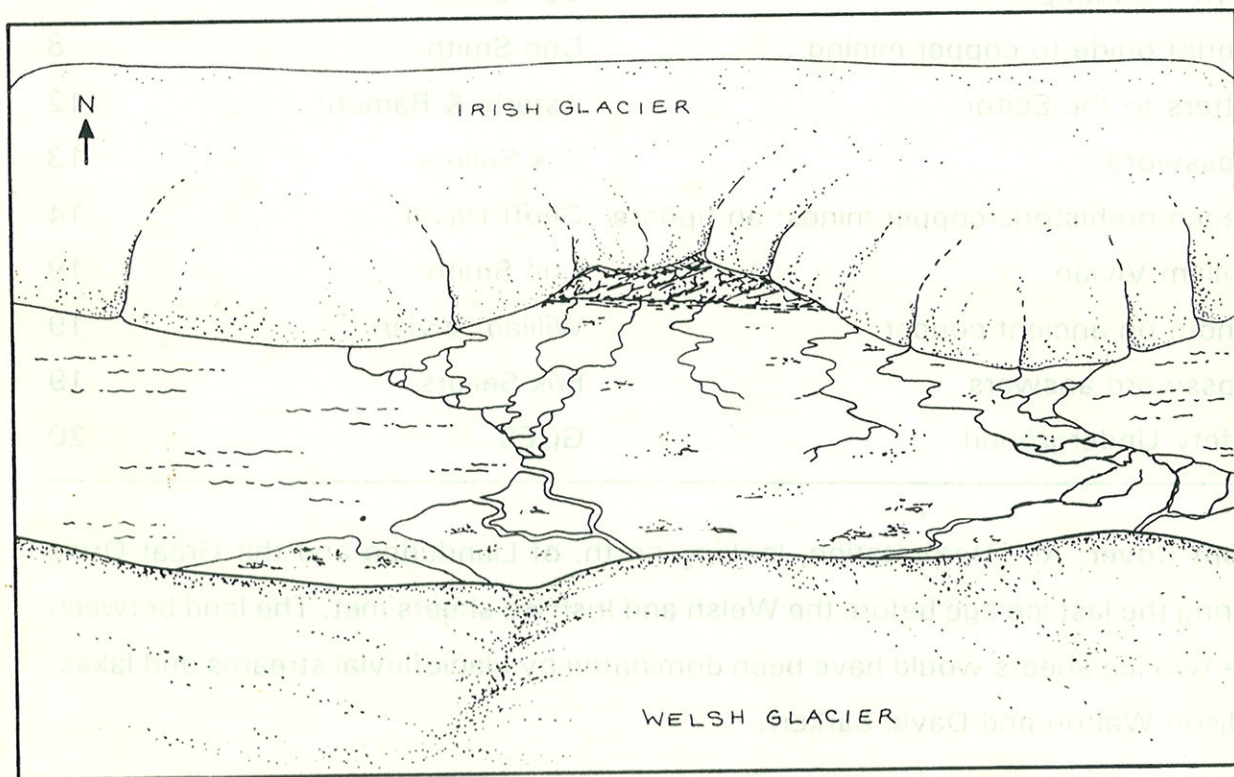


JOURNAL OF THE GREAT ORME EXPLORATION SOCIETY



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Front Cover: An interpretation, looking north, of Llandudno and the Great Orme during the last ice age before the Welsh and Irish ice sheets met. The land between the two ice sheets would have been dominated by glaciofluvial streams and lakes. (Alison Walton and David Barker).

GREAT ORME GARDENING

The Great Orme is not only about 'solid' geology. A great deal of material underfoot comprises unconsolidated fragments in a sand and/or clay matrix known as drift which relates to the 'gardening' part of geology called geomorphology. Drift is a collective term describing unconsolidated sediment deposited by a glacier and includes till (formerly called boulder clay) deposited directly by a glacier and glaciofluvial sediments which are the deposits of the meltwater streams. It also includes locally derived sediment associated with rock breakdown by frost shattering; traditionally, this is termed head. Evidence of all these sediments can be found on the Great Orme and indicate that at some time in the geological past glaciers covered the area.

According to the 'official' glossary from the American Geology Institute, a glacier is a 'large mass of ice formed, at least in part, on land by the compaction and recrystallisation of snow moving slowly by creep down slopes or outward in all directions due to the stress of its own weight and surviving year to year" (Andrews, 1976). For such glaciers to form, climatic conditions must be cold enough for snow not only to fall but to remain over the years and to grow to ice sheets, which are of large size and cover land and surrounding sea areas.

Glacial episodes have occurred throughout much of geological time (4500 Ma¹). However, the glaciations which affected the Great Orme occurred during the Quaternary period, which began 1.62 Ma years ago and continues to the present day. The Quaternary is more familiarly known as the Ice Age and can be viewed as an interlude during which a different set of climatically controlled processes contributed to the geological evolution of the area. Note that it was not a single glacial event - geologists now know that it was much more complex and that the British Isles was covered by ice on numerous occasions during the Quaternary (Table 1).

The Quaternary Period^{*} can be subdivided into a number of climatic stages using geological, palaeontological and isotopic evidence. This has allowed the identification of a number of periods of time characterised by cold climate, glacial conditions (glacial or cold stages) and periods of temperate climate, such as the present, called an interglacial stage. Of these the most recent glacial event (the Devensian stage), began about 115,000 Ka at the end of the last interglacial and lasted until 10,000 years ago (Table 1).

In North Wales, as for Britain on the whole, the Devensian ice limit is poorly recorded by terminal moraines (glacial material deposited at the ice margin). However, much of northern Britain is covered by tills and glaciofluvial sediments reflecting the former presence of an ice sheet during this time (Table 1). The lithology of these tills varies from gravelly clays to sandy clays and even sands, depending on the local source material. For example, in a vertical section a number

¹ Ma millions of years; Ka thousands of years

Table 1. *Pleistocene Correlations in North Wales*

IRISH SEA	WALES	TIME STAGES		AGE ('000 yrs BP)
wind blown sand and periglacial processes; sea level still lower than present	cwm moraines (local glaciers in Snowdonia and other mountains)	Loch Lomond Stadial	Late Devensian	10
				11
brief episode of warmer than present climatic conditions which saw the last remnants of the ice sheet melt away; sea level rising from glacial minima of -150m		interstadial		12
red brown till from ice moving south over the Irish Sea Basin	grey till with erratics from the Welsh mountains and centred over Arenig	Dimlington Stadial		24
lower heads indicate establishment of cold but not glacial climate conditions	older till at Pen-y-bryn/Criccieth -till of Welsh origin	Middle Devensian		59
		Early Devensian		122
Red Wharf Bay & Porth Oer raised beaches-higher than present sea level		Ipswichian		128

of tills may be found representing deposition by ice lobes from different lithological source areas. Glaciofluvial (glacial meltwater) and glaciolacustrine (glacial lakes) sediments are often interbedded with these tills indicating periods of ice withdrawal and sedimentation by meltwater in the vicinity of the ice margin. Within the deposits, which predate earlier stages, there is evidence of glacial advances separated by an interval of ice withdrawal when head was formed and permafrost conditions developed in the periglacial area (Table 1).

In the area of the Great Orme, opinions differ on the mutual relationships between tills which indicate a source area in the Irish Seas basin to the north and tills which reflect a source in the Welsh mountains to the south (Whittow & Ball, 1970). There appears to be no un-equivocal evidence to contradict the assignment of the tills to the Devensian stage (Table 1), although some authors argue that the last glaciation was more limited in extent, and failed to reach the south side of the Lleyn Peninsula.

The relationship of the Irish Sea and the Welsh ice sheets to one another has not been properly established (Addison, 1990). Nevertheless, the opportunity presents itself on the Great Orme where vertical and horizontal drift sections are exposed at and below surface. The validity of these sections cannot yet be correlated regarding events and stages in the British Isles. However, the Devensian can be correlated with the last glaciation in many parts of the world, such as Weichselian in northern Europe, the Wurm in the Alps and the Wisconsinian in North America.

Critical sections regarding these geological problems occur in the Ty Gwyn Mine and may hold the stratigraphic evidence to tie up many loose ends through their detailed analysis, both vertically and laterally from the local limestone. The resulting information could be related to known events at type sites to construct a space-time glacial history for the Great Orme and North Wales.

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David Barker, December 1992

NEWS ROUNDUP

DAVID BARKER

On Christmas Eve, 1992, the Society lost a key member with the death of David Barker. Although a new member to the Society he had joined in all its activities and looked anew at the geology of the Great Orme, recognising a type site within the Ty Gwyn Mine. He was in the process of writing-up this feature to draw it to the attention of the Quaternary Association when he was killed in an accident on icy roads in his Land Rover. Dave's report appears as the leading article in this issue of the Journal. I hope the type site he described will, in due course, be recognised the Quaternary Association and serve as a lasting memorial of his time with us.

ANNUAL GENERAL MEETING:

The 1993 Annual General Meeting was held at 5pm, Saturday 27th March, at the Royal Hotel, Church Walks, Llandudno. After accepting the minutes of the last AGM and the EGM the finances of the Society were presented and met with the Society's approval; the acceptance of the revised constitution was confirmed. The title of the Taliesin Trophy, agreed upon at the last AGM, was changed to the Tudno Trophy, in recognition of Huw Tudno Williams who died last year.

The Society awards for 1992-3 were as follows:

The Tudno Trophy, for the best contribution to the Journal in the past year, was awarded to Nigel Bannerman.

The Silver Rock Bolt, for merit, was awarded to Geoff David, in recognition of his work in local cave and mine archaeology over many years.

The Ty Gwyn Award, for mirth, was awarded to Ian Norman for his detailed tales of the Chieftain tank and total recall of all its working parts.

For the season 1993-4 the Society elected the following officers:

Chairman	Don Smith
Vice Chairman	Nigel Bannerman
Secretary	Tony Davies
Treasurer	Frank Ennis
PRO	Steve Lea
Expedition Sec	Erik Sellors
Equipment Sec	Ian Norman
Editor	Don Smith

The Beach adit project was discussed with a view to further work starting in the near future, probably using a firehose. In the meantime a steel gate (galvanised) would be fabricated and fitted to secure the entrance before the coming summer season. Other projects discussed included the placement of First Aid boxes in the Roman, Treweek's and Penmorfa areas and the conservation of the Penmorfa level. The meeting was closed at 7.20.

WET EARTH COLLIERY:

In December 1992 the Society went for a trip to the Irwell Valley where Alan Davies showed us around the maze of passages associated with the water engineering schemes built by James Brindley. Water drawn off up stream was channelled to the mine to work waterwheels and later a turbine to generate power for the mine's machinery. The wiser amongst us had brought wet suits, those less so (Editor included) braved the chilly waters and ochred gelatinous mud.

PENMORFA FIRST AID BOX:

The first of our first aid-boxes has been completed and is ready for deployment in the Penmorfa when next we venture that way. It is sealed in a watertight container and contains laminated aide memoirs, field dressings, airways, space blankets, candles, matches and sweets. It will be left at the 'breakthrough' from where it may be taken most easily to where it is required. Please do not use it for trivial problems, it is for emergencies only. Eventually it is hoped to leave a box at all key locations underground.

BOOKS:

Congratulations to the Parry household on the publication of 'The Great Orme, Llandudno's Mountain' by P Bardell, Tom Parry & Eve Parry. I believe it is available at all 'good books shops' in Llandudno at £1.95 (i.e. Clwyd Books). A must for all Society members, hurry while stocks last.

Engine House Assessment; Mineral Tramways Project, published by the Cornwall Archaeological Unit, Cornwall County Council, Old County Hall, Station, Road, Truro, TR16 5JL at £12.00 p&p inc. It is a very useful document and although it does not document all the surviving engine houses in Cornwall those in the area of the Mineral Tramways are documented and have been surveyed with a view to selective preservation. Within the document there is also an account of the history of the evolution of steam power from Savory's engine, through the Boulton-Watt years to Sims, Woolf and Trevithick. It is illustrated by line diagrams which clearly demonstrate their operating cycles.

The Mines of Flintshire and Denbighshire by Roger Burt, Peter Waite and Ray Burnley, published jointly by the University of Exeter and the Northern Mines Research Society (ISBN 0 85989 3715) is available at £12.95. This volume, like the others in the series, contains a wealth of mines production and other data which should be interest and value to anyone researching this mining field.

NAMHO CONFERENCE, ISLE OF MAN:

Don Smith, Ian Norman and Edric Roberts sailed on the MV King Orry to the Isle of Man for the meeting; Geoff David had planned to attend but unfortunately could not attend. Mary Brett, an old friend from Noble's Hospital, kindly put us up in her bungalow on the outskirts of Douglas and made us very welcome.

Having Friday free we set out for the Cornelly engine house in the Foxdale area. Cloud was on the ground and it rained intermittently as we surveyed the engine house with a view to discovering what type of engine had been fitted, a 50/90

compound Sims Engine, as at the Ty Gywn Mine, or a Bull engine. From the look of the engine mountings and the location of the shaft well within the house the latter seems the more likely arrangement. However, I shall be in contact with authorities in Cornwall who will in due course give us their opinion.

From there we moved on to Port Erin intending to visit Bradda Head south but on the way we allowed ourselves to be sidetracked to the Beckwith Mine at the far end of Foxdale where we saw more engine houses some launders, buddles and waterwheel cases. The weather, having been miserable, improved as we descended from the Manx uplands and the sun shone on us as we walked onto Bradda Head to see the mine site on the south of the headland. Over the weekend two mauls were found, bringing to four the number so far found at that site which the Manx authorities have recently scheduled as a SSSI. That evening we met the other conference delegates (Cumbria Amenities Trust, Carn Brea, PDMHS, NMRS etc) at the Groudel Glen Hotel north of Douglas and arranged our field trips for the weekend.

The conference itself, hosted by the Laxey Mines Research Group, was held at the Manx Museum (Museum of the Year 1992) starting on the Saturday morning. There was a strong Llandudno flavour to the morning's proceedings as Chris Williams presented a history of copper mining in the Great Orme (1692-1881). This was followed by Don Smith who presented survey and excavation data on the Tom and Jerry engine collected by the Society over the last five years which was well received. That afternoon Ian and Don went down Welsh Shaft (appropriately enough) at the Laxey Mine to see the main tramming adit where the fend-off for the hydraulic man engine, nearly 50 feet long, remains intact. Apart from lamp failure (DS) and an aversion to dynamic rope for SRT, the trip went off well. The following day Mary joined us at the Museum for some lectures in the morning and came with Edric, Chris Williams and Don to the Laxey mine where we enjoyed the Grand Tour of the hydraulic engine, turbine house, adit and the Lady Isabella water-wheel. Interestingly, the main bearings for the T-rocker are almost identical to those in the Tom and Jerry engine, though clearly a lot bigger. Congratulations for a well organised meeting must go to Peter Geddes, Rachel Robertson and members of the Laxey Mines Research Group. We had enjoyed a splendid weekend in the Isle of Man but had seen less than half of what is there to see, so we shall return.

NORTHERN MINES RESEARCH SOCIETY:

We are now members of NMRS, if you would like to see or read their Newsletter, Memoirs or other British Mining Publications please speak to the Secretary.

PEN Y DINAS:

With the survey completed, it is hoped work will start on clearing the excavation site very soon and be followed by the archaeology. For more details, please contact Tom Parry, 3 Cromlech Road, Great Orme, Llandudno.

INTER-SOCIETY LIAISON:

On March 26th Frank Ennis, Tom Parry and Tony Davies made a presentation to the Town Council about Society activities over the last year and our proposed

activities for the coming year. The following weekend (April 4th) Nigel Bannerman and Tom Parry attended the Caernarfonshire Confederation of History Societies and presented data on the beach slag project which was well received. A short resume of the Bronze Age smelting project (DS) has been accepted by the Trevithick Society Journal for publication later this year and a letter about Captain J Trevithick (DS) has been published in the Trevithick Society Newsletter. So we may get some feedback in due course. The Welsh Mines Society have renewed their interest in the derivation of the term Brammock Rod, thought to be equivalent to flat-rod, and possibly named after a Welsh mining engineer.

COPPER SLAG ANALYSES:

I have heard from Dr Martha Goodway FASM, Archaeo-metallurgist at the Smithsonian Institute, Washington D.C. She has provided me with a copy of the XRF surface analysis of some slag I provided, via Dr Joan Taylor of Liverpool University, which confirms the presence of copper. However, since this is a qualitative analysis, and as there is no calibration data, there is no indication of the percentage of copper present. Dr Goodway will be visiting Llandudno in September. Dr Chris Salter from the Archaeology Research Laboratory at Oxford University is interested in the North Wales beach slags and is currently studying dated copper slags from Swansea. A quantitative analysis of the beach slag from the north shore is being performed in South Wales but at the time of going to press the results were not available.

BIBLIOGRAPHY OF THE GREAT ORME:

I am collating a bibliography of the Great Orme, covering its geology, mineralogy, mining history and archaeology. I would be grateful for any references to the Great Orme, no matter how small, in books, journals, local magazines, monographs, manuscripts etc., in English or Welsh. The intention is to publish the bibliography in the Journal, and lodge a copy in the local library for use as a resource. J GOES is being indexed and will be published in the same issue.

TY GWYN BEACH ADIT

After a lull in activity after the New Year, work has recommenced on this project. Having started at the portal last year, mud, sand, gravel and 20th century rubbish has been removed and the floor cleared to the 19th century level to a point well under the Marine Drive 40' above. A great deal has yet to be cleared away before the 'swamp' can be drained in preparation for the final assault. This adit has recently been gated though access is available through the Society.

STOP PRESS: On Thursday, 10th June, the Llandudno area was subjected to a torrential 5" downpour of equatorial, though not quite biblical, proportions. The media have covered the flooding of the town but considerable damage has also been done underground; Great Orme Mines had their gravelled walkways washed away and the water flooding through the mine has carried away deads, possibly exposing new areas and blocking or destroying others. The Society will be inspecting the Ty Gwyn Mine, the Penmorfa level, Roman and Treweeks in the weeks to come to assess the consequences which I will report in J GOES 1993(2).

A BRIEF GUIDE TO COPPER MINING IN THE GREAT ORME

THE HISTORY OF THE GREAT ORME COPPER MINES

Man occupied the Great Orme for millennia before Bronze Age man became interested in the minerals hidden beneath its turf. Remains from the cave burials at Kendrick's Cave (SSSI) have been dated to 10,000 BP and the cromlech at SH 7722 8295 and cairn at SH 7560 8356 are evidence of other Neolithic burial practices.

It is now well established that copper was being mined here during the Bronze Age. The charcoal remains of firesetting and collagen from the miner's bone tools have provided radio-carbon dates from 1800 to 600 BC. There is also an abundance of stone and bone tools within the workings. Over the last 150 years a few bronze fragments up to 3" in length have been found in the mines and recently a large number of smaller bronze fragments have been sieved from the underground waste material. These findings may indicate that metal tools were being used in the mining process, perhaps as wedges or picks.

There is no data on Bronze Age copper smelting in Britain and in the absence of slag it was proposed that a non-slugging process, utilising carbonate ores exclusively, had been used. However, in mid-1992, 'free silica' copper slags were found on Llandudno's north shore and other local beaches. Although they may represent jettisoned modern ballast, if proved to be ancient then our image of British Bronze Age industry will need revision.

This ancient mining industry, and perhaps smelting too, must have required a significant workforce, though their dwellings have not been identified positively. There are a number of hut circles, hut platforms, ancient field systems and a stone avenue scattered over the Great Orme which, when investigated, may answer this question.

One such site is Pen y Dinas hill fort situated at SH 779 830, overlooking the ski slope, and on the basis of its defensive features it has been ascribed to the Iron Age. A community based programme of conservation and excavation is to begin in 1993 which may uncover evidence of sequential occupation, perhaps from as early as the Bronze Age, through the Iron Age and into, or beyond, the Roman occupation.

Definite evidence of a Roman presence in Llandudno is lacking, however, they must have sailed around the Great Orme en route to and from their fort, Kannovium, at Caerhun where a copper bun-ingot, bearing Roman inscriptions, was found. Two large hoards of low denomination brass coins have been found close to the Little Orme, one of which is still the largest collection of Carausius coins yet found in Wales. Several sites on the Great Orme carry the name Roman, such as Roman Well (Ffynnon Rufeinig) and Roman Shaft (Shafft Rufeinig), perhaps because of verbal tradition or Victorian whim. Roman coins are said to have been found in the Old Mine by 19th century miners, a few coins were found near Kendrick's Cave and in 1948 Professor Oliver Davies excavated some Roman coins and pot shards at Gogarth. It is hoped that Roman mine engineering, domestic buildings and artifacts, found in context, will be discovered and confirm their involvement on the Great Orme.

The first scientific evidence of mining related activity AD comes from a carbon date obtained from charcoal excavated from the washing site at Ffynnon Galchog (SH 777 837) on the northern slopes of the Great Orme. This single date, circa AD 800, may result from a sampling error but, if confirmed, has important implications for our understanding of this silent period in history.

Excavation in 1992 unearthed a shard of apparently Medieval pottery, just west of Vivian's shaft. This does not, however, prove there was mining activity during this period, but does at least demonstrate domestic activity. During this period the coal and lead deposits of Clwyd were being exploited, but there is no field or documentary evidence of similar activity here in Llandudno.

The reign of Elizabeth I saw a revival of mining interests throughout Britain. Mining engineers from Augsburg, Germany, were brought over and began prospecting for copper and other minerals. Their rights included North Wales, and though it is probable they were at Parys Mountain it is not known if they came to the Great Orme. From 1568 to 1688 the Mines Royal Society (MRS) had exclusive rights to mine for copper throughout Wales and in eight counties in England and the Mineral and Battery Works Society had rights for the remaining counties and the other mineral rights. Between them they worked a cooperative duopoly, mining themselves and franchising mining rights. The Wyns of Gwydir and the Mostyns were exploiting lead in Gwydir and Flintshire, respectively, during this period.

Following the English Civil War the fortunes of the MRS did not fare well, their principle mining and smelting works in Keswick were destroyed by Parliamentary forces and many of the shareholders were Royalists. To encourage mining enterprise the Mines Royal Act was repealed in 1688 and in 1692 Thomas Mostyn took out a lease to mine the Great Orme for copper. This is the first evidence of 'modern' copper mining in the Great Orme.

Documentary evidence suggests that mining during the 18th century was intermittent, possibly affected by slumps in copper prices. When touring in 1773, Thomas Pennant noted the presence of the copper mines and their depth which he recorded in his 'Tours'. Since he had coal and mineral interests near his home, 'Downing', in Flintshire, and was a subscriber to William Pryce's 'Mineralogia Cornubiensis', his interest is understandable.

Mining became sustained in the late 18th century, at a time when Thomas Williams' copper empire was at its zenith. By the early 19th century two mines emerged, the Old Mine, leased from the Bishop of Bangor, and the New Mine, leased from Lord Mostyn. The Tyn y Coed Mine, part of the New Mine, was leased from the Williams family and the Ty Gwyn Mine, which opened in 1835, was leased from the Mostyns, Mr Lloyd Jones and (subleased from) the Old Mine.

One of the principle entrepreneurs in the heyday of the mines was Samuel Worthington who, in 1812, became the Bishop's agent and managed the Old Mine Royalty account, until he leased the mine in 1824. He had been the manager at the Herculaneum Pottery in Liverpool, and was, with his partners, the sole agent for the export of slates from the Penrhyn quarries, had corn, flint and ochre mills in Llandegai and Llanllechid

and probably had other interests too. For many years he made no profit but his investment and patience paid off handsomely in the 1830s. In 1846 the Worthingtons sold out their interest and probably returned to Liverpool.

As in other British mining fields many of the miners and key men were Cornish. Among these several are noteworthy. Captain George Davey, of the Old Mine, assisted in driving the Penmorfa level with Thomas Jones, Frondeg, of the New Mine, and having patented a water-pressure engine was involved in the Tom and Jerry water-engine. Perhaps the most able was Captain William Vivian who came to work the Old Mine for the Taylors in 1853. He was an experienced and travelled mining engineer, a geologist, skilled in the study of minerals by microscope, author of many papers on geology, mining engineering and natural history and as a Methodist local preacher was a leading light in the foundation of the English Methodist Church in Llandudno.

By the 1850's, when Llandudno was a rapidly growing seaside town, the mines were no longer the major employer. The mines were competing against cheap imports from the New Worlds and wooden ships, formerly copper bottomed for trade in tropical waters, gave way to iron construction. The New Mine closed in 1864 and the Old Mine in 1881. The Ty Gwyn Mine, however, was the first to close in 1853, the deciding factor being serious flooding in the deep levels below chart datum with which three pumping engines could not cope.

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The Great Orme Copper Mines, Don Smith, 1989.

The Llandudno Copper Mines, C J Williams, 1st Ed 1979, 2nd Ed 1993.

GEOLOGY OF THE GREAT ORME

Formed of fossil bearing carboniferous limestone, laid down in tropical seas 340 million years ago, the Great Orme stands today as an island, detached from limestone outcrops on Anglesey in the west, adjacent outcrops and the extensive deposits of Clwyd in the east. Once a single unit, gently folded and faulted, it has been eroded by weather, sea and glaciation to the landform we recognise today.

Rising to a height of 207 metres (683 feet) above sea level, the Great Orme's limestone was laid down in three major units, lower (brown), middle (white) and upper (grey), totalling over 300 m (~1,000 ft). Between and within each limestone unit shale bands, punctuating periods of limestone deposition, form impervious layers of importance to mineralogy, mining engineering and quarrying.

Over millions of years much of the Great Orme's limestone (CaCO_3) was dissolved, by magnesium rich sea water percolating through faults, and then re-precipitated as dolomite (calcium-magnesium carbonate [$\text{CaMg}(\text{CO}_3)_2$]). It is in the dolomite where the minerals were deposited, by ground water, mineralised and heated by contact with magma and forced upward, through the same faults, by the colossal pressure of earth crust movements.

There are, in addition, deposits of silica in the form of chert, analogous to flint found

in chalk. It is likely they were of little use to Neolithic man, due to their friable and fractured nature, but in the 19th century deposits were probably farmed and milled by Samuel Worthington for use as pottery glaze.

As a legacy of glaciation, isolation and limited water catchment, the Great Orme has comparatively few known caves. The longest system, Brenda's, running ~ 850 m from Ty Coch to Pen Trwyn is interrupted by quarrying below Pen y Dinas, faulting and erosion of the Happy Valley and beyond is filled by glacial slip. However, limestone pavements and swallet holes are developed in several areas of exposed limestone on the upper plateau and are being investigated by the Great Orme Exploration Society. In addition, sites have been identified within the Ty Gwyn Mine where Irish Sea glacial deposits meet and overlay the limestone breccias.

MINERALS OF THE GREAT ORME

Malachite: $[\text{Cu}_2(\text{CO}_3)(\text{OH})_2]$ This green carbonate ore is mainly found near the surface and may have been the dominant ore extracted during the Bronze Age.

Azurite: $[\text{Cu}_3(\text{CO}_3)_2(\text{OH})_2]$ Similar chemically to malachite, this blue ore is also found near the surface, mainly as coatings on shale but around Higher shaft can be found in well developed crystal formations.

Chalcopyrite: $[\text{CuFeS}_2]$ This brassy sulphide ore was the dominant ore extracted during the period of modern mining from 1692 onwards. Generally it underlies the oxidised carbonate ores though it does outcrop on the surface.

Galena: $[\text{PbS}]$ This shiny grey sulphide ore of lead was found in small but commercial quantities in the Old Mine in the last century. These deposits were said to contain silver.

Native copper $[\text{Cu}]$ Specimens of native copper were found in the 19th century in an area of enrichment and described by Captain William Vivian in the Journal of the Geological Society in 1859.

Pyrolusite: $[\text{MnO}_2]$ Deposits of this black oxide have been found at the trials in Pen y Ffridd but it can also be seen in Vivian's workings where it stains diffusely the copper deposits.

Bitumen: This pitch black hydro-carbon can be found throughout the Great Orme but is most common below Bryniau Poethion.

Erythrite: $\text{Co}_3(\text{AsO}_4)_2 \cdot 8(\text{H}_2\text{O})$ This crimson red ore of cobalt can be found beneath Bryniau Poethion. It is uncommon and is regarded as an indication of other cobalt ores.

Don Smith, December 1992

This article is, as the title suggests, but a brief guide. It will be published by the Society as an information sheet in 1993 to provide an overview of the Great Orme's mining history for visiting groups and the public at exhibitions.

LETTERS TO THE EDITOR

An Ode to the Bannerman Premise

Now in the Bronze Age days of yore,
The Orme was full of copper ore
Not only did it call for mining,
It also needed much refining.

Men worked away with hammer stones
And scraped the ore with greeny bones,
And all the malachite they found
Was stacked in heaps upon the ground.

Now digging ore is very fine,
In fact essential for a mine,
But getting it is not enough
They also have to smelt the stuff.

Now learned men of high degree,
All versed in archaeology
Debate upon the shape and form
Of Bronze Age smelters on the Orme.

But one rude chap will not agree,
He says, "This don't make sense to me,
Your reasoning chaps is well amiss,
Hark to the Bannerman Premise.

Converting ore to copper form,
Could scarce be done upon the Orme,
To do the job one really oughter
Have lots of fuel and running water.

No rivers were there near the site,
The growth of tree was very slight,
And would it not be rather silly,
To lug the fuel right up the hilly.

In smelting is it not the rule,
To transport ore to stocks of fuel?
If this dear readers is the norm,
Why then be different on the Orme?"

Now Bannerman he roams the shores,
A man in search of slags and ores,
And there are many think he might,
Locate the Bronze Age smelting site.

His yacht it sails in Conwy Bay,
Investigating day by day,
And it is said that he is waiting,
To come across with carbon dating.

And of this novel premise bold,
What secrets has he left untold?
Events are moving on apace,
So pray dear readers, watch this space!

Asterix

Pen y Dinas, Great Orme's Head

With the Pen y Dinas community project about to get underway,
this description by G.A. Humphries, written in 1912, may be of
interest to readers. Ramon.

The prehistoric hill fortress of Pen-y-Dinas is an excellent
example of a Welsh promontory fortress. The shape has been
governed by the formation of the hill, which is a very bold spur
jutting out from the south side of the Great Orme's Head, and
terminating along the south-west, south and east sides with
precipitous cliffs forming a natural protection that needed little
strengthening.

The area is seven acres in extent, outlined by the rampart of
stones and earth, and full advantage was taken of the rocks
which protruded above the general surface, to incorporate them
in this inner line of defence.

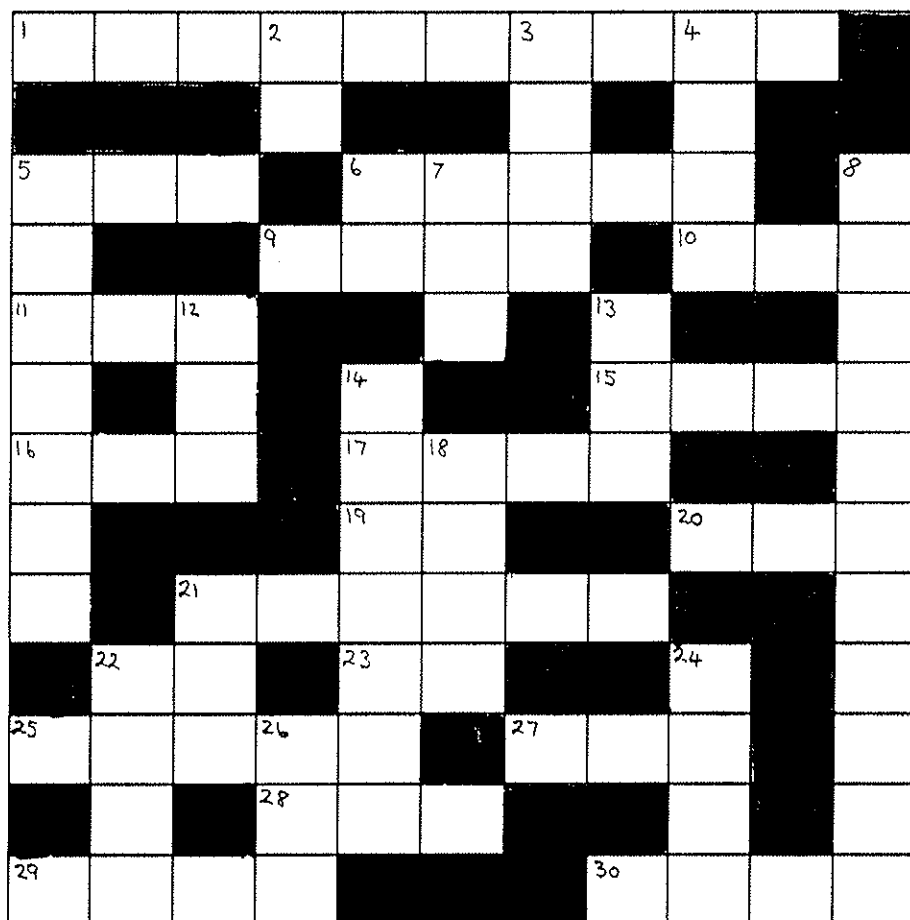
Where there are no rocky cliffs, which is chiefly on the north and
north-west side, artificial defence was resorted to in the shape
of double or triple vallum and fosses. The inner escarpment is
longer and steeper than the others, as will be seen by the
section AA.

The main entrance appears to have been along the south-west
side and is shown by double dotted lines on the plan. Its route
was well selected, as it would be commanded by a succession
of dominating positions. Between the inner ramparts and the
valley below, on the south side, there are traces of a wide track
leading straight up to the famous rocking stone. A short distance
to the north-east of the rocking stone, is a prominent upright
stone, which probably had some significance, but it is difficult to
even hazard an opinion as to its meaning.

The limestone protrudes above the general surface of the interior
of the fortress, in almost parallel lines, running from north to
south, then curving off westward. Between these lines of rocks
are to be seen the remains of numerous hut circles, while, on the
north-west side of the seven acre area and immediately within
the triple vallum defence work, practically the whole available
space was occupied by hut circles. The most prominent remains
show that the huts - 60 - 70 in number were from four to seven
yards in diameter, and that they were constructed with
concentric rings of large stone. There is no well within the fort
but on the western slope there is a very good spring which may
have supplied the occupiers with water.

G.A. Humphries 1912

CROSSWORD



Across

- 1 Exploring of caves (10)
- 5 Beer ____ (3)
- 6 Mark or slope (5)
- 9 ..plough .. and scatter .. (4)
- 10 Long runner (3)
- 11 Boring tool (3)
- 15 Strong current of water (4)
- 16 Sack or pouch (3)
- 17 Entrance (4)
- 19 Not you (2)
- 20 Observe (3)
- 21 Bronze money or coin (6)
- 22 Towards (2)
- 23 American junior officer (2)
- 25 It has new rope handlines (5)
- 27 ____ and even (3)
- 28 Ask orient policemen for it (3)
- 29 Fissure with ore (4)
- 30 Left after smelting (4)

Down

- 2 US law abiding city (2)
- 3 Soft heavy metal (4)
- 4 Went (4)
- 5 Compartment or cavity (7)
- 7 Colour (3)
- 8 Mining before explosives (4.7)
- 12 Limb (3)
- 13 Technique on ropes (3)
- 14 Take for tests (7)
- 18 Department. 'cut' (4)
- 21 Swindle (3)
- 22 Spike of fork (4)
- 24 They worship it (4)
- 26 Japanese meditation (3)

Answers, see page 19

Erik Sellors, December 1992

FRENCH PREHISTORIC COPPER MINES: AN UPDATE

Members of GOES with archaeological leanings may remember an article that I wrote about a year ago called "Prehistoric Copper Mines: An Update", and which appeared in the Journal (1992(2)).

Since then, a large, shapeless mass of archaeological articles in French has descended on me from various sources, mostly dealing with the discoveries at that place Cabrières which I mentioned in my previous article. Now, with the help of wet towels round my head and a great deal of carefully chosen invective I have at last - I think - succeeded in reducing all these articles down into a sort of English.

The results, I think, are interesting and might have some relevance to the ongoing diggings on the Great Orme, so here is a summary of the main points - with my apologies in advance for any mistaken interpretation: I am **NOT** a linguist, and some of that academic French could, in mountaineering terms, be graded XS.

First of all where is Carrières? The sketch map attached (Fig 1) will, I hope, give you some idea - it is a small village in the foothills just inland from the Mediterranean coastal plain, between the valleys of Orb and the Hérault, about 40 k west of Montpellier and roughly 30 k NNE of Béziers. The region is known as the 'Garrigues' - which is really the name given to the natural vegetation of course, prickly bushes which grow everywhere on the limestone hills, and which can be a menace to any foolish tourist who leaves the road and tries going for a little walk over the hills in the heat of the noonday summer sun.

The geology is interestingly mixed - the hills are mainly Devonian Dolomite, much faulted (the faults often marked by quartz veins), and the intervening valleys mainly Schists (Ordovician to the north of Carrières, and the Carboniferous to the south). Many of the quartz veins are mineralised - with copper (chalcopyrite, malachite and azurite - just like the Great Orme and also 'grey copper'), and these have been exploited with varying success from at least Roman times up to the early 20th century (AD), so the whole area is a mass of little holes and spoil heaps of various ages - fascinating!

The first discovery that suggested they might be even more ancient than Roman was made by a geologist - a Professor Vasseur, from Marseilles, in 1911. He was on holiday in the district at the time, and while visiting Carrières he was introduced by an amateur geologist friend of his - a Monsieur Escot - to some of the local sites. This included an old 'Roman' mine called 'Neuf Bouches' (literally, nine mouths, referring to the number of visible entrances), near the top of a hill called Bellarde (spelt Vellarde in some accounts), about 1.5 k NE of Carrières. The good professor noted with approval the vivid green and blue staining from the copper ores, and then was intrigued to see a mass of rounded pebbles strewn everywhere on the spoil heaps and in the entrances. His amateur geologist friend - Monsieur Escot - had a ready answer - "They are bullets used by the Roman catapults", he said, "At least, that is what everybody in the village thinks." But the professor was not convinced: and looking more closely at them he discovered that

they were obviously stone hammers, much like those he had previously come across around the Neolithic flint mines near his home town of Marseilles.

Most of them showed the marks of heavy battering at each end, and they were all made of either quartz or quartzite - the latter a very hard rock which does not occur naturally in the Carbrières district. There was no sign of any flint in the surrounding area, so Professor Vasseur dismissed the idea of a flint mine. But a few days later, on a return visit to this mine, he came across even more of these pounders, and some of these showed on their battered ends the telltale signs of blue and green from azurite and malachite. Closer inspection showed that these were only superficial stains - and at once the penny/centime dropped - these hammers must have been used for treating the ore from the copper mine.

The next big question was - from what period did they date? And here the doughty professor added two and two and arrived at five. Barely 600 m down the hill from the mine, in a region called Roque Blanche, was a famous cave properly known as the Grotte du Broum, though known to the local people over many years as the 'Cave of Bone', as it was full of human remains. Archaeologists had examined these and found bits of Neolithic/Early Bronze Age pottery mixed up with them. So professor Vasseur made a quantum leap in imagination and decided that these burials must have been the miners from the top of the hill. Logical, yes, but NOT fully supported by the actual evidence, though the Professor did also point out that:

- 1 At none of the other copper mines in the area which were known (from pottery, etc.) to be of Roman date, had any of these stone pounders been found.
- 2 The area around Rogue Blanche is very stony and arid, and would be quite unsuitable as a place for a Bronze Age community to settle, unless they were attracted by the copper ore.

So there the matter rested, for 68 years, until 1979 when a municipal road-widening scheme less than 400 m from Cabrières, by chance uncovered yet another ancient copper mine. This one, since named La Vierge after the statue of the virgin on the hillside above, was completely undisturbed by later workings, was obviously following the quartz vein mineralised in malachite and chalcopryrite, and despite its tiny size, 2.3 x 0.5 m, contained exactly what the archaeologists were hoping for - a large pottery jar, and other pottery fragments, all of definite Early Bronze Age date, and quartzite pounders just as Professor Vassuer had found in 1911. So the connection between these pounders and a definite Bronze Age date was at last proved, and the professor was vindicated.

This latest discovery sparked off a series of excavation by a research team of French archaeologists, led by Paul Ambert, over the next five years, resulting in a number of finds: Firstly, a series of small ancient mines around the east and west sides of the hill above La Vierge. This hill is called Pioch Farrus (Pioch, meaning hill in the local patois, and Farrus signifying something to do with metal). So these mines were called Pioch Farrus-1, -2 etc., (PF-1 etc) as shown on the sketch. All

of them had been disturbed by later working (Roman and onwards) but PF-1 soon answered the archaeologists' prayers by providing about 20 Chalcolithic/Bronze Age shards of pottery, and another of those stone pounders. Then, in 1983, PF-4 produced another group of Chalcolithic/Bronze Age bits of pot - and also some interesting proof of Roman working, in the shape of two graffiti - the name **Gaius** followed by 4 short vertical strokes, and the letters **AVR** (short for Avrelius or Avrelianus?) - all cut into the rock wall by blows from a Roman(?) miner's pick. One theory is that both graffiti were cut by the same person who was acting as tally-keeper for the jolly fellows under his charge. So Gaius, bless his heart, had produced four loads of copper ore that day - good luck to him.

However, judging from the pottery already found in other parts of the mine, PF-4 must have been worked long before the Romans, indeed in Bronze Age times, and there was some excitement in 1983 when stone steps were found cut into the floor, leading downwards, presumably to lower galleries, but alas! these lower workings were all flooded, and I believe they still await drainage.

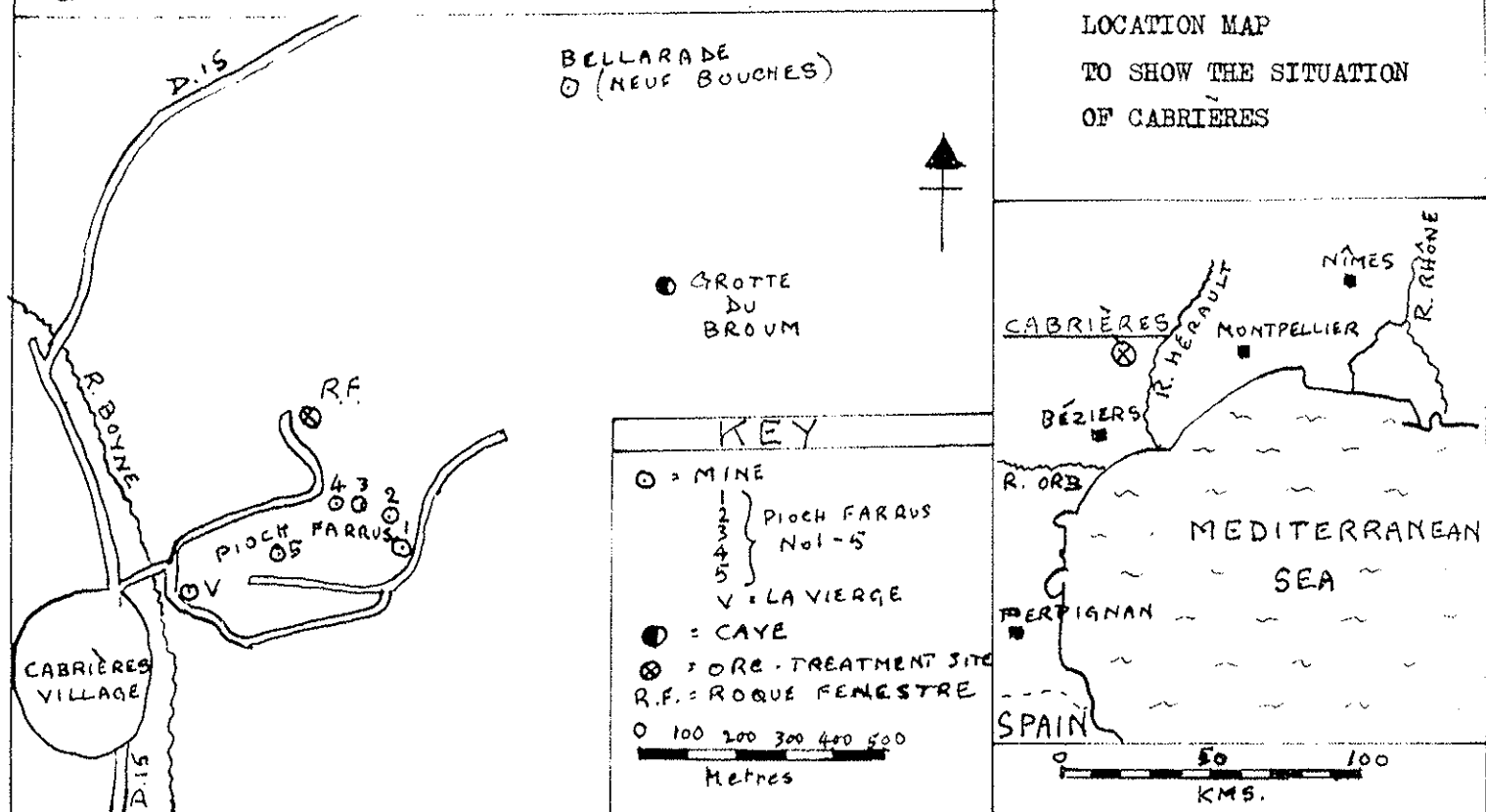
Much to my disappointment, when I at last found this mine during my holiday visit in 1991, the entrances were all blocked up with heavy timbers with 'Keep Out' signs attached, so I do not know what, if any, progress has been made since the 1980s.

A few hundred metres NW of PF-4 is a prominent upstanding rock called Rogue Fenestre, and it was there that the French team made one of their most spectacular discoveries. This was not a mine but an ore treatment area (where the crude ore from the mine was sorted and crushed to extract copper). The surface evidence consisted of about 30 stone blocks, made of basalt, mostly with two opposite sides flattened, and a cup-marked depression - a few centimetres in diameter, carefully pecked into one flat side - very much like the mortars found on the Great Orme. Mixed up with these was a number of stone pounders, of a smaller size to those found in the mines, and some shovels made of the shoulder blades of oxen, some grindstones, and many fragments of broken dolomite, quartz and copper ore. A typical pounder and cup-marked stone is illustrated in Fig 2.

Not only that, but three ditches were found, carefully cut out of the Schist bedrock, and then backfilled with spoil. The fact that schist is an impermeable rock, and that the spoil lies in thin horizontal layers - beds of iron oxide (limonite), alternating with coarse quartz sand, rich in copper and charcoal - suggested that these ditches were washing basins where the copper ore, having been ground down to the consistency of coarse sand, was separated from the pulverised rock by washing it in water. All these layers were saturated in copper salts, and this had imparted to the animal bones mixed up with them a beautiful blue-green colour, just like the Great Orme samples.

Finally, just to clinch the issue, about 30 small bits of copper slag were found in or near the ditches, and four small globules of copper - obviously from a nearby smelting site. In support of this idea, a peculiar structure was found near the top of the fill in one of the ditches, which has been tentatively interpreted as part of

Fig.1: SKETCH MAP OF THE AREA AROUND CABRIÈRES (HÉRAULT)



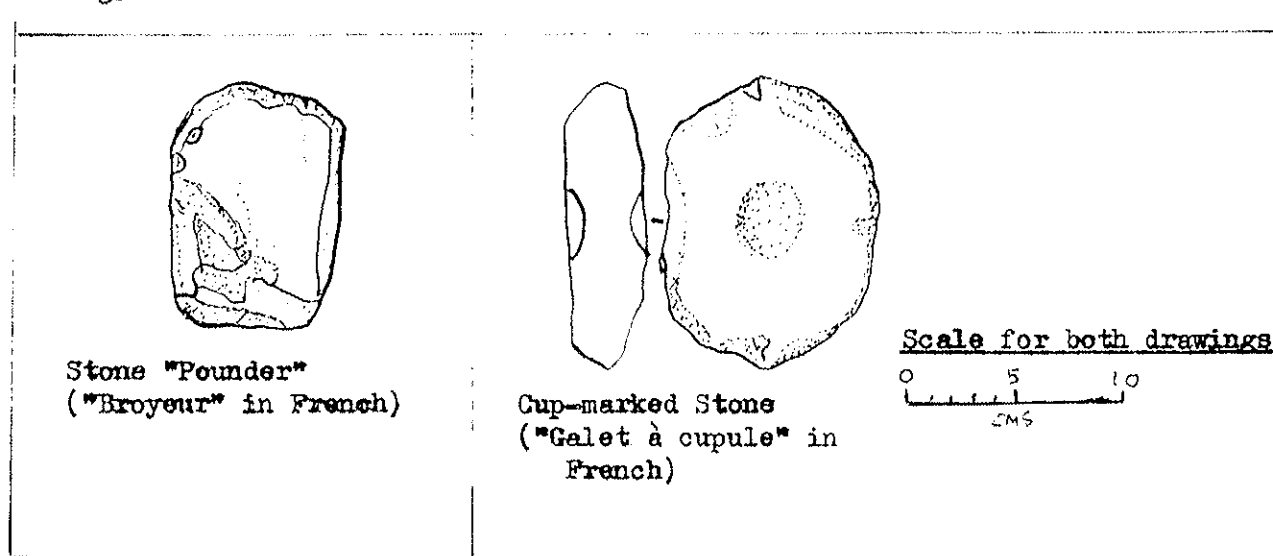
(Adapted from "Les Mines de Cuivre de Ploch Farrus (Cabrières - Hérault) - Préhistoire et Antiquité".

par Paul AMBERT, Hélène BARGE, et Christian LANDES.

(Actes du 110^e Congrès National des Sociétés Savantes, Montpellier, 1985)

- Études Languedociennes.

Fig.2: TYPICAL ARTEFACTS FOUND AT ROQUE FENESTRE.



(Adapted from Fig.17 in "Les Mines préhistoriques de Cabrières (Hérault) -

- Leur importance pour la métallurgie chalcolithique languedocienne"

by Paul AMBERT and Hélène Barge-Mahieu: Congrès International du C.N.R.S.

"La découverte du Métal", Musée des Antiquités Nationales, Saint-Germain en Laye, Janvier 1989).

a roasting furnace. It consisted of a vertical wall, 40 cm long by about 10 cm high and 3-4 cm thick in a quartz sandstone, 'indurated to a quite extraordinary degree', and coloured green by the copper carbonate. Under the microscope, this material was found to consist of fragments of schist, dolomite, copper ores, charcoal, slag and whitish quartz which was very fragile and believed to have been calcined by heat.

Just to prove the antiquity of the Rogue Fenestre site, a sample of the charcoal has given a C¹⁴ date of 1950 ± 130 BC (Ly 2869), which compares well with another C¹⁴ date - from the Grotte du Broum - of 2040 ± 70 BC (Gif 6048).

One last question is - where did this knowledge of metallurgy come from - was it an independent local invention, or brought in by migrants from some other area? At present this question seems to be unanswered, except that a recent find, near Carrières, of a type of copper blade called a "Palmela Point" - well known in the Chalcolithic Age of Southern Spain and Portugal - suggests that the initial impetus may have come from that area.

Time will tell, but meanwhile it is obvious that there is still a great deal more to be learnt from this intriguing site - just as there is from the Great Orme!

Geoff David, November 1992

Any member of GOES who would like to borrow my copies of the French articles, on which this report is based, is very welcome to do so. Your translating ability may well be streets ahead of mine.

GCD

WILLIAM VIVIAN

Since the last mention of William Vivian in this Journal I have made a great deal of progress and have located nearly all of his known essays and letters. One essay on mine ventilation, for which he won a prize from the Royal Cornwall Polytechnic Society, is proving a little difficult to locate but as a bonus I have found some uncited works in the South Wales literature. The subject matter includes mining engineering and geology as expected, as well as natural history, one of which is reproduced below.

In December I made a trip down to the London area to see William's Great Grandson who was most hospitable and more than helpful. A few years ago a family photograph album had passed into his possession, he recognised a few of the family members such as William, his sons and his grandsons, but many of those in the album remained unrecognised to him. Having browsed through the album I was able to identify his wife and daughter, his sister and brother in law as well as Captain and Mrs J Trevithick.

Don Smith, February 1993

A NOTE ON ANCIENT COPPER

A piece of ancient copper implement, or weapon, was lately found here; from its curved and bladed form, it seems to have been part of a bill-hook or large knife. On applying a microscope to it, to observe its structure, I find it is composed of very impure metal, having about one third of its bulk of the oxide of copper. According to the present mode of liberating the oxide from the metallic copper before it is ladled out into the moulds, a green pole is plunged into the bath of metal, causing violent ebullition, when the oxide, from its lighter gravity, rises to the surface, and is then skimmed off at the furnace front. In this piece of ancient copper, however, the oxide is retained in a mass, from which it may be inferred that the process of poling copper was not applied in the days when this was made.

William Vivian

Trans Cardiff Nat Soc 1868-9;11:48

CROSSWORD ANSWERS

Across: 1, Speleology. 5, Can. 6, Grade. 9, Seed. 10, Ski. 11, Awl. 15, Race. 16, Bag. 17, Adit. 19, Me. 20, See. 21, Copper. 22, To. 23, LT. 25, Winze. 27, Odd. 28, EST. 29, Vein. 30, Slag.

Down: 2, LA. 3, Lead. 4, GOES. 5, Chamber. 7, Red. 8, Firesetting. 12, Leg. 13, SRT. 14, Samples. 18, Dept. 21, Con. 22, Tine. 24, Idol. 26, Zen.