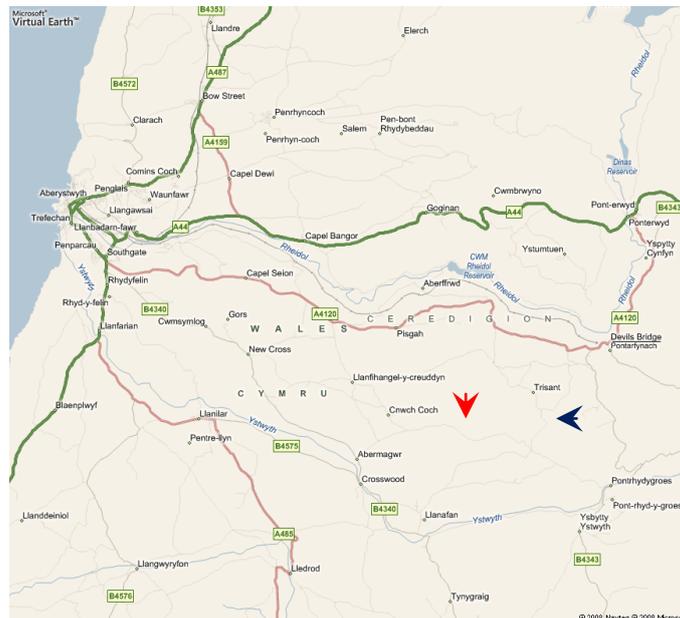


**PRESENTATION TO  
CEREDIGION ARCHAEOLOGY DAYSCHOOL  
28<sup>th</sup> FEBRUARY 2009  
PONT CEUNANT GENERATING STATION**



*Slide 1*

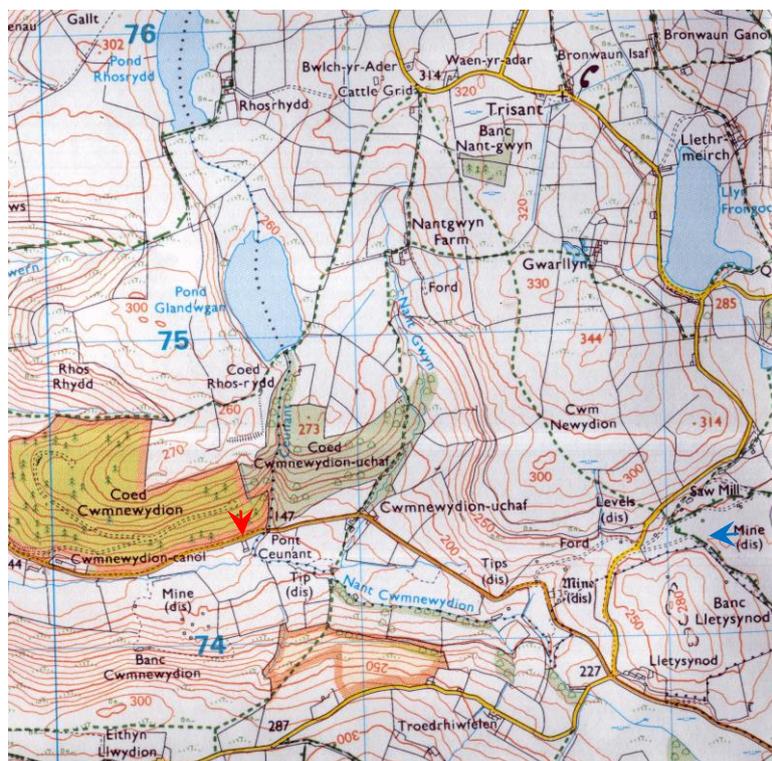
To begin I will give you a brief account of the history of Frongoch Mine and the Generating Station at Pont Ceunant.



Slide 2

Location Map Pont Ceunant Generating Station red arrow, Frongoch Mine blue arrow

Frongoch Mine is located 11 miles east of Aberystwyth



*Slide 3*

*Location map, Pont Ceunant Generating Station red arrow, Frongoch Mine blue arrow.*



*Slide 4*

*Aerial Photo, as previous slide Pont Ceunant Generating Station red arrow, Frongoch Mine blue arrow.*



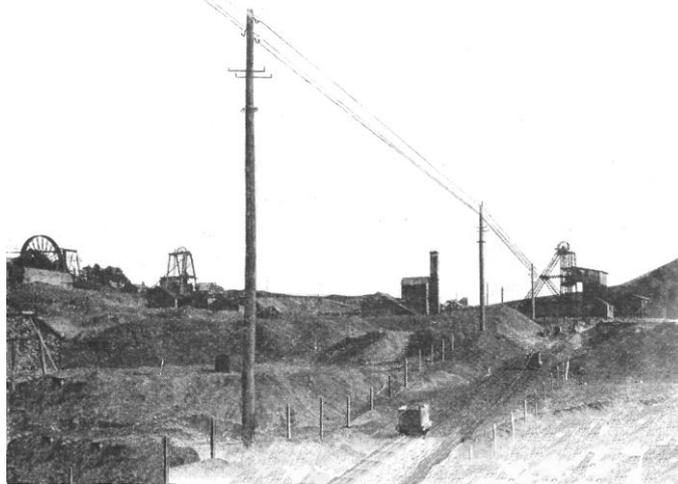
*Slide 5*

*Close up of Pont Ceunant Generating Station*

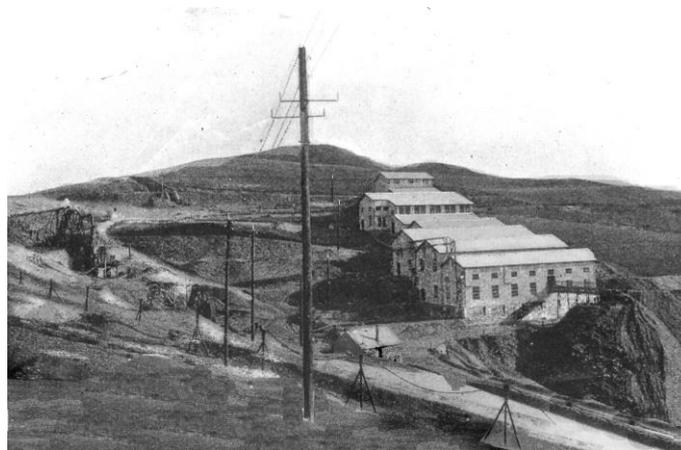
**Frongoch was one of the largest and most productive mines in Ceredigion. The first lease for 21 years was granted by Lord Lisburne to a Philip Pugh on 30<sup>th</sup> May 1759. The mine was worked for the next 150 years by several of the leading companies and individuals in Welsh Metal mining. In later years it included the nearby Wemyss and West Frongoch Mines.**

**The mine finally closed in June 1903.**

**Although there was a dump re-processing scheme during the first World War, when a 3000 yard long aerial ropeway was constructed from Frongoch to Gwaith Goch on the banks of the Ystwyth, where a new processing mill was built.**



*Slide 6*  
*Vaughan's Shaft Incline 1901*



*Slide 7*  
*The Belgian Mill at Wemyss Mine 1901*

**In November 1898 the mine was taken over by a Belgian company, who had a lease for 42 years.**

**When the new company took over the mine, the machinery was powered by steam engines and water wheels. The company decided that to work the remaining low grade zinc ores productively, modern machinery powered by electricity had to be installed.**

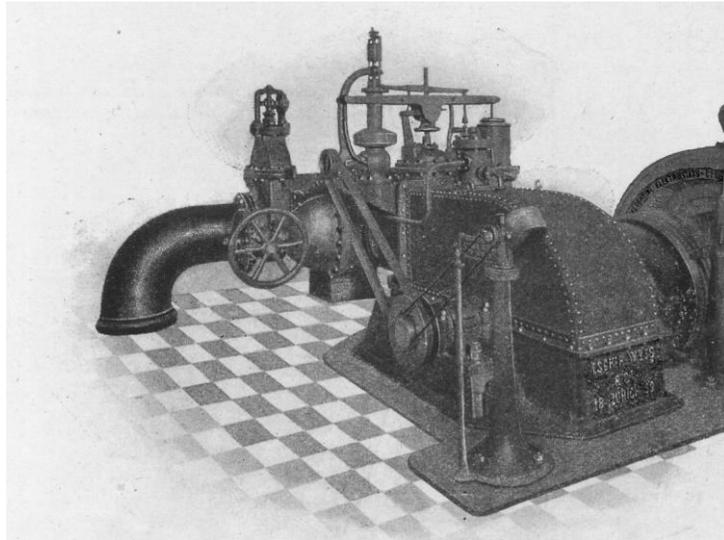


*Slide 8*

*Pont Ceunant Generating Station viewed from the south 1901*

**For this purpose a Generating Station, one of the first in Wales, was constructed 1¼ miles west of the mine in Cwm Newyddion. This was designed and built by an young Italian Engineer named Bernardino Nogara (who, later in his life became the head of the Vatican Bank)**

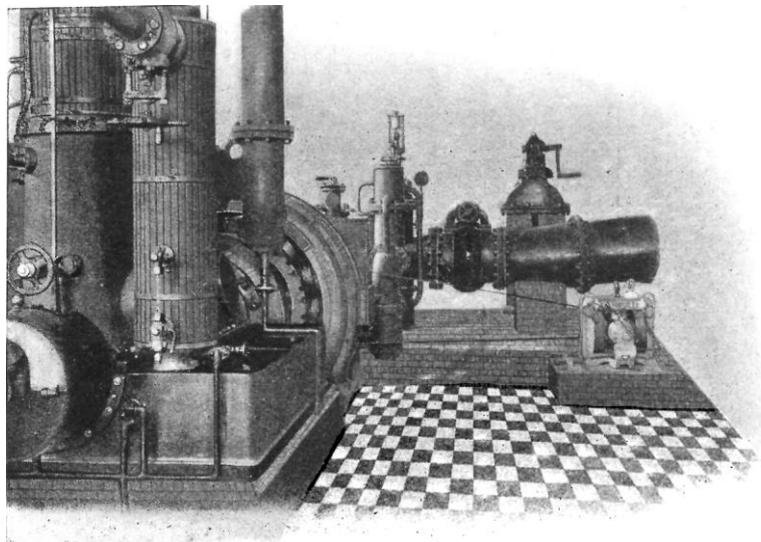
**The existing system of reservoirs and watercourses (known as leats), that previously powered the water wheels were reorganised; this involved the digging of a 3 mile long leat from the old Frongoch Pool to the header pond above the Generating Station, giving a 400 feet head of water.**



*Slide 9*

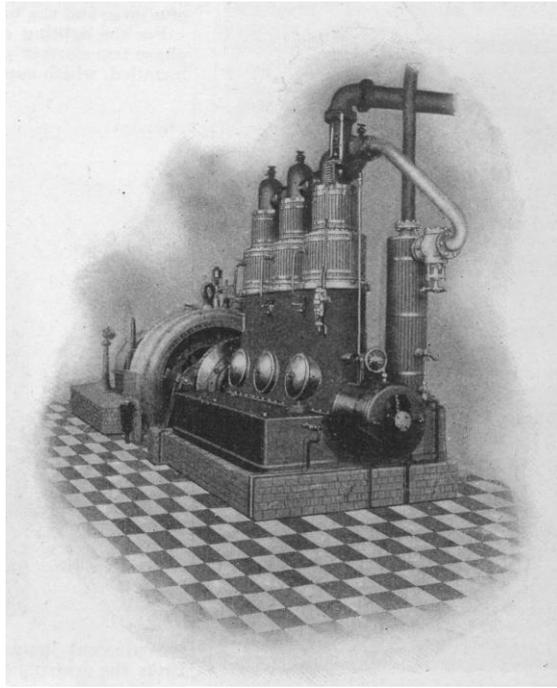
*The Pelton Wheel and the Alternator*

**The water was fed to a Pelton Wheel which drove the 2300 volt AEG alternator. A 360 hp Willans & Robinson 6 cylinder steam engine delivering 140 psi, complete with a Babcock & Wilcox boiler was installed to power the alternator during times of drought and frost.**

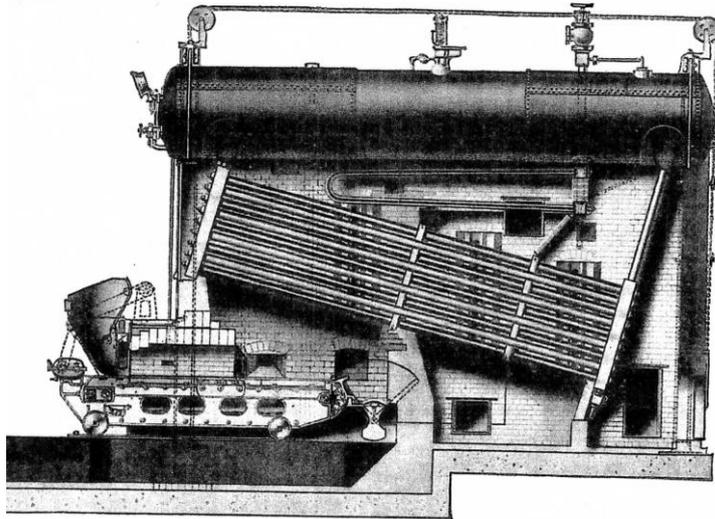


*Slide 10*

*The Willans & Robinson Steam Engine, with the Alternator and Pelton Wheel in the background.*



*Slide 11*  
*Willans & Robinson Steam Engine*



*Slide 12*  
*Drawing of a Babcock & Wilcox boiler, similar to the one installed at*  
*Pont Ceunant*

**The electricity produced was conveyed 1¼ miles to the mine by bare copper wires mounted on wooden poles.**

**The total cost of the project was £11,400 (in excess of £1.5 million in today's prices).**

**In spite of all the investment the mine failed to run at a profit, mining ceased in December 1902; the processing mill continued to process material on the surface until June 1903, when the company went into liquidation. The equipment from the mine and the generating station was sold for a fraction of its cost by auction in April 1904.**

**Now, to jump forward 100 years.**

**The Welsh Mines Preservation Trust (Trust), had been concerned for many years that this historic building had become what can only be described as a local dump for rubbish and “white goods”.**



*Slide 13*

*Pont Ceunant Generating Station before work commenced*



*Slide 14*

*Pont Ceunant before work commenced*

**In 2004, European Funding enabled Ceredigion County Council to establish their “Spirit of the Miners” project. Following discussions between the Trust and “Spirit of the Miners”, we were able to design a project to clear all the dumped material within the building, deter future dumping and give the local community a building to be proud of.**

**In June 2007, with funding from the Spirit of the Miners, the Environment Agency and the landowner Mr Henry Williams, volunteers from the Trust, Ceredigion County Council along with Mr Williams and his family cleared all the dumped refuse from within the building.**



*Slide 15*

*Ready to begin*



*Slide 16*  
*The clean up operation in progress*



*Slide 17*  
*Job done*

**In addition to clearing the interior of the building we wanted to discourage future dumping, with this in mind a decorative grille was designed and installed across the entrance to the building alongside the road, along with an interpretation board explaining the history of the building.**

**The theme of the grille was to illustrate the transition from water power to electrical power, which the building fulfilled.**



*Slide 18*



*Slide 19*



*Slide 20*  
*The Decorative Grille in place*





point by three lighting wires of the Hertz type. The aerial line consists of three bare copper wires of 4 millimetre diameter supported on porcelain insulators. Fig. 5 shows the points of the aerial line passing two



FIG. 7.—FRANCIS MIRA.—90 H.P. INCREASING MOTOR.

water wheels, which were formerly used to work the underground pump in the Vaughan shaft alone, which requires about 10 horse-power, and which is combined with the half-mile away from the wheels. A cut-off

is connected direct to the 2,000 volt transmission line. The rotor is of the squirrel-cage type, with an arrangement to insert resistance in the structure to facilitate the starting up. The E. M. F. of the rotor is only about 200 volts. When the motor is up to speed, which takes about ten seconds, the rotor is short-circuited by means of a lever and the brushes can be lifted off. For the lighting of the dressing floors, etc., a three-phase transformer of eight kilowatts capacity has been installed, which supplies 18 arc lamps and a number of

There is no difficulty whatever in regulating the power and speed exactly to the most steady and by means of a steam engine. Part of the distribution board is on the winding house, and is conveyed through a steel-encased three-phase high tension cable down the Edward shaft to the pump room, which is at the 50 fathom level. Here a number of 60 horse-power pumps is connected to and driven a three-throw pump by means of a flexible coupling.



FIG. 10.—FRANCIS MIRA.—PUMP ROOM AND WINDING HOUSE.

incandescent lamps, at a pressure of about 225 volts, from the dressing floor the overhead line comes in all round diameter of three millimetres to the Vaughan shaft (see Figs. 9 and 11). The incline railway shows in these pictures bringing in the ore from the pit-head to the dressing floor is also driven from the top of the dressing floor by the same two motors before described. Fig. 10 shows the pit-head and the winding house, while Figs. 11 and 12 illustrate the machinery in the

The motor illustrated in Fig. 13 works with a pressure of between 2,000 and 2,500 volts in a similar manner as those working at the dressing floor. The slipping arrangement can be clearly seen on the top of the motor (Fig. 13). A simple pull of this lever breaks the circuit of the indicator almost spontaneously, and the motor stops immediately. The field is switched off by means of a high tension switch on the board, which is also shown in Fig. 13.



FIG. 8.—FRANCIS MIRA.—TRANSMISSION LINE FOR DRESSING FLOORS.

example of engineering at this point is that the lower phase motor drives the heavy winding machine. The pressure for this purpose is reduced to 200 volts by means of a stationary transformer, which at the same

interior of the winding house. An 85 horse-power three-phase motor drives the heavy winding machine. The pressure for this purpose is reduced to 200 volts by means of a stationary transformer, which at the same

The lighting of the pump room, as well as the 60 incandescent lamps, which take current from a small single-phase transformer, is properly protected against rain and damp. It supplies



FIG. 11.—FRANCIS MIRA.—WINDING MACHINERY.



FIG. 9.—FRANCIS MIRA.—TRANSMISSION LINE.

and dressed. Two 50 horse-power induction motors supply the power, of which one only is shown in Fig. 7. These supply current for incandescent lamps for lighting about 140 volts. A similar transformer is placed on one of the posts of the aerial line opposite the office, and is properly protected against rain and damp. It supplies

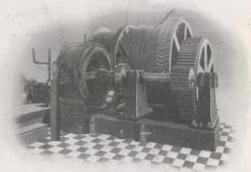


FIG. 12.—FRANCIS MIRA.—WINDING MACHINERY.

## Slide 22

**Simon Hughes from Talybont provided us with a copy of an article (in Italian) written by Bernardino Nogara the designer of the building, in 1901. This was translated by Trust Director Robert Ireland and provided much detail of the operation of the Generating Station.**

DESCRIZIONE  
dell'impianto idro-termo-elettrico  
DELLA  
MINIERA DI FRONGOCH

---

La miniera di Frongoch è ora proprietà della « *Société Anonyme des Mines de Frongoch* » (Società Belga), ed è situata nella Contea di Cardigan nel Paese di Galles.

La miniera venne scoperta circa 80 anni or sono e successivamente lavorata con profitto, dapprima per l'estrazione del minerale di piombo (galena), e in seguito per l'estrazione del minerale di zinco (blenda). Un totale di 80000 tonnellate di minerale mercantile vennero estratte, delle quali circa 40000 furono di galena e 40000 di blenda. La miniera venne estesamente lavorata fino alla profondità di 280 metri a mezzo di un pozzo principale; ma fu ripresa per l'estrazione della blenda circa 25 anni fa, ed i lavori di coltivazione per blenda non oltrepassarono la profondità di 140 metri.

Quando la nuova Società rilevò l'impresa, l'impianto consisteva in un vecchio sistema a base di ruote idrauliche successivamente installate l'una sotto lo scarico dell'altra, e può dirsi che ciascuna macchina aveva una ruota idraulica più o meno grande per il suo movimento. In questo modo alla miniera, con una portata di 200 litri d'acqua al secondo, si utilizzavano circa 120 cavalli di forza, applicati alla pompa, alle macchine d'estrazione e alle laverie.

Per potere utilmente lavorare la miniera era necessario ricorrere ad apparecchi moderni e ad un impianto considerevole, per poter mettersi in grado di utilizzare i minerali di basso tenore. L'impianto richiedeva una forza da 350 a 400 cavalli, e tale forza bisognava domandarla alle acque della regione, e non al carbone delle lontane miniere del Sud. Perciò si diede mano ad un completo rimaneaggiamento del regime preesistente delle acque, in vista di creare un salto, che, con una quantità media di 200 litri d'acqua

*No flat rods anywhere*



## CATALOGUE.

First Day's Sale.

MONDAY, APRIL 11th, 1904,

At 11 o'clock prompt,

At the Stores Building, near the Office, Frongoch Mine.

### Stores.

#### Lot

- 1 Tool Chest and quantity of empty Boxes
- 2 5 Acetylene and 5 Hurricane Lamps
- 3 Kitchen Grate and Sundries
- 4 Box containing sundry detonator and gelegnite tins
- 5 12 Large Wooden Explosive Boxes
- 6 12 Small ditto
- 7 Quantity of Old Sacks
- 8 Hemp Rope
- 9 450ft. 7/16in. Hemp Rope. 4cwt. 2qrs. at per cwt.
- 10 2 Casks Carbolineum, 87 gals. at per gal.
- 11 4 Coils Steel Wire Rope, 1/2in. diam., 8 cwt. at per cwt.
- 12 17 Miners' Mallets

### Slide 24

Simon also supplied a copy of the Sale Catalogue from April 1904, listing everything that the mine owned in 1002 lots; from a Cornish Beam Engine and a 50 foot x 4 foot overshot waterwheel to 5 galvanised buckets and 34 knives and forks from the canteen.

There were 73 lots from the Generating Station, including the Babcock & Wilcox boiler, the Willans & Robinson Steam Engine, the Pelton Wheel, the AEG Alternator, a 6 ton weighbridge, 62 creosoted poles fitted with lightning conductors, even a set of spanners 5/16 to 1 inch and two India Rubber Mats.

One interesting point is the note:

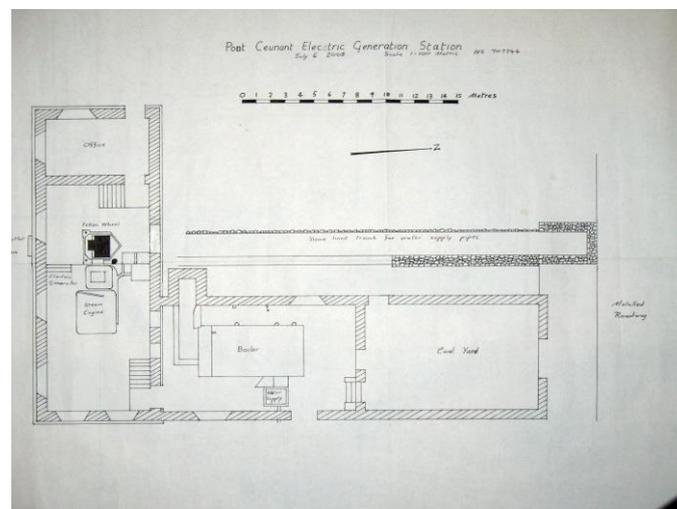
“Buyers of Lots 280 to 339 will be required to make good any damage done to the building before they remove lots from the ground”.

**This unfortunately never happened; the entire eastern wall was demolished to enable the machinery to be removed from the Generating Room and is now an increasing cause of concern to the long term stability of the rear of the building.**

**The sale lasted 5 days, unfortunately no details of the purchasers or prices paid have been found.**

**Our research highlighted the fact that we were unable to find a floor plan, showing the internal layout of the Generating Station. With the blessing of Mr Williams we decided to carry out an archaeological investigation, in an attempt to find the “footprints” of the various pieces of machinery installed within the building. This work commenced in 2008.**

**There are three “rooms” within the building; nearest the road is the Coal Store, the next room is the Boiler Room and at the rear of the building is the Generating Room, with offices above in the south western corner.**



*Slide 25*  
*Plan of the Generating Station*

**In April 2008 a weekend was organised to excavate the floor of the Generating Room, with the aim of locating what remained of the bases of the Pelton Wheel, Alternator and the Steam Engine.**



*Slide 26*

*Generating Room looking east, showing the demolished wall, that should have been repaired by the purchasers of the equipment.*



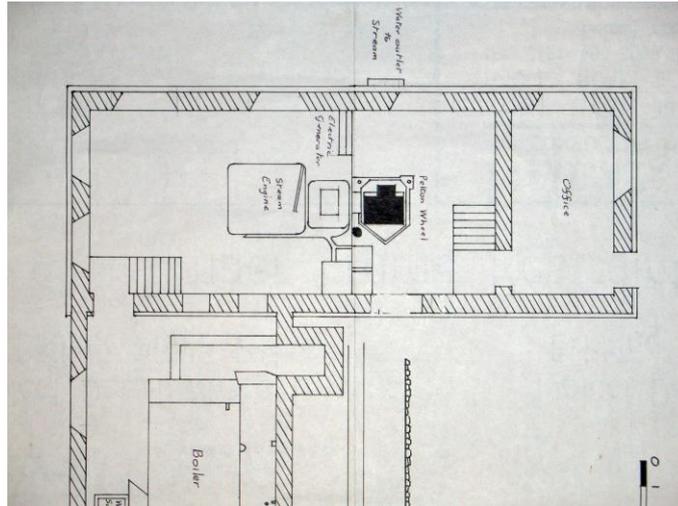
*Slide 27*

*Generating Room looking west, Pelton Wheel base in centre*



*Slide 28*

*Another view looking west, showing office accommodation above*



*Slide 29*  
*Generating Room Plan*



*Slide 30*

**The excavation commenced at the western end of the building, where a flight of steps, the base of the Pelton Wheel, and the water exit pipe were uncovered.**



*Slide 31*



*Slide 32*  
*Base of Pelton Wheel with water drain on the right*



*Slide 33*  
*Water drain on outside of building*

**Work then progressed across the building, the base of the AEG Alternator and the Willans & Robinson Steam Engine were revealed.**



*Slide 34*  
*Base of Steam Engine and Alternator are uncovered*



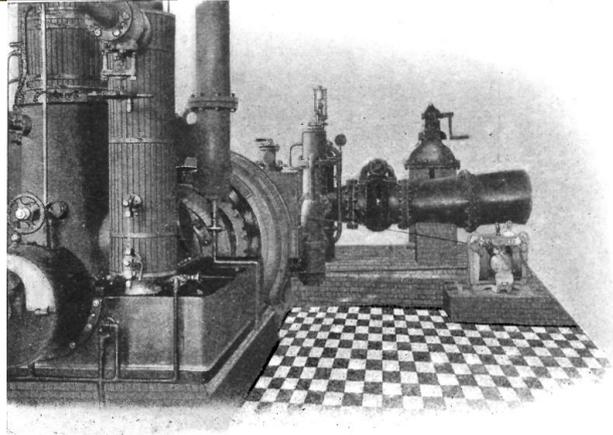
*Slide 35  
Base of the AEG Alternator*



*Slide 36  
Base of Willans & Robinson Steam Engine, with cable duct from Alternator on the left*



*Slide 37  
Excavation complete, looking west*



*Slide 38*  
*Steam Engine, Alternator and Pelton Wheel 2008 and 1901*



*Slide 39*  
*In situ cable*

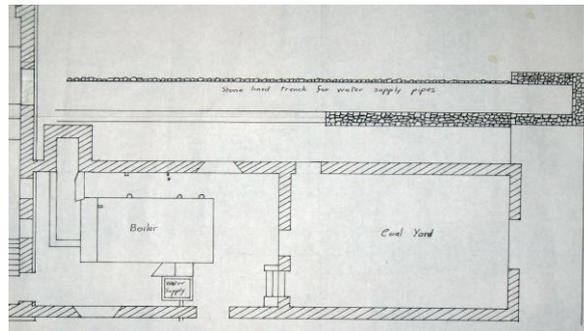


*Slide 40*  
*Tar insulation*



*Slide 41*  
*Completed excavation looking west*

**We returned in June 2008 to continue our investigations, on this occasion we concentrated our efforts in the Boiler Room, our aim being to expose the foundations of the Babcock & Wilcox Boiler.**



*Slide 42*



*Slide 43*  
*Work begins to expose the flue*



*Slide 44*  
*The flue looking south*



*Slide 45*  
*The flue, looking west*



*Slide 46*  
*Water tank and inlet*



*Slide 47*  
*Excavation complete*

**We exposed the Flue, Boiler Surround which had a sand bed in the middle and the water tank. Also discovered was one of the fire bricks from the boiler.**



*Slide 48  
Firebrick*

**Careful measurements were taken and drawings are being prepared. We plan to return this spring to excavate the coal storeroom, when this is completed we will be publishing a booklet on our work and research.**



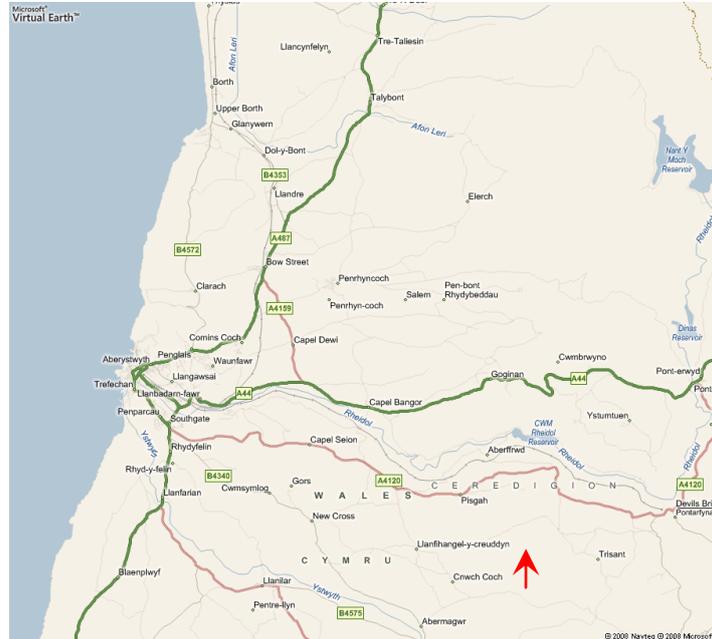
*Slide 49  
Our Surveyor Nigel Chapman*

**This winter with financial help from Spirit of the Miners we published a leaflet about the Generating Station. These will be distributed locally and to the various organisations concerned with Industrial Archaeology. I have some copies with me today if any one would like one.**

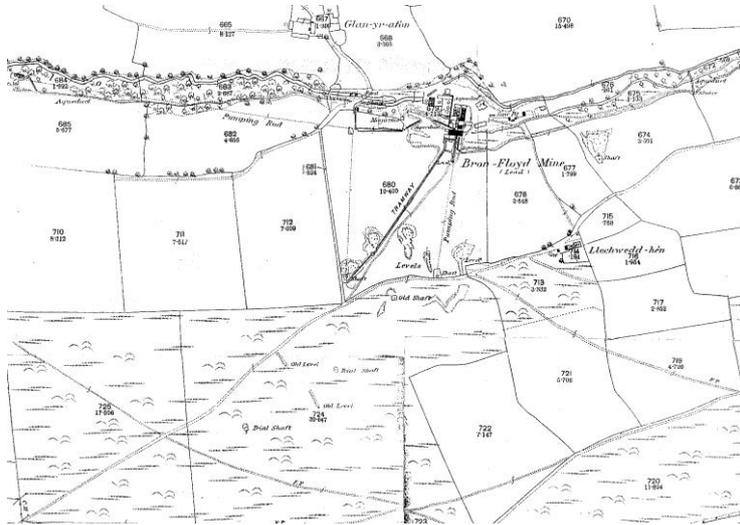
**The Trust thanks the Spirit of the Miners project, the Environment Agency and Mr & Mrs Williams for the help and support with this project.**

## BRONFLOYD MINE

**Bronfloyd (Bryn Llwyd) Mine is situated to the east of the village of Penrhyncoch**



*Slide 50*



*Slide 51*  
*Extract from 1<sup>st</sup> Edition OS Map*

**For the last three years we have been carrying out vegetation clearance and survey work at the mine. This year we will be applying for Scheduled Monument Consent to undertake Archaeological Excavations at the mine. In the longer term the Trust plans to carry out restoration work at the mine.**

**The mine has one of the best collections of Industrial Remains in Mid Wales.**

**There are 2 adits, 3 Shafts, 6 Waterwheel Pits 2 of which have the Waterwheel axles in situ, the remains of an unusual double Crusher House, the Mine Office, Blacksmith's Shop, Carpenter's Shop with Sawpit, an Incline as well as several tram wagon bodies scattered around the site. In addition there are 17<sup>th</sup> Century workings higher up the hillside.**



*Slide 52*

**The history of the mine begins in the early 17<sup>th</sup> Century when it was worked by Sir Hugh Myddleton and Thomas Bushell.**

**In the early 18<sup>th</sup> Century the mine was held by William Waller and The Company of Mine Adventurers, their lease being surrendered in 1744. In 1756 the mine was under the control of Lewis Morris, following his tenure the mine laid idle for many years until revived by Matthew Francis in 1850.**

**In 1852 the mine was not meeting its costs, arrears totalled £536.**

**John Barton Balcombe became Manager and Secretary in 1854, J B Balcombe was involved with several mines in the area including Blaen Caelan and Llywernog – the site of today's Mining Museum.**

**Balcombe also built the Queen's Hotel on the seafront in Aberystwyth in 1866, this is now the home of the Ceredigion Archive and other Council Offices.**



*Slide 53*  
*Queen's Hotel*

**You will notice the decorative yellow bricks much favoured by Balcombe, these are also to be found on buildings at the mines he was involved with.**

**Balcombe's management of the mine during the 1850's and 1860's, was very successful, the mine paying a 30% dividend to shareholders in 1869. The mine was one of the most profitable in Wales at the time. With a drop in ore prices the mine entered a downward spiral finally closing in 1892 after producing over 6,000 tons of lead ore.**

**Balcombe totally reorganised the ore dressing processes and most of the remains visible at the mine today date from this period.**

**I will now give you a photographic tour of the mine, along with some examples of our work there**

**We begin at the top of the mine, before descending the incline into the valley.**



*Slide 54  
The 17<sup>th</sup> Century Working's now unfortunately used as a rubbish dump.*



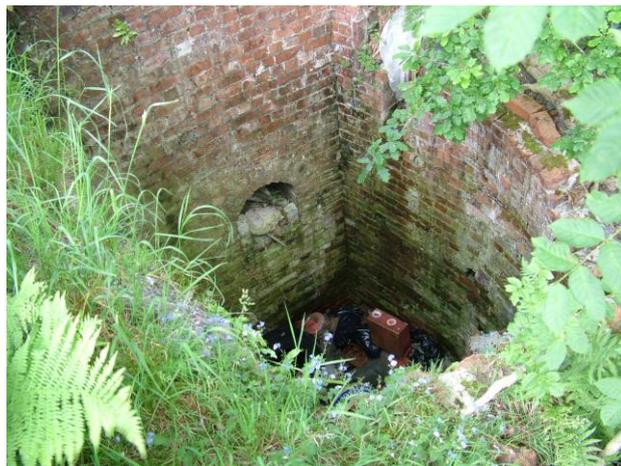
*Slide 55  
A collapsed adit*



*Slide 56*  
*No 2 Shaft*



*Slide 57*  
*No 2 Shaft*



*Slide 58*  
*No 2 Shaft*



*Slide 59  
No 3 Shaft*



*Slide 60  
No 3 Shaft*



*Slide 61  
No 3 Shaft, remains of headframe*



*Slide 62  
The incline*



*Slide 63  
Bottom half of the incline, the processing area is in the valley floor beyond the trees*



*Slide 64  
Tram wagon bodies at the foot of the incline*



*Slide 65*



*Slide 66*



*Slide 67*  
*Entrance to Balcombe's Level of 1859, now unfortunately collapsed just inside the entrance.*



*Slide 68*  
*One of the two semi-circular ore bins, before clearance*



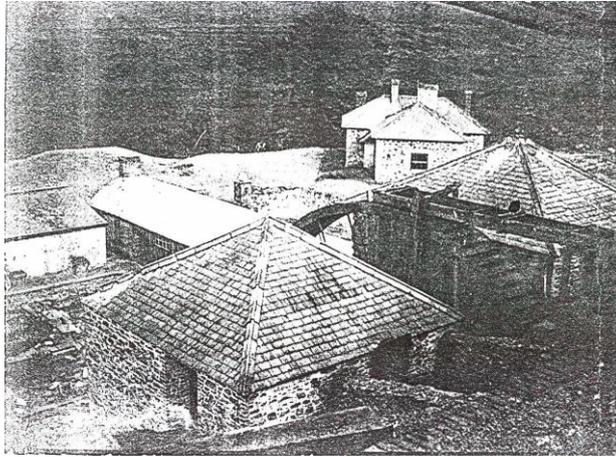
*Slide 69*  
*After*



*Slide 70*  
*Other side of ore chutes*



*Slide 71  
Ore Dressing Area*



*Slide 72  
Taken in 1932*



*Slide 73  
Remains of the 20 foot waterwheel that pumped No 2 Shaft via a line of flat-rods*



*Slide 74  
The 20 foot wheelpit after clearance*



*Slide 75  
The axle of the 20 foot wheel, note tram wagon body in the bottom of the pit.*



*Slide 76  
Close-up of the axle*



*Slide 77  
The ruins of the Mine Office*



*Slide 78  
Wall of Office Building showing Mr Balcombe's favoured yellow bricks*



*Slide 79  
One of the yellow bricks made by Browne & Co, Bridgewater*



*Slide 80*  
*The 40 foot wheelpit, viewed from above, with the remains of a crusher house each side.*



*Slide 81*  
*The 40 foot wheel pit before clearing*



*Slide 82*  
*After*



*Slide 83*

*The wheelpit contained a 40 foot iron waterwheel as opposed to the normal wooden variety. This wheel was purchased from the Oola Mine, in Co Limerick, Ireland.*



*Slide 84*

*Some of the iron spokes from the wheel*



*Slide 85*

*28 foot wheelpit, with axle in situ, this is the wheel that wound No 3 Shaft.*



*Slide 86*  
*Another view with pit for cable drum alongside*



*Slide 87*  
*The lower side of the wheelpit*



*Slide 88*  
*Flat rod wheel and rollers in the bottom of the wheelpit*



*Slide 89*  
*The axle viewed from below*



*Slide 90*  
*The route of the flat-rods from the wheel to No 3 Shaft on the skyline*



*Slide 91*  
*A length of flat-rod, near the wheelpit*

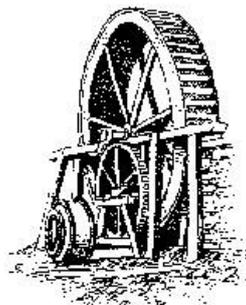


*Slide 92*  
*Following clearance*



*Slide 93*

**The End**



**Welsh Mines Preservation Trust**