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GWYNEDD SLATE QUARRIES

APPENDIX 1 - ARCHAEOLOGICAL AND DOCUMENTARY DATA

Report No. 252

Ymddiriedoleth Archaeolegol Gwynedd

Gwynedd Archaeological Trust

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Appendix 1 contains written descriptions of selected archaeological features from within Gwynedd slate-quarrying sites related to the four separate categories discussed in the present report, namely **1 Power sources and transmission, 2 Mills, 3 Uphaulage systems - ropeways and shafts** and **4 Barracks**. Each description is divided into four parts, namely *site history*, *archival and bibliographic sources*, *archaeological description* and *conclusion*. In some cases these descriptions are accompanied by measured plans. It also includes **5 Documentary data for features not selected for detail study**.

In addition, **1 Power sources and transmission** includes case-studies of four different sites.

Notes on figures

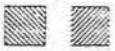
Where possible written descriptions are accompanied by diagrams.

These make use of the following conventions:

Building materials are represented thus:

Igneous rock = 

Unsawn slate = 

Sawn slate = 

In the case-studies, lengths of rail are shown in red or green, according to date and gauge.

Diagrams of mills are printed at a scale of 1/400; diagrams of uphaulage features and barracks are printed at a scale of 1/300.

1 POWER SOURCES AND TRANSMISSION: ARCHAEOLOGICAL AND DOCUMENTARY DATA

Site name: **Dorothea Slate Quarry**

Community: **Llandwrog**

Quarry area: **Nantlle**

Trust PRN: **20033**

Site history: Dorothea quarry in the Nantlle quarrying area was opened in the 1840s, and operated as a series of pits on the valley floor. It therefore needed power-sources to lift wagons to the working bank, and to pump out the workings. Initially the pumps were operated by waterwheels, but between 1899 and 1906 a Cornish beam engine (feature 31 below) was installed. There may have been an earlier Cornish engine at Tal y Sarn quarry, also in the Nantlle district, on a site which has now been quarried away (CRO XCHS 195 15).

Feature no: **31** Feature type: **Cornish beam engine**

Grid ref: **SH49735312** Statutory protection: **Scheduled Ancient Monument**

Archival and bibliographic sources: D. Morgan Rees' *Cymmrodorion* article of 1970 gives a full account of the installation of this Cornish engine. Work began on a pump shaft in December 1899 and the full depth of 155 yards was reached in October 1903. Work on a subsidiary shaft started in June 1900 and was completed in August 1901. The connecting tunnel was finished in October 1903.

The order for the Cornish engine was given to Holman Bros of Camborne at a cost of £1,925. Pit 00work was manufactured by the Redruth Foundry Co. and the various items sent by sea to Caernarfon. In October 1904 the 35' long beam, weighing 22½ tons was sent by rail from Camborne to Nantlle (Tal y Sarn) station. Twelve logs of Oregon pine for the pump rod were sent from Liverpool and the steam boilers came from Radcliffe and Sons of Bolton. These heavy items were moved from the railhead to the site by a traction engine and trucks.

The work of erecting the beam engine began in April 1905, and erection work was completed on 15 June 1905. The pit work was then lowered into the pit. A steam cargo winch for use as a capstan was installed in a small building adjoining the main pump house; wire for the purpose was supplied by the Caledonian Rope Co. Ltd, Airdrie. On 28 April 1906 steam was raised and the engine was started on 14 May. By June it was working satisfactorily.

The engine remained in regular use until 1952 when electric pumps were installed in the shaft, but it continued to be used on an occasional basis until 1956 (Morgan Rees 1970 pp. 174-175). Conservation work was carried out in the early 1970s, which enabled the beam engine to be operated on compressed air. The winch engine was also operated on condensed air in this period, to allow access to the pump shaft to sever the pump rods.

Archaeological description: This feature is constructed on a ridge of bastard rock which divides Dorothea quarry to the north-east from South Dorothea to the south-west, by the side of the road access to the quarry, and near a number of other items of coal-fired machinery.

The site comprises an engine-house with associated boiler house and winch-house and related structures, a shaft-head and a remote chimney.

The engine house is a tall rectangular plan structure orientated north to south, built out of sawn slate blocks, with a pitched roof. Access is by an arched doorway in the southern gable wall, reached by a flight of five sawn slab steps to ground floor level. There is also a cellar, inaccessible at the time of visit, and a first and a second floor.

The cellar, visible through gaps in the ground floor boards, contains the cylinder base, the lower part of the steam chest *i.e.* the equilibrium and exhaust valve, and an exhausting passage into the condenser, which is situated to the north, outside the building. There is also a hydraulic cataract mechanism here.

The central part of the ground floor is occupied by the 68" diameter cylinder. This is clad in a steam jacket on which the traces of decorative lining-out survive up to 1m above floor level, thereafter by wooden cladding, intact, but with the bands missing. On the bob-wall side is a double steam-chest. A vertical cast-iron frame for the trip mechanism remains *in situ* alongside it, but the exhaust-valve spindle is missing.

There is evidence of water-penetration on the west wall. The bob-wall is 5' 6" thick.

The first floor is at the level of the cylinder head, surrounded from floor level by a steam jacket supplied from the steam valve in the steam-chest, regulated by a valve. Standard Watt-type link motion is fitted and remains intact, and the plug rod depends from the link motion spindle in the beam.

The second floor is at the level of the beam, which is in the "indoor" stroke (*i.e.* down at the cylinder end). The beam itself is a fabricated item (rather than cast), built out of wrought iron and in very good condition, painted grey with a black trim. The maker's plate is missing. Two timber doors in the northern gable wall give access to the usual inspection balconies. Two substantial timber baulks run across the upper room, and the roof is supported by a cross-truss. A timber frame against the east wall formerly supported a clock; the clock itself is missing, but the cast-iron framework for the clock face survives in the external wall, though the glass has been shot away with airgun pellets. There is evidence of water-penetration in the west wall, in the form of badly addled internal rendering.

Outside the main engine house a lean-to structure on the west side, roofless though the timbers survive, houses two Lancashire boilers, badly corroded. These are set in the usual brickwork, and damper holes are evident at ground level in the northern wall. Feedpipes into the engine house survive, together with the boiler isolation valves. At the firedoor (southern) end is a firing area, with a slate-built bunker behind and inclined pathway for removing ashes. There is a profuse growth of ivy over much of this area, which threatens the west wall of the engine house. The boiler house extends further south than the south gable wall of the engine house, and in the angle thus formed are the walls of a lean-to structure, now roofless.

A pitched-roof structure built partly against the south gable wall of the engine house and partly projecting further to the east is accessed by a doorway in its west gable wall. This has now been sealed up with aluminium sheeting, but contains a two-cylinder winch engine driving a winding-pulley by means of a worm reduction gear. A cylinder cover and a connecting rod are said to have been removed from this engine (pers. comm., Dr Gwynfor Pierce Jones). A length of wire rope projects from an aperture in the northern wall of this structure and passes over an idler pulley supported on brackets projecting from the wall. The rope has been snapped at this point.

The shaft head is surrounded by a wall, 2m high, of sawn slate blocks surmounted by capstones, and is bisected by two rolled steel joists laid east to west. The wall has collapsed along its eastern wall, thereby giving access to the shaft itself. The wall has been repaired with an inadequate wire-mesh fence. The shaft area is extremely dangerous. Timbers survive over the shaft, but are in places rotted. The rising main survives, but the launder which formerly ran from it is missing. Against the engine-house bobwall is a timber hotwell, partly collapsed, within which stands a condenser, operated from within the building. The condenser rod survives but has been disconnected at the condenser end. Immediately to the west of the hotwell is the boiler feed-pump, whose operating rod survives and is still connected. The 18" square pine pump rod has been sawn through.

To the east of the pumpshaft there survives the lower part of a pair of sheerlegs, consisting of a substantial baulk of pine inclined from the vertical, snapped off 3m above ground level. Double pine struts support this lower fragment of leg, and a 1.5m pulley wheel for the wire rope which formerly ran from the winch engine. No trace survives of the sheerleg to the west of the pit.

In the corner formed by the angle between the pit wall and the engine house gable end to the west is a small (60cm diameter) tank on a wooden frame, fed from the boiler feed-pump.

To the south west of the engine house is the slate-built base for a a remote chimney. This survives up to 3m high, but the iron extension has been removed.

25 September 1996 DRhGwyn

Discussion: Cornish beam engines for pumping were and are found world-wide, but the Dorothea example is the only one surviving in the Gwynedd slate industry. Not even engine houses without machinery have survived in the other sites encompassed by this and the preceding studies. Within the old county of Gwynedd, an engine house of *c.* 1819 survives at the Mynydd Parys copper mine (Bick 1988 *passim*) and the second report alluded to the possibility that the feature uncovered by Mr Brynley Jones at Tal y Sarn quarry might be the cylinder or condenser of an early beam engine. Elsewhere in the slate industry, an Cornish engine house survives at Curraghbally quarry near Portroe in County Tipperary.

Whilst it is clear from archival and bibliographic sources that this was not the only such engine within the Gwynedd industry, the use of Cornish engines seems never to have been extensive (Pierce Jones 1971 passim, CHS 528/195/15).

It has the distinction of being the youngest surviving Cornish beam engine, and is the penultimate example constructed; the last of all was installed at the Phoenix United Mines in Cornwall in 1909. The last rotational beam engine is believed to have been constructed as late as 1919 (Crowley 31). It is the only surviving example to have been designed by Nicholas Trestrail, described as "the last of the great Cornish pumping engineers" (Crowley 131).

The three-floor construction and the use of a remote chimney, rather than a stack integral with the building, was unusual in Cornish terms, but by no means unknown (Barton pp. 173, 178). Steam capstans were first installed as early as 1839 at Tamar Cools (Bere Ferris) and they were common after about 1880. The use of a double cylinder worm-gear drive was also typical (Barton pp. 230-3)

Conclusion: of national importance as a Cornish beam engine surviving largely intact.

Site name: **Penrhyn Slate Quarries**

Community: **Llandygai**

Quarry area: **Bethesda**

Trust PRN: **20061**

Site history: In 1803 Penrhyn Quarry in the Dyffryn Ogwen quarrying area set up a slab mill, *y felin fawr*, at Coed y Parc, north of the quarry, at the first point where the quarry's exit railway crossed a river capable of turning a waterwheel. This later also became the quarry's main engineering focus, comprising a foundry, locomotive repair facilities and a fitters' and joiners' shop. Two waterwheels survive *in situ* (features 4 and 8 below).

The quarry site itself made extensive use of water, particularly for operating the hydraulic shafts; the introduction of pneumatic drilling in the early twentieth century led to the construction of a turbine-driven compressor house in the quarry (feature 123 below).

Feature no: **4** Feature type: **waterwheel**

Grid ref: **SH61556635** Statutory protection: **Listed grade II**

Archival and bibliographic sources: Some sources suggest that this was erected in 1906 to power the blower in the quarry's iron foundry, constructed in 1832 (Boyd 1985). However, it appears to be shown on a plan of 1873 (UWB Penrhyn Further Additional 1873).

Archaeological description: Situated on the made-up ground on the eastern perimeter of Penrhyn Quarry's former complex at Coed y Parc, a slab-walled and slate-roofed waterwheel pit, orientated north to south. The doors and windows have been blocked up with breeze blocks. Integral with the pit building and to the north side is a pyramidal roofed structure, thought to be a lavatory, and against the eastern longitudinal wall is a lean-to extension. Both these structures are unstable, and are coming away from the main building; the main wheel housing, however, appears to be sound.

The waterwheel is a backshot suspension type, 9.1m (30') diameter, 2.6m (4'3") breast, with alternate direct and crossed wrought-iron spokes. The words HENRY SUGDEN AND SON MAKER BRAMLEY NEAR LEEDS are cast in the shrouds. Water supply is from a header tank at the northern end of the building, fed from two iron pipes slightly below ground level which rise into the tank. Unusually, the spur wheel operates on the upward motion of the rim gear, and is therefore situated at the southern end of the building. A layshaft leads off it in a vaulted underground chamber in the direction of the foundry for a distance of approximately 6m, until a wider chamber is reached, at which point the lay shaft ends and a wall has been constructed across its site.

9 January 1997 DRhGwyn

Discussion: It is curious that a wheel such as this should have been purchased from a source near Leeds, when local firms were capable of turning them out and the foundry seems to have been capable of producing them themselves. It may therefore have been second-hand. The suspension waterwheel was devised by Thomas Hewes in the 1820s and was advocated by William Fairbairn; as a light iron structure in which all the component parts are held in tension, it enabled waterwheels of far greater size to be constructed than would have been possible with timber or composite wheels, but because of the weakness of the iron spokes, it could only operate off a rim gear, not the central axle. It is therefore built to a similar pattern to the other wheel at Coed y Parc (**20061:8**) and to the DeWinton wheel at Gilfach Ddu, built in 1870 (**20091:133**).

Conclusion: of regional importance as an example of hydraulic technology whose value is augmented by related features on site.

Feature no: **8** Feature type: **waterwheel**

Grid ref: **SH61486635** Statutory protection: **Listed grade II***

Archival and bibliographic sources: The waterwheel was made by the Felin Fawr foundry and installed in 1846 (CRO PQ920); it was still operational in the 1960s (pers. comm., Iorwerth Jones).

Archaeological description: Situated on the made-up ground at Coed y Parc, the former engineering complex of Penrhyn Quarry, and built between the two slab mills.

The wheel is situated in a slab-lined pit, formerly covered by a garden-bond brick structure, which has now partly collapsed into the wheelpit. The wheel is a high backshot iron suspension type, 9.1m diameter (30') by 1.6m breast (5' 3"); there are eight arms on each rim, alternately either bolted direct to the shroud or crossed in an X-pattern. The soleing is partly intact but the wrought-iron buckets have rotted. An external rim gear operates a spur wheel at the northern end of the pit, underneath the iron header-tank, which survives in situ, as does its control mechanism. The tank has a downward projection shaped to the contour of the wheel.

The spur wheel is mounted on transverse line-shafting below ground level which appears formerly to have been connected to the longitudinal line shafting within the mill buildings. The corresponding line-shaft bracket within the western mill is not only cast integrally with a plate set into the wall, but also contains an axle box for a vertical take-off spindle which may formerly have connected the spur-wheel line shaft with that at truss level by means of bevel gearing.

9 January 1997 DRhGwyn

Discussion: This iron suspension wheel demonstrates the technical competence of the foundrymen at Felin Fawr; its value is enhanced by the survival of the other wheel on site and by other hydraulic features in the immediate vicinity.

Conclusion: of national importance as an example of locally-built hydraulic technology whose value is augmented by related features on site, in particular the two slab mills.

Feature no: **123** Feature type: **turbine and compressor house**

Grid ref: **SH62476564** Statutory protection: **none**

Archival and bibliographic sources: It was stated c. 1938 that the quarry made use of three air compressors with a total capacity of 4,000 cubic feet a minute (*The Penrhyn Quarry* p. 14). It may be the water turbine working at a head of 47', taking 20,000 gallons per minute from the Afon Ogwen, used to operate a 300 hp compressor.

Archaeological description: Situated on the west bank of the Afon Ogwen, to the east of the main quarry workings, in an area heavily overgrown and foliated, and partly obscured by slate rubble. A single pitch building of slate rubble construction, orientated east to west, losing its roofing slates. It is accessed by a door in its eastern gable. It contains, out of use, a Gilbert Gilkes Francis-type turbine of 1929, which formerly powered a single cylinder vertical compressor of 1918, carrying a plate giving the name of the manufacturers as Fullerton, Hobcart and Barclay Ltd, Engineers of Paisley, the date of construction as 1918 and the cubic capacity as 1500. Both remain in good condition. The iron water-pipe, set in concrete bases, enters the building through the south longitudinal wall. The compressor drew air through a surviving channel entering through the north longitudinal wall, and sent compressed air through a pipe set into the western gable wall.

22 March 1997 DRhGwyn

Discussion: The building probably dates to either 1918 or to 1929.

Conclusion: of regional significance as an example of a turbine surviving in situ.

Site name: **Dinorwic Slate Quarry**

Community: **Llanddeiniolen and Llanberis**

Quarry area: **Llanberis**

Trust PRN: **20091**

Site history: The Dinorwic Slate Quarry in the Llanberis quarrying area was second only to Penrhyn Quarry in terms of size. From 1869 to 1870 an extensive quadrangular workshops, y Iard, was constructed near the terminus of the exit railway to Felinheli, replacing earlier facilities on Ponc Ffeiar Injan, and powered by a substantial waterwheel, later auxiliary to a pelton (feature 133 below) which drew on the waters of Snowdon, on the opposite side of the valley (Roberts 1986 *passim*).

The lack of sufficient water on the quarry-site itself precluded extensive use of hydraulic equipment, but with the electrification of the quarry in 1921 electrically-driven air-compressors became a possibility, one of which (feature 63 below) made use of the little Terfyn stream for cooling purposes.

Feature no: **61-8** Feature type: **compressor house**

Grid ref: **SH59866053** Statutory protection: **none**

Archival and bibliographic sources: At one time five air-compressors were at work in Dinorwic (XM 1072 330).

Archaeological description: Situated on the Australia working level, between the quarry-face and the mill, orientated north-west to south east. Immediately to its east is a circular-plan water-tank mounted on slate plinth. The building itself is a substantial structure, two-storeys high at its south-eastern end, constructed of unsawn slate blocks. In its south-east is a substantial two cylinder vertical compressor on which the maker's name (Tilghman's Patent Sand Blast Co. Ltd Broadheath near Manchester) is recorded, formerly attached by means of a surviving drive-spindle on which is mounted a heavy flywheel, to an electric motor, of which the base survives, and some of the parts lie scattered to the immediate west of the building. Another chamber here appears to have been an electricity sub-station with the remains of d.c. control gear, and in a lean-to on the eastern side is a receiving chamber.

The single-storey range to the north is divided into two; the more northerly contains a single-cylinder horizontal Ingersoll Rand compressor formerly operated by an electric motor, now only visible as a concrete base, by means of a canvas belt drive, which partly survives. A receiving cylinder also survives here. The other room is a smithy.

Outside the building substantial lengths of piping for the compressed air survive.

17 December 1996 DRhGwyn

Discussion: this feature probably dates from the mechanisation of this area of the quarry in the early 1920s.

Conclusion: an outstanding example of a compressor house, demonstrating the two main varieties of compressor, surviving complete with its water-tank and most of its distribution pipes. Its value is further enhanced by its proximity to the other features that survive on Australia level.

Feature no: **133** Feature type: **waterwheel and pelton**

Grid ref: **SH58536023** Statutory protection: **Scheduled Ancient Monument**

Archival and bibliographic sources: Constructed in 1870, along with the new Gilfach Ddu engineering complex, by the DeWinton Union Ironworks in Caernarfon (CR0 X/DQ3222), who also supplied the 4,023' of 24" piping which led the water from the Afon y Bala through two valve houses. Fully operational until 1925, when it was decided to install a pelton to be constructed by Gunther of Oldham. This was to function at 140 rpm, operating the line shafting at 48 rpm (CRO X/DQ 3292)

Archaeological description: Situated at the south-western corner of the Dinorwic Quarry's quadrangular workshops complex (*y iard*) at Gilfach Ddu, itself situated on the valley floor, at the change of gauge from the internal 2' gauge railways to the 4' gauge exit railway to Felinheli.

The wheel is contained within a housing constructed of unsawn slate blocks forming an integral construction with the workshops themselves. There is some use of sawn slate blocks in patching work. Access is by a wooden stairway from the joiner's shop, which leads to a walkway, 2m wide, around the wheel at axle height. There are apertures in the housing to allow for the main wheel axle, and for the drive-shaft, and a corresponding aperture in the south side to allow the wheel to power a further drive-shaft. A cast-iron plate on the south wall reads THIS WATER WHEEL/WAS ERECTED/IN THE YEAR 1870/50ft 5in DIA 80HP.

The wheel is fed from an inverted siphon over the valley floor to the west; a 3' diameter vertical rising main made of wrought-iron sections bolted together leads the water up the western end of the housing to a wrought-iron tank over the pit which is supported on I-section rolled joists. The central part of the tank (that which is directly above the wheel) has a downward extension which is shaped to the contour of the wheel, in which a slide valve is operated by a rack-and-pinion mechanism.

The 12" axle is held in substantial axle boxes mounted on plummer blocks bolted directly to slate slabs.

The wheel is a 50' 5" diameter 5' 3" breast backshot suspension wheel with 140 buckets, turning on a 12" axle. There are twenty arms radiating on each side from the central cast-iron piece to the shrouds, alternately direct or crossed over. Those which are crossed over are united with the corresponding arm in a double X casting. Arms are attached to the shroud casting by a dovetail joint. On one of the shroud segments is cast DEWINTON & CO CARNARVON 1870.

The internal rim gear consists of twenty separate castings, each bolted to the shroud at four points and to the other castings at each end. This operates a six-spoke pit wheel at walkway height, which turns a layshaft which operates a vertical layshaft through a bevel gear, and thereafter a further horizontal layshaft through a second bevel gear. The bevel gears are supported on cast-iron axle-boxes bolted onto cast-iron frames, themselves bolted onto the wall of the wheelpit.

The waterwheel was observed to perform a complete revolution every 37 seconds.

The pelton wheel is situated in a lean-to structure built off the joiner's shop, and is supplied by a main taken off the feed to the waterwheel. The pelton's tailrace joins that of the waterwheel to the west of the building.

A cast-iron plate on the pelton housing reads W GUNTHER & SONS, CENTRAL WORKS, OLDHAM. One valve is integral with the housing, another free-standing near the point of entry, operated by an S-spoked hand wheel. A belt drive from the power-shaft operates a Gunther tachometer mounted on the top of the casing, and an sprocket chain drive operates the same lay-shaft as the waterwheel. The sprocket chain is carried in a protected iron sleeve supported on a rod depending from a roof truss.

18 September 1996 DRhGwyn

Discussion: It appears that this was the largest waterwheel ever put to use in the Gwynedd slate industry, and was amongst the largest waterwheels built in Britain, the largest being the Laxey wheel in the Isle of Man, built by the Haigh Foundry of Wigan to power a pump system. The largest in Wales was the now-vanished wheel at Dylife,

which measured 63' in diameter (ab Owain 1984 p. 42). A 50' waterwheel was installed at the Rhos quarry, Capel Curig, and a pit constructed, but it may never have been used. Waterwheels otherwise in the Gwynedd slate industry were generally 30' diameter.

Its size apart, the Gilfach Ddu wheel is in many ways typical of the waterwheels which archival evidence suggests once powered machinery in slate quarries - backshot, to give better control (and in high locations to minimise the risk of water being blown off the buckets), and making use of an inverted siphon to overcome irregularities in the terrain. The use of a suspension wheel can be parallelled with the two surviving wheels at Coed y Parc.

The pelton wheel is also of considerable significance, as being one of the only four (with the two Gilbert Gilkes peltons of 1904 at Llechwedd, and the Maenofferen example of 1927) still operational *in situ* in the Gwynedd slate industry, and the only one to operate plant through mechanical transmission. Its proximity and relationship to the large waterwheel clearly illustrates the economies of scale and material that were made possible with evolving hydraulic technology from the late nineteenth to the early twentieth century.

Conclusion: the waterwheel and the pelton are of national significance in that they demonstrate the technical capacity of the DeWinton ironworks, the technical demands of the quarry, and the evolution of hydraulic technology.

Site name: **Llechwedd Slate Quarry**

Community: **Ffestiniog**

Quarry area: **Blaenau Ffestiniog**

Trust PRN: **20300**

Site history: Llechwedd Quarry was opened in the 1840s by John Whitehead Greaves, and made early use of mills and uphaulage facilities from the underground workings. Steam and water-power was extensively used before hydro-generated electricity was introduced.

Feature no: **1** Feature type: **Hydro-electricity station**

Grid ref: **SH69714687** Statutory protection: **Listed grade II***

Archival and bibliographic sources: In 1890 a dynamo was installed near floor 2 mill, presumably driven off the mill water-wheel, and from 1896 a Thompson vortex turbine drove two dynamos at 120A and 60A. The purpose-built a.c. station at Pant yr Afon was opened on 11 April 1904 (Jones IW 14), and the invoice from Gilbert Gilkes to Llechwedd for £2,235 13s 7d. is dated November 1905. The instigator was C. Warren Roberts, the Llechwedd manager, who is known to have trained abroad (*Report of the Departmental Committee into Merionethshire Slate Mines* qu. 3703-5, 3724, 3972-3, 3948-9).

Archaeological description: Situated near the foot of the exit incline from Llechwedd quarry to the Ffestiniog Railway and to the standard gauge branch line, alongside the Crimea Pass road, and below the foot of the lowest Llechwedd quarry tip run.

The hydro supply leads to the station in an 18" cast-iron pipe running from Llyn Bowydd across the quarry tips.

The building is a single-storey hydro power-station constructed out of sawn slate with a half-hipped roof, orientated south-west to north-east; in the south-west gable end is a half-hipped porch. There are four large small-paned windows in the north-west facing longitudinal wall.

In use are two peltons by Gilbert Gilkes of Kendal operating two Thomson and Phillips d.c. generators by means of a flywheel, at 175kw, 385 rpm. The machinery is protected by a wooden fence. The switch gear is by General Electric with meters by Lionel Robinson and Co. of Thames Ditton. The machinery is served by a gantry crane, and the whole is kept in excellent condition.

11 September 1996 DRhGwyn

Discussion: Llechwedd Quarry appears to have been the first quarry in the Gwynedd slate industry to make use of electricity, and the present equipment is amongst the earliest hydro-electricity generating stations to remain in use in the United Kingdom. In the absence of any comprehensive gazetteer of surviving plant, and the possibility that older sets survive on estates or farms, no specific claims can be made for the Llechwedd sets, but there can be few older sets in Britain, certainly of this scale of construction.

Conclusion: of national significance for its survival in practically its original form.

Site name: **Maenofferen Slate Quarry**

Community: **Ffestiniog**

Quarry area: **Blaenau Ffestiniog**

Trust PRN: **20306**

Site history: Maenofferen Quarry is a mine, operated from perhaps the 1840s, initially making use of hydraulic and steam power for uphaulage and for operating the mill. The installation of d.c. electrical power in 1911 is represented by feature 1 below, and the introduction of a.c. in 1928-1929 by feature 34 below.

Feature no: **1** Feature type: **Hydro-electricity station**

Grid ref: **SH70904691** Statutory protection: **Listed Grade II**

Archival and bibliographic sources: A direct current hydro-generating station, constructed in 1911 for the use of Maenofferen quarry, which remains in use. Alun Richards refers to a turbo-impulse wheel rated at 345hp, operated by water at 915ft³ per minute on a 250' head at 55- rpm, producing 257kw at 510/580v but gives a date of 1930 (Richards 1995 p. 156). There was rail access from the long tip run railway begun c. 1905 (Boyd 438), dismantled between 1976 and 1995.

Archaeological description: Situated to the north of the main rubble tip of Maenofferen quarry, and formerly accessed by its own railway and incline, now disused and abandoned, running parallel to the supply pipe; both enter the building through the eastern longitudinal wall. The building itself is of slate slab construction, with a slate roof half-hipped at its southern end. To its north is a substantial ruined wall, in which survives a flue and a brick base. A plain yellow brick chimney on a slate slab base stands against the gable wall at the south-west corner. The d.c supply leaves the building from the southern gable.

It was not possible to gain access to the interior, which is believed to contain an operational Gilbert Gilkes of Kendal pelton dated 1927 and a d.c. generator by British Thompson Houston, with switch gear also by British Thompson Houston.

7 March 1995 DRhGwyn

Discussion: The ruined wall to the north appears to have been the gable of a much larger building of which the present structure represents about half. The brick base may have been for a steel chimney which with the flue suggests a steam engine, possibly as an auxiliary to the hydro set.

As an operational direct-current station it demonstrates the advantages of direct-current supply for consumption near the place of generation, as at Llechwedd, just as alternating current is more suited to supply over long distances.

Conclusion: of regional significance as an example of an Edwardian electrical system.

Feature no: **24** Feature type: **Converter station**

Grid ref: **SH71394660** Statutory protection: **Listed grade II**

Archival and bibliographic sources: Though Maenofferen Quarry is believed to have established its own d.c. electricity supply in 1911, the arrival of a.c. electricity from Maentwrog and Dolgarrog in the late 1920s led to the construction of a rotary converter station to change the North Wales Power and Traction's supply to d.c. (Isherwood 1988 p. 14). It remains in use.

Archaeological description: Situated on the main processing level of Maenofferen Quarry on made-up ground. Orientated north to south, and constructed of slate blocks in two section, of which the more southerly has a stepped down roof. On the north gable is a loading bay with a crane arm above.

It was not possible to gain entrance to this building, which is believed to house a rotary converter.

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Discussion: The early use of direct current in Gwynedd was followed very rapidly by the development of alternating current by the North Wales Power and Traction Company and other suppliers, and the use of converters is noted in other local industries (Gwyn 1989 pp. 158-162).

The Maenofferen electrical system is of considerable archaeological significance as an early twentieth-century electricity supply, whose value is enhanced by the fact that the main uphaulage incline continues to be powered by a 1911 d.c. motor powered from the converter and the hydro-station. It is further enhanced by the evidence for earlier power sources on site.

Conclusion: of regional significance as an example of an Edwardian electrical system.

Other examples

Other examples of the archaeological survival of power sources and transmission methods in which machinery survives are discussed in **4.2.2.20036**, **4.2.2.20039**, **4.2.2.20091**, **4.2.2.20306**, **4.3.2.20031**, **4.3.2.20031**, **4.3.2.20039** and **4.3.2.20061**.

4.1.3 CASE STUDY 1

Site name: **Pen yr Orsedd Slate Quarry**

Community: **Llandwrog**

Quarry area: **Nantlle**

Trust PRN: **20039**

Grid ref: **SH51005380**

Site history: Pen yr Orsedd quarry in the Dyffryn Nantlle quarrying district is one of the classic pit quarries which predominate in that area. Pen yr Orsedd quarry is situated on the northern slopes of Dyffryn Nantlle, and has been worked from the late eighteenth century. The purchase of a lease by a new partnership in 1862 led to substantial investment in the quarry, reflected in the provision of mills and uphaulage systems, making use of both water and steam power. Further investment in 1906 resulted in an ambitious programme of electrification. The quarry remained in production until 1978, and was later re-opened using modern methods but a recent rockfall has put its future in doubt.

Case study date: **1862**

Archival and bibliographic sources: A map of Pen yr Orsedd prepared for W.A. Darbishire when he took over from John Lloyd Jones in 1862 (CRO Pen yr Orsedd 375, reproduced here as the 1862 map) shows in great detail the quarry as it then stood.

Archaeological description: Very few of the features shown on the map now survive. The main quarry workings of 1862 have been filled with rubble, and the tips have been extended. The carpenters' shop, the smithy and the waterbalance shaft survive, as does the course of the incline from level VIII to level VI.

Discussion: From archival sources and the surviving archaeology, it is clear that Pen yr Orsedd in 1862 was a quarry that had barely begun the process of mechanisation. Four pits are at work, lettered B, C, D and E, of which only D has reached any size, being worked in four levels, III-IV, VI and VIII, and what appears to be development work, the removal of *brig* (useless top-rock), is taking place on X and XI, possibly also on VIII. A tunnel into floors III and IV is either complete or in the process of being driven, to judge from the fact that lines of rails already emerge from its mouth; it is clearly proposed to connect this to a vertical water-balance shaft to the south-east. Clearly the most active working area is VI; within the pit itself is a feature that is not described on the map, but is almost certainly a strongpoint for a double-acting chain incline, since it is served by two sidings, and from here there is a direct tramming level to a processing area and to tips.

Here, as elsewhere, haulage of blocks from the quarry face to the processing areas and of rubble to the tips (much the greater proportion of the traffic) is carried out entirely by railed vehicle, almost certainly on the 2' gauge (represented here in red), since nowhere is there pointwork connecting this internal system to the 3' 6" gauge exit railway (represented here in green), which reaches all but the uppermost levels of the quarry.

Motive power is either horse or the quarrymen themselves. The volume of traffic requires a double line of railway for much of the way, and if the map is to be relied upon, these seem to have operated independently, since there is no cross-over at the tip end to allow two-way traffic.

Processing is carried out entirely by hand in the slate sheds at the south-eastern extremity of this level. A number of these are independent structures built near the tip-end, but a portent of things to come is the long row of uniform gwaliau alongside the railway and facing the stackyard. A separate length of railway runs along the back of these to remove trimming waste, suggesting that output is already considerable. There are, however, no facilities for making slabs, unless some blocks are hand-processed in the open.

On this level are also to be found two of the quarry's most important ancillary features, the smithy and the carpenter's shop.

Finished roofing slates are either carried or barrowed to a stackyard on the far side of the double line of railway, where a spur runs off the 3'6" exit railway. Here the *wagenni dre'* ("town wagons", to carry the finished slate away) are loaded. They, and other town wagons bringing what production has come down from levels VIII and X, are then dropped down the lowest counterbalance incline to a yard at the foot where they are marshalled into runs (trains) to be taken by horse along the quarry's own private railway, built in 1832 (Sylwedydd 58), which makes an end-on junction with the Nantlle Railway half a mile to the west. From here they went on to the quays at Caernarfon.

Such machinery as there is in the quarry is hydraulically operated. The feature to the south-west of D quarry is served by a launder or stream coming from the north-west, and appears to be a substantial double wheelpit, whose two wheels measure approximately 30' diameter. The nearer waterwheel to the chain incline appears to be of the backshot type, in which water is collected in a header tank. The wheel immediately to the west may be at a lower level and use the run-off from the other wheel. The necessity for two wheels is not clear, unless both powered the chain incline. There is no evidence for a flatrod system to operate a pump. These features appear to date from Miss Lydia Kane's period as manager of the quarry, which came to a end in 1854 (Sylwedydd 59).

The leat itself is carried along the valley to the west, where it operates in turn a pump-flatrod system at Pen y Bryn (Cloddfa'r Lôn) quarry, probably installed by their Cornish manager Gullett in 1848, and ultimately the slab mill and pumping waterwheels at Dorothea quarry, before they discharge into the Afon Llyfni.

The shaft to the level of the tunnel from quarry D floor IV represents an intention rather than an existing feature, since it has been added to the original plan after a couple of years and there is documentary evidence for its having been sunk and installed some years later. This also is to be a hydraulic feature, along the lines of the existing shafts at Penrhyn and at the Welsh Slate Company's quarry at Blaenau. Possibly it is to tip rubble to relieve pressure on the railway from quarry D VI to the tip, as well as forming part of a broader plan to make the entire workings self-draining by means of a lengthy system of tunnels. The shaft would probably have reached daylight on top of a slate column as at Penrhyn and Oakeley and rubble would be tipped around it until it formed a working level. This seems to have happened, in that the shaft head is now at the same level as the main gwaliau.

Conclusion: Pen yr Orsedd Quarry was in many respects at this period a typical example of an unmechanised site, in which power is provided by hand and by animal. The only exception is the waterwheel-operated chain incline. As such it lagged behind some of the major Blaenau Ffestiniog area quarries, which were beginning to make extensive use of mills.

It enjoys a number of advantages and suffers from a few problems. It is reasonably well supplied with streams to operate wheels and hydrostatic machinery, and its position on the slope of the valley makes a self-draining system a possibility. However, the obligation to deliver a supply of water at a certain contour to Pen y Bryn's system means that any machinery contemplated at a lower level cannot make use of waterwheels, but will need to make use of a higher-cost steam engine. Dependence on water-power for the chain incline will restrict the winding speed, and should output rise above a certain level, a steam-engine will become a necessity here.

The main transport artery through the quarry, the 3'6" railway, makes use of a low-cost counterbalance incline system, whereas the main extraction and processing floor (D VI) is entirely on the level, and opens the possibility of locomotive operation to obviate any possible transport bottlenecks either in the disposal of rubble or in the supply of raw blocks to the gwaliau.

Case study date: **1904-6**

Archival and bibliographic sources: Pen yr Orsedd Quarry has an extensive archive which makes it possible to reconstruct developments in this period. In 1904-6 it was working on an extensive scale with 161 men working inside, and 362 outside (CRO Home Office lists). The quarry had undergone a substantial period of investment in the 1870s, when an intensive factory-style approach had displaced the labour-intensive system apparent in 1862, and was by the early years of the twentieth century undergoing a second wave of investment in new technology, which was effectively to see it through to 1978. This involved the introduction of a three-phase electrical supply to the quarry; nevertheless water-, steam- and animal-power were still being used.

Archaeological description: Most of the features from this period survive to a greater or lesser extent. Detailed

descriptions of the main features are to be found in **4.2.2** and **4.3.2**.

Discussion: The present case study confines itself to the system of operations carried out at Wern Ifan, William, Arthur, Ellen and Twll Caled quarries, and the processing levels that served them, no. 4 and no. 6, known colloquially as *Bonc yr Offis*, "office level", level 5 in between never having developed substantially.

The two mills on 4 level, the large mill and the smaller slab mill to the south, process slate from all four quarries, which are accessed by a chain incline directly to the level, locomotive-worked railways through tunnels, and blondin ropeways whose summit is situated at level 7, and which require the slate to be lowered down two counterbalance inclines.

6 level, with its single large mill, has a tunnel access on the level to Ellen quarry, and also processes slate from Ellen and Arthur which has been lifted out by blondin, then hauled by locomotive to the head of the 6-7 incline, before being dropped down on a counterbalance to level 6. The level 7 locomotive also handles the substantial amounts of rubble coming out the pits on a railway running first east then south on level 7 to the tips.

Before electrification, both hydraulic and steam power was used to power the three mills. In the central part of the Bonc yr Offis mill a waterwheel was initially installed to turn the circular saws and to operate the planer, and a hydraulic pressure system was also used to move the blocks of slate against the saws. Water-power was soon augmented by a stationary steam engine, mounted alongside the water-wheel, initially in the shape of a DeWinton single cylinder engine, later a Robey double-cylinder machine.

The relative positions of the three mills - adjacent to each other on a sloping hillside - would have made them ideally suited to the conventional hydraulic system whereby a sequence of waterwheels from the same flow could have operated them. However, Pen yr Orsedd suffered from a legal constraint, whereby water had to be delivered to the neighbouring Pen y Bryn quarry at a certain level; this lay above the level of the no. 4 mills, but below no. 6. Instead of a water-wheel therefore, no. 4 mill was powered by an unusual wire-rope drive from the prime movers in no. 6 mill.

A steam engine initially also powered the blondin system into Arthur quarry, constructed in 1900.

The electrification programme carried out in 1906 involved installing electric motors in the blondin winding house overlooking Arthur, in the level 6 mill and in the trusses of the larger of the level 4 mills. However, while this doubtless speeded up the quarry's work, it did not alter the process flow, and some of the quarry's technology remained unaffected. The internal railway system continued to be operated by steam locomotives, and the exit railway from the stackyards by the mills to the standard gauge railway at Tal y Sarn station by horses, as it had been in 1862, and as it was to remain until 1963.

Similarly, hydraulic power remained important. Not only did a pressure system continue to drive the saw-tables in the mills, but a water-wheel continued to pump out William quarry. The other pits were drained by an extensive underground system driven in the 1870s, but for reasons which are not clear, William quarry was not connected to this. The same waterwheel also operated the chain incline which hauled out of Wern Ifan quarry, until it was replaced by an electrically-driven blondin in 1926.

Conclusion: From being technologically backward for its time in 1862, by 1904-1906 Pen yr Orsedd was a remarkably advanced site, making extensive use of a newly-available and cheap energy source. However, other and more old-fashioned power-sources were still being used. Horses still pulled the slates on the exit railway, and steam locomotives pulled all the internal transport. Water-power continued to pump, to operate a chain incline and to power the saw tables. The wire rope drive from the Bonc yr Offis mill to the floor 4 mill, illustrates the proprietorial constraints within which quarries had to make use of hydraulic power. The site of these mills is ideally suited to a series of waterwheels on the same supply, each supplying its own mill; however, the quarry was under an obligation to pass on its water to its neighbour, Pen y Bryn Quarry, at a particular contour, which lay above level 6, so a waterwheel in the floor 6 mill was not a possibility.

4.1.3 CASE STUDY 2

Site name: **Hafodlas Slate Quarry**

Community: **Betws y Coed**

Quarry area: **Dyffryn Conwy**

Trust PRN: **20156**

Grid ref: **SH77905620**

Site history: Hafodlas quarry is situated in the Dyffryn Conwy quarrying district on the northern slopes of the Llugwy valley, and worked a poorly-cleaved vein of slate from the 1860s to the 1920s. Output was mostly slab, sometimes in the form of roughly-trimmed building blocks, evident in many of the late nineteenth century houses at Betws y Coed, some roofing slate, and some enamelled fancy work. A remarkable feature of the quarry was the involvement of some well-known engineers; James Swinton Spooner was engineer to the company until 1862, when construction of the mills began, perhaps to his design. William Fothergill Cooke of electric telegraph fame succeeded Spooner, and he encouraged George Hunter's work on renewable tip saws, which are much in evidence of the site. Daniel Gooch, engineer of the Great Western Railway, took over the quarry in 1866, and his son Henry became the manager. The quarry owes much to the granite workings of Aberdeenshire, particularly the saw technology developed by the Hunter family.

Case study date: **1890**

Archival and bibliographic sources: No quarry archive survives; however, Fforwm Plas Tan y Bwlch are about to publish a history and archaeological description of the site, information from which was made available to the Gwynedd Archaeological Trust. Map coverage is good, and this case study is based in part on the evidence of the 1890 25" ordnance survey.

Archaeological description: Though heavily wooded in places, the most important features of the site survive. Most of the quarry buildings still stand, apart from the London mill of 1896, which was built out of corrugated iron, and is now only visible as a flat area. The saws with which the impressive mill buildings were equipped have long been removed, but their bases are apparent, and some of the incline equipment remains *in situ*. Fragments of a composite waterwheel were discovered, and the turbine which replaced it in 1896 is thought to survive in use on a farm near Dinas Mawddwy.

Discussion: In 1890 the quarry site was being worked on levels 4 and 5. Operations had apparently been cut back, since the trace of an already-disused incline up to 6 is evident. Extensive tips on level 6 running to the north make it clear that there had been considerable early working on this level. Work was evidently very desultory; a mere eighteen men produced 375 tons, 20.83 tons per man per year, way below the usual quarry-manager's desideratum of thirty tons per man per year, and a lot poorer than the quarry's best in 1905 when 60 men produced 1,840 tons, a make of 30.6. No mechanical power sources appear to have been used in the quarry itself, either for extraction or transport. Hand-held jumpers held sway, and wagons were moved by hand or gravity or horse. Though the remains of a derrick crane survive on floor 5, it appears that this was hand-operated.

The mill complex, however, made use of a sophisticated hydraulic scheme. The two backshot wheels worked in sequence; both were standard mill-wheel sizes - and the lower is known to have been a wooden strut wheel. Each would be capable of generating approximately 26hp. The central waterwheel was attached to line shafting which ran the length of the mills in an underground channel to the south-eastern extremity of the mill complex), where it operated two sand-saws by a lay-shaft. The rear external waterwheel operated a truss-level line-shaft in the north-western mill by a belt-drive through the roof; however, both wheels could be disengaged, or made to operate the entire line-shafting individually.

What they could not do either separately or in conjunction was operate all the machinery, and it is unlikely that it was ever intended to use all of the machines together. Precisely how much power a Hunter saw required cannot now be ascertained exactly; if it did all that was claimed for it, its 4' blades running at a peripheral speed of 45'

per minute, each blade is likely to have required 21 hp. In practice, Hafodlas' Hunters must have operated at a much lower figure, since the very limited power source was rigged up to no less than five Hunters, as well as perhaps five Greaves saws, at least three planers, two sand-saws and other machines as well - a Jenny Lind polisher and the incline uphaulage equipment from floor 3. Whatever the scale of operations, it was congruent with the power sources, but both were far less than the capacity of the processing machinery.

It is therefore highly unlikely that a visitor to Hafodlas mill in 1890 would have seen more than one or two machines operational at any one time, even allowing for more active periods when work would be making up for days lost to drought or ice - remarkably, for a quarry opened by men whose expertise was steam, no-one ever installed an auxiliary engine to tide the quarry over periods without water.

However, a number of suggestions as to process-flow in the mills are possible. The bank of three Hunters would have formed a useful production-line for the squaring of blocks for building stone. The long moving tables of a Hunter saw would enable blocks to be crowbarred from one table to the next set out as they are in a row. Access could be at either end of the mill.

The other side of the same building may have concentrated on more delicate work. One of the Hunters might well have been used for initial reduction, but a sequence of Greaves saws and planers could be used for finer squaring of slabs, a suggestion born out by the Jenny Lind planer nearby. Access could have been from either end of the building. Once this part of the process was complete, they could if necessary be trammed across the mill to the enamelling kilns.

The relationship between machinery in the original 1863 mill is more problematic, compounded by the fact that the diamond saw base uncovered there over the last few years is obviously a twentieth-century installation, and the type of machine in the eastern corner is as yet unconfirmed. However, since both the railways into the building connect directly with the enamelling kilns opposite, it is quite possible that the work here involved a sequence of initial reduction, carried out by the Hunters, then finer work carried out by a planer and other shaping tools, followed by enamelling.

The machinery area (14) to the south-east of (3) has been altered a number of times, and there is no firm evidence for what it contained in 1890. If however, it already contained sand-saws, the likelihood is that this was used for all-night running where blocks with a particularly smooth edge were required, for brewery cisterns and the like.

Conclusion: The comparatively ornate structure and the array of machinery, out of scale for a fairly modest excavation, suggests that Hafodlas as established by Spooner, Cooke, Gooch *et alii* was either a speculation set up purely with the intention of passing it off on to a naive investor or, more probably, a showcase for up-to-date machinery. A remarkable feature of the mill is the use of hydraulic power by engineers whose familiarity was with steam, and the absence of any mechanically-powered features in the quarry pit itself contrasts markedly with the technological innovativeness of the processing areas.

4.1.3 CASE STUDY 3

Site name: **Rhos Slate Quarry**

Community: **Capel Curig**

Quarry area: **Dyffryn Conwy**

Trust PRN: **20110**

Grid ref: **SH72905640**

Site history: Rhos quarry forms part of the Dyffryn Conwy quarrying district, and is situated in one of the tributary valleys, on the northern slopes of Moel Siabod. It belonged to the Gwydir estate. The quarry pit and processing area were connected to a roadside wharf at Pont Cyfyng by a railway which was originally built in the 1860s for its neighbour, Foel quarry. A water-powered mill on the main processing level did duty from 1867, enlarged several times over the years, though plans to create a second processing level on the next floor down came to nothing after a 50' waterwheel had been constructed. A waterwheel on the main level built new in 1920 operated a compressor purchased the previous year (CRO: XD 38 355).

Case study date: **1934**

Archival and bibliographic sources: There is little quarry archive for Rhos, though some records survive in the Gwydir estate papers in the Lincolnshire Record Office and some in the Caernarfon Record Office. The fact that it continued working until 1952 means that a number of central government records survive, and a series of photographs taken by Geraint Madoc Jones after the second world war shows the waterwheels at work (CRO: XS 1608 6). An account appeared in Williams and Lewis, 1989.

Archaeological description: Most of the features of Rhos Quarry survive, though the waterwheels and machinery have been scrapped. Detailed descriptions may be found in **2.20110** and **3.20110**.

Discussion: In 1934 Rhos quarry was working on a small scale with 25 men inside and 20 outside (CRO: Home Office list). Working methods were in many respects archaic.

The pit was worked on four floors, of which the lowest drained the workings by means of a long tunnel out to the abortive processing area. This also seems to have been used to tip rubble, and it is possible that it was locomotive-worked in this period.

Haulage out of the pit, which had at one time been carried out by means of a water-balance incline, whose winding-house survives, was from 1934 carried out by a chain incline operated by an overshot composite waterwheel. This method, more reminiscent of the 1840s than of the 1930s, was devised by the quarry blacksmith, but was probably adequate for the quarry's small scale of operations.

Once loaded wagons had been raised to the gallery in the quarry which corresponded to the main processing level, they were taken either to the tips or to the mill. Locomotive haulage was practised on this level. The mill itself was powered by a 30' diameter, 4'3" breast overshot waterwheel, working under capacity - as early as 1911 seven out of the twenty-one saw tables were out of use. Roofing slates were dressed, either mechanically or by hand, in the semi-integral *gwaliau* along the northern longitudinal wall. Evidence of some recent investment in new machinery was the stationary internal combustion engine in the mill powering a second compressor by a belt drive through a slot in the mill wall. It is also possible that some sort of prime mover in the barrack range powered a compressor.

Conclusion: Rhos Quarry exemplifies the problems of managing a small quarry on a small budget. The decision to install a waterwheel in 1934, and the continued use of water-power until 1952 made sense in view of the comparative remoteness of the site, which would otherwise have involved hauling fuel up the inclines, and rainwater was abundant.

4.4.3 CASE STUDY 4

Site name: **Rhiwbach Slate Quarry**

Community: **Bro Machno**

Quarry area: **Blaenau Ffestiniog**

Trust PRN: **20313**

Grid ref: **SH74004620**

Site history: Rhiwbach quarry is situated on the bleak uplands of Manod, and has been worked since at least 1774, but was only developed on a substantial scale after the arrival of a new company in 1860, who constructed a railway over the Manod ridge from the quarry to Blaenau Ffestiniog. It was worked both as an open quarry and as a mine, and closed in 1953.

Case study date: **1862-1953**

Archival and bibliographic sources: Archive documentation for Rhiwbach quarry is good, and a typescript partial history of the site has been made available by Griff Jones of FForwm Plas Tan y Bwlch.

Archaeological description: Most of the buildings and main features of Rhiwbach quarry survive, though all machinery was removed soon after closure. Detailed descriptions may be read in **2.20313**, **3.20313** and **4.20313**.

Discussion: Arrangements at Rhiwbach quarry dated from a re-orientation of the quarry carried out in 1862-3 in order to connect it to its own railway across the plateau to Blaenau Ffestiniog. Since the first stage of this journey out of the quarry premises unusually involved an incline uphill, unlike the normal situation in other quarries where counterbalance inclines could take the finished product downhill, the quarry management took the unusual step of installing the power source at the incline foot, in the shape of a substantial steam engine known as *injan fawr* ("the big engine") built by the Haigh foundry of Wigan. From here it could not only haul wagons of finished slate up the exit incline, by means of a return sheave at its summit, but also power a shaft to underground workings, and operate a mill. The railways installed in this early period are marked in green.

Raw blocks of slate for processing came from two extraction points. One is the "upper quarry" immediately to the south of the engine house, which involved hauling blocks up the shaft and tramming them to the mill. The other was the "new quarry" on the southern perimeter of the site. Blocks extracted here were raised on an incline from the pit itself, then trammed northwards to a further incline which took them up to the mill. It is not known how either of these inclines worked. Possibly the one by the mill was worked by a remote transmission system from *injan fawr*. Possibly the incline in the new quarry was powered by a waterwheel by means of flatrod system; one such extends from a wheelpit to the south, which certainly worked a pump in the new quarry.

Changes came in the 1880s; from this period the shaft became disused, as the upper quarry ceased to be worked and was used for tipping. The lower mill was built to serve the new quarry on this level (29), powered by its own oil engine. Like the upper mill, this was equipped with sawing, planing and dressing machines, and was therefore clearly capable of turning out slabs (Jones GR nd p. 9).

A further major change in the quarry's alignment came in the late nineteenth century, after the appointment of Henry Humphris as manager in 1896. Humphris resolved to win slate from an entirely new set of workings to the east but to work them underground. Development work began with the construction of an incline down from the main mill level in 1899 (the additional railways installed in this period are marked in red), and the new underground quarry became the focus of operations from 1902. The incline down to these levels was once again worked off the main steam engine, by a wire rope carried on four-legged supports some of which may still be seen (**3.20313**). By the time operations ceased in 1953 working was confined to an open quarry alongside this incline and one underground chamber to which it gave access.

The four original boilers for injan fawr were replaced by one Babcock and Wilcox water-tube boiler *c.* 1889. The

steam engine was replaced by two electric motors in 1934 and a diesel motor was installed to operate a compressor in the mill at around the same time.

As well as stationary plant, the quarry made use of a locomotive, constrcuted on the premises by Ifan Owen Roberts, the quarry blacksmith, out of an Austin 7 car engine and gearbox mounted on a skip chassis.

Conclusion: Rhiwbach Quarry is a particularly impressive archaeological survival, and an unusual site, in which, as much as possible, the one power-source was made to serve a number of separate functions over a considerable distance - unlike other quarries which also made use of steam plant, such as Pen yr Orsedd, which used a number of different engines on a dispersed site. However, as at Pen yr Orsedd, waterwheels were used alongside steam; as at Pen yr Orsedd, steam yielded to electricity, though here as late as 1934.

2 MILLS: ARCHAEOLOGICAL AND DOCUMENTARY DATA

Site name: **Dorothea Slate Quarry**

Community: **Llanllyfni, Gwynedd**

Quarry area: **Nantlle**

Trust PRN: **2033**

Site history: Dorothea Quarry was worked from the 1840s to 1970 as a series of deep pits on the floor of Dyffryn Nantlle, ultimately united in one vast excavation. A waterwheel-powered mill containing sand-saws known as Melin Griffith was constructed in 1842 to produce slabs, and though this has vanished, from 1882 the quarry began the construction of a substantial mill on the bank to process roofing slates (feature 13 below) followed by a smaller mill begun ten years later (feature 8 below).

Feature no: **13** Feature type: **longitudinal slate mill**

Grid ref: **SH50005306** Statutory protection: **Scheduled Ancient Monument**

Archival and bibliographic sources: Construction of this structure began in 1882 and was completed in four stages by *c.* 1900, when it contained forty-one saw tables. The first portion to be built consisted of the western gable, four bays, containing ten saw tables and a house for a steam engine to drive the plant, a single-cylinder horizontal engine, formerly used as a winder, salvaged from a landslip. In 1884 another six bays, containing twelve saws, were added, and two years later a second steam engine, a two-cylinder horizontal was added. Six further bays were added subsequently (Pierce Jones 1980 p.165).

Archaeological description: Constructed on the working bank of Dorothea Quarry, to the south of the main quarry pit, and orientated east to west. A substantial structure built in several stages. It is now roofless and in places severely dilapidated, though the walls for the most part survive up to truss height. The mill is of the longitudinal pattern, with railway access at several points in both gables, and with splitters' booths along each longitudinal wall. Each has a pedestrian egress through the longitudinal walls to give access to loading aisles running parallel to the building.

Along the south longitudinal walls are two extensions, each of which appears formerly to have housed a boiler and a steam engine; further ranges survive to the south of the more easterly engine house.

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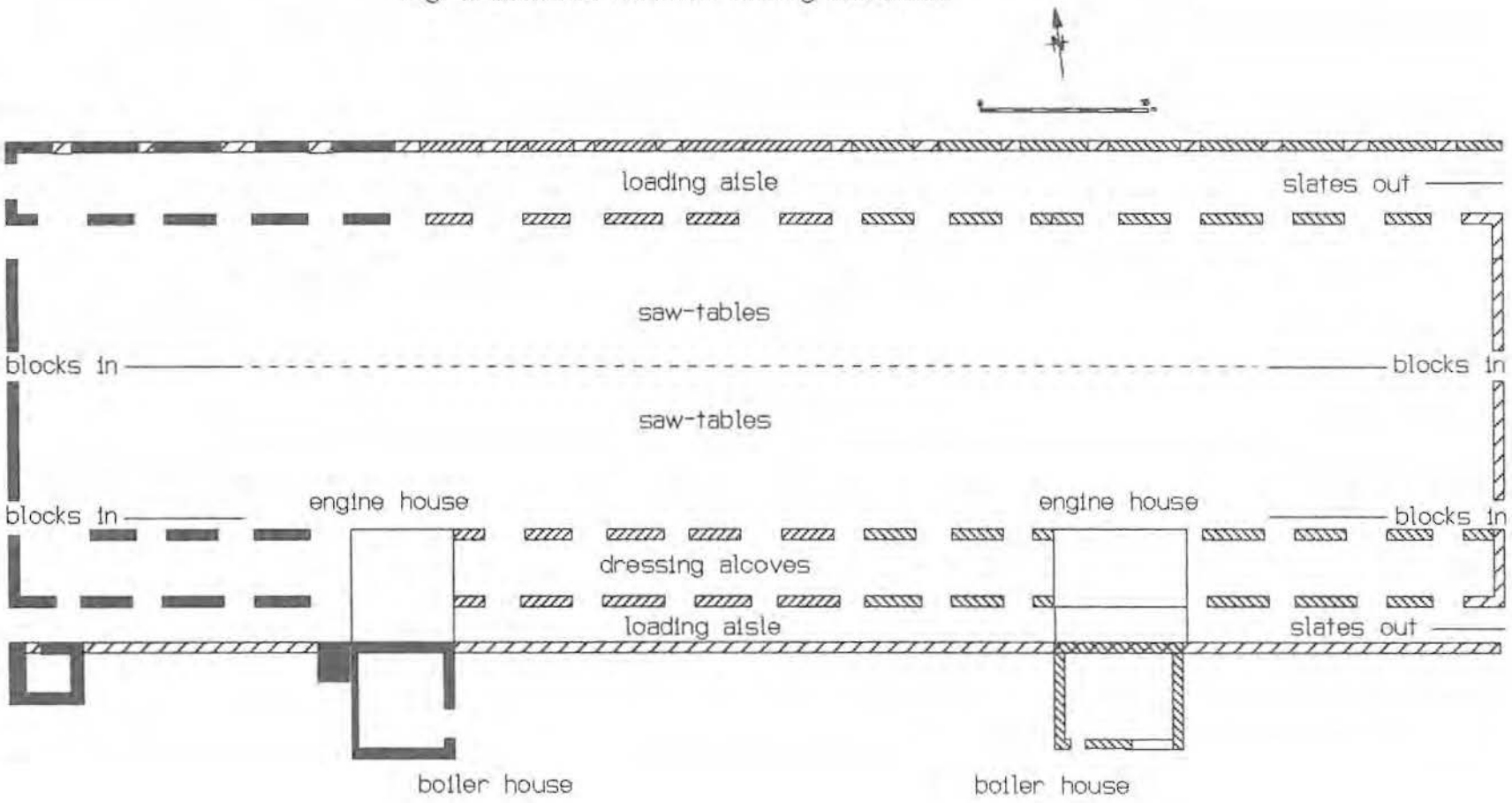
Discussion: a substantial structure, capable of accommodating two rows of saws.

Conclusion: of national significance in that it exemplifies the processing needs of a large slate quarry, and the relationship between mechanical sawing and hand-splitting.

Fig. 1: 20033:13 Dorothea Quarry slate mill



Site name: **Cloddfa'r Lôn Slate Quarry**

Community: **Llanllyfni, Gwynedd**

Quarry area: **Nantlle**

Trust PRN: **20036**

Site history: Cloddfa'r Lôn was the earliest quarry of any size on the lower slopes of Dyffryn Nantlle, and was the original terminus of the Nantlle Railway when it opened in 1828. It was worked in four pits; a programme of investment in the early 1880s caused the quarry to develop a working bank on the eastern perimeter of the quarry, where a barracks had been built in the 1860s. This was equipped with winding equipment, a mill (feature 31 below) and gwaliau. This development proved short-lived as the quarry was sold in 1892, and this part was never put into re-use.

Feature no: **31** Feature type: **radial slab mill**

Grid ref: **SH50245341** Statutory protection: **none**

Archival and bibliographic sources: The mill, dated 1884, contained six DeWinton saw tables "in pairs" and a saw sharpener; steam for the engine was generated by a DeWinton boiler (CRO XD Dorothea 612 and 614), and the engine itself was a single vertical cylinder (15" bore 42" stroke) by W.C. Mather (Pierce Jones 1985 p. 37). The 25" ordnance survey of 1889, the only one to show rails in situ, shows a siding running outside the building, parallel to the northern longitudinal wall, and a length of railway entering the southern longitudinal wall, leading ultimately to a row of gwaliau, a tip run and the exit incline to the Nantlle Railway.

Archaeological description: Constructed near the north-western perimeter of Cloddfa'r Lôn, near the edge of one of the pits, now largely filled with waste from Gallt y Fedw, and within easy tramming distance of Twll Mawr as well as of the exit railway, tips and gwaliau. It is built on the natural ground level, near to a pre-existing farm settlement, Pen y Bryn, which consists of a two-storey farmhouse, now uninhabited, and a two ranges of quarrymen's accommodation.

The mill is a pitched-roof structure orientated east to west built out of unsawn slate blocks. The walls survive up to truss height, apart from an extensive area of collapse on the northern longitudinal wall. The gable ends are each pierced by a doorway large enough for a railed wagon, as is the southern longitudinal wall. Contiguous with the east gable wall but projecting northwards are the roofless remains of a lean-to boiler house, to the west of which is an engine house, with a pit for the engine base and a number of holding-down bolts. To the north are a square-plan chimney and a slate pillar.

The engine, which survives in dismantled form at the Welsh Slate Museum, is a single-cylinder vertical wall-engine, in which a drive axle and flywheel are mounted on an iron casting in the shape of a classical frieze supported by two Ionic columns.

29 January 1997 DRhGwyn

Discussion: The mill itself seems to have processed slabs which were then hand-processed in the gwaliau shown on the maps to the south. It is not clear whether there was an slab sale from the quarry.

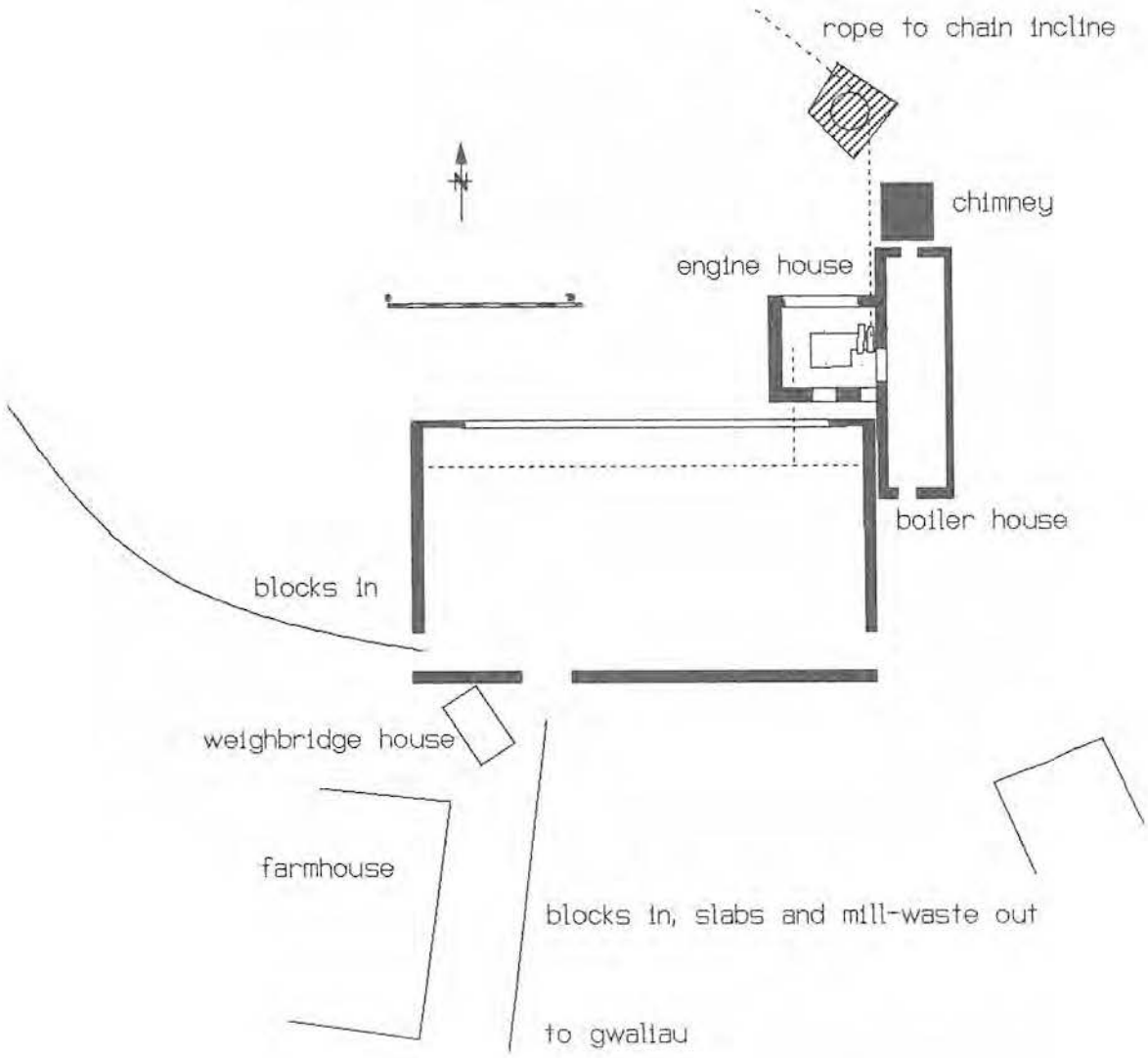
The mill engine was probably bought second-hand, since it is of a type more commonly used in Lancashire cotton mills around the middle of the century. This is the only mill steam engine to have been preserved from the Gwynedd slate industry (Pierce Jones 1985 p. 37).

The engine itself is discussed in D. Morgan Rees' *Cymmrodorion* article; he suggests that it may originally have also been used as a winder when it was *in situ*, arguing that the remains of three bearings on the wall adjacent to where the engine's flywheel was situated suggest as much, since two of these might have carried one end each of the two winding drums, powered through gearing. The bearings are no longer visible, presumably having been displaced when the engine was removed to Amgueddfa Lechi, but it is clear that the drive axle ran parallel to the mill line-shafting, and powered it by a belt-drive through the mill roof. The engine also has reversing gear

(Morgan Rees 1970 p. 173). In all probability the slate pillar near the chimney carried an angled sheave to adjust the direction of winding rope leading from the engine to a now-vanished chain incline base.

Conclusion: of national importance as the only mill whose steam engine power-source survives intact (albeit elsewhere) and as a good example of a radial mill. Its value is further enhanced by other surviving features on site.

Fig. 2 20036:31 Cloddfa'r Lon slab mill



Site name: **Pen yr Orsedd Slate Quarry**

Community: **Llanllyfni, Gwynedd**

Quarry area: **Nantlle**

Trust PRN: **20039**

Site history: Pen yr Orsedd quarry is situated on the northern slopes of Dyffryn Nantlle, and has been worked from the late eighteenth century. The purchase of a lease by a new partnership in 1862 led to substantial investment in the quarry, reflected in the provision of mills and uphaulage systems, making use of both water and steam power. Further investment in 1906 resulted in an ambitious programme of electrification. The quarry remained in production until 1978, and was later re-opened using modern methods, but a recent rockfall has put its future in doubt.

Feature no: **8** Feature type: **longitudinal slab mill**

Grid ref: **SH50885369** Statutory protection: **none**

Archival and bibliographic sources: This, Pen yr Orsedd's first mill, was under discussion in November 1867, when it was proposed to construct a steam-powered mill for two small tables. When it came into being the following year, it was slightly more ambitious; a new steam engine had been bought for it instead of the second-hand one they originally proposed to use, a Hunter saw had been ordered for £200 and a 9' by 5' planer for £100 (CRO Pen yr Orsedd Additional 1873 118-121).

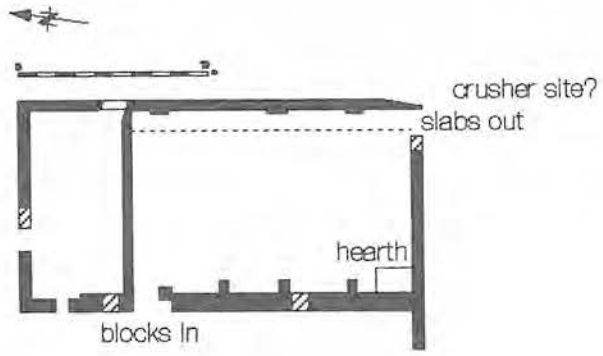
Archaeological description: Situated on the made-up ground of level 4 at Pen yr Orsedd, and orientated north-west to south east. Against its south-east gable wall is the slate-built base for what may have been a slate crusher, fed from a chute on level 5. The mill is built out of unsawn slate blocks; its roof survives, carried on four king-post trusses. It is accessed by a door in the south-east gable and in the south-west facing longitudinal wall. The slab floor gives no indication of what machinery may once have been installed here, though there is a smithing hearth in the southern corner. The bearings for longitudinal line shafting survive. There is a separate room with pedestrian access in the north western part of the building.

27 January 1997

Discussion: This is now the oldest surviving mill in the Nantlle valley. Small independent slab mills may have existed from the early nineteenth century if not earlier, and Melin Griffith at Dorothea was built *c.* 1840.

Conclusion: of national importance as the earliest surviving slab mill in the Nantlle quarrying area, and for its relationship with the other features at Pen yr Orsedd.

Fig. 3 20039:8 Pen yr Orsedd Quarry slab mill



Feature no: **9** Feature type: **longitudinal slate mill**

Grid ref: **SH5085373** Statutory protection: **none**

Archival and bibliographic sources: The lower mill, built next to the slab mill (8), dates from the 1870s, and housed twenty-seven DeWinton hydraulic feed saw-tables and twenty-six dressers. It was initially powered by a wire rope transmission from the waterwheel and steam engine power-sources in the Bonc yr Offis mill (20) (Pierce Jones 1985 37), until after 1906, when electric motors were installed in the roof trusses.

Archaeological description: Situated on the made-up ground of level 4 of Pen yr Orsedd, and orientated north-west to south-east. A large integrated slate mill, built out of unsawn slate blocks, with a dual pitch roof, from which some of the slates have slipped, supported on double king-post trusses, with a timber skylight gable in between. The trusses are in several instances leaning over at a dangerous angle, and collapse of the roof seems inevitable; the north-west gable wall also threatens to collapse. Outside, at the northern corner of the mill, is a substantial area of a collapse from a part brick-built part slate-built structure which formerly stood here. There is a doorway in the south-west facing longitudinal wall, and blocked doorways in the gables for three longitudinal tramways, further evidenced in the form of soot-marks from locomotives on the trusses.

Though the DeWinton hydraulic feed saw tables with which it was formerly equipped have been removed and the floor concreted over when it was in use as a coal store, two sets of line-shafting and their substantial pulleys survive.

27 January 1997 DRhGwyn

Discussion: It is possible that the collapsed building on the northern corner of the mill have been connected to the wire-rope drive from the Bonc yr Offis mill.

This building exemplifies the intensive factory approach to slate processing adopted at Pen yr Orsedd after the experimental mills of the period 1860 to 1874, in which the hand-processing work areas are not separated from the mechanical processing. It has been recorded by students on a Plas Tan y Bwlch/Hull University course in August 1996.

Conclusion: of national importance as exemplifying the intensive factory style approach practised by the quarry, for its unique power-drive and for its relationship with the other features on site.

Feature no: **20** Feature type: **longitudinal slate mill**

Grid ref: **SH51005383** Statutory protection: **none**

Archival and bibliographic sources: In 1875 the DeWinton foundry in Caernarfon drew up plans for a two-gable mill (unit 1 below) on the next level up from (8), on the level known as Bonc yr Offis. This was served by three longitudinal railways, and powered by a waterwheel set in its north-west gable end and an auxiliary steam engine (CRO Pen yr Orsedd 381). This complex was evidently in existence by 1877, when a further set of plans, once again from the DeWinton drawing office, shows an extension to the north-west (unit 2 below), giving a large structure with a central power-source (CRO Pen yr Orsedd 402). The valuation of 1907 records a 30' waterwheel here, as well as a double cylinder 14¼" X 18" Robey steam engine, dating from 1903, and a boiler of 1899 (CRO Pen yr Orsedd Additional 2059). The same source also records the power transmission system to a lower mill, constructed next to the slab mill of 1867/8, operated by a series of endless ropes from the Bonc yr Offis mill.

Archaeological description: Situated on level 6, colloquially Bonc yr Offis, at Pen yr Orsedd quarry, on made-up ground comprising slate rubble. A double-gable two-unit rectangular structure with traces of a skylight gable in between the roof pitches, orientated north-west to south-east built out of unsawn slate blocks. The two units are separated by a central machine area, which includes a wheel pit and traces of steam engines and an electric motor and there are two lean-to structures against the south-east gable end, one partly roofed, as well as the traces of a further one against the north-east longitudinal wall.

The gable ends of unit 1 survive up to roof height except in the centre portion of the south-eastern example, which

has collapsed entirely. The south-west-facing longitudinal wall survives up to the original height, approximately 3m, and the opposite wall survives to a maximum of 1.5m high.

The walls of unit 2 have been demolished above ground level.

The collapse of the central portion of the south east-gable of unit 1 suggests that there might have been a central doorway at this point. Both gable walls are pierced by two side doors suitable for a railway; those on the south-east preserve wooden sliding doors painted in red oxide. The south-west longitudinal wall is pierced by two pedestrian doorways.

The double king-post trusses from unit 1 survive on site but have been removed and stacked along the south-west longitudinal wall. A row of double brick support bases runs down the middle of unit 1, in which vertical timbers were formerly anchored to support the trusses. Two remain in situ at the wheelpit end, secured by a cross member in an H arrangement, secured by iron brackets.

Similar brick support bases are evident in unit 2.

Underneath the one surviving H frame in unit 1, is the vertical cylinder for an accumulator, and nearby is a substantial double DeWinton hydraulic feed slate saw table.

In one of the lean-to structures against the south-eastern gable end of unit 1 is a slate planing table, substantially complete, formerly powered by a belt drive from within unit 1.

In unit 2 there survive the fragmentary remains of wooden frames for Greaves dressers.

The waterwheel pit is sufficient for a substantial overshot or backshot wheel; holding-down bolts for the axle box survive. The nearby engine house is internally rendered, and preserves the trace of a flywheel in the plaster. There is also a switchboard for an electrical installation and an axle box for longitudinal line shafting into unit 1.

27 January 1996 DRhGwyn

Discussion: This was the only large-scale water-powered mill, such as were becoming common in the Ffestiniog area, in Nantlle; it was preceded by a smaller water-powered mill at Dorothea known as Melin Griffith, built 1842, of which nothing now remains (Pierce Jones 1980 165).

The process flow seems to have involved longitudinal access by railway along both edges of the building, feeding in both cases a transverse process to the saw tables and then hand-splitting and mechanical dressing, before trimming waste and finished slates are removed on two parallel railways down the middle of the building.

The two units appear to be little different from those on the plans in the quarry archive, though there has clearly been considerable alteration in the power source. The mark of a flywheel suggests that the Robey two-cylinder engine had been preceded by a single-cylinder machine of uncertain manufacture, and clearly electric motors had been installed more recently. The power needs of a saw with a hydraulic ram are now beyond recovery, but it seems likely that the first steam engine was installed after the rope drive to the lower mill (feature 9) was installed.

The two surviving saw-tables correspond in size to those on the original plan. The hydraulic feed system appears to be unique to Pen yr Orsedd. Whereas normally the same power source fed both the saw and the table itself (through a worm on the drive spindle), here the waterwheel and its successors powered the saw, and hydraulic pressure operated the table. The explanation may be that Pen yr Orsedd worked slate of very different consistency and hardness, effectively from three different veins, and that variations might be found within the same block. Greater control of the sawing process was therefore necessary.

Conclusion: this building is of outstanding archaeological importance in that it exemplifies the three major types of power source in the industry (water, steam and electricity), as well as both mechanical and hydraulic transmission systems. Its value is further enhanced by the survival of unique DeWinton-built saw-tables and a planer.

Fig. 4: 2003:9 Pen yr Orsedd Quarry lower slate mill

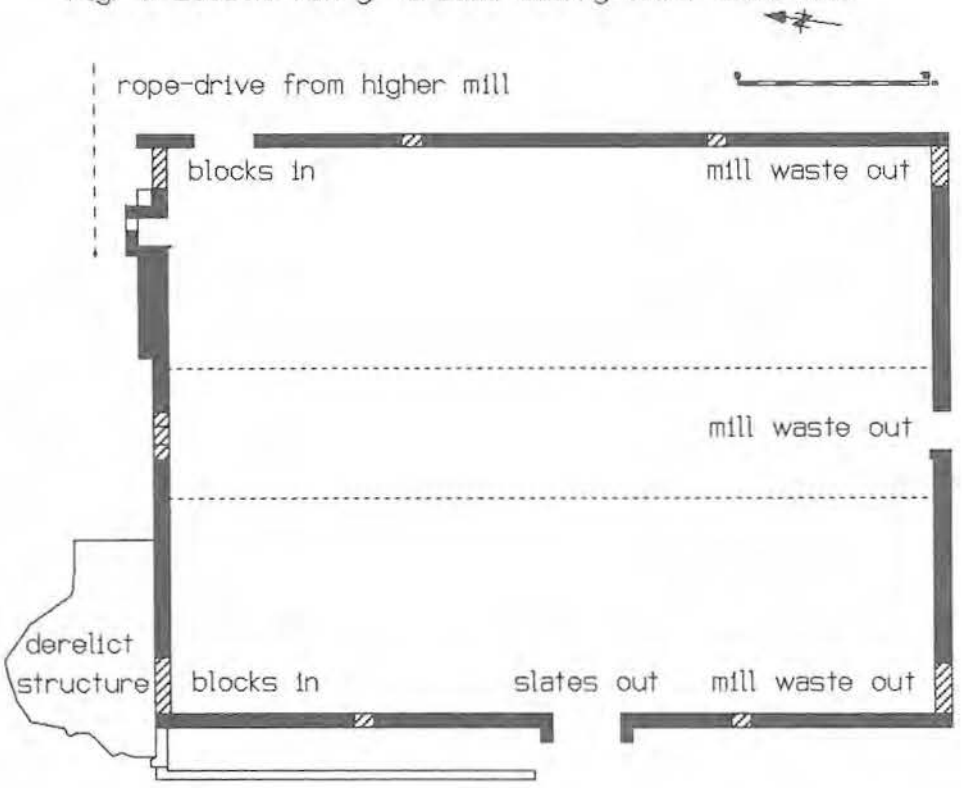
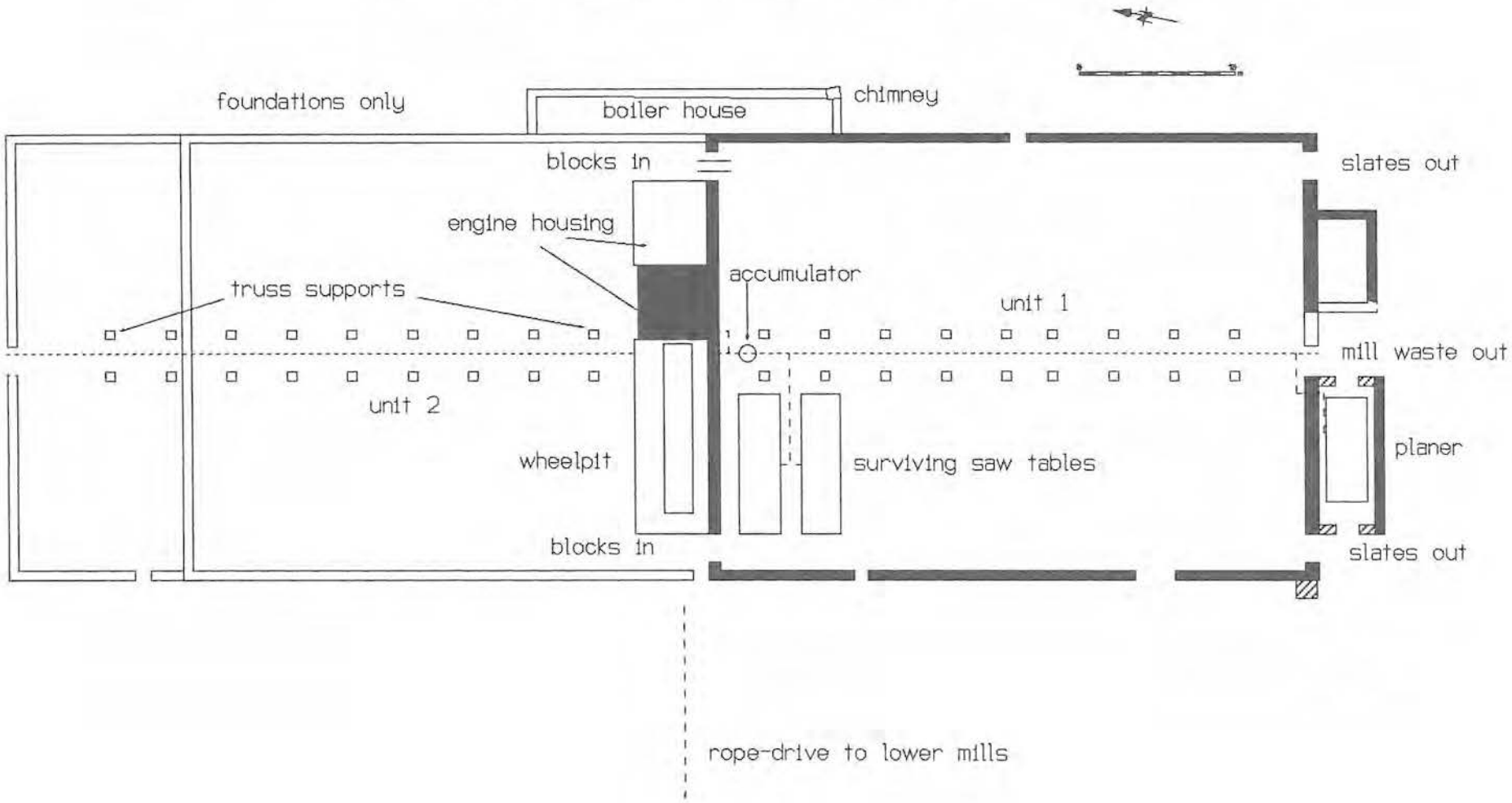


Fig. 5: 20039:20 Pen yr Orsedd Quarry upper slate mill



Site name: **Penrhyn Slate Quarries**

Community: **Llandygai, Gwynedd**

Quarry area: **Bethesda**

Trust PRN: **20061**

Site history: Slates have been worked at Cae Braich y Cafn since at least the sixteenth century, but it was only after the scattered workings had fallen into the hands of Richard Pennant, first Lord Penrhyn, that they began to be worked in an integrated fashion. He constructed an iron railway from the quarry to the port in 1800-1801, and in 1803 at the first point out of the quarry where it crossed a stream, he established a slab-mill, known as *y felin fawr* ("the big mill), equipped with fourteen reciprocating sand-saws. As well as an off-site processing point, it became the engineering focus for the quarry, and remained as such until 1965. Features here were constantly replaced and upgraded.

Feature no: **7 and 9** Feature type: **transverse slab mills**

Grid ref: **SH61496637** Statutory protection: **Listed grade II and grade II***

Archival and bibliographic sources: Though a mill had been operating on this site since at least 1803 (Boyd 1985 22), if not earlier (Williams W 129), and further structures followed in 1846 and 1855, the first built by Francis the manager, the second by him and his son, it appears that both these structures were built in 1865-6 (Hughes 127, XPQ 997 p. 20).

One of the mills was extended in 1867, starting on 3 September, to accommodate a Hunter saw, sold on 25 April 1891 to Prince Llewelyn Slate Quarry, Dolwyddelen (CRO PQ 99 2) and a locomotive shed, first referred to in January 1877 (CRO: PQ 55 4) was added to the western mill with the introduction of steam traction on the exit railway. The upper section of railway was improved for locomotive use in 1874, and a locomotive was at work from December 1876.

One was partly converted to a joiner's shop after 1952, but some processing of slabs went on at the site until the 1960s (pers. comm., Iorwerth Jones).

Archaeological description: Situated on made-up ground north of the Penrhyn Quarry, at a point where the course of the former railway crossed the Afon Galedffrwd, and forming part of a cluster of industrial buildings connected with the quarry, which includes a foundry and locomotive repair facilities.

The two mills are parallel, orientated north to south. Both are built of country rock, though the western mill has a northern extension built of slate slab sawn with a circular saw. Both are of the transverse pattern, with four pairs of doorways in the eastern building, five in the western. The doorways are of the segmental arch type. The roofs remain intact, supported on queen-post trusses.

Truss-height longitudinal line-shafting brackets survive in the western mill, though a central truss-height line-shaft was noted in the northern extension; the central part of the mill is boarded off and is inaccessible. The eastern mill is kept locked, but the pattern of axle-boxes in the southern gable wall suggests that there were at least three longitudinal truss-level line shafts in this structure.

Between the two mills is a suspension waterwheel situated in a slab-lined pit, sheltered by a garden-bond brick structure (see **1.20061**).

In the southern end of the western mill there are traces a three-phase electrical supply; there are timber joists which may have supported an electric motor, and modern concrete machine bases for a diamond saw.

9 January 1997 DRhGwyn

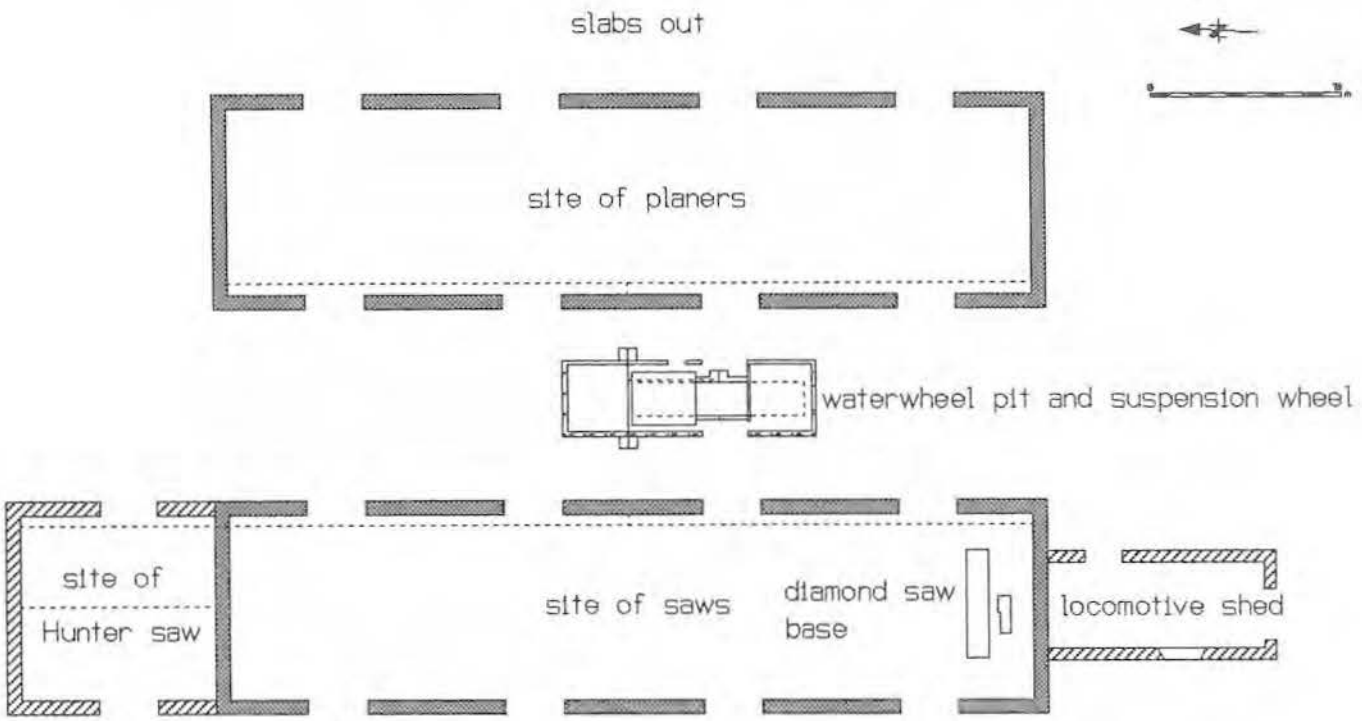
Discussion: These two mills do not date from 1803 and 1834, as has previously been suggested. Both are transverse pattern mills of the period 1865-6, and therefore slightly later in date than the transverse mills at Prince

of Wales (1864), slightly earlier than Cwt y Bugail (1867), Arthog (1868) and the now vanished mills at Cwm Machno (c. 1870).

It is highly likely that William Francis and his son John, who succeeded his father as manager of Penrhyn quarry in 1866 (Hughes 127), were responsible for the Prince of Wales mill, and that it is therefore the immediate prototype of Felin Fawr. Not only does it repeat the transverse pattern, but the style of doorway is similar, though with depressed, rather than segmented arches. The Francises were major investors in the company set up to work Prince of Wales in 1863 (Williams D 15), and were publicising the venture enthusiastically by 1870, much to Lord Penrhyn's annoyance (CRO XPQ921). John Francis became manager of Prince of Wales after his dismissal from Penrhyn in 1874. A further possibility is that they were also responsible for the Arthog mill of 1868, a three-bay transverse mill with the same pattern of segmented arches.

Conclusion: the value of the Felin Fawr buildings is greatly enhanced by the survival intact of the water-wheel, and is further enhanced by the survival as part of the same complex of the 1906 waterwheel to power the blower for the iron-foundry.

Fig. 6 20061: 7 and 9 Penrhyn Quarries (Felin Fawr site) slab mills



Site name: **Dinorwic Slate Quarry**

Community: **Llanberis, Gwynedd**

Quarry area: **Llanberis**

Trust PRN: **20091**

Site history: Dinorwic Slate Quarries were first worked systematically by their owner Thomas Ashheton Smith I from 1787 in conjunction with a succession of partnerships, and in 1821 it was worked directly by his son Thomas Assheton Smith II. Operated mainly as a low-cost gallery quarry, and enjoying good transport links to the sea, it came to rival Penrhyn in terms of size, but proved unable to make the change to modern working methods in the 1960s, and shut down in 1969. In its early days slab production was handled by a number of-site independent mills in the Allt Ddu and Deiniolen areas, but from 1845-6 a steam-powered slab mill was established at the quarry itself, on a site which has now been largely obliterated. Roofing slates continued to be processed by hand in gwaliau until the electrification programme of the 1920s prompted the construction of some substantial modern mills, including Australia (feature 84 below).

Feature no: **84** Feature type: **longitudinal slate mill**

Grid ref: **SH60006003** Statutory protection: **none**

Archival and bibliographic sources: An agreement to build the walls of this structure is dated 1922 (CRO XD40 6 1), the year after the quarry acquired electricity. The Australia level itself was operational by 1869 (CRO Vaynol 4195), and may have become sufficiently developed by 1877 to acquire a steam locomotive (Carrington 49). It may originally have been known as Top y Braich, though the name Australia is recorded by 1888-9 when substantial improvements were in hand, including the construction of eighty dressing sheds and an incline up to the next level, Aifft ("Egypt") (XDQ 1938, Carrington 48).

Archaeological description: A rectangular structure, orientated north-west to south-east, situated immediately to the south of the Garrett working area of Dinorwic quarry, and near the summit of the C5 incline.

The walls are constructed of unsawn slate blocks, and remain intact; the slate roof has largely vanished, but the steel girder supports remain. Along the south-west longitudinal wall is a catslide extension, whose roof is supported on rolled steel joists and timber.

Along the north-east facing longitudinal wall is an integral roofed covering for a waist height line shaft. These formerly powered thirty-two circular-saw tables by means of a belt drive through slots in the wall to pedestal bearings in between two tables. Thirty of these tables remain largely intact, and are of these Greaves pattern, though some formerly bore Ingersoll Rand plates. The tables at the northern corner of the mill have been partly dismantled. It is possible that the machine next in line to these was a planer, rather than a saw but only part of the frame survives. A longitudinal railway, still *in situ*, enters the building from the quarry end and runs at the foot of each of the tables.

Two dormer-roofed extensions projecting from the north-east longitudinal wall formerly housed electric motors to power the line shafting; these have been removed, but their bases and the worm drive are still apparent. An aluminium vacuum-operated dust extraction system survives partly intact, consisting of a pipe from above each of the saw tables to a vertical funnel going through the roof. The catslide extension houses twenty-two splitter's alcoves, in one of which a *trafal* survives, and a smithing area. A longitudinal railway, still *in situ*, runs past each of the alcoves to the head of the C5 incline.

17 December 1996 DRhGwyn

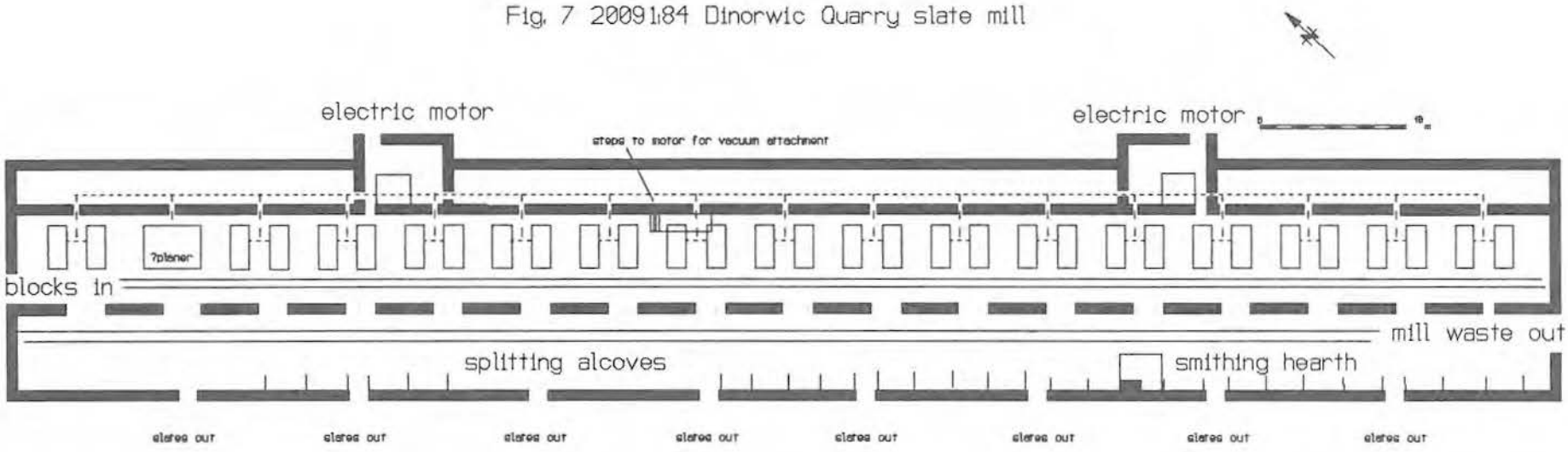
Discussion: The process flow at Australia involved longitudinal access for raw blocks along one railway, feeding a transverse process from the saw tables to the hand-splitting and -trimming areas opposite, then removal by hand to a stackyard.

The Australia mill represents the final stage of development of the longitudinal mill before the introduction of

road vehicles and large-scale diamond saws caused further changes from the 1960s onwards. The use of two electric motors exemplifies the changes in mill organisation made possible by electrification, whereby several comparatively inexpensive and small-scale electric motors could be used in one mill, and the problems of torque in very long line-shafts thereby avoided - though to some extent this is also apparent in some larger steam mills, such as at Dorothea. The use of steel girders in the roof is unusual - the near contemporary *injan draw* at Cwm Penmachno uses queen-post trusses (see **2.20132**). However, in some respects the mill harks back to the very earliest roofing slate mills in the provision of separate splitting and trimming alcoves, and in the absence of mechanical trimming, as exemplified by the survival of the *trafal*. The reason may have been the nature of the rock rather than technical conservatism, as other twentieth century mills at Dinorwic had mechanical dressers.

Conclusion: the Australia mill therefore constitutes an outstanding archaeological survival, whose value is further enhanced by the survival of other features on Australia and the related levels.

Fig. 7 2009.84 Dinorwic Quarry slate mill



Site name: **Rhos Slate Quarry**

Community: **Capel Curig, Aberconwy**

Quarry area: **Dyffryn Conwy**

Trust PRN: **20110**

Site history: Rhos Slate Quarry on the Gwydir estate was begun in 1856 and was developed by Samuel Clift and Owen Evan Hughes, who spent much money on it and equipped it with a mill (feature 25 below), subsequently enlarged. A succession of lessees ran it until 1952. The quarry was worked as a galleried pit, approached by a high-level adit, later quarried out, from the main processing level, and a lower one which drained the workings.

Feature no: **25** Feature type: **longitudinal slate mill**

Grid ref: **SH72955628** Statutory protection: **none**

Archival and bibliographic sources: The original structure dates from 1865, but has clearly gone through many periods of enlargement (Williams and Lewis 1989 10) - for instance, by 1911, when an inventory records that it was equipped with six old dressing machines, fourteen saw tables in use, seven not in use, a saw sharpener and a punching machine, powered by a 30' diameter 4' breast waterwheel (CRO XD 38 359). A photograph taken by Geraint Madoc Jones in the late '40s or early '50s shows that it was still powered by a wooden overshot water wheel (CRO XS 1608 6 143).

Archaeological description: This structure is situated on the made-up ground of the main processing level at Rhos quarry, near the point where the internal railway system gives access to the pit, and the stackyard was set out for the exit railway to Pont Cyfyng.

The building itself is a near-rectangular structure, orientated east to west and mostly survives up to truss height. The king-post trusses, of which the six most westerly are still in place and the remaining eight have been pulled down and partially sawn on site, are or were supported by the south longitudinal wall and by alternate timber posts and columns of shale blocks along the northern longitudinal side. A catslide extension the length of the north longitudinal wall houses sixteen semi-integral gwaliau. Building material is a mixture of unsawn and circular-sawn blocks, the former predominating in the western part of the structure, the latter in the eastwards extension and in the gwaliau.

Constructed alongside the south longitudinal wall of the mill is a substantial waterwheel pit, fed by a launder from the south-west. Other chambers constructed along the south longitudinal walls appear to have served as engine houses or workshops. One contains holding-down bolts for a prime mover and a slot for a belt drive to a machine mounted on a large slab in the mill itself.

Projecting from the west gable wall is a caban with two rounded-arch windows.

No machinery survives in the mill, though bearings for line shafting survive on some of the roof trusses. The engine house to the south probably contained a petrol engine, perhaps powering a compressor in the mill itself.

Greaves-sawn blocks were noted on the tips.

23 October 1996 DRhGwyn

Discussion: The use of unsawn blocks in what is effectively the south-western part of the mill suggests very strongly that this is the earliest part of the building, and that the gwaliau and the eastward extension are later. The original building therefore was probably an open-sided structure extending no further east than the western end of the wheelpit, possibly only concerned with the manufacture of slab, always a staple of the Gwydir/Dyffryn Conwy quarries with their poor cleavage, and that adaptation to a mill capable of turning out roofing slate came later. Though it has suffered some recent dilapidation, this structure is of very considerable significance, as showing the relationship between the machine sawing area and the hand-dressing area very clearly.

In this connection it is worth repeating the suggestion aired by Merfyn Williams that the addition of the extra gwaliau may be connected with the first strike called out by the North Wales Quarrymen's Union in December 1877, which lasted two years and involved two dozen men (Jones RM, 112, 117). The strike itself was called out in defence of the bargain system.

Conclusion: an outstanding site; the mill itself is significant for its group value with the other features, for its integral place within the quarry's hydraulic system and for the evidence of internal combustion machines as a power source.

Fig. 8 20110125 Rhos Quarry slate mill

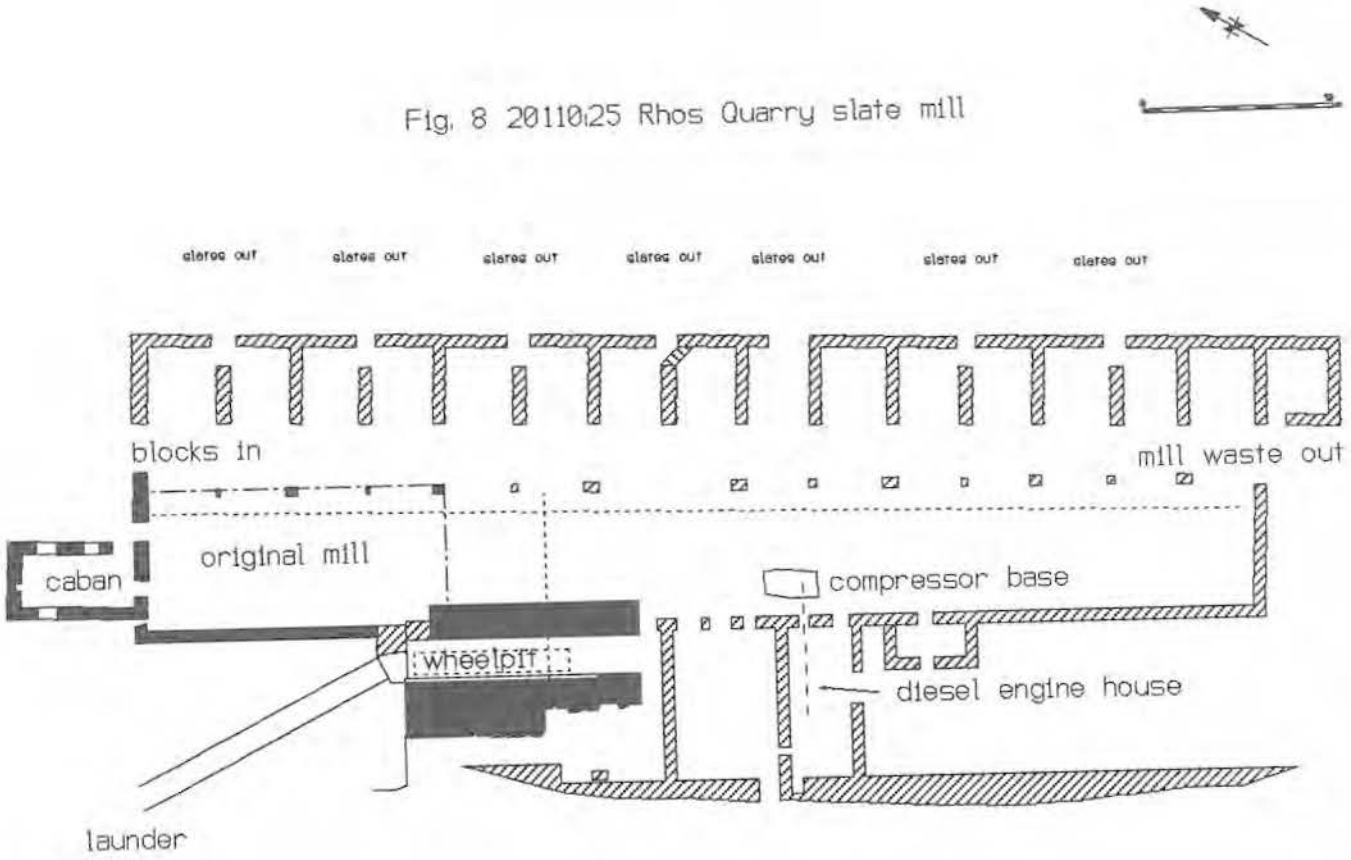
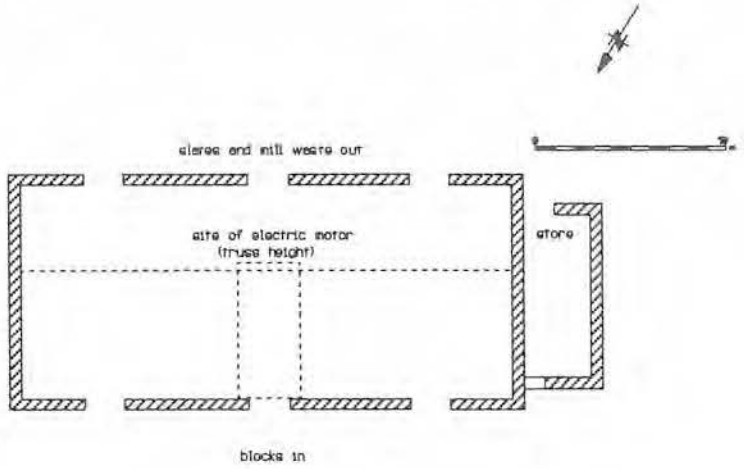


Fig. 9 20132:14 Cwm Machno quarry slate mill



Site name: **Hafodlas Slate Quarry**

Community: **Betws y Coed, Aberconwy**

Quarry area: **Dyffryn Conwy**

Trust PRN: **20156**

Site history: Hafodlas quarry formed part of the Gwydir estate; initial exploration of the site was carried out by the Spooner family of Porthmadog between 1855 and 1860, in which a year a company containing James Swinton Spooner, W.F. Cooke of electric telegraph fame, Hedworth Lee, engineer to the Chester and Holyhead Railway, and Daniel Gooch of the Great Western Railway, whose son Harry became general manager. It was they who equipped the quarry with mills, a hydraulic system and an incline to the Holyhead Road. From 1883 to final closure in 1929 the quarry was run by a series of local investors.

Feature no: **1, 3, 14** Feature type: **longitudinal and bay slab mills**

Grid ref: **SH77965616** Statutory protection: **none**

Archival and bibliographic sources: The mills at Hafodlas quarry appear to have been designed to deal largely with the production of slabs - and, to judge from the number of houses in Betws and the area built out of Hunter-sawn blocks from the quarry, of squared building stone as well. The original structure is dated by a graffito to 1863, and the later to 1867 to the design of James Swinton Spooner and to Harry Gooch respectively (Richards 1991 p. 74, Williams and Lewis 1989 p. 12). The machinery bay at the south-east first appears in its present form on the 25" ordnance survey of 1911, though there had been a building there before.

Archaeological description: An integral range of three structures, constructed on the natural ground surface and orientated north-west to south-east. All are built of slate blocks and survive up to eaves height, but are roofless.

The central structure is a rectangular-plan building with a dual pitch roof orientated north-east to south-west, accessed by two railway doorways in the north-east facing wall. Above these doorways are windows for a second floor.

There is a planer-bed in the northern corner, fed through a slot in the wall and the beds for two other undetermined machines flanking the access railways. In the south-western part of the building are the distinctive H-shaped beds for Hunter saws. The date "1863" is carved on the return of one of the doors. An underground channel formerly accommodated line-shafting to convey power from a wheelpit alongside the north-west gable wall, filled in after excavation.

The wooden roof trusses survive on site, having been sawn up into small segments.

To the north-west is a double-gable rectangular structure, accessed on the north-east longitudinal wall by four corbelled doorways, by a flat roof doorway in the west corner and by a large opening in the southern corner.

An underfloor line-shafting pit runs the length of the building down its centre, above which, at truss level, is a longitudinal wrought-iron beam, supported by four iron girders pierced for line-shafting. From this beam depend brackets to support take-off drives. The north-eastern half of the building is almost entirely taken up with a series of three Hunter saws on H-shaped beds; in the south-western half is a series of machine beds which suggest planers and greaves saws. At one point under the central girder is a small rectangular depression containing fine polishing waste.

The small machinery bay built against the south-east gable wall of the first mill contains traces of a central turntable flanked by sand-saws, represented by a rectangular arrangement of holding-down bolts within which are parallel timbers to support slabs whilst they are being sawn. Along the southwest wall is a line-shaft pit with room for cranks to operate connecting rods to the sand-saws.

Power sources to these three structures are evident in the form of a large wheelpit, between the mills, later converted into a turbine pit, evidence by the iron pipes leading to it. The other hweelpit is a recessed masonry

structure in a position and at a height which allows water to flow from it to the lower wheel.

To the north-east is a seriously dilapidated structure, in which the remains of enamelling kilns are evident.

On the tips and elsewhere on the site are to be found blocks sawn by Greaves, Hunter and sand saws. Planer waste is evident in the large mill. There is much use of Hunter-sawn blocks in Betws y Coed.

28 August 1996 DRhGwyn

Discussion: The mills are unusual in a number of respects. Not only is there some attempt at decoration in the architecture, but the system of internal movement is largely unparalleled. Two of the three units are of the bay type as identified and described in the 1995 report; the largest unit is served by one transverse tramway and one longitudinal siding, joined by a turntable in the south-eastern corner.

There is evidence that the first mill was designed without regard for the machinery actually installed in it; it appears to have been designed as a transverse mill but the Hunter saws block the way through. The unusual slot-feed through the external wall to the planer suggests that this was the result of a change of mind

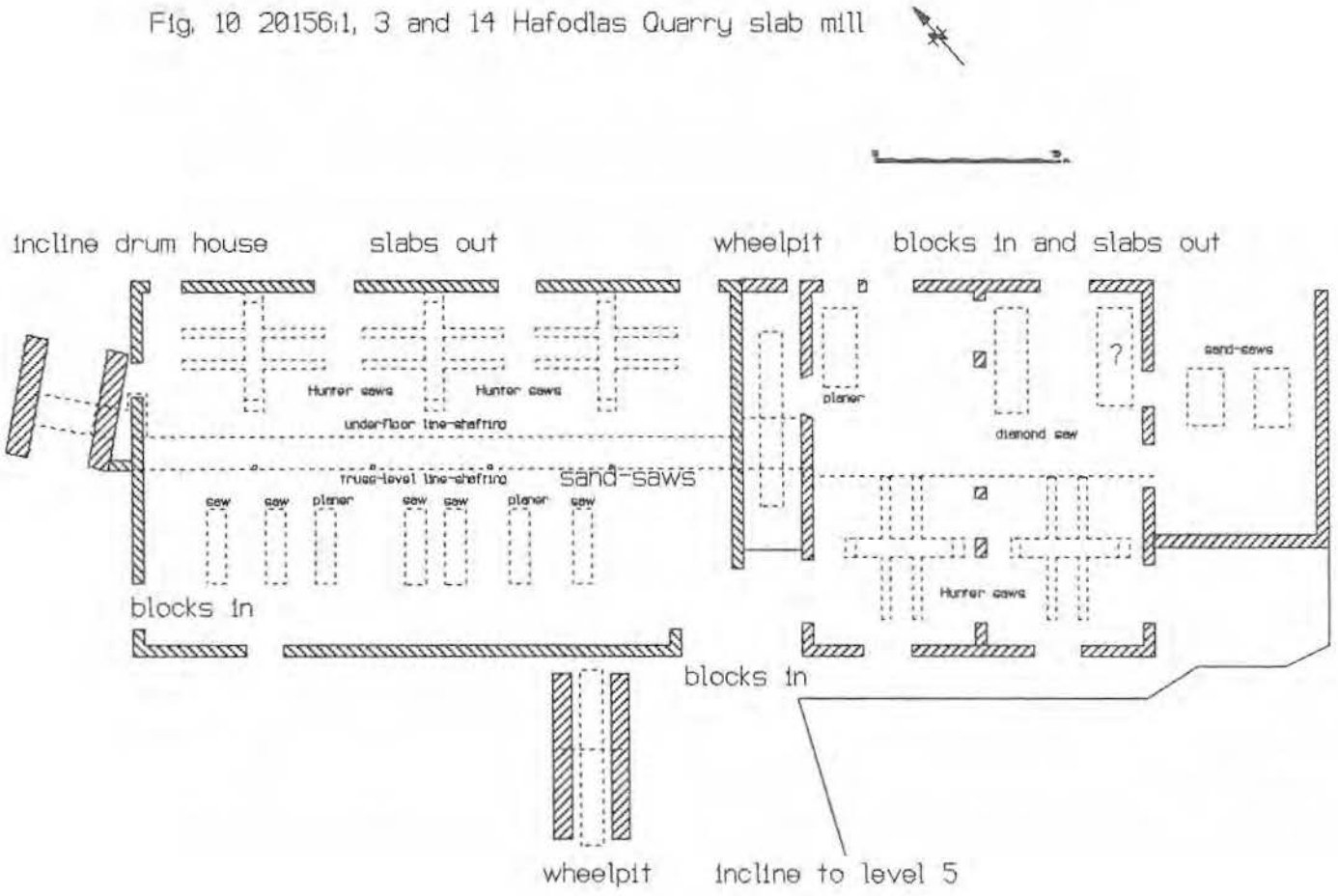
The organisation of the Hafodlas mills has little in common with the other mills which made use of the Hunter saw - Penrhyn or Pen yr Orsedd or, looking further afield, with Delabole in Cornwall. The comparatively ornate structure and the array of machinery, out of scale for a fairly modest operation, suggests that Hafodlas was either a speculation or, more convincingly, a showcase for up-to-date machinery.

Possibly Hafodlas, with its Hunter saws, demonstrates the problems involved in a new type of technology, problems, moreover in this instance being approached by able engineers whose background lay outside the slate industry - not only Hunter himself and his son, who hailed from the freestone quarrying town of Arbroath, but Gooch of the Great Western Railway and Cooke of electric telegraph fame (Boyd 1986 p. 186). Remarkably, in that the quarry company's board included some of the foremost locomotive engineers of the day, it was dependent on water-wheels until 1896, when it went over to a turbine, and never made use of steam.

The use of two waterwheels in tandem in the same mill complex (as distinct from the sequence of waterwheels operating different mill on a slope) is parallelled by the seriously dilapidated mill at Croesor, which was not selected for detailed study. The pattern of the Croesor closely follows that of Hafodlas with a two-bay rectangular structure being erected in the early 1860s (though in this case with the waterwheel between the bays, not to the side) followed by a longer range at right angles to the first, in 1866 (Richards 1991 p. 111, DRO Z DAW Category 11). Similarly the 9 mill at Rhosydd where the original mill is two-bay structure of *c.* 1862 with a waterwheel in its western longitudinal wall, to which an extra two bays were added to the east in 1869-1870, and a transverse western extension in 1875 or 1880 (Lewis and Denton 1974 pp. 52-57).

Conclusion: an outstanding feature on an important site.

Fig. 10 20156:1, 3 and 14 Hafodlas Quarry slab mill



Site name: **Pompren Fedw Slate Quarry**

Community: **Dolwyddelen, Aberconwy**

Quarry area: **Dyffryn Conwy**

Trust PRN: **20108**

Site history: A small and unprofitable quarry on the Gwydir estate, Pompren Fedw was first opened in 1838-44, and from 1875 by the Gee family of Denbigh, the publishers, who operated it until the twentieth century. It was worked as two pits accessed by an adit, at the mouth of which a mill (feature 2 below) was constructed.

Feature no: **2** Feature type: **bay slab mill**

Grid ref: **SH72865207** Statutory protection: **none**

Archival and bibliographic sources: Constructed in 1876-7 (Lewis and Williams); a sale catalogue of 1894 (in private possession) marks it together with some gwaliau immediately to its north.

Archaeological description: Constructed on solid ground near the stream that flows through the quarry and near the mouth of the adit into the pit. The building is orientated north to south, constructed out of unsawn blocks of slate. There is the possible trace of a monopitch gable, and it appears that the east longitudinal wall was open.

The walls survive up to a maximum of 2m. Alongside the west longitudinal wall is a wheelpit and within the building itself are two shallow pits. The fragments of several wrought iron sand-saw blades survive on site.

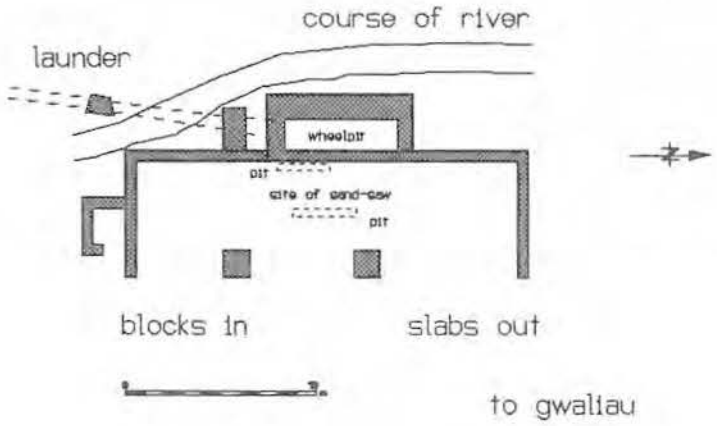
22 October 1996 DRhGwyn

Discussion: Though the building is small and badly dilapidated, it is of interest as an example of a small-scale mill in which a waterwheel of perhaps 15' diameter powered a single sand-saw. Cartographic evidence suggests that these may have at one time been more common in the Dyffryn Conwy area on sites such as Foel (20105:8) or which have now been largely destroyed such as Ty'n y Bryn (20122:2, 3) and Prince Llewelyn (20125), possibly also the hone-stone quarries at Penrhiw and Melynllyn.

The larger of the two pits is almost certainly to catch the paste of sand and water dripped onto the blades of the frame saw.

Conclusion: a feature of regional significance, as possibly typical of the smaller mills in the Dyffryn Conwy quarrying area.

Fig. 11 20108:2 Pompren Fedw Slate Quarry slab mill



Site name: **Prince of Wales Slate Quarry**

Community: **Dolbenmaen, Gwynedd**

Quarry area: **Glaslyn**

Trust PRN: **20221**

Site history: A company was established to work this site in 1863, after initial exploration, under the barrister Thomas Harvey, and with John and Thomas Francis of Penrhyn Quarries as major shareholders, who assumed the management after they had been found guilty of false accounting at Penrhyn in 1874, but operations ceased in 1876, though other lessees may have generated some traffic for the railway until 1881 (Williams D 1986 pp. 13-21, Boyd 1988 p. 27).

Feature no: **3** Feature type: **transverse slate mill**

Grid ref: **SH54534926** Statutory protection: **none**

Archival and bibliographic sources: This structure dates from 1864; a report of 31 December in the *MJ* states that it had been roofed, that the waterwheel was in position and saws and planers were being installed (916). A report of the following year is more detailed; the wheel measured 30' by 4', and the mill included Francis' patent machines, four saws and two planers by DeWinton (p. 335). It was originally served by horse and cart, since the inclines was not ready to receive rails until August 1866 (*MJ* 4 August 1866, 488). From 1875 the Gorsedda *(sic)* Junction and Portmadoc Railways gave the mill direct rail connection to the sea (Boyd 1988 p. 22)

Archaeological description: This structure stands in the defile of the Afon Trwsgwl on the eastern slopes of Cwm Pennant, at the foot of the incline from the main quarry workings. The course of the former Gorseddau Junction and Portmadoc Railways encircles it on the east side. The mill tips extend over the falling ground to the west.

A three-bay rectangular-plan transverse mill orientated north to south, constructed of unsawn country rock, now roofless. The summit of the northern gable has collapsed above truss level. The building was mortared and internally rendered, of which traces survive.

The six tramway doors have an unusual depressed-arch construction; the southernmost on the western longitudinal wall has collapsed.

Stone leat pillars survive, which formerly ducted water from the Trwsgwl to a staggered waterwheel-pit in the south gable. It is not clear whether the wheel was backshot or overshot; it powered machinery through a truss-level axle-box in the western end of the southern gable wall, where a serious crack has opened, threatening the stability of this wall.

The segmented-arch construction is repeated in the tail-race arch in the wheelpit and in the arch in the western end of the southern gable wall.

25 July 1996 DRhGwyn

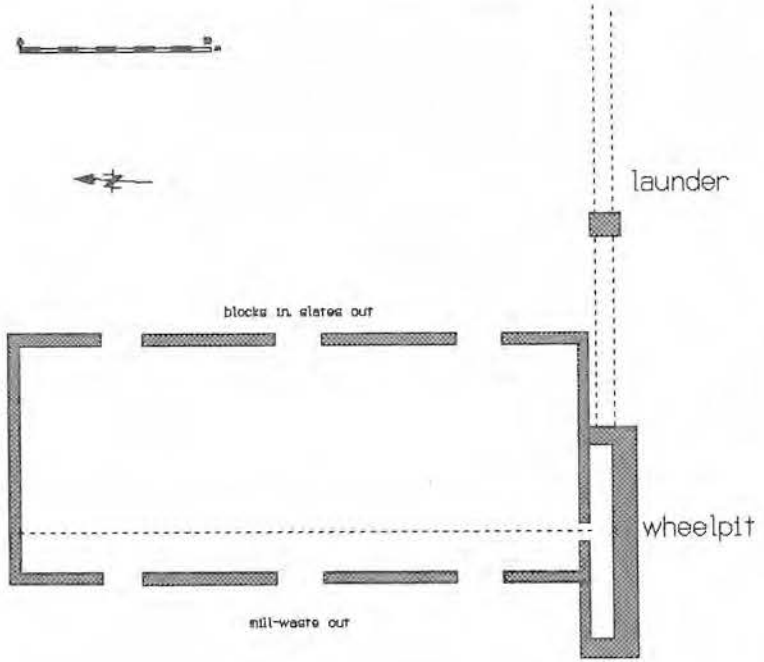
Discussion: The mill's situation, away from the quarry and at a considerably lower level, illustrates the lengths to which quarry engineers were prepared to go to make use of water-power rather than steam. Slate slabs, having been lowered down at least one incline from the quarry to be processed, would then have to be hauled up again to be loaded into carts for transport to Caernarfon, a cumbersome and time-consuming process, only brought to an end with the construction of the railway from Porthmadog to the mill site itself in 1875.

The transverse pattern is repeated, together with the style of doorway, in the two mills constructed by Penrhyn Quarry at the Felin Fawr site, believed to date from 1865-6. It is worth noting that John Francis II, a Penrhyn agent, and son of the manager, had certainly invested considerable sums in the Prince of Wales Quarry, and was publicising the venture enthusiastically, by 1870, much to Lord Penrhyn's annoyance (CRO: XPQ921), and his father ended up as manager of the quarry after his dismissal from Penrhyn in 1874. It is quite possible therefore

that the Prince of Wales mill is a Francis design, and the immediate prototype for those at Penrhyn, especially as his patent machines formed part of the equipment.

Conclusion: a feature of regional significance in that it exemplifies the evolution of the transverse mill.

Fig. 12 202213 Prince of Wales Quarry slate mill



Site name: **Gorseddau Slate Quarry**

Community: **Dolbenmaen, Gwynedd**

Quarry area: **Glaslyn**

Trust PRN: **20238**

Site history: Gorseddau Quarry was developed from 1853-4 by Robert Gill and John Harris in conjunction with the Bavarian mining engineer Henry Tobias Tschudy von Uster and a Bangor money-lender Richard Morris Griffith. It was opened out on the classic gallery pattern, and connected to the sea at Porthmadog by a horse-worked railway engineered by James Brunlees. At Ynys y Pandy, the first point on the railway where the formation passed a good fall of water, a substantial slab mill (feature 56 below) was constructed, but the poor quality of the rock and the over-investment (£160,000 by 1863) soon told against the company, which was bankrupt from 1869. It was acidly observed "There was no quarry there, and the wonder is that it cost this Co. this enormous amount of money to find it out" (Williams D 1986 pp. 4-10).

Feature no: **56** Feature type: **radial slab mill**

Grid ref: **SH55004337** Statutory protection: **none**

Archival and bibliographic sources: Constructed 1856 to serve the Gorseddau quarry, and equipped with a 26' waterwheel. In 1872 it was bought by the Prince of Wales quarry for £10,000, and after it ceased to be used as a slab mill it housed eisteddfodau and preaching meetings, until it was deroofed *c.* 1906 (Williams D 19).

Archaeological description: Constructed on a rock outcrop above the Afon Ystradllyn, orientated north-east to south-west. A roofless single-gable two-storey structure with basement and attic, rectangular in plan, built out of igneous rock. There is a string course of circular sawn slate at first floor level.

A curving ramp built out of igneous rock capped with circular-sawn slate blocks gives railway access at both first and second floor level through the south-east facing longitudinal walls. Tip runs to the north contain circular-sawn fragments.

In the joist holes at first floor level in the south-east facing longitudinal wall are fragments of the pine joists.

The south-east facing longitudinal wall is pierced at ground floor level and at first floor level by two doors. There are three windows at ground level and eight at first floor level, duplicated by two rows of nine on each floor on the opposite wall.

The south-west gable is pierced by two windows at basement level, one of which preserves the traces of holding-down bolts in the sill, four at ground-floor level, of which the central two are blocked, three at first floor level and one at attic level. The north-east gable is pierced at ground floor level by two doors, each wide enough for railway access, three windows on the first floor and one at attic level. The window jambs project to form a chimney, in which is set a circular mounting, possibly for a clock.

All doors and windows are of a round-headed pattern; those on the north-west facing longitudinal wall reach to floor level.

A transverse underfloor wheelpit survives, with a stone mounting for a pit-wheel on both sides of the pit, corbelled outwards. This is fed by an external water channel along the south-east longitudinal wall. The tailrace runs out of the building through an arch below basement level. In a trench for a drive shaft running towards and beyond the north-east gable Dr MJT Lewis and Hywel Lewis in the summer of 1995 found planer waste and fragments of a planer, subsequently removed. Deturfing work carried out the same time by students at Plas Tan y Bwlch under the supervision of Dr Lewis and Merfyn Williams revealed surviving wooden sleepers for the railway supplying the machinery.

As well as the archaeological work carried out in 1995, there has been consolidation of the structure by the

Snowdonia National Park.

31 August 1996 DRhGwyn

Discussion: The surviving sleepers make it clear that the mill, at least on the ground floor, was a variant on the radial pattern. While the position of the underfloor line-shaft, which operated off the waterwheel, is clear, it is not certain how power was transferred upwards to the machinery - possibly by bevel-driven vertical spindles.

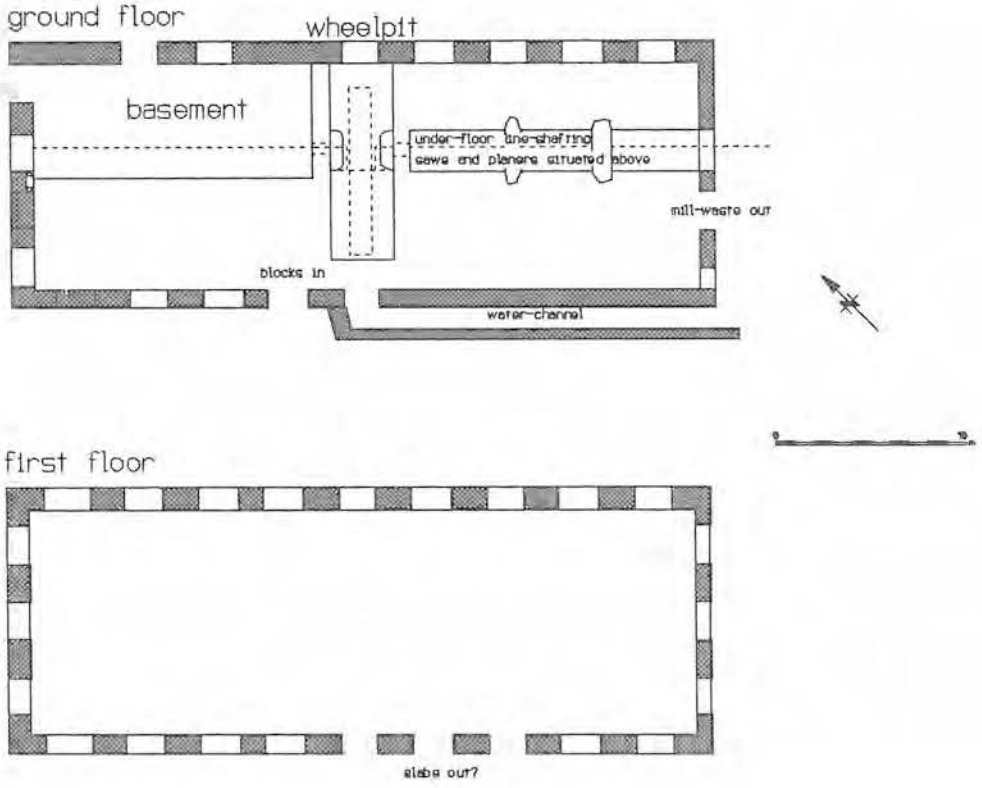
Gorseddau mill is now unique in Wales as a multi-storey slate-mill; there is as yet no archaeological evidence to suggest the function of the upper floors, the first of which had rail access.

Two other multi-storey slate mills are recorded in Gwynedd, both of them independent writing-slate mills (and as such not noted in the second project). These were at Port Penrhyn and the Newborough factory at Blaenau Ffestiniog. However, this massive building is quite without parallel in the North Wales slate industry, and architecturally derives from a completely different tradition of industrial structures, namely the foundry. The rectangular plan, the height, the several storeys, the pattern of windows, even the fact that they have rounded heads, are all typical of early nineteenth century foundries and machine-halls, exemplified locally by the Coed y Parc foundry at Penrhyn quarry and the DeWinton complex at Caernarfon. Possibly the fact that Gill, one of the directors of the 1856 company which opened Gorseddau, was also connected with the Lancashire and Yorkshire Railway, accounts for the decision to adopt such an untypical structure (Williams D 1986 p. 5, PRO BT31 235 755).

In the light of the excavation carried out by students at Plas Tan y Bwlch in the summer of 1995, it appears likely that the building was designed first and machinery was adapted to fit.

Conclusion: a structure of national importance as exemplifying the amount of capital expended on the slate industry.

Fig. 13 20238:56 Gorseddau Slate Quarry (Ynys y Pandy site) slab mill



Site name: **Hafod y Llan (South Snowdon) Slate Quarry**

Community: **Beddgelert, Gwynedd**

Quarry area: **Glaslyn**

Trust PRN: **20255**

Site history: Situated on the Mostyn estate's holdings on the south-eastern slopes of Snowdon, in an area which has seen much small-scale mining for copper, the quarry appears to have begun operations in the 1840s, under the management of the Devonian Alan Searell. A prospectus was issued in 1869 but production appears to have ended in 1881 (Boyd 1988 118-120).

Feature no: **3 and 4** Feature types: **bay slate mills**

Grid ref: **SH61165241** Statutory protection: **none**

Archival and bibliographic sources: The Searell papers at UWB mention an intention to build a "Mill house for Machinery" at a cost of £1,000 in 1865, together with a water wheel, six sawing machines, two planers, a saw-sharpener, a grindstone, a travelling crane and twelve dressers for £1,500 (Searell 9). A "machine house" powered by a 50 hp turbine is noted on CRO BJC/X391, dated 12 June 1869. In view of the comparatively short working life of the quarry, it is likely that the later part was built not long after.

Archaeological description: A dilapidated and roofless structure on the lowest level of the quarry, near the course of the exit railway to Nant Gwynant. The finger-runs of the mill tips project to the south, on which Greaves-sawn slabs and possible trimming waste were noted.

The mill is orientated east to west and was built in two stages; the earlier is to the east and is built out of igneous rock, the later to the west and is built out of slabs sawn with a Greaves saw. The earlier is in poorer condition; in the later part walls survive up to 5m high.

The two units are not built entirely flush, but are slightly staggered, so that the later range is slightly to the north of the earlier. The two parts therefore combine elements of both the transverse and longitudinal arrangements; railway entrances were noted in the south longitudinal walls, but doors for longitudinal railways were also noted in the central and eastern gables. It is possible that the end gables were half-hipped.

A small structure has been added on to the east gable end of the earlier part of the mill, built out of Greaves-sawn slabs; it is possible that this was a small smithy, since it may contain traces of a hearth.

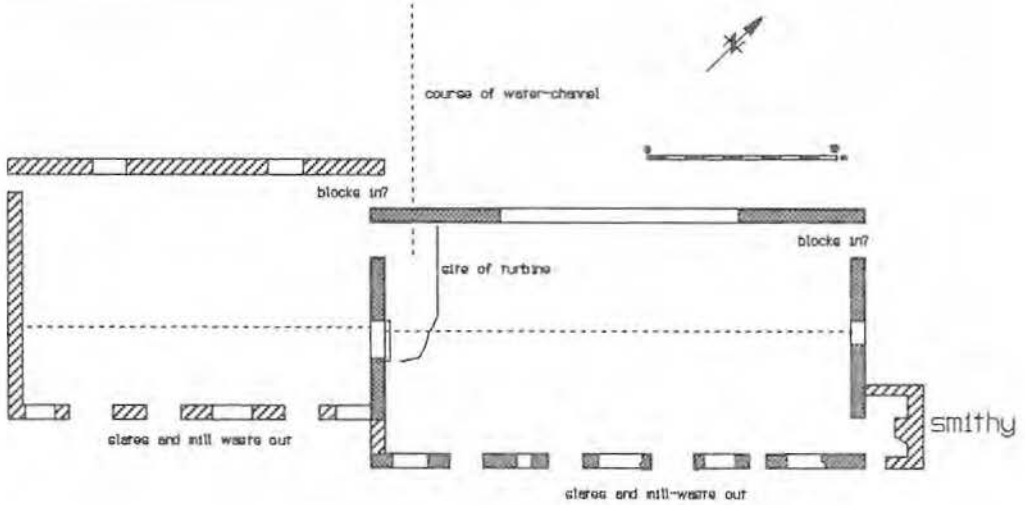
The site of a turbine is evident in the north-west corner of the original mill, visible as a shallow depression and disturbed grown; the course of a head-race to it is apparent on the slope to the north of the mill.

13 August 1996 DRhGwyn

Discussion: The turbine is an early example in the slate industry.

Conclusion: of regional significance as part of the Hafod y Llan Quarry complex.

Fig. 14 2025513 and 4 Hafod y Llan Quarry slate mill



Site name: **Rhosydd Slate Quarry**

Community: **Ffestiniog, Gwynedd**

Quarry area: **Glaslyn**

Trust PRN: **20283**

Site history: Rhosydd Quarry was worked from the 1830s to 1929, and from 1874 until closure was financed and managed by locally-based Welshmen. Early workings were pits near the Moelwyn ridge, but subsequent operations moved progressively downslope to the north, and a series of ever-larger mills were constructed from 1854 onwards, including features 15 and 35 below, as well as a substantial mill on the lowest surface level which has been very substantially dilapidated. Rhosydd quarry was chosen for the pioneering industrial archaeology survey of the Welsh slate industry in 1971 and 1972 (Lewis and Denton 7-16).

Feature no: **35** Feature type: **transverse slate mill**

Grid ref: **SH66584572** Statutory protection: **none**

Archival and bibliographic sources: This transverse mill was built in 1856, and probably housed eight saw tables. The 22' diameter waterwheel also powered a set of flatrods which entered the higher no. 2 adit 400 yards away to the south, and drove a pump (Lewis and Denton 36).

The mill was extended twice to the north before being abandoned c. 1867. It probably contained eight circular saw tables and a number of mechanical dressers. The machinery was moved into the 9 mill in about 1869/70, and it is possible that the waterwheel was later used to power the haulage system in 9 adit (Lewis and Denton 51).

Archaeological description: Situated on level 3, a purely processing level on the rake of counterbalance inclines from level 1 to level 9.

The building is a transverse-pattern mill, orientated east to west. It formerly had a pitched roof, whose gable walls have collapsed to the east in both bases. It is constructed out of unsawn slate blocks.

Alongside the east gable is a pit for a 22' diameter, 4'+ breast waterwheel, either overshot or backshot, supplied from a slate-slab-built launder to the south. At the south-eastern corner of the wheelpit is a crank-pit for a flatrod system, buried by the tips to the south.

Access to the building for raw blocks is through four doorways in the southern longitudinal walls. Four equivalent doors in the north longitudinal wall give out onto an area enclosed by a low wall, a later addition to the main building, pierced at two points. This is turn gives on to another enclosed area, pierced by two openings whose lintels are approximately 1.5m high. Beyond is a stackyard.

In the west gable wall of the mill are two, possibly three, loading bays for transferring sawn ends into wagons for tramming to the tips to the north-west. An extension to the north contiguous with the west gable wall, and once partly covered by a roof pitched at right angles to the main roof, contains three further loading bays and a dressing area. In one of the bays a flywheel for line-shafting has been dumped.

1 October 1996 DRhGwyn

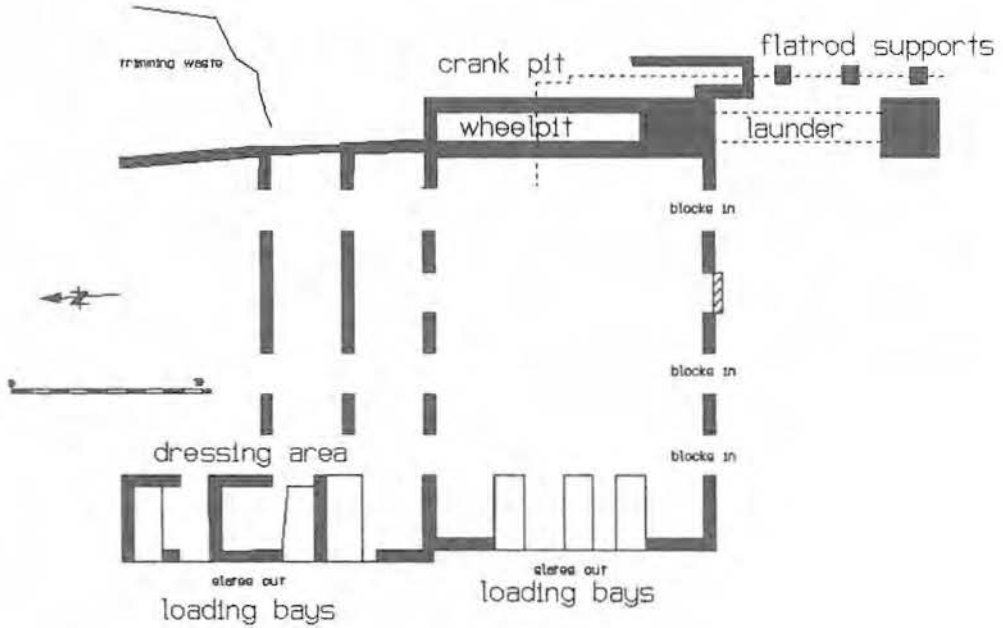
Discussion: Rhosydd 3 mill is one of the earliest examples of a slate mill surviving to such an extent that something of its working methods are apparent. The mill itself and its related features belong to a period when the integrated mill was evolving, but not all the processes which went towards the production of roofing slates went on under the same roof. Here, the slabs were sawn in the mill itself, but were split and trimmed, either manually or mechanically, in adjacent bays.

In this sense, Rhosydd 3 mill is the immediate precursor of the integrated mills built towards the end of the 1850s, even though it now appears that the integrated mill first appeared in 1845 or earlier in the southern part of

Gwynedd, at Minllyn. Rhosydd no. 3 therefore looks forward to the 6 mill at Diffwys Casson, constructed a few years later, in which all the processes were united under one roof, and also to the Rhos mill at Capel Curig, where separate gwaliau were constructed as lean-tos to the main mill sometime after it was built in the 1860s.

Conclusion: Rhosydd 3 mill is of great significance as one of the oldest surviving slate mills and as probably the oldest transverse mill; its value is enhanced by the survival of the wheelpit and the traces of the flatrod system, demonstrating the multiplicity of power-uses.

Fig. 15 20283i35 Rhosydd Quarry slate mill



Site name: **Diffwys Casson Slate Quarry**

Community: **Ffestiniog, Gwynedd**

Quarry area: **Blaenau Ffestiniog**

Trust PRN: **20305**

Site history: Diffwys Slate Quarry (Chwarel y Diffwys, Diphwys Casson Slate Quarry) was established in the 1750s or '60s by Methusalem Jones of Cilgwyn, probably around 1760, and the lease was purchased by the Lakelanders William Turner and William Casson in 1800. For many years the only quarry of any size in the Blaenau Ffestiniog area, it went into decline from the 1870s, and closed down in 1925. Since its purchase by Greaves Welsh Slate Company in 1972, some exploratory work has taken place.

Lacking sufficient water to turn machinery at Diffwys itself, the quarry made use of off-site facilities at Ffatri Rhyd y Sarn, and from 1846 at Pant yr Ynn, on the quarry road to Manod. From the 1850s it began to make use of steam power to operate mills; floor 6 mill (feature 1 below) dates from 1859, with extensions of the 1880s and 1890s, and is frequently described as the first integrated mill for the production of roofing slates in the industry. Later mills are the Alabama mill of 1862 and the floor O mill of 1865-6, which are now heavily dilapidated, as well as other mills from the same period, situated on floors 4 and 7.

Feature no: **1** Feature type: **longitudinal slate mill**

Grid ref: **SH71154614** Statutory protection: **none**

Archival and bibliographic sources: Floor 6 mill was powered by a steam engine, and made use of ten circular saws and ten "guillotine" dressers. An extension to the west was added in the 1880s containing, it is thought, six tables and dressers. An extension to the east was built in the 1890s, containing seven tables and seven dressers. The steam engine may have been either a 5½" bore, 10" stroke engine by Barrett, Exall and Andrews which arrived in 1858, or a Fawcett, Preston (no. 2009) lying obsolete in the Alabama mill in 1892, or more probably another Fawcett, Preston machine (2084) which arrived on 23 April 1861 and was certainly in the floor 6 mill in 1892. It was replaced by two 15hp electric motors in 1913, the main line shaft being cut into two sections. The drive to the machinery was three cotton ropes to each pulley. The mill became disused in 1924 and was scrapped in 1956 (Williams M 1985, 1991 p. 14).

Archaeological description: Situated on floor 6 of the quarry, near the head both of an uphaulage incline from underground workings and a counterbalance to take finished slates down to the exit railway, and at the foot of counterbalance inclines from the higher Penffridd levels. A level tramway leads from Chwarel Newydd.

It is a roofless rectangular building, orientated east to west; the central part is constructed largely of unsawn slate blocks, the two additions of circular sawn blocks. The central section measures 42.5m by 13.15m internally and the westward extension adds another 24.5m to the building. An eastward extension measures 23.5 metres, but is extended further to the south to provide roofed cover for a trimming-waste railway, which runs parallel to the south longitudinal walls, and in which some lengths of bar rail track and a rubbish wagon survives.

Within the central section are ten *stelinau* (working platforms) for the initial reduction of blocks and five chutes to tip trimming-waste into wagons. Over one of these survives the remains of a guillotine dresser. The eastern extension houses seven stelinau and four trimming-waste chutes.

An engine- and boiler-house survive integral with, but at right angles to, the north longitudinal wall in a central position. There is evidence that it also powered the nearby uphaulage incline, and that it was replaced by an electric motor, part of whose control gear is evident. The chimney is built out of sawn blocks in the lower part up to approximately 5m high, with a red- and yellow-brick extension, which adds approximately 2m more.

To the north of the westward extension stands a smithy with two hearths. Integral with this building is a drum-house for a counterbalance incline.

To the north of the engine house is a winding house for an uphaulage incline, which has now been almost entirely

quarried away, and an integral weighbridge house. The winding house has been converted from double-track to single-track operation at some stage, and the ironwork for the winding drum and spindle survive. These structures are built out of sawn slate blocks.

A length of bar rail track survives, which runs parallel to the south longitudinal wall but is otherwise outside the building and is at a lower level than the mill floor. A rubbish wagon survives at this point, and a single guillotine type slate dresser remains within the building at a point where trimming waste could be emptied into a wagon on this length of rail. Otherwise, no machinery survives.

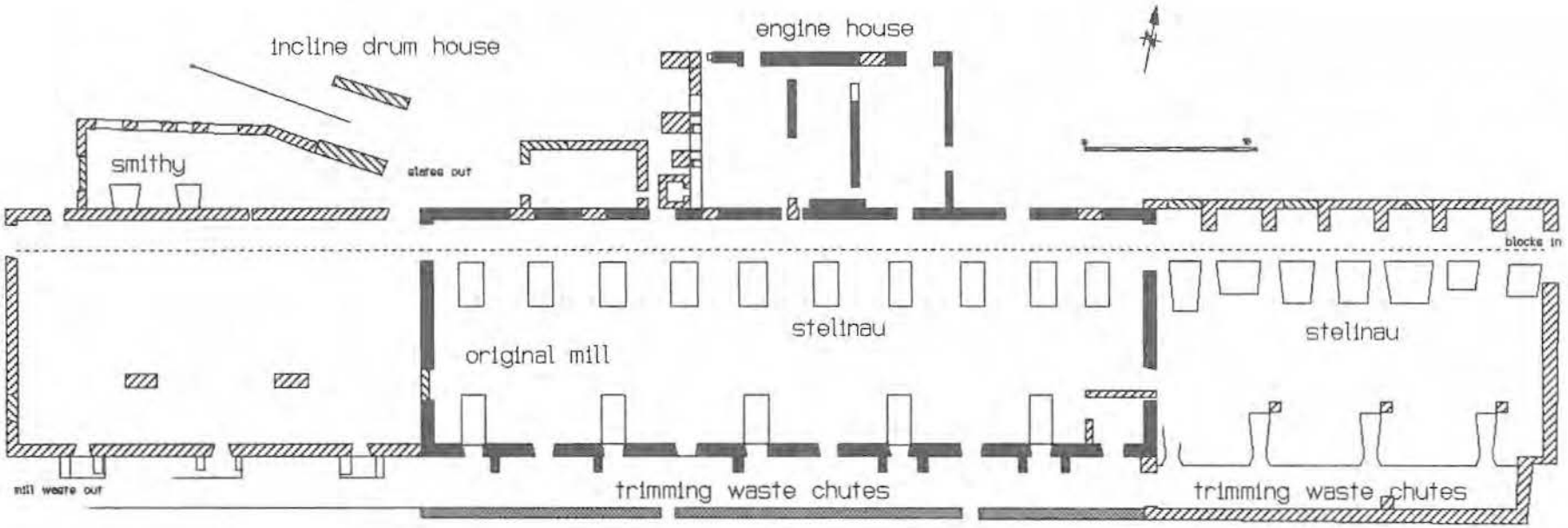
8 December 1996 DRhGwyn

Discussion: The guillotine dresser was patented in 1850 by Nathaniel Matthews (patent 13019) but was less successful than the Greaves rotary dresser (patent no. 2347 of 1860) which quickly replaced it. Another example was identified at Votty and Bowydd and removed for preservation in 1985 (Williams 1985 pp. 53-54).

Though this has several times been described as the prototype integrated mill, it now appears probable that the much earlier (pre-1845) mill at Minllyn was the first such structure. It may be the earliest example in Blaenau Ffestiniog, though in the absence of firm dates for the construction of Melin Bonc Siafft at Oakeley (demolished in the course of the present study), even this has to remain uncertain. Nevertheless, it is a feature of considerable archaeological significance; the survival of the stelinau and arrangements for removing the trimming waste illustrate the way in which such a mill operated. Its relationship with the two inclines illustrate its role in the process-flow of a quarry as a whole, and the several phases of construction emphasise the constantly changing requirements of individual sites.

Conclusion: an outstanding structure, of national importance.

Fig. 16 20305:1 Diffwys (Casson) Quarry slate mill



Site name: **Maenofferen Slate Quarry**

Community: **Ffestiniog, Gwynedd**

Quarry area: **Blaenau Ffestiniog**

Trust PRN: **20306**

Site history: Maenofferen Quarry appears to have begun in the 1840s, and expanded after it was connected to the railway from Blaenau Ffestiniog to Rhiwbach quarry in 1863. Though some early workings appear to have been open pits, it was worked mainly as a mine, accessed by water-balance and steam-powered inclines. The quarry's first mill was built on the reversing neck of the connection to the Rhiwbach tramway, orientated east-west, water-powered from a wheel in its western gable, though by 1881 a turbine had been installed at the opposite end. A "new mill" had been built nearby by this date (DRO Z Dag 547). Both these were later replaced by feature 29 below.

Feature no: **29** Feature type: **longitudinal slate mill**

Grid ref: **SH71304660** Statutory protection: **Listed grade II***

Archival and bibliographic sources: The archive for Maenofferen quarry is poor, and it has not proved possible to date the mill exactly. The present mill is not marked on the 1886 Ordnance Survey. It was originally water-powered and converted to electricity c. 1906 (Cadw, List of Buildings of Special Architectural or Historical Interest in the District of Meirionnydd List 63, Resurvey H).

Archaeological description: Situated on the main processing level of Maenofferen quarry, near the still-active double-track incline which hauls blocks from the underground workings, and adjacent to the stackyard and the now-disused siding connection to the Rhiwbach tramway. This mill is still in active production.

A rectangular double-unit building, approximately 60m in length, orientated east to west, of slate block construction. Each unit has a pitched slate roof; the north range is half-hipped to the west and has a corrugated iron east gable end, while the south range is half-hipped at both ends. A flat-roofed connecting corridor in the centre links the two ranges. Plain skylights along each side light internal bays. There are three plain tin louvres on the south range. At the gable ends and at the central conjunction of the ranges, railways enter the buildings through sliding boarded doors, carrying raw blocks. These tracks emerge through similar openings at the far end. There is a locomotive shed extension at the west end of the south range with a small slate chimney and entrance to the south return; there are various blocked openings along the long sides of the mill.

Each of the ranges is twenty-six bays long and all the original king-post trusses are retained. The north range is currently unused, though it contains various late nineteenth century Greaves dressers, and a planer by Turner Bros of Newtown survives in situ. In the south range the original overhead transmission is use, powering twelve belt-driven Greaves dressers. Thirteen dressing alcoves are in use, though most of the others remain, some with slate slab partitions and all with wooden L-shaped stacking benches. In the thirteenth bay is the wheelpit. Graffiti goes back to 1896.

7 March 1995 DRhGwyn

Discussion: This structure is of considerable importance in that it is one of the very few nineteenth century mills still in active production where the arrangements have not been substantially altered. This is partly to do with the fact that Maenofferen still relies on rail transport, now reduced to a single length of siding, and that there has been no need substantially to alter arrangements to allow forklift trucks to make their way into the building, with the consequent need to create turning spaces and to lower the floor level.

Conclusion: an important example of a slate mill, in that it is the only in use which still employs a rail access.

Site name: **Cwt y Bugail Slate Quarry**

Community: **Bro Machno, Aberconwy**

Quarry area: **Blaenau Ffestiniog**

Trust PRN: **20311**

Site history: Opened by Captain Adam Gregory in the 1830s, but only developed from the 1860s; situated on the ridge between Blaenau Ffestiniog, Penmachno and Dolwyddelen, and worked mainly as an open quarry until its closure in the 1960s (Richards 1991 p. 128). With no water-catchment area, the quarry was obliged to make use of steam power for its mill.

Feature no: 7 Feature type: **transverse slate mill**

Grid ref: **SH73344678** Statutory protection: **none**

Archival and bibliographic sources: The original part of the mill was in existence by 1867, when a literary meeting was held in it - the first in what was evidently intended to be a regular event, suggesting that the building was then new (*Baner ac Amserau Cymru* 7 Awst 1867). An eastward extension was constructed later, perhaps before 1877, and by the 1930s half of the mill was out of use. The later extension was then refurbished, and the older part abandoned. It has been suggested that power was originally derived from a portable steam engine, and that from 1910 its site was occupied by a single-cylinder belt-driven Ingersoll-Rand air compressor. It has been suggested that an oil engine latterly did duty as the power-source (Richards 1991 p. 128). There were latterly eight saw tables, two definitely Griffith Owen of Porthmadog sectional frame types, and another by Turners of Newtown (Plas Tan y Bwlch 1985 2-3). Earlier it had contained fifteen saw-tables and fifteen dressers (Shiloh 61). A measured survey was carried out by Plas Tan y Bwlch/Hull University in 1985.

Archaeological description: Situated on the made-up ground of slate rubble on floor B, at the foot of inclines up and down from extraction areas and near an adit entrance; the exit railway connection to the Rhiwbach tramway runs from a stackyard to its south. It is orientated north-east to south-west. It is roofless and in places substantially dilapidated, though the intermediate gables survive up to 3.5m.

Building material is mainly igneous rock with some use of sawn slate slab for patching and in blocked doors and windows, and very limited use of yellow firebricks underneath a line-shafting axle box in an intermediate gable, and as the lining of the external chimney. Parts of the substantial king-post trusses survive, some with the lower parts of axle-boxes for line-shafting surviving, some with pulley scratch-marks.

Two intermediate gable walls in an approximately central position appear to mark the site of a prime mover; the base of a square plan chimney stands outside the south-east longitudinal wall at this point, and within the building are bases and bolts. Two further intermediate gables in the eastern half of the building appear to demarcate a fitting shop, in which are several concrete bases. Three phases of line-shafting are visible in these gables as blocked holes, and some roof-trusses survive here.

To the east of the fitting shop is a processing area formerly accessed by two doors for transverse railways; no machinery survives here.

Between the fitting shop and the engine base is a slate-processing area accessed by two transverse railways. Some slate saw waste boards survive here, as do saw legs, fragments of saw tables (Greaves type), suction tubes and the wooden framework of four dressers.

The south-western part of the building is made up of a processing area formerly accessed by four transverse railways. No machinery survives here.

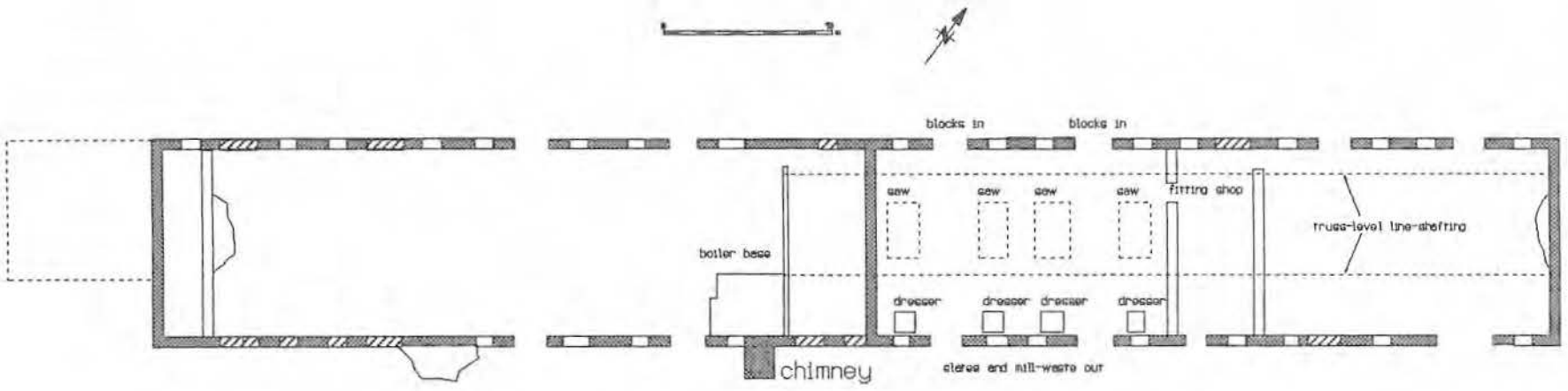
9 October 1996 DRhGwyn

Discussion: Though recent archaeological work suggests that the south-western half is the original, it appears that the engine house and the south-western range have been added on to an earlier structure. The fact that the

chimney does not appear to have been keyed in to the longitudinal wall suggests that this might be an earlier feature.

Conclusion: of regional significance as exemplifying the development of the slate industry in the Blaenau Ffestiniog area.

Fig. 17 20311i7 Cwt y Bugail Quarry slate mill



Site name: **Blaen y Cwm Slate Quarry**

Community: **Bro Machno, Aberconwy**

Quarry area: **Blaenau Ffestiniog**

Trust PRN: **20312**

Site history: Slate is first mentioned on the site in 1813, and a take-note, later converted into a lease, was granted to Hugh Beaver Roberts in 1863. The manager in this period was Captain Twigg of Llandygai, who had been responsible for tunnelling work at Penrhyn, and one of the partners Robert Lecky, who had been involved in Valentia slate quarry, Co. Kerry. Various lessees and managers followed, and Blaen y Cwm ceased work in 1914 (Jones GR 1991 1-5).

Feature no: **11** Feature type: **longitudinal slate mill**

Grid ref: **SH73364628** Statutory protection: **none**

Archival and bibliographic sources: This was built *c.* 1880 (Jones GR 1991 p. 10), certainly before 1888, when it is shown on the OS. It contained six saw-tables and six dressers (Jones GR 1991 p. 31).

Archaeological description: Constructed on made-up ground of slate rubble on the main processing level, to which counterbalance and uphaulage inclines give access from the extraction levels and from which an uphaulage incline connects to the Rhiwbach tramway. The building is a pitched roof structure, rectangular in plan orientated north to south, with an engine house against the northern gable and a wheelpit against the southern; it was accessed by a single length of railway running within the western longitudinal wall. The building is roofless but little dilapidated, and the longitudinal walls survive up to 2.75m high.

Building material is largely of unsawn slate blocks, with igneous rock in the lower part of the wheelpit and in a band from floor level to a height of approximately 1m in the western longitudinal wall.

The engine house is an integral part of the mill construction, and includes a brick base for a Lancashire or Cornish boiler and part of the firebox for a portable engine. Immediately to the east, and separated from it by a trimming-waste channel, is an enclosed area probably used to store coal. The trimming-waste channel runs the length of the eastern longitudinal wall, and extends northwards to a tip; it is approximately 2.5m deep and wide enough to take a railed wagon. Slate slabs are laid across it at three points, giving access to three now-blocked pedestrian doorways in the longitudinal wall. Six chutes for trimming waste run from the mill floor.

The wheelpit is sufficiently large for an overshot 30' wheel; traces of launder-pillars are evident to the south-west, and the tailrace passes under the tips.

Within the mill there is evidence for truss-level line-shafting within the eastern longitudinal wall. The sites of the six circular saws are evident, as are the sites of two pedestals for working the central four tables, and the sites of the dressers. There is also evidence of free-drive pulleys below ground floor level in the centre of the two gable walls for working the two outer saw tables.

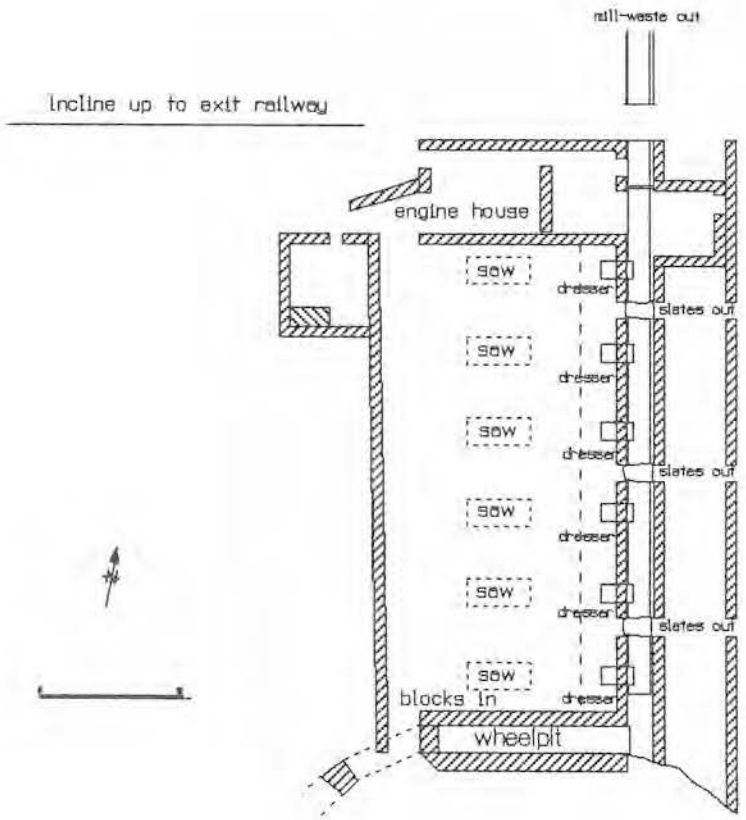
9 October 1996 DRhGwyn

Discussion: The value of this feature is heightened by the archaeological survival of both steam and water power-sources and by the trimming-waste channel.

Conclusion: of regional significance as exemplifying the use of power and process-flow.

Fig. 18 20312:11 Blaen y Cwm Quarry slate mill

Fig. 18 20312:11 Blaen y Cwm Quarry slate mill



Feature no: **16** Feature type: **longitudinal slate mill**

Grid ref: **SH73404625** Statutory protection: **none**

Archival and bibliographic sources: This was built in the early 1870s (Jones GR 1991 p. 26). Plans and elevations were prepared by Fforwm Plas Tan y Bwlch in 1991.

Archaeological description: Constructed on made-up ground of slate rubble on the main processing level, to which counterbalance and uphaulage inclines give access from the extraction levels, adjacent to feature 16.

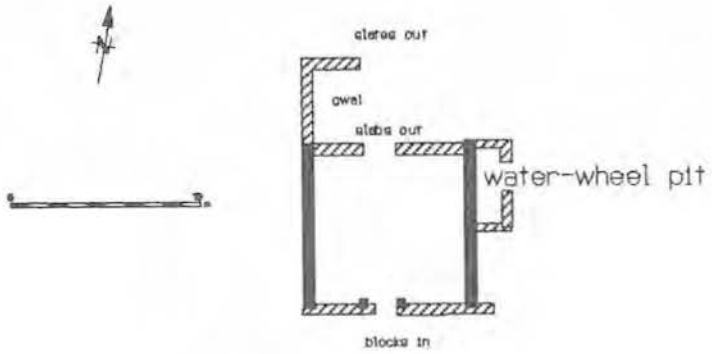
A small square-plan building, built out of unsawn slate blocks with some modifications in circular-sawn slate blocks. The walls are substantially dilapidated, and survive up to 2m high. The west-facing wall has been extended at a later date to the north to form a gwal, and further to the north is the trace of a stackyard. A wheelpit in the east-facing wall has been converted into two privy chambers; there is considerable recent (post-1991) collapse in the more southerly of these. The lower part of a launder pillar survives to the south. Rail access appears to have been by a central door in the southern wall.

9 October 1996 DRhGwyn

Discussion: A small mill which cannot have contained more than two saws, evidently superseded by feature 11.

Conclusion: of importance for its relationship with feature 11.

Fig. 19 20312116 Blaen y Cwm Quarry slate mill



Site name: **Rhiwbach Slate Quarry**

Community: **Bro Machno, Aberconwy**

Quarry area: **Blaenau Ffestiniog**

Trust PRN: **20313**

Site history: Rhiwbach Quarry has been worked since at least 1774, but was only developed on a substantial scale after the arrival of a new company in 1860, who constructed a railway over the Manod ridge from the quarry to Blaenau Ffestiniog. In order to lift this railway up to the level of the plateau, this railway left the quarry premises by an uphaulage incline, operated from a steam engine at its foot. This same engine also operated a mill (feature 11 below) and a haulage shaft. With an enterprising and forward-looking manager in charge, the company prospered in the later years of the nineteenth century, and continued in operation until 1953 (Jones nd *passim*).

Feature no: **11** Feature type: **bay slate mill**

Grid ref: **SH73944615** Statutory protection: **none**

Archival and bibliographic sources: This was built in 1863 and by 1912 contained eighteen saw-tables and eighteen dressers (Shiloh 39). Power came from the central steam engine known as *Injan Fawr* by Haigh and Co. of Wigan which also powered the shaft and the exit incline (Shiloh 38 and pers. comm. the late Ifan Owen Roberts). The 25" ordnance survey of 1888 shows the mill at its present extent. A central truss-level line shaft ran along the length of the building. Latterly power was supplied by a Crossley diesel (pers. comm., Griff Jones). Photographs taken not long before closure show a hipped roof in the south-west gable and skylights (in possession Griff Jones, ex Geraint Madoc Jones).

Archaeological description: Constructed on the natural ground level above the main working areas of Rhiwbach quarry, and at the foot of the quarry's exit incline, with which it shared a power-source. The mill is orientated south-west to north east, and is built out of slate rubble. It is roofless and heavily dilapidated. The longitudinal walls appear to have been made up of pillars built of slate rubble, with the intervening areas filled with timber or corrugated iron partitions. A catslide extension has been constructed alongside the north-west facing longitudinal wall, beyond which is a stackyard, and a compressor house and workshop have been added along the south-east longitudinal wall. Against each gable wall is a substantial buttress which may also have been the base for longitudinal line-shafting.

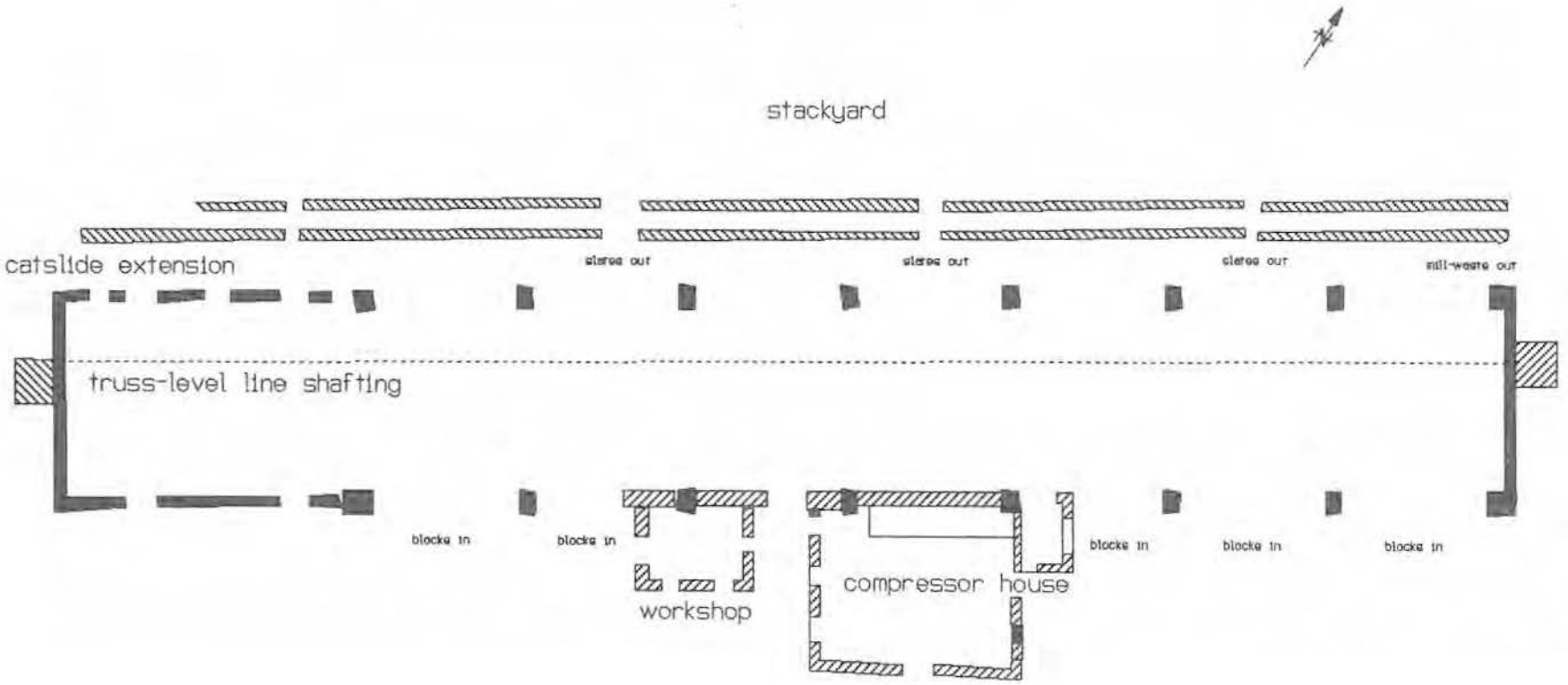
In the northern corner of the structure the trace of an underfloor trimming-waste trench is evident, and there are some lengths of rail *in situ*.

6 February 1997 DRhGwyn

Discussion: Archaeological and cartographical evidence suggest that the raw blocks entered the building at various point along the south-east longitudinal wall, and that there was a transverse process flow, with the finished slates being carried out by hand through the opposite longitudinal wall to the stackyard.

Conclusion: despite the comparatively poor survival of this structure, it is of considerable archaeological significance as part of a rationally-designed integrated power and transport system.

Fig. 20 20313:11 Rhiwbach Quarry slate mill



Site name: **Minllyn Slate Quarry**

Community: **Mawddwy, Gwynedd**

Quarry area: **Dyfi**

Trust PRN: **20449**

Site history: Initially developed on a remote and inaccessible site in the early 1840s, by a consortium that appears to have involved John Bright MP. However, operations appear only to have resumed with the opening of a branch line railway from the Cambrian Railways main line in the 1860s, when a substantial mill building near the terminus, now adapted for reuse as a wool-store, replaced an earlier mill in the quarry itself. The quarry is believed to have closed *c.* 1916 (Richards 1991, p. 172, pers. communication, Richard Morris Williams).

Feature no: **6** Feature type: **longitudinal slate mill**

Grid ref: **SH85341396** Statutory protection: **none**

Archival and bibliographic sources: An advertisement of 23 August 1845 in the *CDH* (p. 2 col. C) is the first record of this structure; a six horse-power steam engine by Blackburn of the Minories, London, powered "three circular saw machines for cutting slate slab; three superior planing machines, 2 of them on the rotatory principle, the whole of large dimension and great power ... nearly the whole of which is new." Letters of 1843 from Frank Howard of Camden Town, the then tenant of the quarry, enquire about the quality of slabs emerging from level 3, below the mill, and it is hard to imagine a mill being built at a higher level after this date - unless the slabs were of a very poor quality (pers. comm., Richard Williams of Llanrwst). An undated map (but later than the construction of the Mawddwy Railway, opened in 1867 [Bradley 1992 p. 116]) shows a water-course leading to it (DRO Z F 6). A 50 hp pelton wheel was installed in 1894, on which the lettering "Pelton Water Wheel Co Pat'd 1880, Feb 1887, August 1887, Motor No 5, San Francisco, California" could be seen for many years (pers. comm., Richard Williams of Llanrwst).

Archaeological description: Situated on floor 5 of the quarry, near the mouth of the tramming adit into the underground workings and at the foot of two inclines from higher levels; from floor 5 a counterbalanced incline descended to the lower mill (6) and the interchange with the Mawddwy Railway. The sawing area itself is built on made-up ground of slate rubble, the engine house and the remote chimney on the sloping natural ground surface.

The remote chimney is square-plan and built out of unsawn blocks. There is the irregular trace of a flue leading to it from the engine house. Running from the engine house in the direction of the tunnel portal is a row of low slate pillars built out of sawn blocks.

The mill and its associated structures constitute a rectangular building orientated south-west to north-east; the south-westerly section is built almost entirely of unsawn slate blocks, the north-easterly almost entirely of slate blocks sawn with a circular saw. The engine house stands uphill of the north-east facing longitudinal wall at a point where the unsawn blocks give way to sawn and is largely built out of unsawn blocks with later patching. On the opposite side of the structure is a smithy with a hearth. Walls are badly collapsed in places, elsewhere survive up to a maximum of 3m high. There is no trace of the outline of a gable but a number of blue earthenware ridge tiles survive on site, suggesting a pitched roof.

Within the south-western part, there is a separate area defined by the south-eastern longitudinal wall and a parallel row of pillars. Within the longitudinal wall itself are three blocked openings at floor level with slab lintels, no more than 50cm high.

Some ironwork was observed under a collapse in the north-eastern part but could not be investigated. In the engine house a dampener door survives in the longitudinal wall near the trace of the boiler, and a cast-iron pipe runs from a penstock to the site of a turbine or a pelton elsewhere in the building. Firebricks survive, scattered over the site.

4 September 1996 DRhG

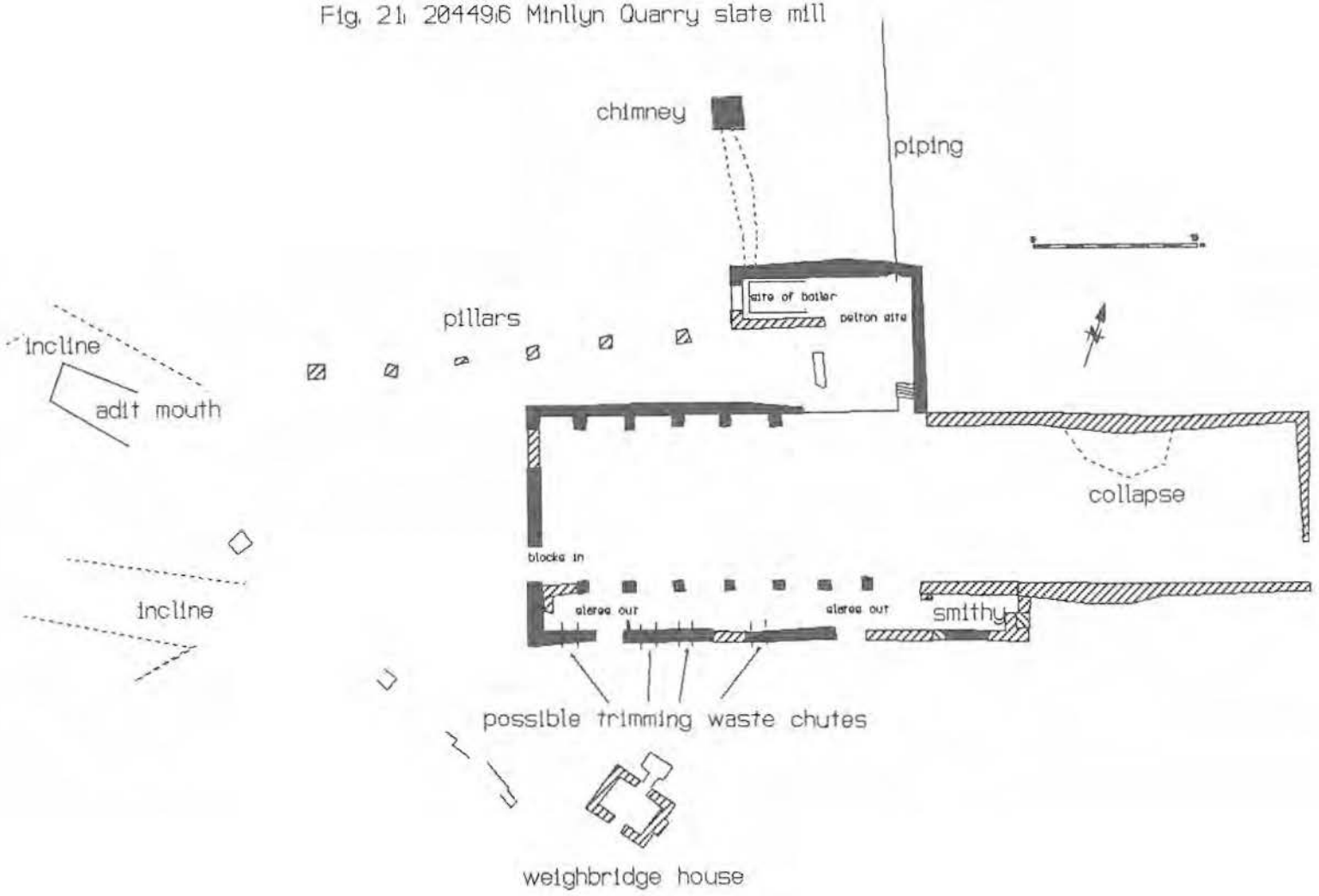
Discussion: The use of two different types of block suggests two phases of building; unfortunately, the post-1867 plan is insufficiently detailed to confirm this, but appears to suggest that the extension was already in place. It also marks a water-course, though not on the site of the existing cast-iron feed to the turbine or pelton

The use of steam power here by 1845 is bizarre in the extreme. There was then no railway nearer than Worcester, and no colliery worth the name nearer than Chirk; sea-access would have involved a punishing road journey from the head of navigation at Derwenlas, below Machynlleth. There was clearly adequate water on the site. This may have been the first steam-powered slate mill in a Gwynedd slate quarry, and possibly third only to the mill at Valentia in County Kerry (pre-1838) and its associated mill at Knightstown (1839-1840) (Gwyn 1995 passim). The use of steam power at Minllyn may have been prompted by the possibility of a railway in the area; it is tempting to suggest that it was somehow connected with Brunel's abortive proposal for a 7' gauge line through the area to Porth Dinllaen, abandoned in favour of Stephenson's proposal for a standard gauge route along the North Wales coast in 1845. This would explain the over-investment in technology, and the attempt to offload the site in 1845. Further evidence for this theory is that from October 1846 Frank Howard was a shareholder in the Meirionethshire Slate and Slab Company, along with John Bright MP. Bright was a major shareholder in Dylife lead mine, and would have been well placed to observe the contest between Brunel's mid-Wales broad gauge route and Stephenson's North Wales standard gauge route.

A further possibility is indicated by the three low blocked openings at floor level. It is a strong possibility that these are trimming-waste chutes, and that the ground here would at one time have fallen away. If these features are coeval with the original part of the structure, then the mill is the earliest example of an integrated slate mill in the Gwynedd slate industry, a possibility mentioned in the second project. The fact that the machinery advertised for sale in 1845 says nothing of equipment needed for roofing-slate manufacture is not a problem; the only dressing machine then available was the Carter dressing knife, for which there is no evidence in Wales.

Conclusion: of regional significance as exemplifying an early stage in the development of the slate mill, and for its use of power-sources. If any future excavation confirms that the splitting booths are coeval with the mill, its significance is increased.

Fig. 21: 204496 Minllyn Quarry slate mill



Site name: **Ty Mawr East Slate Quarry**

Community: **Llanllyfni, Gwynedd**

Quarry area: **Nantlle**

Trust PRN: **20030**

Site history: Ty Mawr East Slate Quarry (also known as Nantlle Vale) worked three veins of slate from a number of pits at the foot of the southern slopes of Dyffryn Nantlle. It is believed to have opened *c.* 1860 and to have shut *c.* 1910 (Richards 1991 pp. 52-3). In order to access the slate and to haul wagons up to the rubble bank, a haulage shaft was sunk and a winding engine (features 1 and 3 below) constructed.

Feature no: **1, 3** Feature type: **shaft**

Grid ref: **SH49895256** Statutory protection: **none**

Archival and bibliographic sources: It has not proved possible to date this feature exactly. It is not mentioned in *SQNW1873*, but it is marked on the 25" Ordnance Survey of 1900. Richards dates it to the 1890s (1991 p. 53).

Archaeological description: A rectangular building orientated north-east to south-west constructed on an outcrop on a north-facing slope. It is situated immediately to the north-east of a pit which has been infilled by recent working for hardcore. The site of a vertical haulage shaft to the north-east is indicated by a shallow depression in the ground. A foundation for a drum, or drums, was noted to the west of this building, though this area has been disturbed by the construction of a base for a caravan. To the south-west is a slot through a built-up platform which appears either to have accommodated a cable to a now-vanished haulage point, for a chain incline, or flatrods to a pump, on the lip of the now-infilled pit.

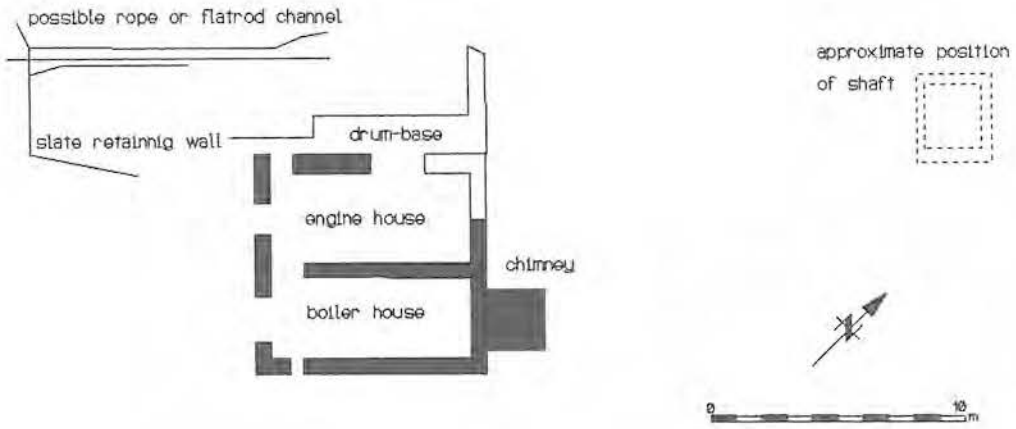
The building itself is constructed of unsawn slate slabs, with some use of country rock, especially as quoins. It consists of two chambers, the south-easterly being for the boiler, and the north-westerly for the engine. The spinal wall survives up to 4 metres high, suggesting that the engine house was a tall pitched-roof structure. The boiler room seems to have been built as a lean-to. The square-plan chimney in the north-east end wall of the boiler room stands complete.

9 August 1996 DRhGwyn

Discussion: There is no apparent reason why an expensive shaft system should have been installed here instead of a more common chain incline.

Conclusion: an excellent example of a rare feature, despite its comparatively poor archaeological survival.

Fig. 22 20030:1 and 3 Ty Mawr East Quarry shaft winding house



Site name: **Blaen y Cae Slate Quarry**

Community: **Llanllyfni, Gwynedd**

Quarry area: **Nantlle**

Trust PRN: **20031**

Site history: Blaen y Cae Slate Quarry in the Dyffryn Nantlle quarrying district operated from the 1830s to the 1930s as a series of open pits on the northern slopes of the valley. A blondin ropeway system and a steam winding engine by Henderson's of Aberdeen for haulage out of the pits to the rake of counterbalanced inclines which gave access to the mill *c.* 1910.

Feature number: **5, 20, 22-24** Feature type: **steam-powered blondin**

Grid ref: **SH49695370** Statutory protection: **none**

Archival and bibliographic sources: The winder dates from c. 1910, and was built by Henderson's of Aberdeen. In 1925, when Dorothea quarry had a valuation made of the site, the engine was valued at £500, and the home-made cableway with its timber masts at £200 (CRO X/Dorothea/1023). Richards suggests that the quarry shut in the 1930s (Richards 1991 p. 46).

Archaeological description: Situated on the top level of Blaen y Cae quarry are the substantial remains of a steam-powered blondin system, consisting of a steam winch, a collapsed mast, together with an embankment for a railway from the mast head, past the steam engine, leading to the head of a counterbalance incline and to a rubble tip. The engine seems to have powered a blondin which spanned the main quarry pit, and whose other mast was on the working bank of the next level down, where its remains survive.

The steam winch is mounted on a concrete base supported on slate slabs, and is covered in slate rubble up to cylinder level on the north-western corner. The boiler is missing, and the steam feed pipe survives, albeit disconnected to the cylinder feed. The two cylinders are mounted at an angle, and operate the drive axle by means of disc cranks. The connecting rods survive, but the crank-pin bearings have been removed. The Stephenson reversing gear remains in situ.

Power is transferred to the winding-drums by reduction gearing. The winding equipment itself consists of a narrow drum for the travelling rope and a wider drum for the hoist, on a split axle, mounted on a substantial A frame. The bearing blocks have been removed. The two clutch mechanisms and their levers survive. The brake bands have been disconnected but survive, and fragments of their wooden lining were noted.

Holding-down bolts for other machinery, probably haulage drums, survive nearby, but are probably not related to this feature.

The course of the wire ropes from the winch to the mast is clear; they pass through a slot in a rubble-heap, across a sheave support and through a channel under the railway near the mast base.

The mast at is a timber H-pole construction with three wooden cross-members, now toppled, but formerly mounted on a slate base, slotted to allow the passage of the ropes around three return sheaves, which survive in situ. The timber verticals appear to have been in the order of 8.5m long, and measure 0.3m by 0.45" in section. Traces of red oxide paint survive in places.

The headframe consists of two U-section steel channels of different dimensions, bolted together to enclose the timber verticals, and incorporating two eyes for support ropes. Another two are attached to the timbers. Two return pulleys survive which formerly ran in bearings on the timber verticals, and a third on an iron bracket projecting from the U-section channelling.

A slate-built rope-anchor base was noted approximately 20m to the north; this consists of a horizontally-mounted screw-adjustable anchorage for a double wire rope, plaited and held together by twelve U-clamps, flanked by two metal rods ending in eyes inclined at a low angle to the horizontal.

Immediately to the south of the mast base is a landing, with a steel landing plate for wagons, with angle-iron to guide the wheels.

The ironwork for a similar mast-head was noted on a lower level, presumably representing the furthest reach of the blondin system.

9 August 1996 DRhGwyn

Discussion: It appears that the blondin system uphauled both rubble and blocks, but that only rubble was raised to the top level, where the winder itself was situated. Logic would suggest that the workable slate, once uphauled from the pit (12), was dropped to the next level down, where the mill was situated. As much is suggested by the fact that the incline to the top level is shown as devoid of rails on the 1913 25" ordnance survey; presumably coal for the winder was brought up by cart.

The steam winch is in fact a more recent machine than the electric motors which operated the Pen yr Orsedd blondins. It is a typical steam winch of its period, little different from the equivalent machines constructed by the Messrs Inglis for the Caledonian Wire Rope Company of Airdrie, who also supplied the Nantlle quarries (Pierce Jones 30, CRO XM/7205 passim). Of the twenty-four blondin steam winders introduced to the Nantlle and Moel Tryfan quarrying districts from 1898 onwards, twelve were of this pattern, the others mainly double cylinder horizontals by Robey, though there were also two single cylinder horizontals, one home-made, one by DeWinton (Pierce Jones 1985 p. 30).

Timber masts were common on smaller cableways, and anecdotal evidence suggests that these were frequently home-made (pers. comm., Dr Gwynfor Pierce Jones and Messrs Levi Jones and Dafydd Price).

Conclusion: an outstanding survival, of national importance.

Site name: **Dorothea Slate Quarry**

Community: **Llanllyfni, Gwynedd**

Quarry area: **Nantlle**

Trust PRN: **20033**

Site history: Dorothea quarry in the Nantlle quarrying district was worked from its inception *c.* 1823 to its final closure in 1970 in a series of deep pits on the floor of the valley. As these grew deeper and amalgamated, uphaulage needs become pressing, and the quarry probably made use of the full variety of methods to uphaul the rubble. Shortly after neighbouring Cloddfa'r Lôn installed their first chain incline, with a steam engine to power it, under the management of the Cornishman Gullet sometime after 1841, and Dorothea had their own chain incline, operated by a beam engine, from 1843. Early railed inclines at Dorothea, apparently worked by horse-whims to begin with (Pierce Jones 1980 p. 113), were altered for steam operation after 1854, when the trial run of the first incline to be converted, a wagon broke away and seriously injured the manager of the quarry, the great preacher John Jones Tal y Sarn (Thomas O 1874 p. 697). An anonymous painting of the quarry dating from *c.* 1861 (Pierce Jones 1980 p. 61), in possession of Michael Wynne Williams) shows steam railed as well as chain inclines, but its was the latter method which survived at Dorothea for uphaulage from the pit until 1966. From the end of the nineteenth century uphaulage inclines were used only for secondary level tipping.

The first blondin cableway arrived in 1900, and these also survived until modernisation in the 1960s.

Feature number: **30** Feature type: **Chain incline engine house**

Grid reference: **SH49765313** Statutory protection: **Scheduled Ancient Monument**

Archival and bibliographic sources: This feature, known in the quarry as winding engine room 11 dates from November 1869, when a new 25 hp single-cylinder steam engine was bought to power a four-carriage chain incline into pit C (Pierce Jones 1980). The engine was constructed by DeWinton's Union Ironworks at Caernarfon, and cost £360; it was 18" bore, 27" stroke, capable of generating 25 horse-power, working at a maximum of 60 rpm. It was set in two large timber baulks set in the floor. The 13' flywheel had a brake band for added safety; the engine driver could see only the drums and the top of the headgear, and messages had to be relayed by a mechanical bell. The original boiler was scrapped in 1904 and an Ingersoll horizontal air-compressor installed in its place; the replacement boiler was installed in a new lean-to structure (Pierce Jones 1985 20-21, 25, 28)

Archaeological description: Situated on a ridge of bastard rock on the south-western perimeter of the pit at Dorothea quarry, and which separates the Dorothea workings from those of Cornwall Quarry. The strongpoint consists of cantilevered timbers projecting over the edge of the pit.

The building is a single pitch structure orientated south-west to north east divided into two chambers by a central spinal wall. Alongside the south-east longitudinal wall is a later boiler-house extension, which preserves the slope of the original roof. The north-western chamber in the original building contains the base for a single-cylinder steam engine, and outside the building to the north-west is the base for two substantial winding drums. A water tank and the lower part of a steel chimney set in a slate base were noted on the exterior of the south-west gable. Alongside the north-east gable are slate-built coal bunkers.

25 September 1996 DRhGwyn

Discussion: The south-eastern half of the original building appears to have been the original boiler room, in which case it it is of a similar pattern to the shaft winding-engine house at Ty Mawr East, in that both were constructed as single-pitch buildings, with a central spinal wall dividing the boiler house from the engine-bed, and with an external base for the winding drum. The winding engine house at Tan y Bwlch appears to have been a similar feature, though here the drums were internal. Though the Dorothea engine house has been described as a typical example (Pierce Jones 1985 p. 20), there was clearly some variation among them.

Conclusion: an excellent example of a Nantlle feature, in a spectacular location at the edge of the pit at Dorothea Quarry. Its value is augmented by having been designed for a winding-engine known to have been designed and built by the local firm of DeWinton.

Site name: **Cloddfa'r Lôn Slate Quarry**

Community: **Llanllyfni, Gwynedd**

Quarry area: **Nantlle**

Trust PRN: **20036**

Site history: Cloddfa'r Lôn was the earliest quarry of any size on the lower slopes of Dyffryn Nantlle, and was the original terminus of the Nantlle Railway when it opened in 1828. Twll Ballast was worked from *c.* 1830 and material was originally raised by a water-balance which gave its name to the pit (*recte* Twll Bala's, "[Water] Balance Pit") and the first chain incline in North Wales was installed here in 1841 by the Cornishman Gullet from Delabole Slate Quarry, on a site that has now been destroyed (Sylwedydd p. 47).

By the 1870s it was worked in four pits; a programme of investment in the early 1880s caused the quarry to develop a working bank on the eastern perimeter of the quarry, where a barracks had been built in the 1860s. This was equipped with winding equipment, (features 34 and 38 below), a mill and gwaliau. This development proved short-lived as the quarry was sold in 1892, and this part was never put into re-use.

Feature number: **34, 38** Feature type: **chain incline**

Grid ref: **SH50265341** Statutory protection: **none**

Archival and bibliographic sources: It has not proved possible to date this feature. The engine house is marked on the 25" OS of 1887, and the *CDH*'s correspondent in 1873 notes "For the purpose of hoisting the products of the quarry there are four powerful stationary engines" (*SQNW1873* 69), possibly one for each of the pits. Sylwedydd, writing in 1889, describes the first chain incline engine as a massive affair with two flywheels, each of which alone required five horses to drag it from Caernarfon (p. 56). The sale catalogue of 1892 describes it as a two-cylinder winder, nearly new, by Ratcliffe's of Hawarden (pers., comm., Dr Gwynfor Pierce Jones).

Archaeological description: Constructed on a ridge of unworkable rock to the west of Twll Mawr, one of the four pits which made up the quarry collectively known as Pen y Bryn or Cloddfa'r Lôn. On the same level are a steam-powered slate mill, a farmhouse and other agricultural buildings, and two rakes of barracks, and the abutments of a bridge over the turnpike road and the Nantlle Railway immediately to the south are visible, which gave access to a rake of gwaliau and a tip run to the east of Dorothea Quarry.

The winding-engine house is a substantial structure which has gone through several phases of modification. The boiler house to the north survives only to approximately 1m high, and the square plan chimney to approximately 3m. The winding-engine house itself and the gable wall to the south survive up to second floor eaves height. There is no trace of the engine arrangements in the winding house, but the large opening at first floor level facing the pit suggests that this unit contained a winding drum and that a rope passed through this opening to the mast on the landing, as well as functioning as a window for the engine-driver. The presence of holding-down bolts on its sill here suggests that a roller here held the rope on its proper alignment. A small opening in the east wall at ground floor level may be a doorway or may be for a rope.

In the northern wall at first floor level is an opening for a steam pipe from the boiler house.

There is evidence in the form of an opening and holding-down bolts that a drive axle passed through the south wall of the main structure and operated a drum through reduction gearing. This drum was supported both by the main structure and a gable wall to its south. A slot cut in the stone-built structure on the pit side of this drum gives an approximate indication of its size, since it is shaped to clear the drum's diameter.

15 Ocotber 1996 DRhGwyn

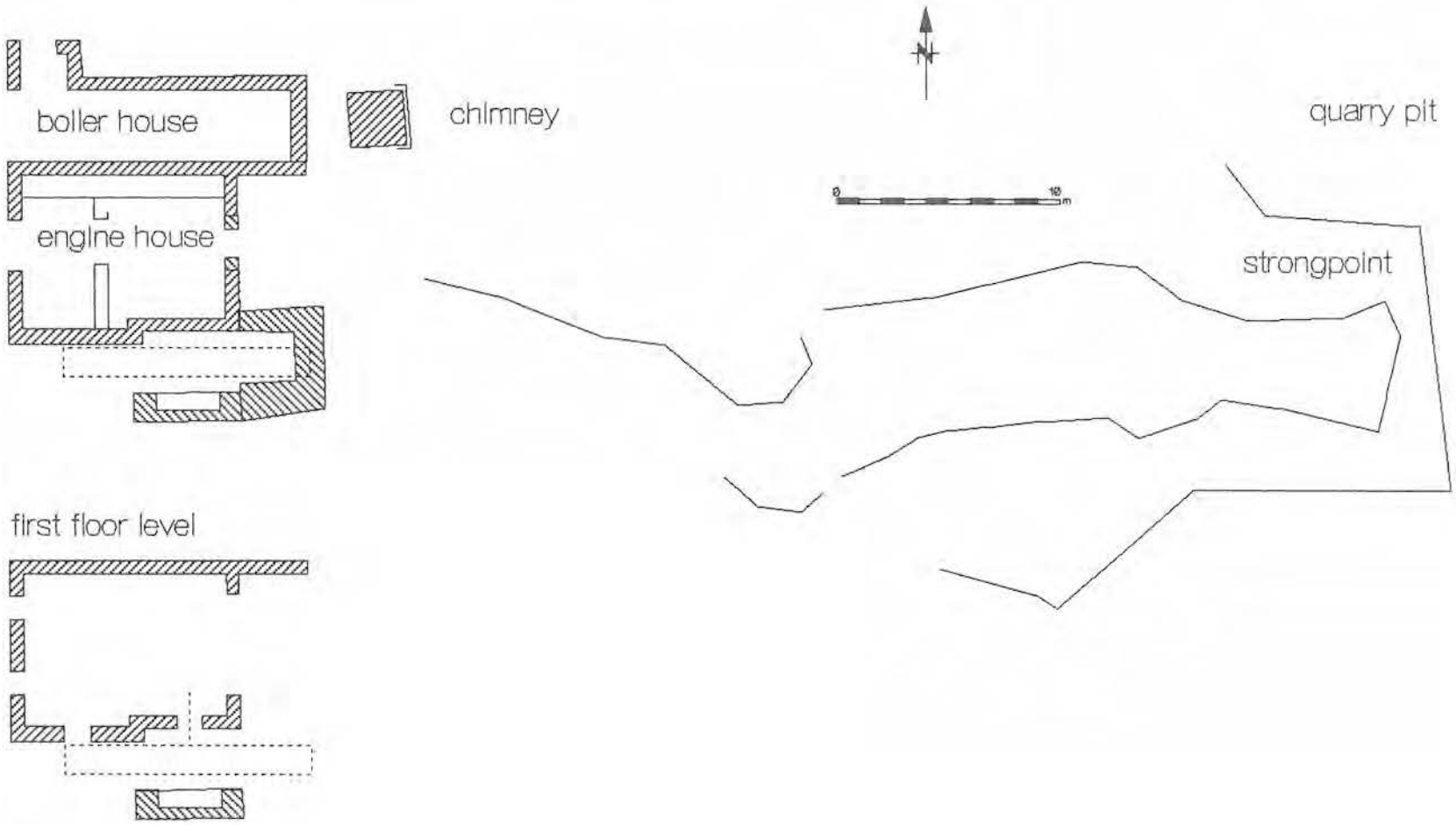
Discussion: It was suggested in the second report that the engine house contained a substantial colliery-type horizontal winder, and this seems very probable. Possibly it was of the same pattern as the original engine described by Sylwedydd, if by flywheels he might have meant winding drums. The location of the hole in the northern longitudinal wall suggests that the cylinders were in the western part of the building (an arrangement

which would also make sense of a boiler house containing a return-flue Lancashire boiler), operating a drive axle to an external drum through reduction gearing. The two ledges inside the north and south longitudinal walls may each have supported a cylinder, operating on both sides of a central drum. The site of the external drum lines up with the centre of the landing platform, whereas the main building itself does not.

The relationship of this feature to the pit itself and the winding platform, as well as to the processing, transport and domestic features on the same level add to the value of this feature.

Conclusion: the value of this feature is enhanced by the other features on the site.

Fig. 23 20036:34 and 38 Cloddfa'r Lon Quarry chain incline



Site name: **Pen yr Orsedd**

Community: **Llanllyfni, Gwynedd**

Quarry area: **Nantlle**

Trust PRN: **20039**

Site history: Pen yr Orsedd quarry is situated on the northern slopes of Dyffryn Nantlle, and has been worked, as a series of pits, from the late eighteenth century. The purchase of a lease by a new partnership in 1862 led to substantial investment in the quarry, reflected in the provision of mills and uphaulage systems, making use of both water and steam power. From 1898 the existing steam-powered chain inclines began to be superseded by blondin ropeways, initially themselves steam-powered, but electrically operated from 1906.

The quarry remained in production until 1978, and was later re-opened using modern methods, but a recent rockfall has put its future in doubt.

Feature no: **10, 12, 48-55, 66** Feature-type:**blondins**

Grid ref: **SH50855408-50725426** Statutory protection: **Scheduled Ancient Monument**

Archival and bibliographic sources: Part of the difficulty tracing the archaeology of the cableways at Pen yr Orsedd is that whereas waterwheel pits involved a substantial amount of capital expenditure, and were restricted to where a water-supply could be contrived, combustion engines and electric plant could be moved around fairly easily. A small quarry like Blaen y Cae would not need to do this particularly often, and the equipment there is almost certainly in its original situation. A large concern like Pen yr Orsedd would need to do so regularly, and it is clear from anecdotal evidence that the blondins have been moved not once but many times. Sometimes plans survive showing where these were relocated (CRO Pen yr Orsedd 410); in any event, the original two blondins on Eureka later became six as the lower pits were worked out, of which three now survive *in situ* and intact, one has collapsed and one has been transferred to the Slate Museum in Llanberis.

A surviving set of blueprints gives the span of one system as 650' (CRO Pen yr Orsedd 388). The original steam engines were replaced by Bruce Peebles 50 hp three-phase electric motors in 1906, and were removed after the new power system proved itself.

The valuation of 1907 describes the steam engines at Bonc Brig as a Henderson and a Robey double cylinder engines, 10" X 18" and 12" by 18" respectively (CRO Pen yr Orsedd Additional 2059).

Archaeological description: The surviving equipment is substantially constructed and largely intact. The masts are of steel lattice construction, not timber. At the summit of each is a control platform, accessed by a ladder up the side. Each mast is supported by wire guy-ropes which are anchored in foundations built of slate slab. The blondin rope and the haulage rope survive, together with the *ceffyl*. The span is considerable.

On the quarry bank pulleys set in steel frames turn the haulage ropes through 90° angles to reach the engine houses.

The engine houses are of a slate rubble construction, roofed and in substantially good condition. The winding drums are substantial castings, latterly operated from Bruce Peebles three-phase motors through reduction gearing. The motors survive in each case, as do the control mechanisms and the liquid controllers.

27 January 1997 DRhGwyn

Discussion: The right-angle turns in the haulage ropes suggest that the blondin masts have been resited several times in each case as the quarry pit grew in order to avoid having to rebuild the engine houses. The three-phase electric motors represent the state of the art at the time. As part of an alternating current system, they form a valuable contrast with the slightly older direct current system at Llechwedd dating from 1904, and similar plant was installed in Oakeley quarry around the same time to electrify the six-track uphaulage incline of 1889 and Twr Babel (Isherwood 1988, pp. 13-14, 38). Messrs Bruce Peebles of Edinburgh were the foremost electrical

engineering company of the time, particularly active in North-west Wales (Gwyn 1989 *passim*).

Conclusion: an outstanding survival of national importance.

Site name: **Penrhyn Slate Quarries**

Community: **Llandygai, Gwynedd**

Quarry area: **Bethesda**

Trust PRN: **20061**

Site history: Though the very earliest workings at Penrhyn were on the hillsides of Cae Braich y Cafn, worked as stepped galleries under James Greenfield's management (1800 to 1825), by the early years of the nineteenth century part of the quarry was being worked in a pit below the processing levels, which required an uphaulage system.

First and last these were hydraulically operated, though their exact form in the early nineteenth century is obscure. A report in the *CDH* on 1 September 1849 speaks of "Descending to the level ground we came to the enginehouses which put all the waggons on the inclines in motion. They are driven by water power, drained from a branch of the River Ogwen ..." Though possibly these were railed water-balances, the reference to "engine-houses" suggests waterwheel-powered inclines. These would have had a very low head off which to work. Possibly this early system, whatever it was, reflects Greenfield's background as a canal engineer, and the hydraulic engineer Joseph Bramah's consultancy work for the quarry (Richards 1994 p. 214).

From the mid-nineteenth century onwards the quarry began to make use of water-balance shafts (in Welsh *tanciau*, "tanks"), a method made possible by driving a drainage adit from 1845 to 1849 which empties at Tan Ysgafell, north of the quarry (CRO XPQ 997 p. 20) Eight of these were constructed, and latterly five remained in use until they were all abandoned in 1965 (pers. comm., Iorwerth Jones, Penrhyn Castle Museum). Two survive with their headframes intact.

Feature number: **58** Feature type: **shaft**

Grid ref: **SH62026543** Statutory protection: **none**

Archival and bibliographic sources: This feature, known as *Tanc Sebastopol*, was complete in 1858; the shaft itself measures 14' 6" by 18' by 210' deep (CRO XPQ 997) It has been suggested that the builder was Ratcliffe's foundry, Hawarden, who unsuccessfully tendered for the installation of the hydraulic shaft at Pen yr Orsedd built by DeWinton in the 1860s (CRO Pen yr Orsedd Additional 1873 24, 32, 71, 88, 115, 117). Penrhyn Quarry paid DeWinton's £868 2s 7d for a water balance in 1858-9, but this may have been for Fitzroy shaft, which was also working from 1858 (CRO XPQ 997 p. 20, p. 23). The name "Sebastopol" commemorates the allied capture of the Crimean fortress on 11 September 1855 (compare "Malakov" level in the quarry). At the foot of Sebastopol shaft is a chamber, opened out by Captain Twigg of Hanley, Staffordshire (CRO XPQ 997 p. 23), in which were installed two hydraulic lift pumps of 30 hp and 800 gallon capacity in 1859 (plan in quarry office). One has been dismantled and removed, the other is said to be still *in situ*.

Archaeological description: The Sebastopol water-balance shaft complete with head-frame survives *in situ* near the office on the made-up ground of Red Lion level, the main processing level at Penrhyn Quarry, north of the main pit, now disused and partly flooded.

The shaft itself is lined with stone slabs in its upper section; the timber cage-guides remain in place, and there are rails for manoeuvring the wagons on and off the cages on the north side of the shaft.

The headframe consists of a substantial cast-iron wheel, partly covered with a protective housing, mounted on two iron cross-members, themselves supported by two one-piece castings in the form of tapering columns mounted on the sides of the pit. Neither cage is visible, though the plaited steel rope has been severed over the western part of the shaft, and it is possible that both cages survive at the foot of the shaft.

The water tank stands immediately to the south of the headframe, and is supported by nine iron columns, one of which presumably contains a rising main. A valve projects from below ground level immediately to the west of the tank. The feed system to the cage tanks is only partly intact.

A monopitch timber shed on the east side, still intact, houses control gear. On its north side is a lean-to structure built entirely out of slate slabs.

The ironwork on this feature has been painted a silver-grey, and overall it is in excellent condition.

20 December 1996 DRhGwyn

Discussion: The evidence of photographs and field work makes it clear that there were considerable detail variations in these structures, only to be expected where they were supplied by two different firms over aperiod of more than fifty years. The water-tanks of "George" and "Douglas" shafts, for instance, are carried on slate walls.

Conclusion: an outstanding feature, of national importance. The survival of this feature largely intact, and its location next to the quarry offices makes it a potent reminder of Victorian engineering skill.

Feature number: **82** Feature type: **shaft**

Grid ref: **62156537** Statutory protection:

Archival and bibliographic sources: One source suggests that the headframe of this feature, known as *Tanc Princess May* was built by DeWinton's Union Ironworks at Caernarfon, and was completed in October 1900, though the shaft was not operational until 1903 (pers. comm., Eric Foulkes). A document in the quarry's archive states that it was complete in 1895 (CRO XPQ 997 p. 20). Princess May gallery, which it served, was opened in May 1894, when the Princess, the future Queen Mary, wife of George V, visited the quarry on 12 July of that year (*Slate: The Penrhyn Quarry* p. 7).

Archaeological description: Situated at Ponc Sling, below the main Red Lion working level, near to the lip of the quarry pit.

This balance not only retains its headframe but also a cage, with a water-tank above the platform for the men and the wagon, and all its piping, and a feed-tank on iron supports, like "Sebastopol". Again, the "ship's wheel" controls survive. The rope is plaited steel.

20 December 1996 DRhGwyn

Discussion: The success of the basic design is attested by the fact that the two surviving headframes differ very little from each other, despite the forty-odd years which separate them. Sebastopol is a more sophisticated and substantial structure than the other two examples surviving in Wales, the balance headframe at Cwmbyrgwm mine near Abersychan built in 1820 (Thomas WG 5), and the later example from the old shaft, Twyncarno colliery, Brynpwllog in the Rhymni, thought to date from the 1830s and moved to the National Museum of Wales in 1935 (Morgan Rees D 93). The Cwmbyrgwm example consists of a chain passed over a six-spoke pulley mounted on axle boxes on timber members supported on iron A-frame supports. The Brynpwllog headframe is built to the same basic pattern, but is of all-iron construction and uses a flat treble chain (NMW 78.738-745).

Conclusion: an outstanding feature, of national importance.

Site name: **Tan y Bwlch Slate Quarry**

Community: **Llanllechid, Gwynedd**

Quarry area: **Bethesda**

Trust PRN: **20062**

Site history: In 1865 Hugh Derfel Hughes remarked that the quarry had been worked for three years by a London company, with a Cornishman, Michael Williams, as manager and a local man, John Griffith, as overseer (129). The site had indeed been taken over by John Taylor and William Jones in 1862, as the Tan y Bwlch (Bangor) Slate Company Ltd (BT31/658/2779), which was succeeded by the Port Bangor Slate Company Ltd in 1868 (BT31/1407/4028). The quarry shut down in 1876 (Williams and Jenkins 1996 p. 75) and from 1903 to 1907 it was worked in a very desultory way by W.J. Parry as part of his Co-operative quarrying enterprise (Roose-Williams pp. 179-187). The pit was accessed by a shaft operated by a steam engine (feature 20 below).

Feature number: **20** Feature type: **shaft**

Grid ref: **SH59856065** Statutory protection: **none**

Archival and bibliographic sources: Precisely when the shaft and the steam engine were installed remains obscure, but clearly it was between 1865, when Hughes, who normally had a sharp eye for new technology, does not mention them, and 1873 when the anonymous series of articles in the *Caernarfon and Denbigh Herald* in 1873 (28 June) describes them as being of enormous size for a fairly small site.

The men responsible for the sinking of the shafts were two families from Hanley in Staffordshire (Stoke on Trent), the Salts and the Twiggs, whose speciality was this type of work. Both families lived in Tan y Bwlch in this period, having been involved in the sinking of shafts for the Penrhyn Quarry in the 1850s and 1860s. The power-source was a steam beam engine (Williams and Jenkins p. 1996 75, CRO XPQ 997 pp. 22-3).

It is likely that the shaft was not used after 1876. The engine survived until the 1950s, when the engine house was in use as a barn (pers. comm., Anthony Griffith).

Archaeological description: Situated at the top level of Tan y Bwlch quarry, orientated north to south and built into the hillside, which has been quarried away on the upslope (eastern) side to allow construction of the building.

A substantial pitched-roof structure built out of igneous rock, with a lean-to on the western side. The whole building has been substantially altered between 1994 and 1996 with its conversion to a dwelling; it has been re-roofed and an extension added. However, it is still possible to make out the original structure. The lean-to has two convergent flues in its southern gable, which enter a chimney, collapsed and now rebuilt as part of a modern dormer extension in the south-west corner. The spinal wall of the main building is breached at one point, and there is a substantial pine beam which once went across the gap but has been sawn to provide a doorway. The present owner, Anthony Griffith, noted the words and the date "J. Jones 1886" written in the plaster at a point which is not now visible. The shaft is filled in about 8m below the surface. It is lined with igneous rock, which extends above the ground level to form a wall, now dilapidated, approximately 1.8m thick. The shaft itself measures 4.15m by 4.8m.

5 September 1996 DRhGwyn

Discussion: The size of the engine does appear to have been enormous for the site, though the surviving archaeological evidence does not allow a precise calculation. The use of a beam engine at this late period is unusual, and suggests that the engine was obtained second-hand.

Conclusion: the engine house has been described as "one of the greatest treasures of the industrial revolution in Dyffryn Ogwen" (Williams and Jenkins 1996 p. 76), and it occupies a commanding position about the villages of Rachub and Caellwyngrydd. However, its original form has been substantially disguised by later additions, even though much of the original fabric survives.

Site name: **Dinorwic Slate Quarries**

Community: **Llanddeiniolen, Gwynedd**

Quarry area: **Llanberis**

Trust PRN: **20091**

Site history: Dinorwic Slate Quarries were first worked systematically by their owner Thomas Ashheton Smith I from 1787 in conjunction with a succession of partnerships, and in 1821 it was worked directly by his son Thomas Assheton Smith II. Operated mainly as a low-cost gallery quarry, and enjoying good transport links to the sea, it came to rival Penrhyn in terms of size, but proved unable to make the change to modern working methods in the 1960s, and shut down in 1969. There was some need for uphaulage to the main working levels from 1829, when an incline operated by a horse whim appears to have been introduced. The introduction of electricity in 1921 made possible the installation of inclined blondin ropeways, which enabled work to be concentrated in particular extraction- and processing-points.

Feature number: **123-126** Feature type: **ropeways**

Grid ref: **SH59856065** Statutory protection: **none**

Archival and bibliographic sources: A number of inclined cableways survive largely intact at Dinorwic quarry. The comparatively late mechanisation of Dinorwic is made clear by a valuation of 1901 (CRO M/623/342) which reveals the paucity of equipment of Australia, Egypt and Lernion, the areas suggested as of national importance in the second report - only railways and their incline drums are mentioned. The probability is that they were introduced after the quarry was electrified in 1906.

There were at least twelve of these systems, in length between 235' and 440'; those on Lernion level had a 440' span (Carrington 1994). A blueprint in the quarry's archive in the CRO shows a 58hp slip ring electric motor working on a single fixed barrel by means of 1/18 worm reduction gearing (CRO DQ 3343).

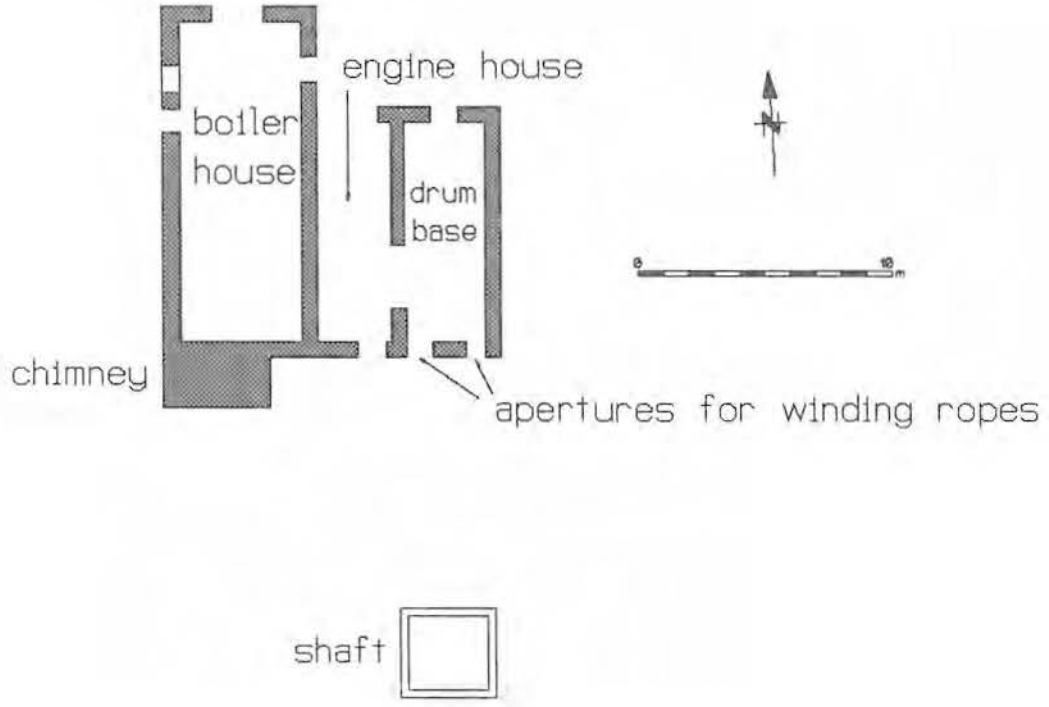
Archaeological description: situated on Lernion level, and formerly spanning the Garret quarry in the Dinorwic complex. A substantial iron framework mast which formerly supported them has collapsed and is lying on its side, and the ropework itself has come adrift. The *ceffyl* lies on the level near the access railway. It was clearly built as an incline blondin, unlike the shallow catenary system at Pen yr Orsedd.

17 December 1996 DRhGwyn

Discussion: these features represent typical Dinorwic practice.

Conclusion: of outstanding value for their relationship to other features on Lernion, Australia and Egypt levels.

Fig. 24 20062:20 Tan y Bwlch Quarry shaft winding house



Site name: **Rhos Slate Quarry**

Community: **Capel Curig, Aberconwy**

Quarry area: **Dyffryn Conwy**

Trust PRN: **20110**

*Site history:*Rhos Slate Quarry on the Gwydir estate was begun in 1856 and was developed by Samuel Clift and Owen Evan Hughes, who spent much money on it and equipped it with a mill (feature 25 below), subsequently enlarged. A succession of lessees ran it until 1952. The quarry was worked as a galleried pit, approached by a high-level adit, later quarried out, from the main processing level, and a lower one which drained the workings. Uphaulage from the pit to the mill was initially by a waterbalance incline, latterly by a chain incline.

Feature number: **19**

Feature type: **chain incline**

Grid ref: **SH72895628**

Statutory protection: **none**

Archival and bibliographic sources: This cableway was installed in the 1930s, replacing a water-balance incline, and was powered by a waterwheel (Lewis and Williams 1989 p. 10). Photographs taken not long before the quarry ceased working in the 1950s make it clear that this system remained in use until the end, and that the headframe consisted of two verticals with a pulley or pulleys mounted on cross-members (CRO XS 1608 6 147, 148). The cable itself was inclined into the pit, rather than spanning it. It is said to have been designed and built by the quarry blacksmith (pers. comm., Steffan ab Owain).

Archaeological description: This feature is situated immediately to the south of the pit at Rhos quarry. It consists of a substantial wheelpit, constructed out of slate blocks, built on an existing water-course from the quarry's extensive reservoir system to the waterwheels which powered the mill and the compressor. The headframe is situated to the north of the wheelpit, and now consists only of the stumps of the steel verticals set in a concrete base. The wheelpit is a substantial feature, constructed out of slate rubble.

23 October 1996 DRhGwyn

Discussion: Despite the late date of construction, it appears that this device harks back to a much earlier form of slate-quarry technology, both in its use of a water-wheel to provide power and in the use of a chain incline system, rather than a blondin, for the ropeway itself. The very simple headframe is reminiscent of early nineteenth century construction techniques.

Conclusion: of considerable significance as one of the hydraulic features on this important site.

Site name: **Rhiwbach Slate Quarry**

Community: **Bro Machno, Aberconwy**

Quarry area: **Blaenau Ffestiniog**

Trust PRN: **20313**

Site history: Rhiwbach Quarry has been worked since at least 1774, but was only developed on a substantial scale after the arrival of a new company in 1860, who constructed a railway over the Manod ridge from the quarry to Blaenau Ffestiniog. In order to lift this railway up to the level of the plateau, this railway left the quarry premises by an uphaulage incline, operated from a steam engine at its foot. This same engine also operated a mill and a haulage shaft (feature 6 below). With an enterprising and forward-looking manager in charge, the company prospered in the later years of the nineteenth century, and continued in operations until 1953 (Jones GR nd *passim*).

Feature number: **6** Feature type: **shaft**

Grid reference: **SH73924614** Statutory protection: **none**

Archival and bibliographic sources: The decision to build an elaborate mills complex at the foot of an exit incline above the main working levels at Rhiwbach was taken when the quarry was extensively mechanised in the period from 1863. The existing workings lay immediately to the south of the central power source, the Haigh Foundry steam engine, and the decision was taken to access this pit by shaft rather than by any other means. The first edition 25" OS map of 1888 shows rubble already being tipped into this quarry, suggesting that it and the shaft were out of use. The Abandoned Mines Plan of 1953 (CRO X AMP Plans 24) shows limited chambering in the area of the shaft.

Archaeological description: Situated on the main mill level of Rhiwbach quarry. The shaft itself is immediately adjacent to the engine house and there is evidence for the passage of a haulage rope from the engine house to the site of a head-frame. The shaft has been capped, and is also inaccessible from its foot. A three-sided wall built out of unsawn slate blocks survives at the shaft-head, which may have supported the head-frame. Across this are several substantial timber baulks with traces of a horizontal sheave on them.

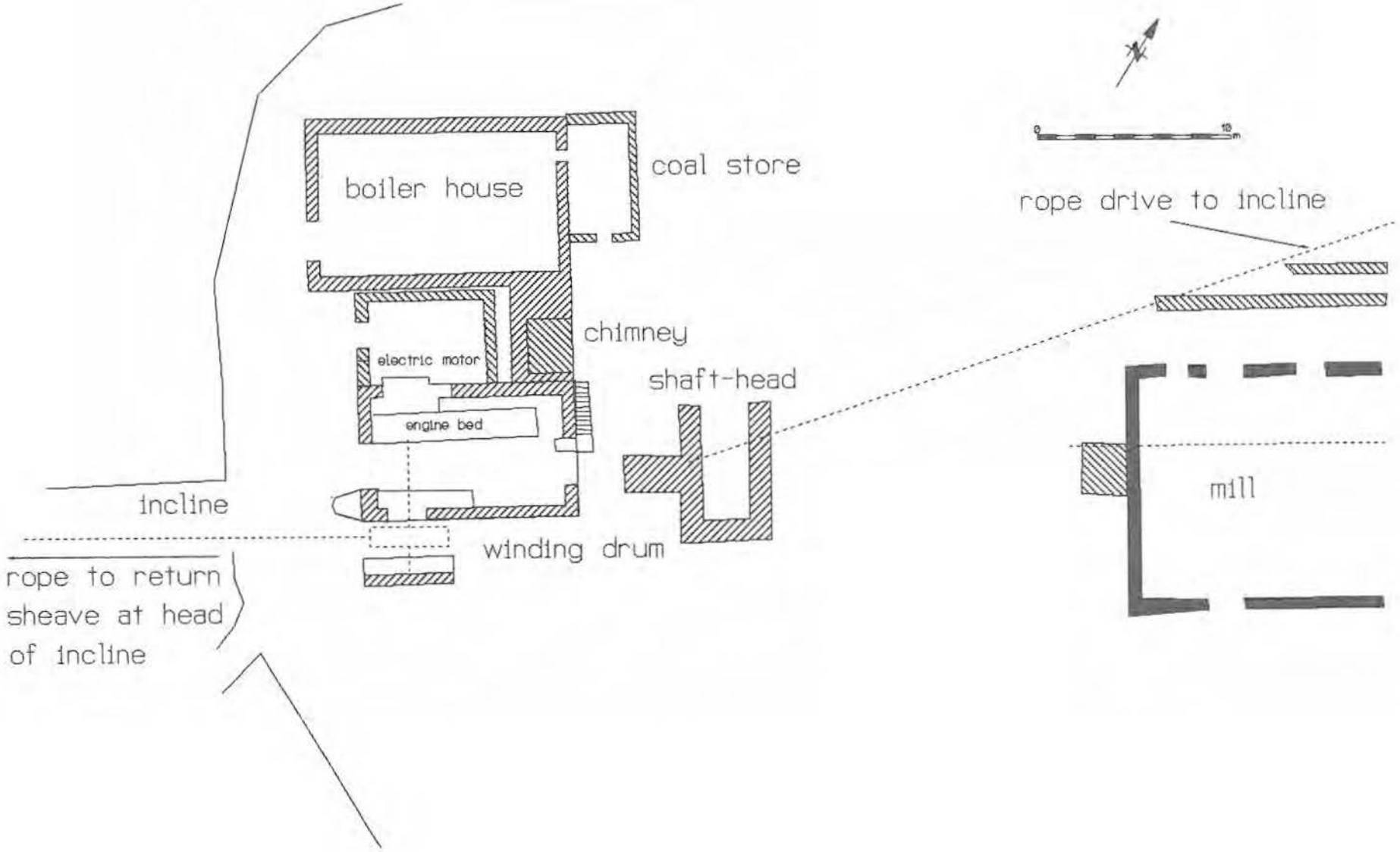
The engine house occupies a prominent position to the south-west of the shaft head, and comprises a drum-bearing, a bed for a horizontal steam engine, a boiler house, a coal shed, and a tall square-plan chimnney, built out of slate rubble. The damper at the base of the chimney survives, and rthere are traces also of the electrical supply. These buildings are now roofless and have suffered some dilapidation.

6 February 1997 DRhGwyn

Discussion: The area enclosed does not seem to allow room for more than one cage, or possibly the rocks were raised in a kibble. The timber baulk's sheave marks may date from a later alteration after the shaft ceased to function, whereby a rope was passed from the engine house to the lower incline. The reason for building an expensive shaft is obscure, since the topography does not appear to rule out either a railed incline or a chain incline.

Conclusion: of outstanding value as one of the items in this important and visually spectacular site.

Fig. 25 20313:6 etc. Rhiwbach Quarry shaft and incline winding engine house



Site name: **Bryneglwys Slate Quarry**

Community: **Llanfihangel y Pennant, Gwynedd**

Quarry area: **Dyfi**

Trust PRN: **20430**

Site history: Bryneglwys Quarry was worked from 1844 and extensively developed from 1862 by John Lloyd Jones of Nantlle, with Robert Williams as manager. Under their regime a chain incline system was installed (features 28, 30, 34 and 36 below) before selling out to Messrs McConnel and Kennedy,one of the largest Lancashire cotton spinners, in 1863. From 1911 to closure in 1946 the owner was Sir Henry Haydn Jones of Tywyn, Liberal MP for Merionethshire (Holmes 11-35).

Feature number: **28, 30, 34, 36** Feature type:**chain incline**

Grid reference: **SH69340520** Statutory protection: **none**

Archival and bibliographic sources: Two recent publications have referred to this feature, and one includes a plan (Boyd 1988 pp. 22-4, Holmes 1986 pp. 46-8, fig. 6). The earliest part is known to have been constructed in 1862 on behalf of John Lloyd Jones after he had purchased an interest in the site, by Robert Williams, who had worked in various Nantlle quarries, and as a boy had helped build the first water-balance incline in the area, in Tal y Sarn Quarry in 1828 (Robert Williams Hunangofiant Chwarelwr *Cymru* XVI 90 p. 57). He had latterly been manager of Tal y Sarn. He opened two new pits in the narrow vein, one on the boundary between Bryn Eglwys and Cantrybedd, and built a water-wheel which measured 30' by 3', and was "connected to the machines necessary to raise blocks and pump water" - "a chysylltwyd wrth y periannau anghenrediol i godi cerrig a rwbel ac i bwmpio dwfr" (Robert Williams, Hunangofiant Chwarelwr, *Cymru* XVII 90 pp. 55-59, XVIII 107 p. 330 b, NLW Ms 8412). Holmes suggests that the second waterwheel was installed to power a remote incline within the pit itself (48).

Archaeological description: The wheelpits appear to be constructed on the natural ground level to the north-west of the narrow vein open workings, and are surrounded by slate rubble, held back by retaining walls. The feature is largely constructed out of unsawn slate slabs, with some circular-sawn blocks.

Two parallel wheelpits are evident, with tailraces surviving in the north-west ends of the pits. In between are the ill-defined traces of bases for a winding drum or drums; three holding-down bolts were noted here, and inclined channels for a winding rope or ropes and for timbers to support a headframe. There is also a hearth for a *caban*.

To the north-east of the north-easterly wheelpit is a further area for a winding drum. A steeply inclined underground channel for a winding rope emerges at surface level, and a recess in the retaining wall may make the site of an axle-box for the drive spindle. The lower retaining wall around this feature appears to have supported a mono-pitch roof over the winding drum.

Access to the wheels and drumbases is by a set of steps in the western corner. From its foot a souterrain passageway gives access to the site of the north-eastern winding drum.

The central winding-rope channel aligns up with a strongpoint built on the edge of the pit, consisting of a footwall built of unsawn slabs, from which three slabs project.

A less well-defined strongpoint is constructed on the edge of the pit to the east, from which a rope channel, part underground and part in a cutting, runs towards the wheelpits.

The trace of a launder running to the north-eastern wheelpit, constructed of slate slabs is evident on the made-up ground level, but it reaches the edge of the pit within a few metres. There does not appear to be any visible trace of a water-supply to the other waterwheel.

3 September 1996 DRhGwyn

Discussion: Though both Boyd and Holmes have described this feature, many aspects of their analysis are puzzling. Neither alludes to the apparent absence of pump-rods, despite the fact that Robert Williams alludes to a pumping-wheel. The opening of the *lefel fawr* tunnel would have meant that the workings would have been self-draining down to floor 50, until the lower *sinc dywyll* (dark pit) was opened, suggesting that there might have been a few years when a pump here was necessary (Holmes 47-48). There seems, at any rate, to be no trace of a pump-rod system now, and it may well have been buried by the development of the tips which surround the site.

Another puzzle is that there appears to be only one haulage chain leading to a double chain incline strongpoint. Though the north-east wheel may have aligned up with this feature, it appears latterly to have powered a railed incline or chain incline from the eastern strongpoint.

Holmes suggests that the mono-pitch roof over the north-eastern winding drum was intended for the workmen's benefit; more likely it was to keep the rope dry and the souterrain passage which gives access to it was to allow the machinery to be oiled and the clutch to be operated. However, the presence of a domestic-sized hearth indicated that there was some sort of *caban* between the two wheels. It is curious that it should have been situated here, since the operator would need to see the wagons, as they rose from the pit - a false move with the clutch or the brake would have demolished the haulage frames. Possibly there was a wooden platform above here, and the system was normally operated from above the level of the wheels.

Another problem is the water-supply to the drums. There is little archaeological evidence for this beyond the channel noted above. Either it was channelled through an inverted siphon in the pit itself or it has been quarried away.

Both Boyd and Holmes are, however, clearly correct in saying that it represents Nantlle thinking about up-haulage, though steam power was most commonly used to power chain inclines there (Pierce Jones 1985 18). However, a plan of Pen yr Orsedd quarry dated 1862 (CRO Pen yr Orsedd 375) shows a feature which has now been buried by rubble, a double pit for two water-wheels, one certainly operating a chain incline, the other perhaps a pump, which may be the immediate prototype of the Bryneglwys example.

Conclusion: despite its poor survival, it is of outstanding importance as representing a link with early quarrying at Nantlle, and as exemplifying the diffusion of particular types of technology.

Fig. 26 20430:28 etc. Bryneglwys Quarry chain incline

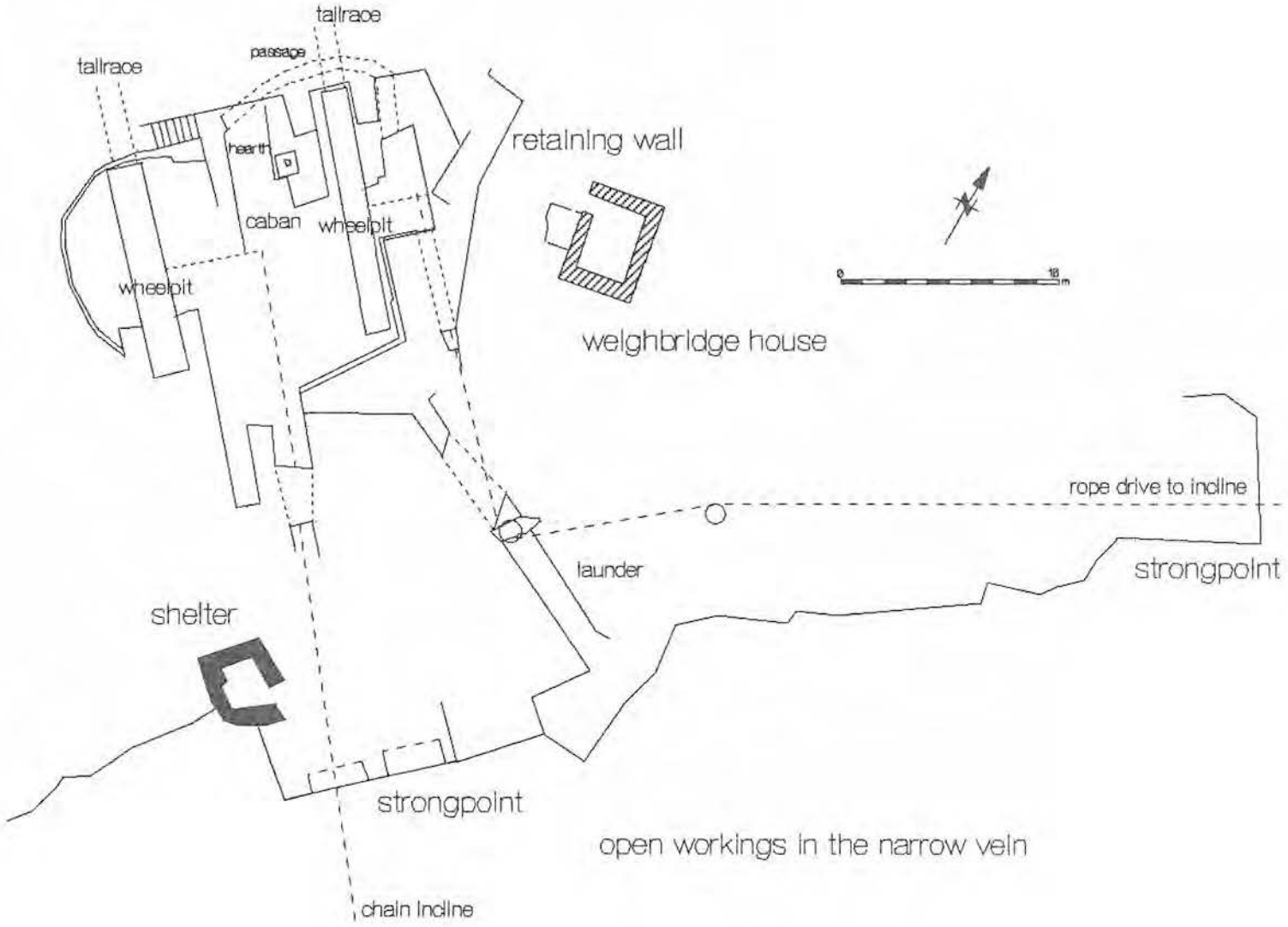
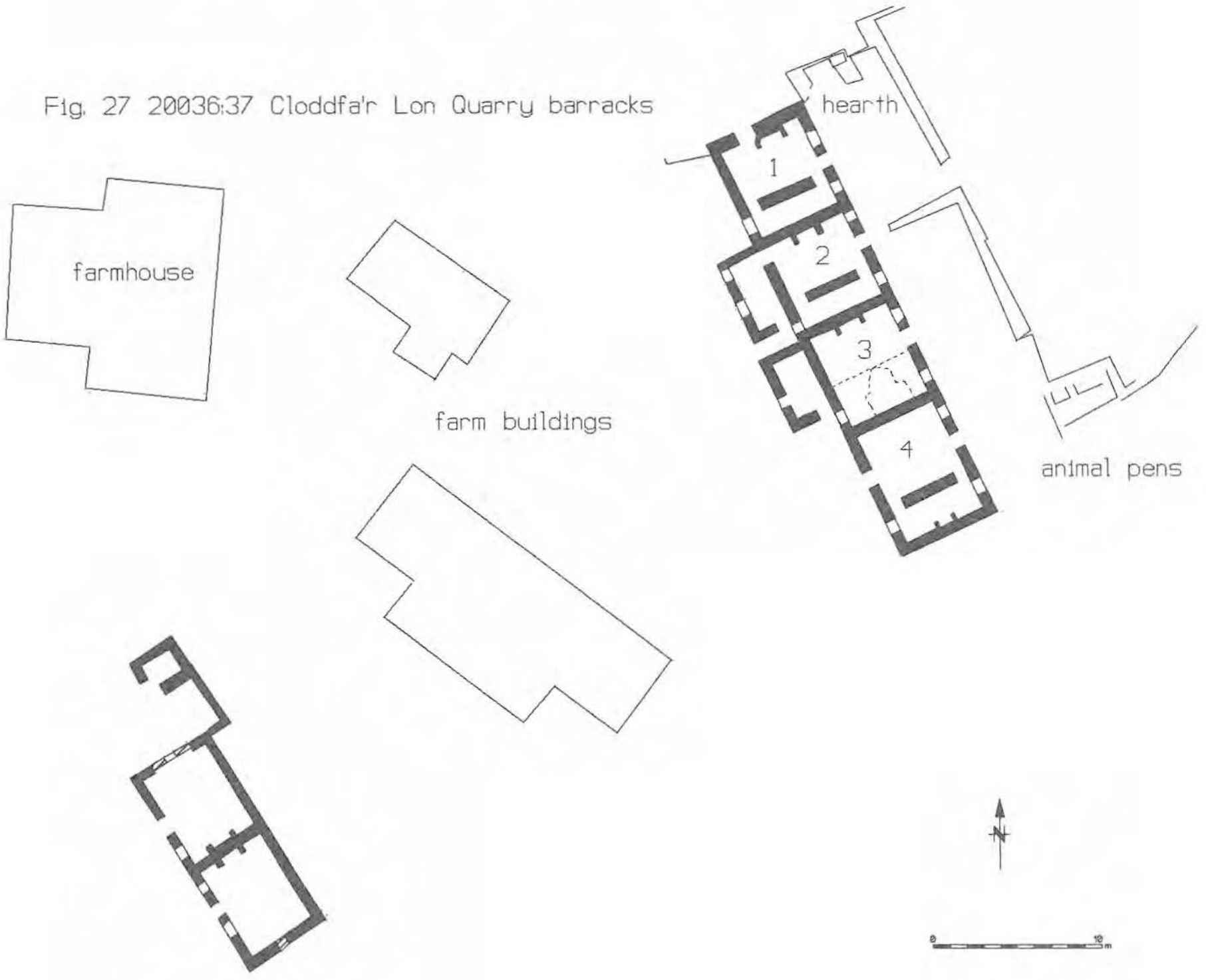


Fig. 27 20036:37 Cloddfa'r Lon Quarry barracks



Site name: **Pen yr Orsedd**

Community: **Llanllyfni, Gwynedd**

Quarry area: **Nantlle**

Trust PRN: **20039**

Site history: Pen yr Orsedd quarry is situated on the northern slopes of Dyffryn Nantlle, and has been worked from the late eighteenth century. The purchase of a lease by a new partnership in 1862 led to substantial investment in the quarry, reflected both in new technology and in the provision of housing for the workforce. This took the form of a purpose-built village, grafted onto an existing development along the Pen y Groes to Rhyd Ddu road and also of barracks in the village and in the quarry itself.

Feature number: **32**

Grid reference: **SH50965374** Statutory protection: **none**

Archival and bibliographic sources: A valuation of the quarry dated 1907 (CRO Pen yr Orsedd Additional 2059) speaks of seven barracks in the quarry and four in the village. These former are probably the buildings surviving on Bonc yr Offis identified as offices in the second survey; a resolution of 23 October 1860 set aside £500 for "Labourers Cottages in the neighbourhood of the Quarry", and stipulated that the rent be fixed at £6 pa for the larger size, £4 5/- for the smaller (CRO Pen yr Orsedd Additional 1873, p. 3, p. 20). There is no mention of them in the Llandwrog census of 1871, suggesting that with the construction of the village of Nantlle in the 1860s the need for them had vanished, and that they were a temporary expedient during development work.

Archaeological description: Situated on one of the main working floors of Pen yr Orsedd quarry, near the main slate stackyard at the head of a rake of inclines which gave access to the exit railway, and orientated south-west to north east. To the north-west is an enclosed garden with outhouses and a privy.

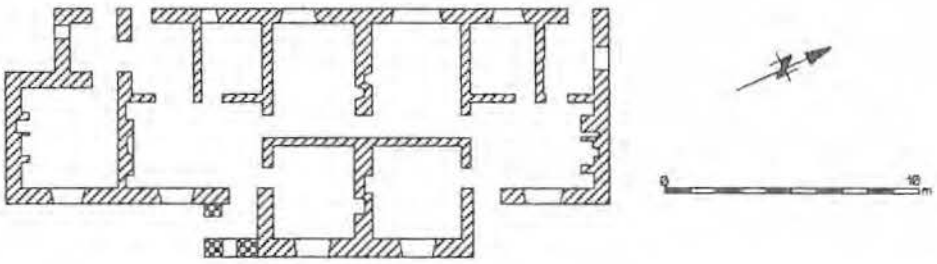
The barracks consists of two semi-detached dwellings, each of which is entered by its own doorway on the south-east facing longitudinal wall. That of the south-west range has had a pyramid-roofed porch built over it. Building material is slate blocks, hung with an attractive pattern of blue and green slates. Within there is a communicating door between the two dwellings. Internally the plastering is becoming severely addled, and the internal fittings, windows, doors and grates have suffered considerable recent damage from New Age Travellers. A measured survey has been carried out by students on a Snowdonia National Park/Hull University course in August 1996.

27 January 1997 DRhGwyn

Discussion: A remarkably attractive structure, though fully in keeping with the housing provided for Pen yr Orsedd workers in the company-built village of Nantlle by the socially-conscious Darbishire family. The decoration lavished on it would suggest that it was built for a steward.

Conclusion: a unique example of a decorated barracks structure.

Fig. 28 20039:32 Pen yr Orsedd Quarry barracks



Site name: **Dinorwic slate quarries**

Community: **Llanddeiniolen, Gwynedd**

Quarry area: **Llanberis**

Trust PRN: **20091**

Site history: Dinorwic Slate Quarries were first worked systematically by their owner Thomas Ashheton Smith I from 1787 in conjunction with a succession of partnerships, and from 1821 it was worked directly by his son Thomas Assheton Smith II. Operated mainly as a low-cost gallery quarry, and enjoying good transport links to the sea, it came to rival Penrhyn in terms of size and workforce, but proved unable to make the change to modern working methods in the 1960s, and shut down in 1969.

Feature number: **145**

Grid reference: **SH58956022** Statutory protection: **Scheduled Ancient Monument**

Archival and bibliographic sources: These structures, known as *y dre' newydd* or the Anglesey barracks, were one of a number of barrack complexes at Dinorwic. The Vaynol estate survey of 1869 does not mark them, but shows others immediately to the south-east, and another one near Cei Newydd (CRO Vaynol 4194). The 1900 25" OS map shows a range near the steam mills (a site now obliterated by 20091:1), and Emyr Jones' *Bargen Dinorwic* mentions other barracks at Muriau, Pont y Bala, Allt Ddu, Ponc Rowler, the Mills and "Hospital Hall", possibly the Cei Newydd site, and Ponc Aberdaron, known as "Ireland View". His account makes clear that the typical unit here was the working male members of a family - a father and his sons, perhaps an uncle, who would share double beds for warmth - and that their home was likely to be in Anglesey. He suggests that Gruffydd Ellis was responsible for the larger barracks, and that most were constructed before 1873 (104-107).

Research carried out by Paul Sivyer, of Padarn Country park, suggests that each unit held four men, each with 200' cubic feet. His notes record that the furniture would consist of an oak table and four chairs, with a lump of slate to support the waterpot, the bucket, the kettle and saucepans. The furniture was made out of wood growing near the barracks, and the chairs were made out of powder casks bought from the magazine, which would be put to supporting the washpots when they became too rickety to sit upon. The bedrooms had a wooden floor, two double beds and one or two single beds. The mattresses were filled with chaff, which tended to move up to the sleeper in the course of the night, and which prompted some to sleep on the wooden base of the bed without a mattress at all. The chaff also attracted rats and mice (ex info. Paul Sivyer).

The end came in 1937, when on 12 April the men were informed that the barracks were to be shut on 1 May "owing to recent legislation having come into force." This not only affected the twenty-two tenants of y dre newydd but also the seven tenants of Aberdaron barracks, the twelve of hen dre, the five of Muriau and the single tenants each of A4 mills, "Under Glanbala", Glanbala and the Hospital (CRO X/DQ/3168). Richards speaks of an alternative 'bus service provided for the remaining 200 lodgers (Richards 1994), and doubtless the fifty men who appear in the rentals do not represent the whole number but only the head of household.

Archaeological description: Situated near the head of the A2 incline, on one of the lower working levels of the quarry and near one of the main internal transport arteries, as well as near the terminus of the passenger service on the Dinorwic Quarry Railway.

This barrack block is orientated north west to south east; two rows each of eleven two-cell single-storey pitched roof dwellings face each other across an open area approximately 7m wide.

Two mono-pitch roofed privies were noted, one to the north-west and one to the south-east.

Building material is unsawn slate blocks, with the exception of the most south-easterly dwelling, which is built out of circular-sawn slate blocks, as is the wall which unites it to the range opposite and which effectively forms a semi-courtyard of the area enclosed by the two ranges. In every case the better-shaped blocks are used on the front faces of the dwellings, except for the central dwelling of the south-west facing range, which is built out of the same substantial blocks as the front walls.

Each dwelling is accessed by a central doorway which opens into the larger of the two rooms; a central doorway in the intermediate gable gives access to the smaller. A window in each room gives out onto the central area. There is a central fireplace in each of the larger rooms, and there are traces of internal rendering. All of the dwellings in the south-east range have a small window in the back wall.

The walls survive up to eaves height at 2m, and the chimneys are intact. The southernmost dwelling on the north-western range includes a dummy chimney stack in its external gable wall.

The two most northerly dwellings were in the process of being re-roofed and internally plastered on the date visited.

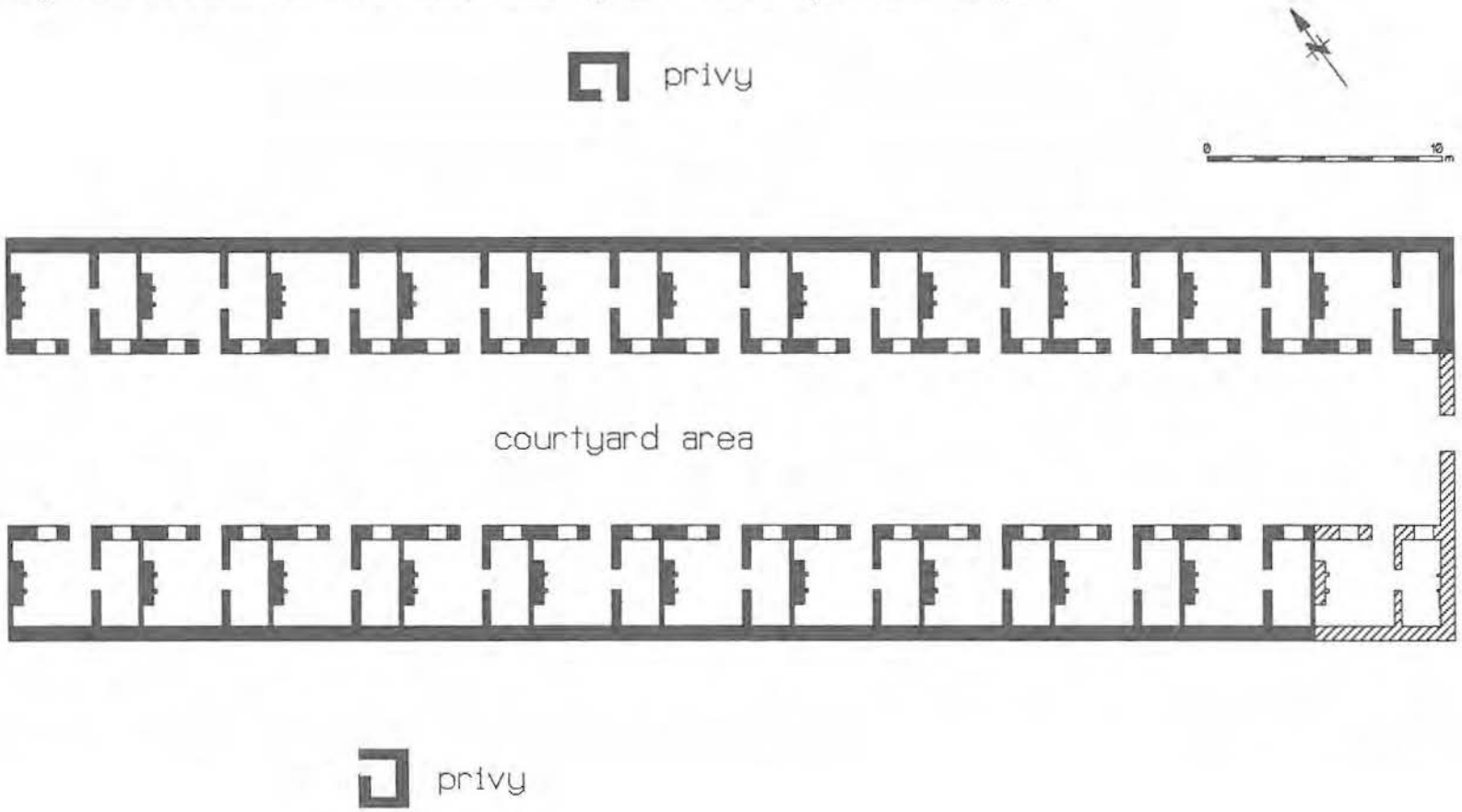
18 September 1996 DRhGwyn

Discussion: Jones' suggestion about dates seems very probable; a source from a completely different literary tradition, Sir John Eardley-Wilmot's *Thomas Assheton Smith, The Reminiscences of a Famous Fox Hunter*, originally written in 1859, though it stresses the care his subject took of the quarrymen, mentions only his habit of allowing them to support themselves on *tyddynod* around Deiniolen, and says nothing about providing accommodation for them. They are not shown on a quarry map of 1869, though yr hen dre on the other side of the incline is, and the first document from the quarry's archive which refers to them is a valuation of 1877, which costs each individual unit at variously £43 3s 4d, £33 and £23, including plastering, the floor grates and a deal floor (CRO XD 40 1 4, p. 47). This document makes a distinction between older and newer structures, and it seems reasonable to conclude that y dre' newydd was therefore built between 1869 and 1873.

Emyr Jones's emphasis on the fact that the typical working unit was the male members of a family appears to be born out also by the surviving structures, effectively two-room cottages with a living and a sleeping space. Mr Sivyer's suggestion that each one contained four men appears to be qualified by his suggestion that each one contained a double bed and one or two singles. A regular number of four would be unlikely in any event with a family group, but fluctuating numbers between three and six certainly seem probable.

Conclusion: of national importance for its association with Dinorwic Quarries, for its distinctive adaptation of vernacular patterns of architecture.

Fig. 29 20091:145 Dinorwic Quarry barracks (y dre' newydd)



Site name: **Rhos Slate Quarry**

Community: **Capel Curig, Aberconwy**

Quarry area: **Dyffryn Conwy**

Trust PRN: **20110**

Site history: Rhos Slate Quarry on the Gwydir estate was begun in 1856 and was developed by Samuel Clift and Owen Evan Hughes, who spent much money on it and equipped it with a mill (feature 25 below), subsequently enlarged. A succession of lessees ran it until 1952. Though there are a number of dwellings within walking distance of the site, a barracks was constructed to house some of the workforce (feature 4 below).

Feature number: **4**

Grid reference: **SH73025635** Statutory protection: **none**

Archival and bibliographic sources: This structure is not recorded on the 1871 census for the township of Gwydir, but appears on that of ten years later, when it was inhabited by two families. William Edwards and his wife, both natives of Llanllechid, lived in one dwelling with their six sons; the youngest, a two-year old, was born in Llangollen, suggesting that his father had worked in the Denbighshire slate quarries, but the other boys had all been born in the USA. The other was inhabited by a married couple and a one-year old daughter. The quarry's letter book observes that all but one were in ruins in 1916 (CRO XD 38 355 p. 7) and there was much discussion about the need to build family accommodation near the main road at Pont Cyfyng. Photographs taken in the 1940s or 1950s show that the range was already losing its roof, and that there were dormer windows in the east slope of the roof over one of the units (CRO XS 1608 1 7).

Archaeological description: Situated to the north of the main quarry stackyard, between the exit railway which took slate to Pont Cyfyng and the roadway access to the quarry, and orientated north to south. It is built out of unsawn slate blocks, though with considerable patching and modernisation with circular-sawn blocks, especially in the cross walls; the walls are substantially complete, and the slate roof survives on the most southerly end of the range. Some cross pattern trusses survive. The range is divided into six separate units. 1 and 2, numbering from the north, consist of a single-unit dwelling with a central door on both longitudinal walls and flanking windows, with traces of internal wooden partitions. Each has a fireplace in the northern cross-wall. 3 is a single-room dwelling, accessed by a door in the eastern longitudinal wall. 4 is similarly only accessed from the east side, and has a substantial fireplace in the northern cross wall, as well as traces of two others in the southern cross wall. 5 has been adapted to house machinery on a concrete floor, perhaps a compressor, and 6 has been adapted as a smithy, containing an impressive smithing hearth. There has been some recent dilapidation, especially on the eastern longitudinal wall of 5.

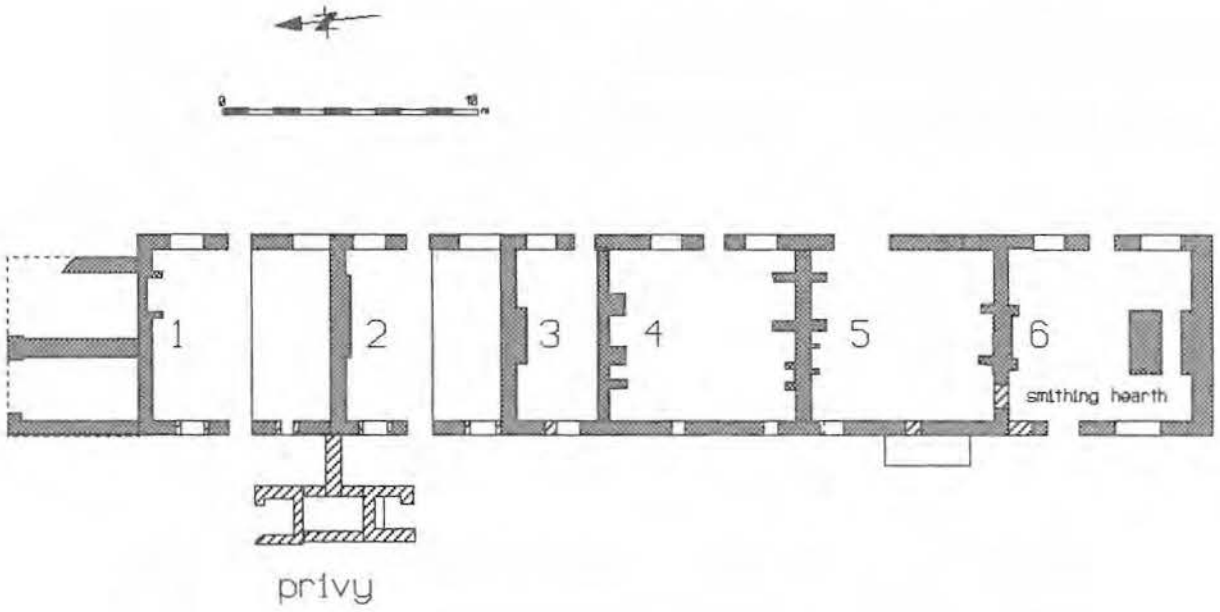
Immediately to the west of the building is a heavily dilapidated privy, and a lean-to shed has been built against the north gable.

23 October 1996 DRhGwyn

Discussion: It appears probable that the entire range was built originally as a barracks, but that two of the dwellings were adapted as workplaces later on, possibly after the 1916 reference. This range of buildings therefore exemplifies the need to adapt structures, and its value is increased both by its archaeological survival and by its group relationship with other features on the site.

Conclusion: of outstanding importance for its group value with other features on this site.

Fig. 30 20110:4 Rhos Quarry barracks



Site name: **Glanrafon Slate Quarry**

Community: **Waunfawr, Gwynedd**

Quarry area: **Moel Tryfan/Cwm Gwyrfai**

Trust PRN: **20196**

Site history: Glanrafon Quarry lay on the Vaynol estate on the lower western slopes of Snowdon. A lease was granted to E.H. Owen of the Vulcan foundry, Caernarfon in 1878, and the quarry was intensively worked as a pit until closure *c.* 1914 (Bradley 1992 p. 267).

Feature number: **5**

Grid ref: **SH57755409** Statutory protection: **none**

Archival and bibliographic sources: This building is not marked on two lease documents of 1878 and 1879 (CRO Vaynol 524, 526), and the CRO does not possess a copy of the relevant 25" OS earlier than 1915. There is no reference to it in the 1871 censuses for either Beddgelert or Betws Garmon.

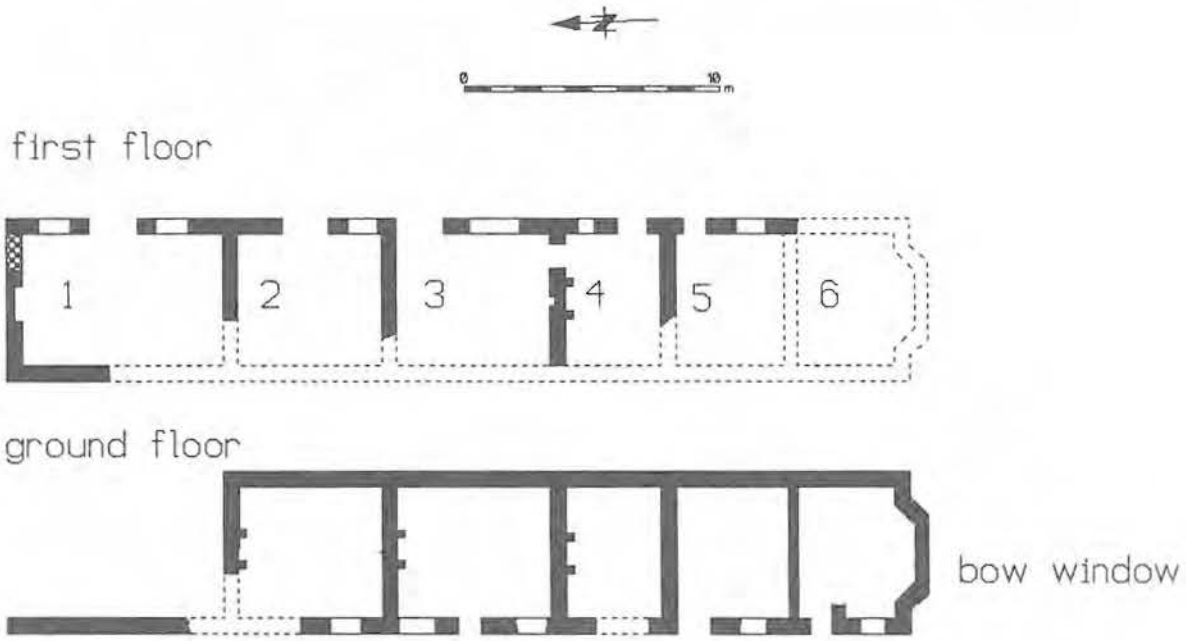
Archaeological description: Situated on the north-western perimeter of the quarry, near to the exit incline and alongside a larger structure which may have been a mill or a workshops. Orientated north to south, and constructed mainly out of substantial blocks of igneous rock, with some slate in the cross-gable walls. It is roofless and dilapidated. It is built into the slope of the hill, divided into six separate cells (numbered 1-6 north to south), accessed on the east side at first floor level; on the west side all but 1 are also accessed at ground floor level on the west side. In the southern gable wall are traces of a bow window at first floor level. The building survives to the full height of the gable chimneys in 1 and 2, approximately 7m+ above ground level, and elsewhere up to eaves height in places, but there is very serious collapse in much of the structure.

31 January 1997 DRhGwyn

Discussion: The only known example of a Gwynedd dual row; if it does date from the period when the quarry was extensively developed in the 1880s, it is a very late example indeed, since most appear to have been built between 1790 and 1840, and were commonly found on sloping hillside sites in the industrial areas of South Wales (Lowe 1989 p. 17).

Conclusion: the poor survival of this building prevents it being of more than regional significance.

Fig. 31 20196:5 Glanrafon Quarry barracks



Site name: **Hendre Ddu**

Community: **Dolbenmaen, Gwynedd**

Quarry area: **Glaslyn**

Trust PRN: **20208**

*Site history:*Situated on the western slopes of Cwm Pennant, on the Bryncir estate; a company was set up to work this site in 1861, and after stops and starts, work was brought to an end by the bursting of the quarry's dam in 1875 (Williams D 1986 pp. 22-27).

Feature number: **7-10**

Grid reference: **SH51954454** Statutory protection: **none**

Archival and bibliographic sources: The structures date from *c.* 1863 (pers. comm., Dr MJT Lewis). There is no reference to a barracks in the 1871 census for the parish of Llanfihangel y Pennant, though the quarry manager was still living at Hendre Ddu farm.

Archaeological description: Situated on the upper tipping level of Hendre Ddu quarry, above the exit incline and the mill, on an south-east-facing slope. It is a rectangular building orientated north-to south, built out of unsawn slate blocks, heavily pyritic, with some use of igneous rocks and some fissile stone in unit 2. The walls survive up to 4m high.

An eight-unit structure; numbering from north to south, unit 1 is pierced by two doors, one in the gable end and one in the western longitudinal wall, and there are traces of a gable-end hearth near the north-western corner. Unit 2 has a central doorway in the western longitudinal wall, and traces of a smithing hearth in the opposite wall; this unit shows evidence of having been constructed as a free-standing structure. Units 3 to 7 are each built with a tall doorway in the eastern longitudinal wall and a varying pattern of doors and windows in the western wall. The doorways are tall structures, up to 4m high, with collapsed lintels. Unit 8 is buttressed against the gable end but the south-east corner has collapsed. It is pierced by a doorway in the eastern longitudinal wall.

The cross wall between units 7 and 8 contains evidence of a hearth; within unit 8 is a raised floor at the northern end and a curious stone-built pit alongside the western longitudinal wall.

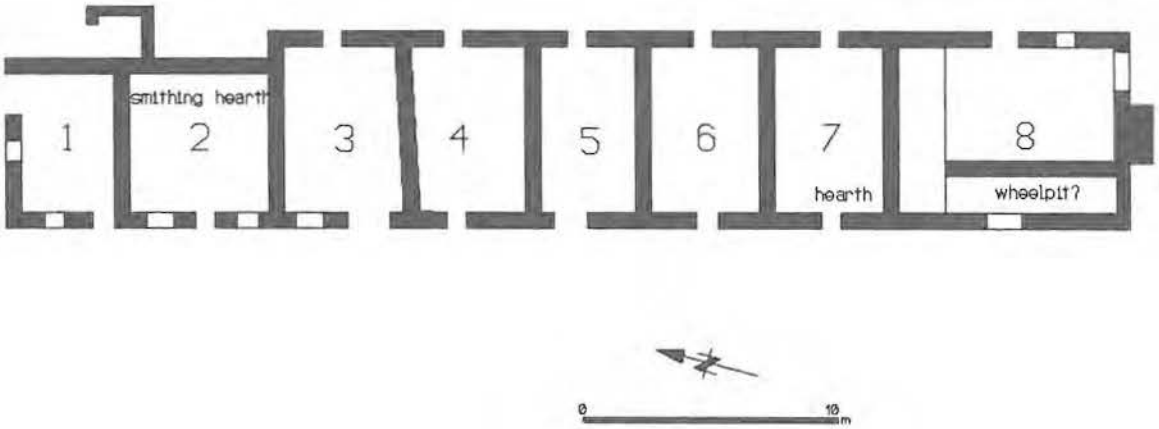
25 August 1996 DRhGwyn

Discussion: The tall doorways and the entire absence of windows from some of the dwellings suggest that the doors might have been surmounted by fanlights, a most unusual arrangement for such a building. It has been suggested that the pit in unit 8 is in fact a wheelpit, but there is no trace of a launder to it, nor is there much evidence as to what purpose it might have served. It could accommodate a 20' diameter wheel 2' breast wheel, too small to saw slates, too large for a butter churn.

No obvious parallells suggest themselves for this structure.

Conclusion: an unusual construction, of regional significance.

Fig. 32 20208:7 to 10 Hendre Ddu Quarry barracks



Site name: **Prince of Wales**

Community: **Dolbenmaen, Gwynedd**

Quarry area: **Glaslyn**

Trust PRN: **20221**

Site history: A company was established to work this remote site, near Bwlch y Ddwy Elor, the col from Cwm Pennant into the Gwyrfai valley, in 1863, after initial exploration, under the barrister Thomas Harvey, and with John and Thomas Francis of Penrhyn Quarries as major shareholders. They assumed the management after they had been found guilty of false accounting at Penrhyn in 1874. Operations ceased in 1876, though other lessees may have generated some traffic for the railway until 1881 (Williams D 13-21, Boyd 1988 27).

Feature number: **45**

Grid ref: **SH54945500** Statutory protection: **none**

Archival and bibliographic sources: The *MJ* for 31 December 1865 speaks of barracks for about fifty as having already been built, but more were contemplated (916). The 1871 census for the parish of Llanfihangel y Pennant only gives three residents, a slate miner, a slate quarry labourer and a stonemason, all married, staying by themselves in the barracks.

Archaeological description: These are situated on level 3, the top main working level of the quarry, opposite a row of gwaliau and a short step from open workings. The path from Rhyd Ddu through Bwlch y Ddwy Elor leads to them. They are built partly into the hillside, partly on made up ground of slate waste, and are orientated east-west. Added onto the east gable is a weighbridge-house, and an earlier rectangular structure was noted contiguous with the range and joined on to it at the west end. To the north of the western end of the barracks range is a large monopitch structure, with a monopitch privy immediately to its east. All the buildings are dilapidated, built out of unsawn slate slabs, and all are now roofless, apart from the weighbridge house, roofed with untrimmed slabs supported on unsawn timbers, and some slabs surviving on the privy and the building at the west end of the range. A window in the east gable of this structure has been blocked by the construction of the gable wall of the barrack block.

The barracks themselves constitute a row of four separate three-cell dwellings; the cells are here numbered 1 to 12 from the west. Each is accessed by a doorway into the central cell from which doorways lead through the cross-walls into the other two. Each cell has one window on the south longitudinal wall. The north longitudinal wall is completely windowless. There is no trace of a hearth in any of them. In the 8 and 1 a slot was noted in the north wall below roof level, possibly for a stovepipe.

The walls survive in places up to their original height, but there is some collapse in the tenth from the east, and the walls of 12 and 5/6 in particular are bowing, and are in danger of collapse. The southern wall of the weighbridge house is also in danger of collapse.

4 September 1996 DRhGwyn

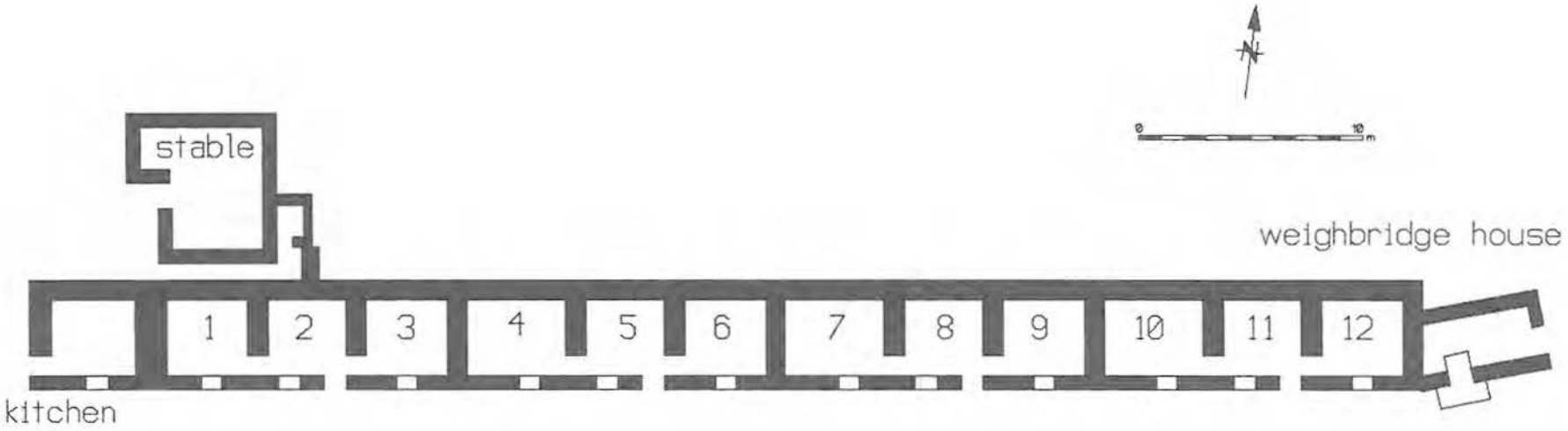
Discussion: it has been suggested that the earlier structure to the west is a kitchen, and that the large structure to the rear of 12 is a stable (Plas Tan y Bwlch report). The presence of a stable seems a reasonable supposition, as the trackway through Bwlch y Ddwy Elor was the exit route before the Gorseddau Junction and Portmadoc railway was built.

These barracks are not so much near the workplace as within it; a length of railway evidently ran by the front door, and for both rockmen and splitters the journey to work cannot have taken more than a few minutes.

The nearest parallel to the Prince of Wales barracks appears to be the Anglesey barracks at Dinorwic; both blocks are constituted by rows of separate dwellings which confer a certain amount of privacy, though neither are of a traditional vernacular type, nor yet a typical industrial pattern. Possibly, like the Anglesey barracks, these were designed for the male members of the same family, or at least the members of the same bargain.

Conclusion: a range of buildings of at least regional significance, as exemplifying the development of the slate industry on remote sites in an outlying quarry district.

Fig. 33 20221:45 Prince of Wales Quarry barracks



Site name: **Hafod y Llan Slate Quarry**

Community: **Beddgelert, Gwynedd**

Quarry area: **Glaslyn**

Trust PRN: **20255**

Site history: Situated on the Mostyn estate's holdings on the south-eastern slopes of Snowdon, in an area which has seen much small-scale mining for copper, the quarry appears to have begun operations in the 1840s, under the management of the Devonian Alan Searell. A prospectus was issued in 1869 but production appears to have ended in 1881 (Boyd 1988 pp. 118-120).

Features: **29**

Grid ref: **SH61335241** Statutory protection: **none**

Archival and bibliographic sources: A letter of 17 September 1864 from a Caernarfon ironmonger offers 4' by 6' bedsteads "with Palliasses and Bed Clothes for Barracks" at 44/- each (UWB Searell 8 letter 226) which follows an estimate for "putting existing Cottages into repair & erecting barracks for about 50 men" (Ibid., letter 238). The following year estimates were prepared for repairing the "Existing Cottages & Barracks" for £150, and the provision of fifteen beds and sets of bedclothes with a view to accommodating a total of thirty men. A proposal is also recorded to build ten new cottages (Searell 9). A map of 1869 records feature 15 as a smithy and feature 29 with seven internal divisions; the accompanying prospectus claims that there was accommodation for 120 men on site (CRO BJC/X/391). These must date to the period 1865 to 1869 (UWB Searell 9). The barracks are recorded as eight uninhabited dwellings in the Beddgelert census of 1871, though William E. Parry, the manager, is recorded as living at Hafod y Llan itself.

Archaeological description: The building is orientated north-west to south-east on a slope that falls away both to the south-west and to the south, overlooking the quarry mills and immediately downslope of a tip run. Building material is unsawn slab with some use of country rock as quoins, and there is slight evidence of patching with Greaves-sawn blocks. The building was mortared and rendered.

It is a substantial two-storey structure divided into eight separate units by cross-gable walls. It is now roofless and dilapidated. The walls survive up to a maximum of 6m, and the joist-holes suggest that the headroom on the ground-floor was in the order of 2.4m. The three most north-westerly dwellings are built at a higher floor level than the others, and there are suggestions that the three most north-westerly pre-date the others, in that there is a butt joint between the gable end and longitudinal walls at this point.

Each unit is entered by a door on the upslope side flanked by one window. There is a further window on the downslope side, and the pattern of windows is duplicated on the first floor. Where the gables survive there is evidence of a hearth. There is no trace of stairs to the first floor.

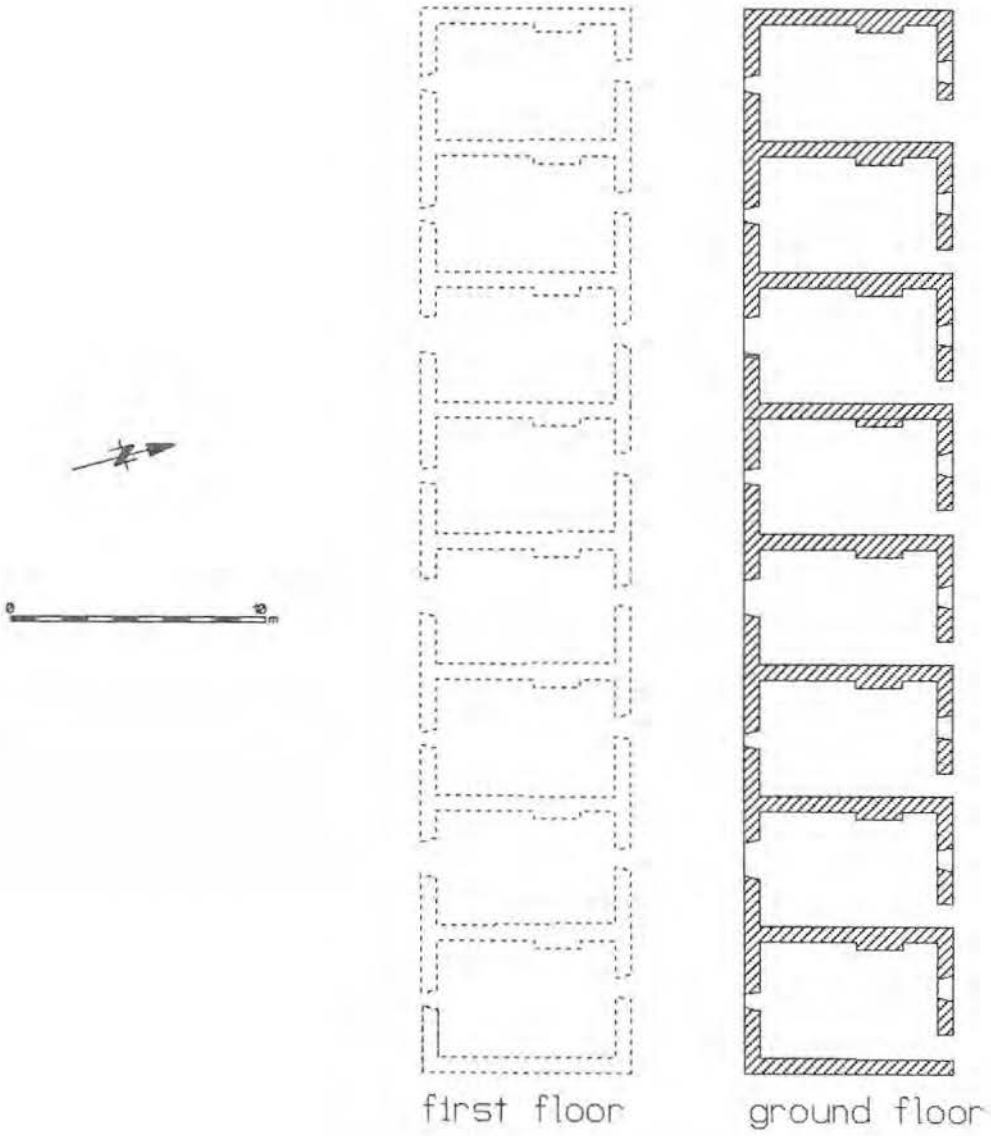
Immediately to the north west is a privy built over a stream and immediately downslope is another, non-domestic, building.

7 August 1996 DRhGwyn

Discussion: While it is possible that feature 15 was an original barracks, its function seems to have changed when feature 29 was constructed. They appear to have been remarkably short-lived buildings even by the standard of others in the industry.

Conclusion: of regional significance as exemplifying an attempt to work a remote site.

Fig. 34 20255:29 Hafod y Llan Quarry barracks



Site name: **Rhosydd Slate Quarry**

Community: **Ffestiniog, Gwynedd**

Quarry area: **Glaslyn**

Trust PRN: **20283**

Site history: Rhosydd Quarry is situated on a plateau between the Croesor and Dwyryd valleys. It was worked from the 1830s to 1929, and from 1874 until closure was financed and managed by locally-based Welshmen. Early workings were pits near the Moelwyn ridge, but subsequent operations moved progressively downslope to the north. Rhosydd quarry was chosen for the pioneering industrial archaeology survey of the Welsh slate industry in 1971 and 1972 (Lewis and Denton 1974 pp. 7-16).

Feature number: **39**

Grid reference: **SH66454583**

Archival and bibliographic sources: These, the floor 4 barracks were probably constructed in 1859 (Lewis and Denton 89).

Archaeological description: Built on a north-facing slope near the 4 adit entrance, and orientated east to west; built out of unsawn slate blocks, part-double-storey and part single-storey, it is dilapidated and roofless.

The main block is a five-cell structure in which the most easterly is a weighbridge-house at ground floor level, serving the railway from the adit, with accommodation at first floor level, evident as a fireplace in the intermediate gable.

The central ground-floor cell is accessed by a central door in the southern longitudinal wall, flanked by two windows. Traces of joist-holes are visible in the walls.

The western cell accessed by a door in the northern longitudinal wall and illuminated by a window in the southern. The outline of the roof pitch in the external gable confirms that there was no first floor here.

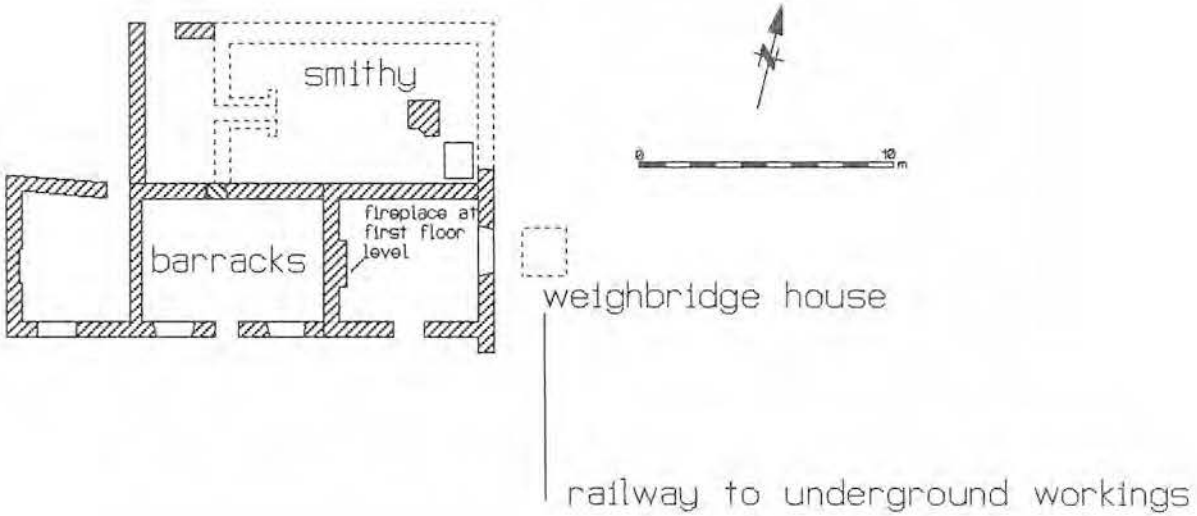
Added on to the building to the north, and surviving only to the level of the lowest courses, is a smithy in which traces of the hearth and the bosh survive.

1 October 1996 DRhGwyn

Discussion: Rhosydd 4 barracks are unusual in that they form an integral block with buildings serving other purposes, in this case a smithy and weighbridge.

Conclusion: of regional significance as exemplifying the development of Rhosydd Quarry.

Fig. 35 20283:39 Rhosydd Quarry barracks



Site name: **Oakeley Slate Quarry**

Community: **Ffestiniog, Gwynedd**

Quarry area: **Blaenau Ffestiniog**

Trust PRN: **20296**

Site history: on-site accommodation is known to have been provided at two of the three quarries which went to make up the Oakeley site, Gloddfa Ganol (Rhiwbryfdir or Mathews) and Holland's quarry, where six separate structures survive. Those at Gloddfa Ganol have been preserved and rebuilt as part of the Museum. Those at Holland's quarry are more problematic, since their specific locations are not given in the census. The 1861 census incomprehensibly refers to two dwellings as "Soar Holland"; the most obvious explanation that they were near a chapel called Soar, appears to be vitiated by the fact that no such chapel name is known in the area until October 1871 (Williams GJ 1882 p. 184). The 1871 census gives five families as resident at "Holland's quarry", the heads of the families being three quarrymen, an engine-driver and a widow-housekeeper, of whom it is tempting to suggest that she ran the *ty cinio* ("lunch house") at either 34 or 45. These dwellings are completely missing from the 1881 census, either because they were already abandoned, or, more probably, because the enumerator forgot to include them. What is clear from bibliographic sources is that Holland was actively involved in constructing houses for his labour force and their families; as early as 1827 he built the houses known as Pant y Lleidir (sic) in Rhiwbryfdir, an area later engulfed by the Oakeley tips (DRO Z/M/2532/3), and in the 1850s and '60s he created a community at Tan y Grisiau, two miles away from the main quarrying focus, taking advantage of the introduction of steam locomotives (1863) and passenger transport (1865) on the Ffestiniog Railway (CRO BJC Addit. boxes H1073-1181, Malchow 1991 *passim*). Earlier houses were built by the quarries themselves, as close to the workplace as possible, thereafter houses came to be built at a distance from the quarries by building societies (Jones E 1985 p. 78).

Feature no: **52**

Grid ref: **SH69254691** Statutory protection: **Listed grade II**

Archival and bibliographic sources: three dwellings known locally as Bythynod Harry Williams, from an astronomer-quarrymen who lived in no. 2, are said to date from the 1840s and to have been inhabited specifically by families whose head was responsible for machinery, and who needed to be on site early in the morning (Gloddfa Ganol guide 9). This is to some extent borne out by the census. The count of 1861 records the heads of the families as a "Qua Braker" (presumably an incline brakesman), a fireman and an engineer. This last styled himself more modestly "Engine fitter" ten years later when he was a lodger in another one of the houses, but his neighbours of ten years previously had gone, their places being taken by an "Engine driver", another fireman and a carpenter. These three houses accommodated twenty-two people that year. By 1881 the pressure was off, and the number was down to eight (census for Blaenau Ffestiniog, 1861, 1871, 1881). The census details tend to confirm that the barracks at Oakeley were built for men whose duties included manning the pumps and raising steam in locomotives and stationary engines, a process that required several hours at a time when the working day might begin at 6 am. One of the cottages remained inhabited until 1971 (Gloddfa Ganol guide 9).

Archaeological description: Situated on the natural ground level of the north-facing slopes of Pen y Foel, orientated east to west, alongside the main transport artery of the Rhiwbryfdir Slate Quarry. A single-storey terrace of three units built of slate rubble, each accessed by a central doorway with narrow flanking windows. Internal arrangements include a hall and a *parlwr* on the ground floor and two attic bedrooms, reached by a wooden staircase from the hall. There are outhouses and lavatories to the rear. These buildings have been renovated as a tourist attraction by the Ffestiniog Slate Company as part of the Gloddfa Ganol museum, one in the style of 1885, one in the style of 1914 and one in the style of the 1960s. They have been listed Grade II (Cadw ref: 44/H/35 to 37 (1).

9 December 1994 DRhGwyn

Discussion: An example of dwellings for complete families on site, comparable to the possibly later Tai Holland in Holland's Upper Quarry nearby. The buildings also represent a development from the simpler *crog-lofft* type of architecture, in that they have two bedrooms in the loft.

Conclusion: of regional significance as exemplifying the pre-urban industrial development of the Blaenau area.

Site name: **Cwt y Bugail**

Community: **Bro Machno, Aberconwy**

Quarry area: **Blaenau Ffestiniog**

Site history: Opened by Captain Adam gregory in the 1830s, but only developed from the 1860s; situated on a bleak ridge between Blaenau Ffestiniog, Penmachno and Dolwyddelan, it was obliged to provide barrack accommodation for its workers.

Trust PRN: **20311**

Archival and bibliographic sources: Cwt y Bugail went into production in 1864 (Shiloh p. 60), and the essayist dates the barrack accommodation to the same period as the upper mill (Shiloh pp. 60-61), thought to date from *c.* 1867 (see *Baner ac Amserau Cymru* 7 Awst 1867).

Other barrack accommodation was provided at the site; the Shiloh essayist speaks of Barigs Scotts, which stood near the weighing machine, and barigs bach, near the mill - which, he does not say (Shiloh 62-63). Barigs Scotts was probably named after the "Scottish Company", the Cwt y Bugail Slate Co. Ltd, who leased the quarry from 1863 to 1875 (Bradley 229). An advertisement of sale in the *Caernarfon and Denbigh Herald* for 8 May 1875 does not mention the barracks. More recently, after (1) became disused, another barracks was built in the stackyard, probably of timber and corrugated iron. It was also used as a caban, and contained four folding beds and a billiard table (Plas Tan y Bwlch 1985 p. 22).

Feature no: **1**

Grid ref: **SH73244667** Statutory protection: **none**

Archaeological description: Constructed on an outcrop of igneous rock in the angle formed by the Rhiwbach tramway and the siding access to Cwt y Bugail quarry, and effectively overlooking the lower level of the quarry. A rectangular plan structure orientated north-west to south east, constructed of mainly of igneous rock, and surviving up to 3m high internally and 4m high externally in the south-east corner, where windows are evident. Elsewhere, the building is heavily dilapidated.

In each of the end-gable walls and on both sides of the one intermediate gable are two fireplaces, in which there is some use of dressed stone up to lintel level. Both the units thereby formed appear to have been accessed by a door in both of the longitudinal walls, each flanked by two windows. There are faint traces of cross-corridors joining the doors, made out of unsawn slates and with dressed stone reveals where side doors give access to the rooms. A spinal wall also constructed out of unsawn slate appears to run the full length of the building, making in effect eight separate cells. There are traces of steps up to the easternmost door.

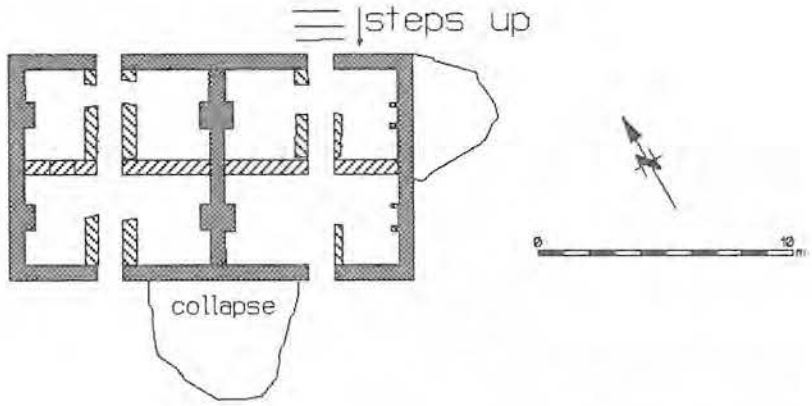
A series of stone launder pillars runs from under the tips to the north to connect to this feature.

9 October 1996 DRhGwyn

Discussion: The substantial stone pillars to the north of the building were presumably for domestic water supply.

Conclusion: Of regional significance as exemplifying the growth and development of the Blaenau Ffestiniog quarry area.

Fig. 36 20311:1 Cwt y Bugail Quarry barracks



Site name: **Blaen y Cwm**

Community: **Bro Machno, Aberconwy**

Site history: the quarry was first worked on a serious scale by Hugh Beaver Roberts, a local solicitor who was involved in many quarry and railway enterprises, with Captain Twigg of Llandygai and Robert Lecky of Cork as manager and partner. Its remote situation, on the high slopes of Manod Mawr, obliged the company to provide accommodation for its workers.

Trust PRN: **20312**

Archival and bibliographic sources: A small building by the side of the railway from Rhiwbach quarry was built between 1872 and 1888 (Jones 1991 p. 45). The Shiloh essayist gives no dates, but describes "these houses" (*y tai hyn*) as a bleak place, especially when the wind was from the west or the north (78).

Feature no: **32**

Grid ref: **SH73334615** Statutory protection: **none**

Archaeological description: Situated on a spur of igneous rock to the east of the Rhiwbach tramway and overlooking Blaen y Cwm quarry, this rectangular plan structure is orientated north-west to south-east, and is heavily dilapidated; nowhere do the walls survive more than 2m high.

The building consists of eight separate cells, formed by three intermediate cross walls and one spinal wall. Each of the larger rooms on the north-east (downslope) side is accessed by a door through the longitudinal wall, and each is illuminated by a single window in the longitudinal wall. Through doors in the spinal wall connect the front and back rooms, and three of the back rooms have a separate access either through the end gable walls or the south-west longitudinal wall. The only hearth identified is constructed in the spinal wall dividing the two most south-easterly rooms.

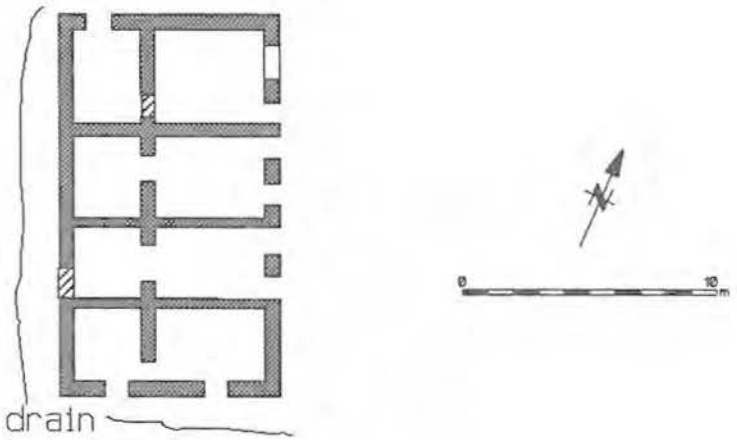
Around the gables and the upslope wall of the barracks is a drain. Recent archaeological work by Fforwm Plas Tan y Bwlch revealed domestic waste in the form of tin cans and bottles on the downslope side of the building.

9 October 1996 DRhGwyn

Discussion: The Shiloh reference to "these houses" implies that they were separate dwellings. The absence of hearths presumably suggests free-standing stoves.

Conclusion: of regional significance as exemplifying the growth and development of the Blaenau Ffestiniog quarry area.

Fig. 37 20313:32 Blaen y Cwm Quarry barracks



Site name: **Rhiwbach Slate Quarry**

Community: **Bro Machno, Aberconwy**

Trust PRN: **20313**

Site history: Rhiwbach quarry shared the problem of working a remote site with its neighbours Cwt y Bugail and Blaen y Cwm, but working on a larger scale than either of them it needed to offer more accommodation. As well as the village of Rhiwbach, a row of houses was built in Cwm Penmachno in 1869 (Williams VP 109).

Feature no: **57**

Grid reference: **SH74184610** Statutory protection: **none**

Archival and bibliographic sources: The Shiloh essayist is very weak on dates and specifics, but states that "in the early days of the quarry two or three houses were built near the original office, along with a row of small houses; a large yard; barracks, a smithy for the blacksmith, a workshop for the carpenter, and a building named Field Barracks (Barics y Cae), that was many years ago turned into a farmhouse with rich fields around it."

Some of the inward investment of the 1860s went into creating a more developed and self-sufficient community. The Rhiwbach Literary Society held its first meeting in 1867, and the Reading Room was in existence by 1872; a room for a day-school and weekly and Sunday meetings, came later (Shiloh p. 41). The schoolmistress latterly made the journey over from Blaenau every day, travelling on the quarry inclines. The schoolroom was a corrugated-iron structure erected in the most easterly enclosure; the only photograph known to survive of it, taken in 1909, shows Miss Kate Hughes the teacher with twenty-three children against a background of timbering. It functioned from 1908 to 1916 (Williams VP 1997 pp. 100, 106).

Goods for the village shop were sent over from Brymer's department store in Blaenau, along the quarry railway (pers. comm., Griff Jones).

The barracks remained inhabited until the 1930s (Williams VP 1997 p. 111).

As well as the community in the quarry itself, the quarry company built three rows of houses in the existing hamlet of Cwm Penmachno in 1869; in 1905 thirty-seven quarrymen lived in the barracks and eighty-eight in Cwm (Williams VP 1997 p. 111).

Archaeological description: Situated on made-up ground of slate waste near the north-eastern perimeter of Rhiwbach quarry, at the point where the original access road to the quarry entered the premises. The main buildings form two discrete areas.

Those on the south of the site consists of a row of five *crog-lofftydd* orientated east to west to which a two-storey range running north to south has been added on to the west gable wall, consisting of (from north to south) one unit accessed by a central doorway with two flanking windows, understood to have been a shop, and two other units accessed by a side door with a single window in the other two. A notable feature of this range is the slate-slab drip-moulding over the ground floor doors and windows. A substantial buttress supports the southern gable.

The *crog-lofftydd* are roofless but the walls survive up to eaves height; some of the chimneys have collapsed. The two storey range is roofless and though the walls survive up to eaves height in places, there has been considerable dilapidation in the most southerly of the unit.

Those on the north consists of a range of buildings constructed on the north, south and east sides of a central courtyard, accessed by an archway in a perimeter wall on its west side. Building material is slate rubble. Most survive up to eaves height, but all are roofless.

The building to the south of the courtyard is a narrow structure 27m long built to house core samples. That to its north is a domestic range showing considerable evidence of reconstruction and re-use with doorways in both the longitudinal walls. To its east is a concrete base, believed to have been the foundations for the school. To the west is a single-cell dwelling unit.

On the east of the courtyard is a single-unit structure, perhaps a store-room.

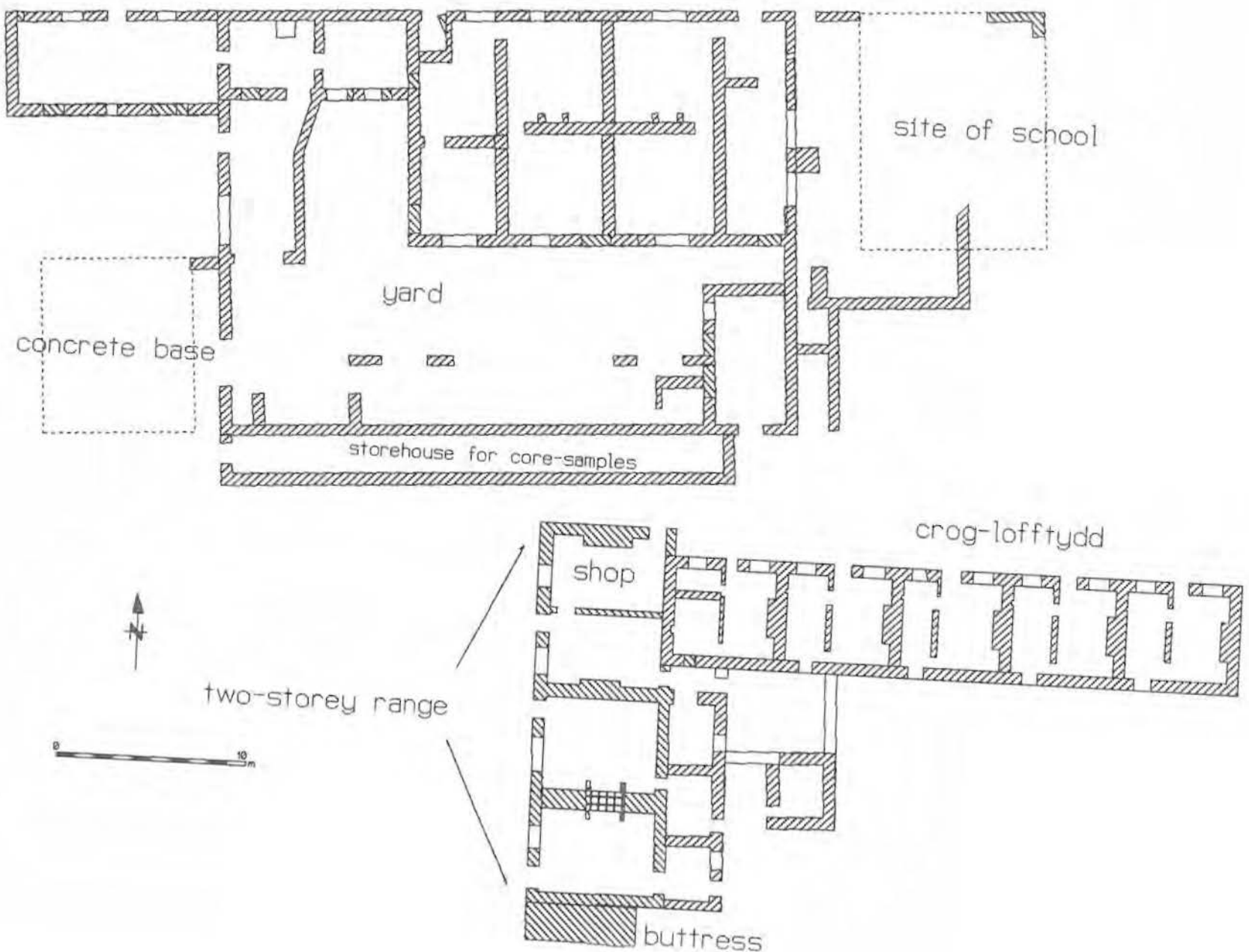
To the west of these two areas are other ruined buildings, partly buried by tips, and concrete bases for timber and corrugated iron structures.

6 February 1997 DRhGwyn

Discussion: An outstanding example of a self-contained quarry village on a remote site, illustrating a half-way stage between on the one hand simple on-site dwellings for men or families, and, on the other hand, company villages such Aberllefenni or Nantlle, or the houses constructed by quarry companies in existing settlements, such as Rhiwbach's own houses at SH 750 473 in the village of Cwm Penmachno (listed as 41/B/10-19 [3]).

Conclusion: of outstanding importance as an element in the landscape of Rhiwbach quarry and as exemplifying the barracks system developed to the point of becoming a small village.

Fig. 38 20313:57 Rhiwbach Quarry barracks



5 FEATURES NOT SELECTED FOR DETAILED STUDY: DOCUMENTARY DATA

This section gives dates of construction and other archival and bibliographic information for features listed in the second Cadw-funded project and where sources have been identified but which were not chosen for detailed study in the present project.

5:1 Mills

Site name: **Tal y Sarn Slate Quarry**

Trust PRN: **20025** feature no: **22**

This appears on a map of 1868, when it is recorded as a slab mill (CRO uncat., report of directors of British Slate Company 1 February 1868). It may be the mill previously dated to 1895 but was later extended. A single-cylinder horizontal engine powered eleven saws and six dressers (Pierce Jones 1985 p. 37).

Site name: **Gallt y Fedw Slate Quarry**

Trust PRN: **20032** feature no: **4**

Mill 4 was constructed in the 1890s, and contained six circular saw tables, and six dressers which were housed in the gwaliau to the south. Later twelve open-air saws were added in (7), with ten adjoined gwaliau for hand-splitting and dressing. Two other saws and two gwaliau functioned immediately to the west of this complex in (22), and in the 1920s an experimental crushing plant was installed in (4). Power was provided by a single-cylinder Marshall engine (Pierce Jones 1985 p. 36).

Site name: **Dorothea Slate Quarry**

Trust PRN: **20033** feature no: **12**

Started in 1892 and completed *c.* 1920 (Pierce Jones 1980 p. 166). The long delay in finishing has been accounted for by the fact that rates were not payable on functioning but incomplete buildings (pers. comm., Pierce Jones).

Site name: **Gwernor Slate Quarry**

Trust PRN: **20035** feature no: **4**

The first two saw-tables were set up here between 1889 and 1897, powered by the winding turbine; a new and larger mill containing three saw-tables and one planing machine was built between 1900 and 1905. The southernmost gwal was extended about 1913 to house a Sentinel air-compressor driven by a Tangye oil engine (Pierce Jones 1987 p. 59).

Site name: **Pen y Bryn Slate Quarry**

Trust PRN: **20037** feature no: **26**

The mill was originally constructed in 1884, and was later extended; it latterly contained eighteen saw tables. A Ruston Proctor double-cylinder overtype steam engine was installed initially, 7.5" bore and 14" stroke, sold in 1891. At the reopening in 1897 a single-cylinder DeWinton engine was installed, 11.3" bore and 30" stroke (Pierce Jones 1985 p. 37).

Site name: **Pen yr Orsedd Slate Quarry**

Trust PRN: **20039** feature no: **41**

The Eureka mill on the top level dates from 1898, and remains in use. It was built to house thirty-three saw-tables and thirty-two dressers, and was powered by a compound condensing horizontal steam engine (Pierce Jones 1985

p. 37). It was substantially rebuilt with modern equipment in the late 1960s (photographs in possession of Peredur Hughes) and was further altered after the abandonment of rail transport in 1978.

Site name: **Cook and Ddol Slate Quarry**

Trust PRN: **20069:20** feature no: **20**

This is not mentioned in *SQNW1873* but was in existence by the time of the 1900 25" OS.

Site name: **Cefn Du Slate Quarry**

Trust PRN: **20490** feature no: **25**

This was constructed in 1888: the 25" ordnance survey shows a rectangular plan building accessed by a railway in its northern gable end (Lindsay 1974 p. 158, UWB Cefn Du 19 and 271).

Site name: **Glynrhonwy Lower Slate Quarry**

Trust PRN: **20075** feature no: **17**

A painting by George Campion of *c.* 1840 entitled "Llanberis" shows an overshot waterwheel operating a single sand-saw (in NLW). These were replaced by steam plant; Abbott refers to DeWinton-built compound horizontal steam engines of 40 to 50 hp with jet condensers and Lancashire boilers, and observes "One is known to have gone to the Glyn-Rhonwy Slate Quarry at Llanberis for driving the slate-tables", but does not make clear to which Glynrhonwy quarry he refers (Abbott 1956 p. 92). The likelihood is that it was Glynrhonwy Lower, since *SQNW1873* refers to "the machine house which is by the lake side" but says nothing about any other mills in the quarry area on the west of Llyn Padarn (pp. 86-7). He also refers to the Hunter saw, for which there is evidence in the immediate vicinity of this site in the form of building stone with the distinctive mark.

The mill is unlikely to predate the LNWR branch line to Llanberis, opened in 1869, and was in existence by 1873 when it is noted in *SQNW1873* (p. 86).

Site name: **Cwm Eigiau Slate Quarry**

Trust PRN: **20100** feature no: **9**

The original mill was erected in 1855 (*MJ* 10 Feb 1855 p. 85) and was powered by a 30' diameter 4' breast water wheel. It was converted to a storehouse after only a year (*MJ* 11 October 1856 p. 695)

feature no: **6**

The manager, Jordan, resolved to build a new mill in 1856 because of the design weakness inherent in the long shafting necessary to power the original mill. It contained "six pairs of saws" (*MJ* 11 October 1856 p. 695). It was in existence by August 1857 (CRO X AMP Maps 5)

feature no: **8**

The *MJ* for 1 September 1864 records that a new machine house had been erected since May to house Hunter saws; a "fair number" of these had been installed by September 1866 (*MJ* September 1866).

feature no: **4**

A lease map of 1 July 1865 shows this building in existence (UWB Baron Hill 4433, 4434)

Site name: **Foel Slate Quarry**

Trust PRN: **20105** feature no: **8**

This dates from the period 1861 to 1863, when the quarry was worked by Foudrinier of the paper-making family, and Joseph Jennings (Williams and Lewis 1989 p. 8).

feature no: **20**

This dates from after Foudrinier's withdrawal from the business in 1865 (Williams and Lewis 1989 p. 8)

feature no: **34**

This dates from the period 1861 to 1863 (Williams and Lewis 1989 8).

Site name: **Cedryn Slate Quarry**
Trust PRN: **20106** feature no: **4**

The *MJ* reports on 1 September 1866 that the British Slate Company hoped to complete this structure by the middle of the month; a week later a report spoke euphorically of the Hunter sawing machines and planing machines "of every description" which it was proposed to install (*MJ* 8 September 1866). On 14 March of the following year the *MJ* referred to a planer, a circular saw, a Hunter and four sand-saws (14 March 1867).

Site name: **Cwm Machno Slate Quarry**

Trust PRN: **20132** feature no: **4-6 Yr Hen Injan, Injan Newydd**

The older mill (4) is to the north-west, and is shown on a map of 1853 (CRO X Plans R 2). It was probably then newly built, as the quarry had recently paid £835 to the Ffestiniog Railway for castings (CRO FR [old] 000478]) - too much to be simply railway chairs, and PRO Kew BT41 674 3684 records the expenditure of large sums of money on reservoirs, machinery and buildings from 1852 and 1853. It seems originally to have been equipped with saws and planers, as CRO X Plans R 2 refers to it as a "saw and planing mill", but by 1912 it contained eight saw-tables and eight dressing machines (Shiloh p. 11).

The newer (6) is attested *c.* 1854; the Shiloh essayist of 1912 recalls it in operation "fifty-eight years ago" (11), which ties in with the delivery of machinery for the quarry from Trefriw wharf in 1856 and 1857 (Grimsthorpe Castle, Trefriw wharf books, courtesy of Dr Michael Lewis). He further remarks that this newer mill was built with the intention of making slabs, and that in 1912 it contained six saw tables and three planers. A photograph in the John Thomas collection at NLW shows this buildings as forming two radial mills.

Site name: **Hafodlas Slate Quarry**

Trust PRN: **20156** feature no: **34 The London mill**

This, the so-called London mill, was built in 1896; the ordnance survey shows a rectangular building orientated south-west to north-east apparently accessed by railway at three points - in the north-east gable end, the centre of the north-west facing longitudinal wall and at a point in the opposite longitudinal wall (Jones GR, forthcoming).

Site name: **Cefn Madoc Slate Quarry**

Trust PRN: **20165** feature no: **2**

The company which worked Cefn Madoc was set up in 1865, and a mill powered by a 10 hp steam engine operating two planers, two saws and a saw sharpener are recorded in the advertisement of sale in 1867 (PRO Kew BT31 1093 2078C, *CDH* 21 September 1867).

Site name: **Braich Rhydd Slate Quarry**

Trust PRN: **20176** feature no: **29**

This structure dates from the 1880s, and was subsequently extended. It contained sixteen saw tables (Pierce Jones 1985 p. 37).

Site name: **Fron Slate Quarry**

Trust PRN: **20178** feature no: **20**

This feature may date from the lease to the British Slate Company from 1864 to 1869 (PRO Kew BT31 504 1993, CRO uncatalogued, reports of directors' meetings of the British Slate Company, ex limited company microfiche files, Guildhall Library London).

Site name: **Hafod y Wern Slate Quarry**

Trust PRN: **20182** feature no: **2**

The quarry is not described in *SQNW1873*, but it was already disused when the North Wales Narrow Gauge Railway was constructed in 1877, restarting in the 1880s (Boyd 1988 p. 196). The mill is marked on the 25" OS map of 1900.

Site name: **Alexandra Slate Quarry**

Trust PRN: **20181** feature no: **10, 11, 12**

The earliest mill here dates from 1887, and was later extended. It contained twenty saws, and was steam powered. The saws were moved to a new mill *c.* 1910, which was gas-engine powered (Pierce Jones 1985 p. 37).

Site name: **Bwlch Cwm Llan Slate Quarry**

Trust PRN: **20197** feature no: **7**

Richards suggests improbably that this feature dates to the 1840s (Richards 1991 p. 87)

feature no: **14**

Richards suggests that this feature dates from the 1870s (Richards 1991 p. 87)

Site name: **Hendre Ddu Slate Quarry**

Trust PRN: **20286** feature no: **18**

The mill was built *c.* 1863 near the foot of a steep slope, down which runs an incline from the quarry, a location which may have been dictated by the fall of water. It last operated in 1946, after a period of long disuse, powered by a Fordson tractor driving a a short lineshaft through a belt in the wall. Enough of the mill survived until 1976 to enable a reconstruction drawing to be prepared, showing a single-gable slate-built structure pierced by three doors in its south-east longitudinal wall and two in its north-west longitudinal wall, and a suggested "H" plan underground drive-shaft channel (Weaver 1976).

Site name: **Portreuddyn Slate Quarry**

Trust PRN: **20241** feature no: **1**

This structure was in existence by 1840, when the tithe maps show an engine house and waterwheel, and in the same year the owner was sued by William Jones of Rhyd Ddu for non-payment of £133 for "a machine, a sawing engine and waterwheel" (*CDH* 21.03.1840). An advertisement of 3 July 1841 in the *CDH* speaks of "long and circular saws, worked by water power, smoothing plains, engine turns &c." In 1845 there were "eight mills" (presumably individual saws) with an auxiliary steam engine (*CDH* 29 March 1845, *MJ* 1845 p. 550).

Site name: **Parc Slate Quarry**

Trust PRN: **20259** feature no: **11, 21**

This structure appears to have been constructed from 1870, when the quarry was under the management of Joseph Kellow. The Croesor Tramway accounts refer to the movement of machinery to the site from January of that year, specifically parts of a waterwheel, planers, boilers and a chimney, flywheels and a pump (UWB Bangor MS 588 pp. 470-474, 476). In 1878 a further waterwheel was sent up the tramway, along with a dressing machine - probably not a trimming device for roofing slates, but a device for producing the patent ridging tiles which were the quarry's speciality (UWB Bangor 590 pp. 65-6). In 1886 a further planing table went up (UWB Bangor 590 p. 118).

Site name: **Fronboeth Slate Quarry**

Trust PRN: **20278** feature no: **1**

The quarry's tunnel and incline to the Croesor Tramway were completed by May 1890, and its first output is dated 1891 (Lewis 1988 p. 8). It is therefore likely that the mill dates from this period; it is marked on the 25" OS of 1900.

Site name: **Croesor Slate Quarry**

Trust PRN: **20279** feature no: **6**

The first part of the mill dates from the early 1860s, when about a dozen saws were installed powered by a 28' wheel. An extension was put up in 1866 with a 39' wheel powered from the tailrace of the first, operating either twelve or fourteen saws (Richards 1991 p. 111, DRO Z DAW Category 11, plan of 22 July 1868 and undated following). Photographs of the mill in its heyday shows a longitudinal structure illuminated by skylights with two ranges projecting on the uphill side and one on the stackyard side (Isherwood 1988 p. 5).

Site name: **Pant Mawr Slate Quarry**

Trust PRN: **20280** feature no: **4**

The construction of this feature appears to be reflected in the Croesor Tramway accounts for 1878/9 when a boiler and nine saw tables were sent up to the site (UWB Bangor 590 pp. 151-2).

Site name: **Rhosydd Slate Quarry**

Trust PRN: **20283** feature no: **15 Floor 2 mill**

This tiny one-roomed building may have contained a single saw, and was probably powered by a portable steam engine. It was in use from 1854 or 1855 (Lewis and Denton 1974 p. 48)

feature no: **50/51 Floor 9 mill**

The first part of this longitudinal mill was in existence by 1862; an extension to the east side was added in 1867-9. The wheel was housed in a pit at the south-west corner. By the end of the century it housed forty saw-tables, forty dressers and a planer. A transverse extension was built to the west in either in 1875 or the early 1880s and contained ten tables and dressers. The waterwheel not only powered the saw-tables and dressers but also the rope-haulage system in the long 9 adit. The arrangements and the building were substantially altered and rationalised between 1909 and 1910. After the second world war a group of Llanberis quarrymen were given permission to work the walls for slates (Lewis and Denton p. 53)

Site name: **Conglog**

Trust PRN: **20287** feature no: **11**

This structure may date from the mid-1870s, when Joseph Kellow of Parc Quarry was at work here: the Croesor Tramway accounts refer to the movement of machinery to Conglog in May 1874 (UWB Bangor 589 p. 102).

Site name: **Wrysgan Slate Quarry**

Trust PRN: **20289** feature no: **25**

This structure is dated to 1865 by Richards (1991 140). A valuation of 1884 records a Hunter saw table, two saw sharpeners, six small and thirteen large saw tables, twenty dressing machines, as well as drive shafts and bevels. Power came from a water-wheel and two steam engines, and the whole was valued at £1,437. Elsewhere was a planer, valued at £50 (CRO BJC Addit. D41).

feature no: **44**

This structure may have been the original hand-powered mill constructed in 1853 (MJ 1853 677, 1854 516, Richards 1991 140), in which case conversion to water-power came later. The valuation of 1884 speaks of a water-wheel valued at only £20 and pulleys and shafts valued at only £3 1/4d, suggesting that the machinery had either been scrapped or moved into 25 (CRO BJC Addit. D41).

Site name: **Oakeley Slate Quarry**

Trust PRN: **20296** feature no: **11**

This is not shown on the 25" OS of 1889 but is marked on the 25" OS of 1914 (Merioneth IV 5).

feature no: **12 Bonc Goedan mill**

This structure is not shown on the 1889 25" OS but is shown on that of 1914 (Merioneth IV 5).

feature no: **24 Rhiwbryfdir slab mill**

This was constructed in 1989 on the site of the 1897 slab mill (Gloddfa Ganol guide 6).

feature no: **28/29 Felin Isaf Holland**

A modern rebuild using the original trusses of a mill built c. 1868 and operational until the first world; originally a single integral structure with feature 29. Originally steam powered, it was converted to 500 volt a.c. in 1906 (Isherwood *Rhiwbryfdir Fawr* p. 2). It was roofless, dilapidated and devoid of machinery at the time of the closure in 1970 (photographs in possession of Dr Gwynfor Pierce Jones)

feature no: **42 Injan Uchaf Holland/floor 4 mill.**

In existence by 1870 when it is referred to as a "slate dressing mill" (DRO Z DAF 2309), and constructed for Samuel Holland's quarry, which became the nucleus of the Oakeley quarry in 1877. Isherwood suggests it dates from the 1850s, and was powered initially by a steam engine which drove six saw tables arranged along the walls of the building. He also suggests that it was later extended to the north by a similar building also accommodating six saws, and that a further three were operated by line-shafting running through the west wall. He observes that lean-to gwaliau are visible on a photograph of the 1890s, as is the base of the original chimney. The present engine house (44) is not the original, but nevertheless predates the later mill (Isherwood, *Rhiwbryfdir Fawr* 32), which is marked on the 1889 ordnance survey.

Site name: **Llechwedd Slate Quarry**

Trust PRN: **20300** feature no: **21**

This, Llechwedd's first mill, was built in 1852-3 to saw slabs (Jones IW).

feature no: **25**

This is shown in 1871 (CRO X Plans R LNWR 8) as a two unit mill with a central waterwheel, orientated north-south, of which only the southern end survives.

feature no: **31 Floor 5**

The south-eastern range is marked in 1871 (CRO X Plans R LNWR 8), and the north-western range was apparently under construction in 1890 (CRO XS 1058). Only the north-westerly waterwheel is marked in 1901 (OS IV 9).

feature no: **47**

The so-called tin-can mill, built and roofed out of corrugated iron on a steel frame; it appears to be represented by a plan of 20 May 1935 by the Britannia foundry, Porthmadog for a fifty-table mill (DRO Z DAF I 58).

Site name: **Votty and Bowydd Slate Quarry**

Trust PRN: **20303** feature no: **7**

The north-east range was in existence by 1887 and the south-western range by 1899 (Weaver 1983, Merioneth IV 10).

feature no: **20**

The upper mill, which has now been completely obliterated (23), and the lower mill (7) were both in existence by 1887, and it is unlikely that the intermediate mill would not have already been in existence since they shared the same water-course. It is marked on the 25" OS revision of 1899 (Merioneth IV 10).

Site name: **Diffwys (Casson) Slate Quarry**

Trust PRN: **20305** feature no: **15 Floor O mill**

The floor O mill was built in 1865, and the equipment from the off-site slab mill at Pant yr Ynn moved into it. This had consisted of a planer, two circular saws, a hand saw machine, a grindstone and a travelling crane (CRO BJC X647).

Site name: **Rhiwbach Slate Quarry**

Trust PRN: **20313** feature no: **29**

This was built in 1882 (Jones GR nd p. 9) and by 1912 contained seven saw-tables and seven dressers. Both the 1888 and 1900 25 ordnance survey maps show it as crossed by three transverse tramways.

Site name: **Arthog Slate Quarry**

Trust PRN: **20375** feature no: **11**

A date stone confirms the date of construction as 1868.

Site name: **Minllyn Slate Quarry**

Trust PRN: **20449** feature no: **2**

The origins of this structure may date to 1868. The Merioneth Slate and Slab Co. Ltd had been set up two years previously by a group of Manchester and Macclesfield merchants, and in May of 1868 the *Merioneth Standard* reported that they had erected two large sheds eighty foot long, which are to be supplied with planing and sawing machines" (pers. comm., Richard Williams of Llanrwst). This may have the first parts of the feature to be constructed. It is described by the anonymous author of *SQNW1873* as containing "over forty planing and sawing machines driven by water power" (p. 61), though local memory speaks of a steam engine being used at one stage in conjunction with a turbine (pers. comm., Richard Williams of Llanrwst).

Site name: **Ty'n y Ceunant Slate Quarry**

Trust PRN: **20465** feature no: **1**

This may date from 1868 (Richards 1994 p. 63).

Site name: **Abercwmeiddaw Slate Quarry**

Trust PRN: **20468** feature no: **13**

This was constructed pre-1893 (Richards 1994 p. 51-58)

Site name: **Cambergi/Wenallt Slate Quarry**

Trust PRN: **20483** feature no: **1**

This was constructed between 1873 and 1875 and contained nine Owens saw-tables, one planer, a saw-sharpener, and a grinding stone. The waterwheel was 30' diameter and ten india-rubber belts are recorded, presumably to carry the drive to the saws and planer. The mill was described as being 98'4" by 42' (Richards 1994 pp. 105-9).

Site name: **Aberllefenni Slate Quarry**

Trust PRN: **20487** feature no: **1**

This was in existence by 1873, when it is described in SQNW1873, but had been extended and an additional waterwheel installed by 1888 (Corris Railway Society 1988 pp. 60-1).

feature no: **12**

This was in existence by 1859 (Richards 1994 p. 77).

Site name: **Ratgoed Slate Quarry**

Trust PRN: **20489** feature no: **1**

Richards notes the building as being in existence by 1855 and equipped with circular saws and, at some stage, a pelton, with underfloor shafting; it is described as largely redundant towards the end of the quarry's working life, though it is suggested that some fine finishing may have gone on there (Richards 1994 pp. 95-104). NLW Ratgoed 5 refers to sawing slabs at the quarry the previous year (entry for September 1854). An entry for July 1854 for "repair of machinery" might be for railway equipment or an incline, or might imply an existing mill (NLW Ratgoed 6).

feature no: **16**

In existence by 1873 and powered by a turbine until 1936, when an oil engine took over (Richards 1994 pp. 99,

102).

feature no: **25**

Richards suggests that this was in existence by 1864 (Richards 1994 p. 97), in which case it would be the destination of the turbine which arrived in June 1864 (NLW Ratgoed 6). A saw and a planer were bought from an Aberystwyth foundry for £140 the following month, and skylights and doors were installed in the autumn (NLW Ratgoed 7).

5.2 Ropeways and shafts

Site name: **Tal y Sarn Slate Quarry**

Trust PRN: **20025** feature no: **8**

A cableway powered by an Inglis steam winch was installed at Tal y Sarn quarry in 1910, and its site was moved in 1927 (Pierce Jones 1985 p. 30)

Site name: **Cornwall Slate Quarry**

Trust PRN: **20027** feature no: **4**

An inclined cableway was rebuilt in 1933, and powered by a Robey double cylinder horizontal engine (Pierce Jones 1985 p. 30).

Site name: **Gallt y Fedw Slate Quarry**

Trust PRN: **20032** feature no: **38**

This feature is not marked on the 1889 25" ordnance survey map (Caerns XXI.9), but appears on the equivalent survey of 1916, apparently out of use.

feature no: **26-29, 43**

This blondin cableway was operated by a DeWinton single cylinder horizontal of c. 1900, which made use of parts of an old cable winch (Pierce Jones 1985 p. 30).

feature no: **42**

This structure may date from 1933; it does not appear to have been completed (Pierce Jones 1985 p. 30).

Site name: **Dorothea Slate Quarry**

Trust PRN: **20033** feature no: **7, 36 SAM**

This strongpoint and its attendant winding house were constructed in 1881; from here there operated two single two-carriage chain inclines each powered from a separate steam engine. A third chain incline and steam engine were added in 1899 (Pierce Jones 1980 pp. 47-48).

The two original steam engines were double-cylinder undertype engines bought new from Robey and Company of Lincoln, each 9" bore and 14" stroke, capable of generating 16hp at 160rpm. The third addition was a single-cylinder horizontal by J.M. McKullock of Kilmarnock supplied second-hand by T.W. Ward of Sheffield in 1899, 13" bore, 30" stroke, generating 13hp at 100 rpm.

feature no: **26 (pyramid C), 35 (incline winding house for incline C) SAM**

This huge strongpoint supported two chain inclines each from its own steam engine. Construction began in 1907, and the winding house dates from 1913 (Pierce Jones 1980 pp. 62-3). The engines were a double cylinder overtype by

Ashby, Jeffrey and Luke of Stamford, bought second hand from T. Mitchell of Bolton in 1880, 10½" bore, 14" stroke, generating 25hp at 130 rpm, and a single-cylinder horizontal of uncertain manufacture built in 1885, 16" bore, 33" stroke, generating 20hp at 68rpm. Both were transferred here from other duties at the quarry, in 1914 and 1921 respectively (Pierce Jones 1980 p. 63, 1985 p. 28).

feature no: **27 (winding engine room 10) SAM, 28**

This winding house contained an engine which operated a two carriage chain incline from strongpoint 28. The winding engine house was built in 1884, but the strongpoint is older, having previously been used for a two carriage chain incline on a different alignment, installed in 1860 (Pierce Jones 1980 pp. 61-2). From 1884 the engine was a single cylinder horizontal built by Edward Ratcliffe of Hawarden, possibly bought, possibly second-hand, from the makers, 18" bore 36" stroke, generating 25hp at 25rpm.

Site name: **Cilgwyn Slate Quarry**

Trust PRN: **20034** feature no: **5**

Cilgwyn quarry installed three Robey double-cylinder horizontal steam engines to power cableways between 1904 and 1910, to which were added two steam winches, one in the 1920s and one in the 1930s, and a double cylinder horizontal ex Moel Tryfan in 1936 (Pierce Jones 1985).

Site name: **Gwernor Slate Quarry**

Trust PRN: **20035** feature no: **6**

The original uphaulage system was a chain incline which may have been installed in the 1860s or 1870s. It was operated by the same power source which later also operated the mill, a water reaction turbine, possibly of the Thomson vortex type, coupled to a reversible geared winding engine operated a double-acting chain incline, whose original wrought-iron chains were replaced in the 1890s with a steel rope. A single acting version was erected nearby in 1900 on a newly-built slab platform.

It is possible that the original turbine may have been replaced by a pelton at some stage. As modified, the capacity was eighty loads each nine-hour day (Pierce Jones 1987 pp. 55-57).

Site name: **Rhiwgoch Slate Quarry**

Trust PRN: **20131** feature no: **15**

The strongpoint on the edge of the pit suggests a chain incline to raise waste out of the pit. The mill nearby was constructed in 1865, and it is possible that this feature dates from the same phase of operations (Lewis and Williams 1989 p. 14).

Site name: **Alexandra Slate Quarry**

Trust PRN: **20181** feature no: **6, 7, 21, 24**

Four steam winch engines were installed in Alexandra between *c.* 1900 and the 1920s to power blondin cableways (Pierce Jones 1985 p. 30).

Site name: **Oakeley Slate Quarry**

Trust PRN: **20296** feature no: **6**

This feature is shown on DRO Z DAF 2306 of 1870 as "vertical balance", connecting floor G to the Bonc Siafft mill named after it. Built by the Welsh Slate Company initially to raise rubble and later, once a level had been established around the headgear, raw blocks to Melin Bonc Siafft (Isherwood *Rhiwbryfdir Fawr* p. 28). It was 242' deep, and functioned until 1922 when the equipment was wrecked by overfilling the tanks (Isherwood 1988 7). A photograph on display in the Gloddfa Ganol museum confirms that it was very similar to the two surviving

headframes at Penrhyn Quarries, and an accompanying note dates it to the late 1840s or early 1850s. It is stated that the headgear was housed in a timber building when operational. The dimensions of the shaft are given as 25' by 18' 6", working off a drum 8' 6" diameter and 8' deep. It was demolished in 1937 to make was for a headframe purchased second-hand from a colliery, which was not successful (Gloddfa Ganol guide).

5.3 Barracks

Site name: **Tan yr Allt Slate Quarry**

Trust PRN: **20020** feature no: **3**

Built by the Caernarvonshire Slate Company between 1853 and 1856 (PRO Kew BT31/63/239) this barracks has been renovated and converted into a house.

Site name: **Cwm Eigiau Slate Quarry**

Trust PRN: **20100** feature no: **11**

The *MJ* refers to the construction of a barracks on this site in 1854-5 (26 December 1854 579, 10 February 1855), and they are shown on a map of 1857 (CRO X AMP Maps 5). However, they may be considerably older. They are not noted in the census of 1841 or 1851, but these coincided with periods of the quarry's disuse, and it is possible that it dates from the lease of the quarry to the Rigby family of Hawarden in 1827 (UWB Baron Hill). A structure may be identified here on the first edition 1" map of 1839-1840.

Site name: **Foel Slate Quarry**

Trust PRN: **20105** feature no: **3, 11, 12**

It has not proved possible to date these features exactly, though the probability is that most if not all were built during the tenancy of Foudrinier and Jennings from 1858 to 1865 (Lewis and Williams p. 8)

Site name: **Cedryn Slate Quarry**

Trust PRN: **20106** feature no: **23**

A report of 1865 in the *MJ* speaks of a barracks being erected for 120 men (11 March 1865 152-3). It was described as abandoned in the census of 1871.

Site name: **Gorseddau Slate Quarry**

Trust PRN: **20238** feature no: **4**

This building almost certainly dates from the period of investment in Gorseddau from 1856 to 1857. The 1861 census for the parish of Llanfihangel y Pennant refers to "Gorseddau Quarry's sleeping apartments", in which John Pritchard, who hailed originally from Llandrygau in Anglesey, a married quarry labourer of 66, was spending a lonely weekend. Nine of the thirty-six *crog-loffiydd* which made up the nearby village of Treforys were inhabited by quarrymen and their families, but the 1871 census lists only Thomas Evans "slate quarry manager" living at Plas y Llyn with his wife and daughter.

Site name: **Rhosydd Slate Quarry**

Trust PRN: **20283** feature no: **53**

The southern block of floor 9 barracks was complete by 1866, the north block between 1888 and 1899 (Lewis and Denton 90-92). The condition of the southern block was severely criticised in 1886 by the Inspector of Mines who pointed out that there was:

"scarcely 200 cubic feet of space per man in rooms used for sleeping, taking meals and keeping provisions and

coal ... the men were nearly all sleeping two in a bed, and some of the rooms were dark, with a bad floor and an indifferent roof" (Jones RM 1982 p. 29)

Worse was to come; in November 1890 a storm ripped off the roof during the night and the men had to flee, half-naked and clutching their beds (Jones RM 1982 p. 29 quoting *Y Rhedegydd* [15 Tachwedd 1890]).

Site name: **Oakeley Slate Quarry**

Trust PRN: **20296** feature no: **33**

This structure, near the mouth of Holland's main level, is not marked on CRO FR 500050 (old) of *c.* 1838 but is marked on the 25" OS of 1889 (Merionethshire IV 9)

feature no: **34 Clogwyn Hall**

This structure, near the mouth of Holland's main level, is not marked on CRO FR 500050 (old) of *c.* 1838 but is marked on the 25" OS of 1889 (Merionethshire IV 9). It was a *ty cinio* (lunch house) and a barracks (Steffan ab Owain 1984).

feature no: **41**

This two unit dwelling is not marked on the quarry plan of 1870 (DRO Z DAF 2309) but is marked on the 25" O.S. of 1889 (Merionethshire IV 9).

feature no: **45 Tai Holland**

This three-dwelling two-storey barrack block is marked on the quarry plan of 1870 (DRO Z DAF 2309). One source states that the central house was a ty cinio (lunch house) managed by women, who prepared food in an enclosed oven. They would shop in Blaenau once a month, and the foodstuff would be crewled up the incline from Diffwys. It is also stated that they were built by Alexander Dunlop, the quarry manager; this seems unlikely, as Dunlop is said to have been appointed in 1878 (Steffan ab Owain 1984, Ffestinfab 1879 p. 79).

feature no: **47 Barics Holland**

This *crog-loffiydd* block is marked on the quarry plan of 1870 (DRO Z DAF 2309).

feature no: **49 Barics Holland**

This single-storey block is marked on the quarry plan of 1870 (DRO Z DAF 2309).

Site name: **Votty and Bowydd Slate Quarry**

Trust PRN: **20303** feature no: **31**

Shown as "Lord's Cottages" on the 25" OS of 1899 (IV 10), they may possibly date from *c.* 1874, when the company archives refers to Lord Newborough's preparedness to allow a piece of land to be used for a barracks (DRO Z DAG 1, p. 24).

Site name: **Maeofferen Slate Quarry**

Trust PRN: **20306** feature no: **4**

These, the "Maenofferen Cottages", are first shown on a map of 1899 (DRO Z DAG 556); they are not shown on a map of 1872 (CRO X Plans R LNWR 8).

Site name: **Ratgoed Slate Quarry**

Trust PRN: **20489** feature no: **29**

Twenty-seven men were being charged rent from the beginning of records in January 1853 (NLW Ratgoed 6). In June 1864 "bedding and bedsteads" were purchased for £12 2s and blankets were bought in September. In July of the following year an entry appeared for "pulling down and rebuilding barracks", which were being plastered in January and February 1866 was paying "Rent on cottage" (2s 2d) in August 1868 (NLW Ratgoed 7). The Abandoned Mines Plan, annotated up to 1928, marks the building as a barracks, and shows it as being roofed (Abandoned Mine Plan 14095, copy in possession of Elfed Jones, Cymerau farm).