sieved material, ie from a jig, after it had been hand sorted and machine crushed. If the assumption is made that the jig had a sieve mesh of 5 holes to the inch, this would allow particles under 4 mm to pass through; the remainder was discarded. The orange colour to the spoil may be attributed to the weathering of iron pyrites.

Type 5. Dark brown (10YR 4/3), 60% sub-angular to sub-rounded fine pebbles of an equal mix of Ordovician shale and quartz, and 40% coarse sand. Visually the most dominant feature of the spoil, along with the mine waste.

TP5 0 - 0.05 m brown sandy soil and tailings

- 0.05 0.9 m yellow orange tailings of 3-10 mm diameter. Two 50 mm thick lenses of brown silty tailings.
- 0.9 -1.5 m orange mine waste with cobbles to 200 mm diameter.
- 1.5 2.5 m dark brown silty peat. natural ground.

2.5 m bedrock

Interpretation: This waste is the result of a combination of sieving and waterbourne separation processes, using a sieve with a mesh of 6 holes/inch, allowing particles under 2.5 mm to pass through. Jig waste.

Type 6. Dark yellowish brown (10YR 4/6) fine sand, about 15% of which has naturally formed into balls of 10-30 mm diameter. A very uniform spread of spoil covering the southern half of the western hillock.

- TP6 0 0.15 m brown clayey tailings up to 10 mm diameter
 - 0.15 2.2 m yellow, brown and orange layered tailings ranging from 10 mm 150 mm.
 - 2.2 2.6 m Dark brown peat. natural ground; end of pit.

Interpretation: This sample represents tailings from the lower portion of the stuff lodged on a dressing table or buddle.

Type 7. Very dark greyish brown (2.5YR 3/2) sandy silt, about 10% of which has naturally formed into balls of 5-25 mm diameter. Underlies samples 1 and 3.

TP4 0 - 0.08 m brown sandy soil with some cobbles

0.08 - 1.9 m yellow-rusty orange tailings up to 15 mm diameter, but averaging 5 mm

1.9 - 2.3 m yellow grey shale mine waste with cobbles to 200mm diameter

The pit was abandoned at 2.3 m due to wall collapse.

Interpretation: This is the finest material in the spoil area, and has settled into a natural bowl in the centre of the middle hillock. The high proportion of clay material may be residue (tailings) from the round buddle (R.W.V. comm.) or skimpings from the surface layer of the jigger. The spoil may also simply represent the finer particles washed out from the spoil above.

Type 8. dark greyish brown (2.5YR 4/2) coarse and medium sand, a mixture of samples 5 and 7.

Interpretation: Processing waste.

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Type 9. Black (7.5YR 2/0) Ordovician shale and mudstones, 70% very angular coarse pebbles, 30% very angular fine pebbles. This is probably material imported from Parc Mine in the 1950's, when spoil to the west of this point was removed for re-processing. Generally overlies sample 5 material.

Appendix I: BUDDLING

A buddle was a round or flat inclined wooden surface over which water and ore was passed in order to separate the ore from the tailings or waste.

The round buddle separated the particles of unequal specific gravity on a gently sloping enclosure resembling an inverted cone. After being thoroughly mixed with water, the ore stuff was fed through a revolving funnel on to the apex of the cone surface and flowed slowly towards the circumference, gradually depositing the heavier constituents as it moved. Mechanically operated lathes of different lengths swept the surface so as to arrange the different grades of ore in concentric bands. It was claimed that use of the round buddle method could increase the ore content of the stuff by twenty to sixty per cent by ridding it more thoroughly of its impurities.

A flat buddle was a large, slightly inclined, flat board peculiar to Welsh mines. On this the ore was placed in a small heap on one side and then drawn by a hoe through the stream of water flowing across the buddle. This treatment was designed to wash away alien substances, such as blende and pyrites, which might have resisted previous operations because of their high specific gravity.

Much ore was carried in suspension in the water used in these processes, and the slimes produced by allowing the sediment to settle were concentrated in a special trunking buddle by the action of revolving vanes (after Lewis, W.J. 1967, 345).



Fig. 25 Table showing output and ownership at Cyffty mine.

