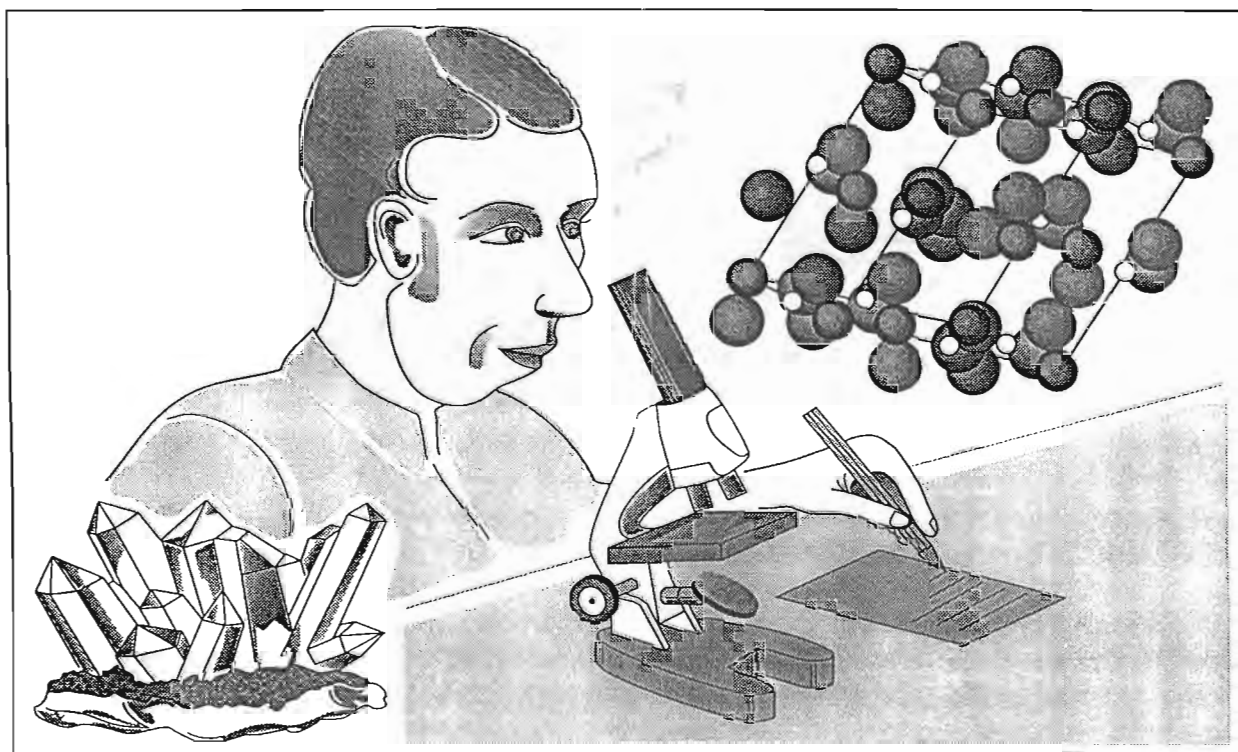


JOURNAL OF THE GREAT ORME EXPLORATION SOCIETY



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Front Cover: William Vivian at work with his microscope, drawn by Alison Walton from a contemporary photograph provided by John Vivian.

NEWS ROUNDUP

BEACH SLAG: Erika reports that copper slags have been found on the levels near Rhymney in South Wales which a local archaeologist says are Roman. In what context they were found and upon what his opinion is based is not known but I shall endeavour to find out. They appear similar in many ways to some of those found on the Llandudno beach. In the meantime the Society has conducted a dig on the North Shore with the aid of a JCB. The depth of the slag deposits was not as deep as anticipated and I understand CADW will be conducting a similar excavation in the spring when the tides allow. I hope to carry a report of the GOES dig in the next edition of the Journal. As yet I have heard nothing from Dr Salter at Oxford University.

MARINE ARCHAEOLOGY COURSE: The Department of Marine Archaeology at UCNW, Bangor, has just completed its first extra-mural course of six lectures in Marine Archaeology. With the interest the Society is taking in local Marine Archaeology investigating beach slags I was very pleased that 20% of the audience were from GOES or associated in some way with us. I understand they plan to run the course again next year and hope a short contribution from one of the participants might appear in the next issue of the Journal.

WILLIAM VIVIAN: As suspected, but never proved until now, Captain William Vivian lived at Ty Glas, now the site of the Bodlondeb Castle Hotel. I traced the birth certificate of William's son Stephen who was born at Ty Glas where I presume his brother and sister were also born. I think I have exhausted every avenue of enquiry in my search and now must prepare a paper for the Memoirs of the Northern Mines Research Society. Draft one is published in this Journal; your critique is invited.

THE AFTERMATH OF THE LLANDUDNO FLOOD, 11 JUNE 1993

TY GWYN MINE: (F + 10) A large volume of water has run down both of the Tyn y Ffron faults into the mine. These clay choked faults has run-in damming the chamber between them. Water running in through the faults has flooded the chamber and overflowed into the adit before causing the breached clay plug to collapse. Water continues to drain through the clay dam and eventually down the fissure beneath the ventilation shaft. The coffin level has been flooded by surface water running into the back of the Golden Goose but no evidence is obvious at the surface. A slope of 'porridge' now runs up towards the end of the adit. The lower level was completely flooded and inaccessible and the Ty Gwyn shaft flooded over the top of the pump rod.

TY GWYN BEACH ADIT: (F + 10) Soil from the steep vegetated bank above the adit portal was carried away taking grass and bushes with it in to the portal. To the north a larger landslip carried hundreds of tons of soil and sod onto the beach 20 metres away from the portal. No damage occurred within the adit though there remains a great deal of work to be done, including some engineering, to complete this project.

PENMORFA LEVEL: (F) After the downpour little water was seen in the adit until about 1.5 to 2 hours later. The portal was completely submerged and water was seen to be boiling as it made its exit. The ditch was filled and set to overflow the confines of the wall, threatening not only the wall but also the road as well, when the Fire Brigade brought in two 24" suction pumps to assist the under-road drains. This volume of water, if denied exit from the mine, would have posed a serious threat to the Penmorfa area if it had blown, not to mention threats to the workings in the Vivian's shaft area which might contain archaeological material. (F + 11) As expected, the roof-sag approximately 30 metres in from the portal has fallen a few inches and the glass telltales have broken. Further down the adit, in the right hand (north) wall, a large ginging block has been turned across the adit by the flow of water though it continues to bear weight. The mudslide has largely been washed clear of the grey-black glutinous mud familiar to many of us, leaving displaced ginging in the floor. Beyond the mudslide the adit was flooded to the roof and largely filled with a muddy porridge washed down from the mine.

TOM AND JERRY (F + 11) The course of the Tom and Jerry engine has changed considerably at Ffynnon Gogarth. The water running down this section of the hillside was concentrated down the water course flowing out from Ffynnon Gogarth and, like flash floods anywhere, it cut out a deep wadi removing overburden to a depth of up four feet, exposing masses of tufa. Walking up the wadi from below the concrete box I came across two wooden beams, one laid across my track and the other one at 90 degree to it.

When I revisited the site a few weeks later with Tom Parry I was able to establish, by use of transits, that the beam lay exactly along the course of the Tom and Jerry engine, 23.2 metres uphill from a temporary bench mark (TBM), established earlier this year by Steve Lea and myself, and 22.6 metres below the next Brammock Rod pit. A TBM was placed one metre to one side of the beam.

Closer inspection revealed that a pedestal bearing had not been used here as in the pit excavated at Pyllau, but an iron stub axle, mounted on the beam end, retained within a tenon by a saddle-strap of iron. The walls of the wadi contained limestone rubble above and below this find but to one side there were the remains of a good ginging wall. Only half of the axle was exposed, the other half being still buried in limestone rubble. A careful excavation later in the year will, I hope, expose the remainder of the ginging, the axle a complete bearing and, perhaps, some remains of the pendulum. What might this mean? From what period does this find date, the early or late phase? Does this help or hinder us in the search for the early bucket-engine site? All these questions and many more have yet to be addressed.

ROMAN AND TREWEEK'S SHAFTS: No significant changes have been seen here.

FFYNNON GALCHOG: The slopes below this washing site have been effectively hushed and the top soil of many hundreds of years stripped away to expose datable tufa, copper traces and charcoal.

BRYNIAU POETHION: Water flooding down the old shafts and trenches has

washed away the finer material within the infill and caused settlement. One of these depressions has been excavated by JCB (GOM Ltd, Tom Parry) to reveal a labyrinth of what appears to be late tunnels radiating out from the shaft at a depth of about 20 feet. Some 19th century tools were found and left in situ. On the brief inspection no suggestion of firesetting was observed nor any sign of bone or stone tools. The excavation was immediately filled and levelled with surface.

These workings may represent 19th century activity alone, 'Welsh California', equally they may be reworkings from an earlier period (GOM Ltd). If the latter, what age are ridges and furrows covering Bryniau Poethion; these must at least predate the modern phase of 19th century mining activity. Might they predate an earlier phase too? All this has yet to be proven, but if you have any thoughts you know to whom to write, the Editor.

LLECH: The route to Llech, already exposed for many years and not a route for the faint-hearted, has finally been destroyed by the elements. Access may still be possible from above using SRT at half-tide or less, or by boat landing on the slabs below the lighthouse.

OWEN'S SHAFT: The lower levels of this shaft are normally flooded during wet winter conditions; inspection has been postponed until early summer.

TYN Y FFRON SHAFT, GOGARTH ADIT, FFYNNON GOGARTH LEVEL: To date these features have not been entered since the flood.

ARCHAEOLOGY IN WALES 1992;32 In response to Chris Briggs paper in last years volume, P Budd et al, in 'Early Mines in Wales; a reconsideration' (p36-38) appear to be in academic conflict with CB who seems unconvinced with the evidence of prehistoric mining. Watch this space for more fur and feathers next year! Seriously, this review is worth reading and gives a good overview of the current state of affairs.

Our Ty Gwyn Lauriet, Geoff David, has an abstract (p58) detailing his work underground which appeared in J GOES last year. He also provides additional data on the bronze fragments he found during the course of this dig. This is followed by two brief abstracts by Peter Muckle (pp 58 & 88, GAT) regarding the activities of Gwynedd Archaeological Trust in the last year.

CURRENT ARCHAEOLOGY 1993;134 Of interest to the beach slag researchers within the Society will be the letter (p 79) by Professor Keith Brannigan and Martin Dearne from Sheffield University who have a particular interest in Roman-British coal and requested information regarding such activities. What information they have of the Anglesey coal deposits I didn't know, so I wrote to them to find out. Dr Dearne replied very promptly indeed but he, like us, knew very little about this aspect of Anglesey's industrial past. However, he sounded interested and did give me a couple of references which I hope to pursue shortly.

John Musty's Science Diary (p 71) reports a paper by P Budd et al in Antiquity

(1992;66:677-?), again dealing with Bronze Age smelting technique, the authors suggesting the use of bonfire smelts near the mining site. This might add weight on the finds made by Bannerman et al. I shall report in detail when I have seen the original paper.

A contribution from Tony Salt, with his apologies to Omar Khayyam.

The moving digger digs, and having dug, moves on:
Nor all thy digging skills nor kit,
Shall lure it back again by even half a scrape,
Nor all thy matrices interpret it.

PLYMOUTH MINERAL AND MINING CLUB JOURNAL 1993;23(1) An article by Chris Stone on aerial ropeways is of interest and draws heavily on ropeway systems operating in the mountains of Snowdonia and Mid-Wales. He refers to two previous papers by Peter Roberts of the Society (JPMMC 17(3) and 18(2)) which I will trace and report to you in a later edition.

PDMHS Reports the successful prosecution by the Forestry Commission of Steve Boydon in the Llanrwst Magistrate Court for trespass into the Rhiw Bach Mine near Cwm Penmachno. I am sure that many before and since have entered a 'Forestry Commission Mine' and slipped away undetected. Boydon's luck ran out when rescue services were called in to extricate and casevac an injured member of his party. The explicit messages are the willingness of the Commission to prosecute and that lack of notice and warnings will not be accepted as a defence. The implicit message is the continued relevance of the 11th commandment, 'Thou shalt not get caught'. You have been warned.

NMRS Their latest newsletter reports the Shropshire County Council awarding the contract for the phase one environmental clearance of the Snailbeach Mine site to Kilmain Construction. The work will include filling old workings, shaft capping, installation of safety grills and venting with access for bats.

TREVITHICK SOCIETY Having had a letter published about Captain J/T Trevithick (Llandudno) in the last Newsletter I was hoping to see a reply, perhaps with some more information upon which I could work. Unfortunately there has been no such response, at least not yet, nor from the Cornwall Family History Society.

COURSE IN INDUSTRIAL ARCHAEOLOGY

There will be a course on Industrial Archaeology (WEA(N)) in Llandudno this winter, starting January 11 1994. There will be 10 meetings at the Craig y Don Community Centre; course fee £17.50. For more details contact Dr Lloyd-Jenkins.

RHUALLT MINE SITE

The remains of the Barytes/Witherite mines at Rhualt have been under threat of reclamation but the Welsh Mines Preservation Trust are taking steps to preserve this site. It seems support from the Clwyd-Powys Archaeological Trust and grants from the Welsh Development Trust may be available to help them in this task.

GWYNFYNYDD

Gwynfynydd Gold Mine has reopened and is working gold from the Chidlow lode. Like Cloggau, they appear to be using their product to produce jewellery etc. Tourist trips are available April to October, punters being bussed up from the town (Deja Vu!).

BRONZE AGE COPPER SMELTING IN NORTH WALES

Journal of the Trevithick Society 1993;20:55-57

It is well established that during the early-middle Bronze Age copper was being mined in North Wales at the Great Orme, Llandudno, and Parys Mountain, Anglesey, and in mid-Wales at Cwmystwyth¹. Of these sites, the Great Orme has the most extensive system of Bronze Age copper workings yet known and although most of the data and hypotheses presented here relate to the Great Orme much is also applicable to the other sites.

At the Great Orme, the C¹⁴ dates available indicate mining activity extending over 1000 years; the opencast trenches, inclines and deep early galleries also suggest the volume of copper ore extracted during this period could be measured in thousands of tons². During the 19th century, copper ore from this mine averaged about 10% copper³ and it is probable that during the Bronze Age the copper yield was at least this high. Therefore, the copper harvest from 50,000 tons of ore might be as high as 5,000 tons, a considerable quantity which should leave hearths and many thousands of tons of slag or residue.

In the absence of primary slag and smelting hearths related to these Welsh sites, or of smelting sites remote from these mining fields, it had been proposed that the copper ores extracted during the Bronze Age were predominantly, or perhaps exclusively, the carbonate ores, malachite and azurite, which might be smelted quite easily in a non-slagging process¹.

The native rock of the Great Orme is carboniferous limestone bearing only small deposits of the silicate chert. Today no unworked ore bodies exist between surface and adit level. Ore body remnants demonstrate that the dominant ore at depth is chalcopyrite though malachite can be found; close to the surface, strings of chalcopyrite exist and there are traces malachite as well as malachite staining. Quite how large the unworked malachite and chalcopyrite bodies were is not known, nor their proportions. Since they are both found close to the surface, where early workings abound, it is probable that chalcopyrite would have been extracted with the carbonates, and if smelted would have required the addition of silica, in a slagging process, to chelate iron from the pyrite.

The Great Orme is almost an island, joined to the Cambrian landmass by the broad low lying spit, Morfa Rhiannon, which during the last century was described as a wild place, a rabbit warren of sand dune and marsh⁴. Old Llandudno, with its steep

narrow streets, hugs the lower slopes of the Great Orme, and only after 1850 was Morfa Rhiannon reclaimed and defended from the sea to build modern Llandudno. Thus isolated, and sharply defined by steep slopes and cliffs, the land available for forestry and coppicing, to provide fuel to be charcoaled and used domestically, for firesetting and smelting, would be limited and very likely insufficient to provide fuel over the prolonged period the mines appear to have been active during the Bronze Age.

Having run short of locally produced fuel this would have to be obtained elsewhere in the district and transported to the smelting site, or sites. In view of the geography transport by boat seems likely. However, considering the difference in density (and volume) between charcoal and copper ore it would make sense to move the copper ore to sites of charcoal production, where there was also running water for washing ore and matt as well as draught for the smelt². Return passages might have brought in charcoal for firesetting and domestic use.

With this in mind, local beaches were examined, the first being at Port Penrhyn, Bangor (Gwynedd), from where slate was exported widely during the 19th century. Beneath the footings of a demolished quay, built in 1790, were found large quantities of copper slag. Spectrographic analysis demonstrated 1-2% residual copper and suggested it was produced from a pyrite copper ore². The most recent date for this specimen must be late 18th century, perhaps imported from the Charles Roe's smelting works in Liverpool which became the Herculaneum Pottery run by Samuel Worthington who was also involved in the Penrhyn slate business⁵. However, it may predate this enterprise by hundreds of years. Within a few weeks copper slags were discovered on beaches at Dulas (Anglesey), Llandudno's north and west shores (Gwynedd) and Llanddulas (Clwyd).

At Llandudno the deposit on the north shore is 100 m broad and extends over 1Km along the beach but is only fully exposed on spring tides; its vertical distribution is as yet not known. At one time this part of the beach was dry, or at least usable, land on which can still be found numerous tree trunks. Roman coins and a palstave were also found here in recent years⁶. Gwynedd Archaeological Trust are due to examine the site at the next suitable spring low water and will, hopefully, recommend investigation. The slags are black vitreous material containing paler islands of 'free silica', a non-specific feature which may be found in slags from antiquity onwards⁷; they bear malachite and azurite stains. Slag specimens are being investigated at present at the Smithsonian Institute in Washington DC. Initial results from spectrographic analysis confirm the presence of copper and data from quantitative analysis is awaited which may give us a clue to its age and how it was smelted.

While it is hoped that these slags, found so close to such a large Bronze Age mine, will prove to be ancient it must also be considered they might be modern ballast, jettisoned as boats arrived to load copper ore for Liverpool, Parys Mountain, and Swansea. However, given the nature of the material, very hard, durable and sharp, I would not wish to beach a wooden sailing vessel upon it, particularly as beaching was the only option available on this shore to masters of the period⁸. Whatever

their age, 19th century, medieval, Roman or Bronze Age, when dated, these slags will at least be useful reference material in the study of ancient copper smelting⁹.

Indications of early smelting, having been absent for so long, seem to be coming to light. Although unconfirmed at this stage, these discoveries have stimulated debate and examination of earlier assumptions. Cornwall is also the site of ancient mineral exploitation and of course a source of both tin and copper. If copper smelting and bronze alloying took place in Cornwall during the Bronze Age then slag might be lying unrecognised, perhaps in similar circumstances to those in North Wales. We in North Wales would be most interested in debating this area of common interest, directly or perhaps through letters to the editor.

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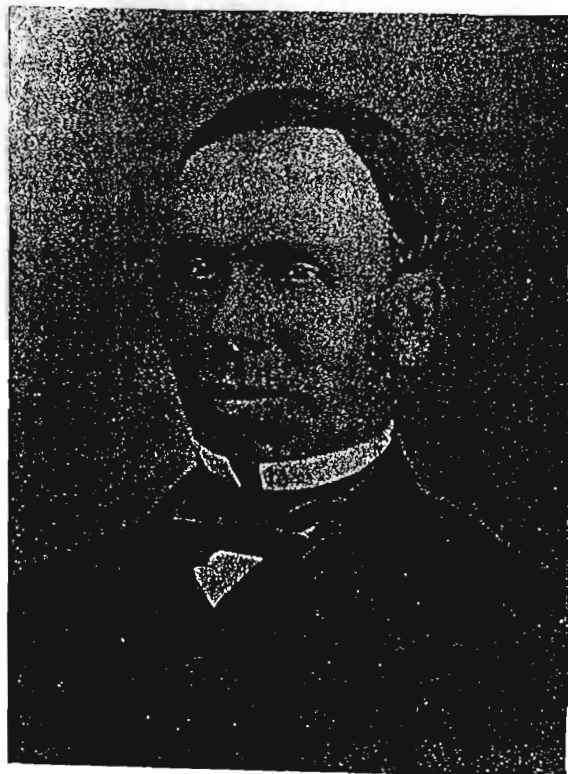
Don Smith, Plymouth, March 1993

THE LIFE AND ESSAYS OF WILLIAM VIVIAN,
CORNISH MINING ENGINEER, 1817-1879.

During the 19th century, when mining was still profitable, men with mining knowledge and skill came to work in and run the copper mines of the Great Orme. Among these men were William Kendrick and his son Thomas, miners; Joseph Tamblin, engine-man; Jonathan Rawlings, George Davey and J Trevithick, mine captains (RCPS; Old Mine reports UCNW; Williams CJ, 1979; Smith D, 1989). But the man who stood head-and-shoulders above the crowd was William Vivian, Captain of the Old Mine from 1853 to 1860.

He was born on June 2nd, 1817, at Bissoe Bridge in the Parish of Kea, Cornwall, to William Vivian (b1789 Redruth d1843 Redruth) and his wife Jane (nee Toy, b1789 Helston d1864 Redruth) (Bibliotheca Cornubiensis, 1878). It is not known if he had any brothers but bearing his father's name it is likely he was the eldest son; a sister, Elizabeth Jane, was born in 1830 in Redruth, Cornwall (Glamorgan Census 1871). Nothing is known of his childhood, his education or his early employment and although he is described as a mining engineer in 1851 it is not known where he was working or for whom. Within the family there is sustained by verbal tradition the belief that William may have worked on the Plymouth breakwater early in his career (Vivian J, 1992), however, I have been unable to confirm this.

His first paper published in 1852 perhaps indicates his mining engineering credentials were established abroad. In this short essay, published in the Transactions of the Royal Cornwall Geological Society (TRCGS 1852;7;216-219), he describes the Californian Gold Field around Sonora; it is clear from the content that he had visited and worked in California, perhaps with other Vivian's (family?) known to have been in California. To have secured a post as mine captain from the Taylors suggests they knew of William's worth from previous experience. He arrived in Llandudno in 1853 at the age of 36 to manage the Old Mine, Great Orme's Head, Llandudno (Llandudno Mine reports, UCNW MSS) and it's there the story begins.



Captain William Vivian

THE OLD MINE, LLANDUDNO

The Great Orme is formed of carboniferous limestone laid down in three major units which are heavily dolomitised, particularly around the numerous mineralised faults running north-south across the headland. Copper ores predominate (malachite and chalcopyrite) though small quantities of lead were produced in the 19th century. There are in addition small quantities of manganese and cobalt as well as native copper. Exploitation of its mineral wealth began in the Bronze Age and manuscripts record mining recommencing circa 1792. The Romans may have mined the Great Orme but no trace has yet been found to prove it conclusively.

After a long period of prosperity under the management of Samuel Worthington and sons, the Old Mine had been sold to John Hughes in 1846 who, as the Bishop of Bangor's agent, had previously managed the Royalty account for the mine. The 1846 sale inventory lists the plant and facilities available and was accompanied by a glowing and very optimistic mine report, prepared by Captain Francis (NLW MSS B/EP/185).

The subsequent lack of success of the Old Mine owes as much to Francis' puffed 1846 report as to John Hughes' lack of aptitude and perhaps failing ore reserves. Following his death in 1850 the mine was run by his executors who allowed the tributers to prospect and mine without direction, deads were dumped at convenience, ventilation suffered and maintenance was ignored. It was against this background that John Taylor and sons took over the mine in 1853.

In his first report to the Company William Vivian wrote, "I beg to remind you that we have found the mine entirely out of order; it was practically an abandoned mine; and there was not ore enough in sight in any place in the mine to pay for working; and every thing was so much out of order as to require considerable labour and expense before we were able to make any trails on the mine for ore."

However, before he could make much impression on the rundown state of the mine the Taylors forced new working conditions upon the miners. No longer would a six hour shift be acceptable, an eight hour shift was insisted upon. Having small holdings and other jobs to run, the men walked out and were to stay out for a year. The Taylors' report of 1853 stated the eight hour shift was standard in all their mines, and worked agreeably by all their miners, but it made no mention of the successful strike at Talargoch over the same issue and of course the strikes at Mold.

When the strike ended and the men came back to work the eight hour shift William set about putting the mine back in order. Hafnant shaft had been crushed and required new support work, ventilation was attended to, many hundreds of kibbles of rubble were hauled to surface to clear the access and new strings of ore developed. Again the mine was worked on tribute, but this time supervised.

This period of mine restoration without doubt stimulated William to write his next essay which would be an interesting insight to the condition and operation of the

Old Mine at the time. Unfortunately this essay, submitted for the annual exhibition of the Royal Polytechnic Society of Cornwall, was not reproduced in their annual report and there appears to be no surviving copy in the Society or other archives. Entitled 'Essay on the more perfect opening and ventilation of mines (RCPS 1855;xviii) it was submitted in competition for the Polytechnic Society's 1855 Exhibition for which he won a handsome premium of £5. (William was a subscriber to the Society from 1855 to 1862 (RCPS 1855-1862)).

In 1862, writing in the Mining and Smelting Magazine, William appears to reiterate some of his philosophies relating to mine ventilation which include a generous size for all levels which seems to be born out by the dimensions of the Penmorfa level. Extended towards Treweek's Shaft and Porth yr Helig on William's orders, it expands from adequate proportions to a lofty and spacious passage but failed to reach Treweek's Shaft or Porth yr Helig on the cliffs as intended.

The economy of Llandudno in the mid 1850s was changing. No longer was it an isolated hamlet, hugging the lower slopes of the Great Orme, depending on the mines, fishing and small holdings for its survival. The town plans of modern Llandudno had been drawn up some years before and the town was growing fast, hotels were being built, the railway had arrived at Llandudno Junction and would arrive soon in the town. There were now other, more certain, ways to earn a living, a state of affairs which William reflects in his 1857 mine report when, referring to the miners, he wrote, "There is not any spirit of adventure in the men now they can earn certain wages on day work though I believe many of the abandoned pitches would pay quite as good wages on an average as the wages given in town."

It had been assumed that Vivian's shaft was named after William, to mark his contribution to the success of the Old Mine. However, the first manuscript reference to the shaft by that name, rather than the Welsh 'Shafft Copr Ddu' (black copper shaft), is in the 1846 sale inventory which predates William's arrival by seven years (NLW MSS, B/EP/186). The naming of Vivian's shaft remains obscure though it seems likely it recognises the Swansea Vivians who had interests at Parys Mountain as well as previous employees such as James Treweek (Faraday) after whom another of the Great Orme shafts is named.

While in Llandudno William wrote a second paper on the Californian gold field, a paper on North Wales slate and two abstracts on native copper found in a zone of secondary enrichment within the Great Orme. It was clear at this stage he was applying the microscope to his study of mineralogy, an interest he was to pursue throughout his career and write upon in the future.

In the closing years of the decade the fortunes of the Old Mine ran low, ore reserves ran low and luck ran against them. The accountant, Joshua Williams, worked on unpaid and William relinquished 25% of his salary and reduced his Royal Cornwall Polytechnic Society subscription from £1 10/- to 10/-; it was time to move on.

The summit of the Great Orme provides an outstanding vantage point to view the coast to the east towards Liverpool, the Isle of Man to the north, the Menai Straights and Anglesey to the west and Snowdonia to the south. It was to the west, to Parys Mountain, well within view, that the Taylors moved and with them they brought William Vivian, as manager, and Captain J Trevithick (UCNW MSS 31660, f31659; RCPS).

THE PARYS MINE COMPANY

The host rock at Parys mountain is igneous felsite intruding into Palaeozoic sediments, bearing massive deposits of low grade pyrite which were worked by shafts and levels initially and later opencast. Like the Great Orme, it has been mined since the Bronze Age and certainly during the Roman occupation. From a comparatively early time in modern mining history its mineral deposits were known and it was prospected by the Mines Royal Society. Under the direction of Thomas Williams it dominated the copper industries of Britain and the world before its output failed.

That Llandudno ore was taken to Parys Mountain for use as a flux when smelting the Anglesey ores is well known. Although James Treweek had died just before William's arrival in Llandudno, cargoes of copper ore continued to be sent to Amlwch from Llandudno and may have been accompanied by William who seems, from his publications, to have been familiar with their smelting operations.

At the time William moved to Parys Mountain the fortunes of the mine were not good. The Parys Mines Company was set up with 200 shares each at £50 providing a working capital of £10,000; William bought one share which he retained until the company was wound up (UCNW MSS, 31660, f31659) in 1870. There followed a period of expansion and investment, building of housing, engine houses, mills after which the mines sustained a profit, paying its adventurers a regular dividend. William was a regular attender at their board meetings in London and although the minute book of the company survives none of William's mining reports have.

He and his family lived at Carreg Gwnach (OPCS) but in August 1862, within two years' of their arrival, his wife Jane died at the age of 41 of heart disease, perhaps rheumatic heart disease. His sister Elizabeth Jane Whitto, whose husband was working abroad in California, came to live with him and look after the children aided by a Cornish servant he retained. During his stay at Parys Mountain William wrote papers on mining practice, silica, and corresponded in journals. His work on mineral microscopy was presented by Henry Hussey Vivian (Lord Swansea) at the British Association meeting in Manchester, and although credited to Henry Hussey in the British Association papers, the Bibliotheca Cornubiensis attributes the work to William. Shortly afterwards William moved to take up the position of Agent at the Mwyndy mines, Llantrissant, commencing work there on August 1, 1863.

THE MWYNDY IRON ORE COMPANY

Once again the native rock is carboniferous limestone overlaid by shales, dolomitic conglomerates and grits. Iron ores deposited between the limestone and higher strata also penetrated deeper into the limestone body along joints and fissures. At Llantrissant, situated near the western pole of the iron ore deposits stretching east-west across Glamorganshire, the carboniferous limestone outcrops allowing access to the iron deposits (haematite conglomerates) laying along the foot wall. Like Llandudno and Parys Mountain there is evidence to suggest that the mineral wealth of Llantrissant was exploited comparatively early, perhaps as early as the Roman occupation and Iron Age (Hunt R, 1868, Vivian S, 1884, Vivian S, 1887, Atkinson M & Boyns T, 1981).

Once again William appears to have been working for the Taylors who may have been managing the mine at some stage. The mine, having started as an open cast, became compromised by the hanging wall requiring the sinking of shafts and levels. This was followed by the installation of an new and unusual 45" Bull engine, built by John Hocking and son in Redruth, which operated on a 45° angle, in the 45° inclined shaft, to pump the mine (Taylor's Diagonal Engine, Barton DB, 1969). During the period 1857 to 1891, Mwyndy Mine dominated the iron ore production in Glamorganshire producing (63.7%) of the county's



William Michell, William and Stephen

haematite (Atkinson M & Boyns T, 1981) though like its neighbours, its output fell dramatically circa 1880. William stayed at the Mwyndy Mine for the remainder of

his career living at Llantrissant House. In later years he was assisted by his younger son Stephen who took over the running of the mine in due course. Ore prices fell, reserves were more difficult and costly to extract and unwatering the mine became more expensive and forced the Mwyndy Mine Company into voluntary liquidation in June 1884.

PAWTON IRON ORE COMPANY AND CONSULTANCY

Once again the local geology is limestone and the mineral haematite. The antiquity of the mine is not known but it was described by J.H. Collins FGS in the Miners Association of 1875. Pawton Mines (SW 952701) between Padstow and Wadebridge.

While iron ore was not available from abroad it seems that additional supplies were obtained for the smelting works located close to Mwyndy from Pawton. Some data of mineral production is available from Roger Burt's Cornish Mining (1990) which also confirms William as Chief Agent between 1863 and 1864. He may have held this position for longer but as a great deal of data is missing we shall never know. William was in addition mentioned as Chief Agent to this mine in the Mining Journal of 1863; perhaps this was Roger Burt's source of information.

William's entry in Bibliotheca Cornubiensis mentions travel abroad travel abroad on business France, Sweden, Ireland, and California, perhaps for the Taylors. Precisely where he went and when I don't know but if any reader knows I would be most interested.



Jane Vivian

HIS FAMILY AND OTHER INTERESTS

William Vivian married Jane Michell in Redruth on August 31st, 1853. The marriage certificate (OPCS) gives their address at the time as Wheal Rose, Scorrior, where he may have worked at one time; the Wheal Rose engine house still stands close to the A38. On the marriage certificate his father, William (senior), is described as a miner and Jane's father as an agent (OPCS). William (junior) was also described as an agent and though his place of work is not specified it seems probable it was the Great Orme (OPCS). They took up residence in Llandudno in Ty Glas on the lower slopes of the Great Orme, now the site of the Bodlondeb Castle Hotel. During their stay in Llandudno their three children were born

(Glamorgan Census 1871), William Michell (b1854 Llandudno d1906 Australia), Stephen (b1857 Llandudno (OPCS), d1937 Ealing) and Susan Jane (b1860 Llandudno d1911 Ealing?).

In addition to his professional and family life, William was active in the community, particularly among the English Methodists, as a local preacher on the Abergele and Conwy circuit (Williams AH). During the 1850s the Welsh Calvinistic Methodist chapel, Ebenezer, became unable to cater for the growing English speaking congregation which was coming to the town. Assisted by Captain J Trevithick, also from the Old Mine (Crump E, 1906), he played a leading part in founding St John's, the first English Methodist Church in Llandudno, and using material sent to him by a Liverpool minister he taught and preached within the English Methodist community.

He died on April 18th, 1879 at Mwyndy aged 61, having spent the majority of his working life in Wales (Mining Journal 1879, Mineralogical Society 1879). As a mark of respect and as an indication of their long association, the Taylors placed an obituary in the Mining Journal which reads: *"John Taylor and Sons have lost another excellent agent, one who has served them faithfully both at Mwyndy and other mines previously with great skill, and with utmost scrupulous truth and fidelity. Captain Vivian combined with a perfect knowledge of mining great scientific knowledge as a geologist, which enabled him to contribute many useful papers upon geological subjects to several local societies, as well as to those in Cornwall."* He was also eulogised by the President of the Royal Cornwall Geological Society who said of him: *"Of our Associate Members I cannot but testify to the value of Captain William Vivian, whose death took place at the iron mines of Mwyndy, in Glamorganshire, of which for some years he had been manager. He had long been a prized and trusted agent in the employ of Messrs Taylor; and from a period when, years ago, he had managed the copper mine on the Orme's Head, North Wales, he had applied himself to the study of minerals produced at his mines, and even to microscopic examination. He was, in fact, a good example of the eminence in technical experience and observing power which, with little or no assistance from the outside, has in so many cases been attained by the industry and reflective mind of our miners and mine captains."* He was a member of the Mineralogical Society, the Cardiff Naturalist Society, the Local Preacher's Association, the Royal Cornwall Polytechnic Society and the South Wales Institute of Engineers.

Both these tributes strongly suggest a long association between the Taylors and William who I suspect must have acted for them on many occasions, perhaps as travelling fireman. Sadly, the majority of the Taylor records for this period were destroyed by aerial bombardment in the WW2 so we shall very know for sure.

His two sons, William Michell and Stephen, became mining engineers. William Michell married Gwen Rees (b1858 d1889) of Llantrissant who suffered from tuberculosis, because of which he took her and their young family to Australia. They had two sons, William Percy (b1879 d1965) and Howard Michell (b1885 d1961). Gwen died of pulmonary tuberculosis in 1889 and William Michell later

married Lillian Waddell, an Australian with whom he had a son and daughter.

It is through William Michell's first marriage that this branch of the Vivian family survives as neither Stephen nor Susan Jane married. Stephen remained in South Wales and became a well known consulting mining engineer. He was a devote Methodist, a tea-totaller and sea fisherman who frequently holidayed in Cornwall. As a boy, William Percy travelled to Rio Tinto with Stephen Vivian and in due course he too became a mining engineer before leaving and going into industry.

John Vivian, William Percy's son and William's great-grandson, became an engineer starting his career building that versatile fighter-bomber, the de Havilland Mosquito. He then went on to manage his own engineering firm and is now retired. When I last spoke to him he told me an old brass microscope remains within the Australian branch of the family, having come from Stephen Vivian's estate. One wonders if this once belonged to William himself.

LETTERS AND ESSAYS OF WILLIAM VIVIAN, 1817-1879

- 1 Observations on the Mining District of Sonora, Tuolumne County, California. Transactions of the Royal Geological Society of Cornwall 1852;7:216-219.
- 2 Essay on the More Perfect Opening and Ventilation of Mines. Report Royal Cornwall Polytechnic Society 1855:xviii.
- 3 Observations on the Gold Fields of the Pacific Coast and their Probable Extent. Transactions of the Royal Geological Society of Cornwall 1858;7:327-331.
- 4 Constitution and Structure of Slate. Transactions of the Royal Geological Society of Cornwall 1858;7:339-342.
- 5 On the Arborescent Native Copper in the Llandudno Mine, near Great Orme's Head, North Wales. Journal of the Geological Society 1858;15:109-110.
- 6 Observations on the Crystalline Forms of Native Metals. Report Royal Cornwall Polytechnic Society 1859;26:46-48.
- 7 Practical Mining etc, Letters. H C Salmon's, Mining and Smelting Magazine, Falmouth 1862;1:pp332-334, p334, p404.
- 8 Microscopic Observations on the Structure of Metals. Report of the British Association 1862;part 2:34-35.
- 9 On the Cellular Structure of Metallic Iron. Proceedings of the South Wales Institute Engineers 1866;9(12):179-181.
- 10 On the Application of the Microscope to the Study of Mineralogy and Metallurgy. Transactions of the Cardiff Naturalist Society 1868-69;1:13.

- 11 A note on Ancient Copper. Transactions of the Cardiff Naturalist Society, 1868-9;2:48.
 - 12 Birds' Nests. Transactions of the Cardiff Naturalist Society 1868-9;2:48.
 - 13 Water-Its Conditions of Solid, Fluid, and Vapour. Transactions of the Cardiff Naturalist Society 1871;3:10-17.
 - 14 Notes on Silkworms. Transactions of the Cardiff Naturalist Society 1871;3:61-63.
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 - 17 On the Use of the Microscope in Mineralogy, Geology, and Metallurgy. Western Chronicle of Science. Ed J A Collins, Falmouth, 1872;1:199-204.
 - 18 Miner's Diseases. Western Chronicle of Science. Ed J A Collins, Falmouth, 1872;1:205-206.
 - 19 Rocks, do they grow? Transactions of the Cardiff Naturalist Society 1872;3:1,75-78, inc Fig 1 & 2 p79.
 - 20 Notes on the Oxides of Iron Enclosed in Quartz, at Mwyndy, Glamorgan-shire. Mineralogical Magazine 1877;part 1: 18-19.
 - 21 Notes on the Oxides of Iron Enclosed in Quartz, at Mwyndy, Glamorgan-shire. Mineralogical Magazine 1877;4:117-118).
- cf Proceedings of the Institute of Mechanical Engineers 1874;247-248.

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ABBREVIATIONS

OPCS	Office of Population Census and Survey
PCC	Plymouth Caving Club
NLW	National Library of Wales (Aberystwyth)
NMRS	Northern Mines Research Society
NMW	National Museum of Wales (Cardiff)
RCPS	Royal Cornwall Polytechnic Society (Falmouth)
RIC	Royal Institution of Cornwall (Truro)
UCNW	University College, North Wales (Bangor)
TRCGS	Transactions of the Royal Cornwall Geological Society (Penzance)
TS	Trevithick Society
WMS	Welsh Mines Society

Don Smith, Plymouth, December 1993

ON ARBORESCENT NATIVE COPPER IN THE LLANDUDNO MINE, NEAR GREAT ORMESHEAD, NORTH WALES.

**BY CAPTAIN WILLIAM VIVIAN, OF THE LLANDUDNO MINE.
(COMMUNICATED BY JOHN TAYLOR ESQ., F.G.S.)**

**Quart J Geol Soc 1858;15:109-110.
[Abridged]**

It is well known that copper, like some other native metals, sometimes crystallizes in filiform and arborescent shapes; but in these forms they are mostly diffused through the masses of mineral gangue, or spread out upon the matrix, apparently unable to bear their own weight. The symmetrical forms, however, to which we now refer are seen by a microscope to stand up like a crystalline grove of trunks and branches.

The entire group is composed of separate crystals, strung out in the axial lines; the crystals under the high magnifying powers show the flat wedge-like octahedron;

but there is no uniformity; each crystal, or spike of crystals, varies more or less in size and modification. In the small cavities containing these crystallizations, are associated crystals of ruby copper; the latter never ran out into spikes or branched forms, but exist in single perfect or modified octahedrons, or are dotted about in irregular clusters of crystals.

The whole of these minute crystallizations occur in a bed of brown limestone, yielding a soft, rich, yellow bisulphuret of copper, -the rich ore, however, being very intimately mixed up with the crystalline limestone, something like the material of a fine-grained granite or porphyry. The ore contained in this bed seems to be a medium or transition between the harder and more sulphureous ore of the bed below and the carbonates and oxides of copper of the bed above. The copper crystallizations here are peculiar to this bed alone, and are doubtless the result of the decomposition of the ores of copper. We observe that the ore of this bed is saturated with a large quantity of moisture, which, if not the decomposing agent, no doubt, facilitates the precipitation in these symmetrical forms. What seems also worthy of remark is, that all these minute crystallizations of copper, whether ruby or metallic, have been formed subsequently to the lime-crystals: or overlaid with spikes of native copper, as described; but the lime never covers, the different forms of copper.

Note by W.W. Smith Esq, Sec G.S.- The minute arborescent crystals described by Captain Vivian are very similar to those from Bogoslowk in the Ural, figured and explained by Gustavus Rose (*Reise nach dem Ural*, vol i p403). These twin crystals, which group themselves in three directions parallel to the three edges in which the cube-faces intersect one another in the common plane of contact of the twin, thus forming angles of 120 with one another. Subsidiary groups attach themselves to the above, in such wise that they form is due to the grouping of a great number of individuals, the parallelism of their planes gives the whole the character of one large compound crystal.- W.W.S.

This abstract by William Vivian, perhaps the best known of his works in the Llandudno literature, was published in the *Quarterly Journal of the Geological Society* in 1858(15:109-110). It is one of his early descriptions of the use of the microscope in mineralogy, a subject on which he was to write in later years and use for a presentation to the British Association when they met in Manchester in 1862.