



Cymdeithas Daeareg Gogledd Cymru
North Wales Geology Association

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Front Cover Image:

Ordovician flow banded rhyolite with quartz intrusive vein, from the Nant Ffrancon Formation, Cwmorthin (see field trip write up this issue).

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Chairman's Message

Back in the closing years of the last century (that sounds very serious) the youthful Association invited Malcolm Howells to speak on the subject of the mapping work for the BGS and elucidation of the volcanic geology of Snowdonia, and I was delighted when he accepted. At that time my employer, Robertson Geologging Ltd. was in the process of drilling a borehole for testing purposes at the back of their factory in Deganwy, and I had hoped that his knowledge of the local geology might help in the interpretation of the rock cuttings which were coming to the surface. I regarded this as one of the more interesting phases of my career, since I had been employed as a computer software specialist and at last the diversification into geology which I had hoped for was beginning to take shape. The proposal of the Conwy Mountain for a RIGS site was proceeding, and a renewed focus on rhyolite was most enjoyable after a long gap since my first field season as a geology student in 1975.

Assisting me was Professor Andy Siddans, who had logged the formation as 'sandstone' while I was out of the office in the week previously, and I had regarded that as suspicious to say the least. Our sampling was primitive because the rig was normally used for drilling water wells for farmers, and with air-flushing and no dust control there was no simple way of catching the cuttings. Fortunately, the borehole proved to be very wet and dust was not a problem, but a fountain of grey water gushed continuously while the rig was working and we simply propped a wooden tray by the surface casing and tipped the bigger bits out every time we had a gap in the mud-shower. Malcolm arrived with his BGS hat on, lamenting that there was no time or budget for any work on the (important) sort of material which we were bringing to the surface, and

quickly demolished the sandstone myth (to my relief and satisfaction). I think that a compressor failure brought an early finish to the day's drilling, so we retired for a chat and a cup of tea. It transpired that Malcolm had planned to use his caravan (bear in mind that he had been working since the early 1970s on the adjacent Snowdonia multi-disciplinary study, and needed a cheap base for operations) for accommodation, but when he had called by to ascertain its condition had decided against the attempt. Instead we found him B&B at the Deganwy Castle Hotel and in due course he came for a meal at my house with my mother-in-law and children. We had a nice meal together and then departed for the Conwy Civic Hall to conduct the meeting and a summing-up at the Castle Hotel in Conwy. Eventually, I suppose he wended his way back to Leeds and his day-job. All-in-all as fine and sociable a day of geologising that one could wish for.

I did not have the pleasure of meeting him again until the Herdman Conference a few years ago when he was an enthusiastic listener to the tales of volcanism in Korea, or was it Antarctica, but no matter really. We conversed again on the Conwy Rhyolite Formation and he corresponded with me for a while, filling-in a lot of the background to the woeful lack of publication on that subject and the history of research into ground conditions for tunnelling at Penmaenbach.

Yes, there is a point to this long anecdote, and it is that I read with sadness Malcolm's obituary notice in *Geoscientist* a few months ago. In reading it I found that all my perceptions of the man had been noted by his obituarist, particularly his love of the rocks of Wales, Snowdonia especially, dedication to the job of tackling the rocks on the ground and a warm, outgoing personality that explained why he was so kind as to come over to address our fledgling Association and offer his time and expertise.

The loss of such great men is a consequence of a longer march of time than I really care to admit, and it must be noted that Andy Siddans (a specialist in structural geology and the development of fabrics such as cleavage in slates and welding in ignimbrites) has also passed away, as have both the Deganwy Castle Hotel and the Conwy Civic Hall. In recent weeks, Robertson Geologging has rebranded itself as Robertson GEO, “Unlocking Your Geodata”, and both of the senior directors who were in post while I was employed have since retired. In fact, news reached me just today that Tony Wright had passed away very recently. It seems that the past is already a foreign land indeed! However, the rocks of North Wales are made of sterner stuff and are a constant over human timescales at least, so read on.....

Last year we made a foray into one of the country’s iconic holes in the ground at Penrhyn Quarry, where the working for slate is entirely open to the sky. Back in 1991 I was persuaded by a work colleague, Richard Holmes, who lived in Dolwyddelan that it would be a wheeze to take torches and wellies and explore the Rhosydd Quarry perched on the col between Cwmorthin and Cwm Croesor. My son, who was 6 years old at the time, came with us and we had a fascinating time following the main adit with its abundant water flow, abandoned haulage cables and occasional log-jam of half-floating wooden sleepers from the tramway to the main incline half a mile inside the mountain. The beautiful and slightly melancholy landscape took hold of me, and I have returned at intervals ever since to explore the cwm and its geological and industrial legacy.

Following the success of the trip(s) to the Cambrian slate belt in recent years, it seemed logical to follow up with a visit to the hidden world of the Ordovician slate workings, and I had long known that

Cwmorthin was accessible, but not in the public sense of tourist attractions at Llechwedd or the late Gloddfa Ganol. Over the intervening years, suited and booted descents into the Parys Mine and Great Orme Mine, or the potholes of Loggerheads Country Park had shown just how wonderful exploration of the underground realm could be, so the scene was set. The first attempt a couple of years ago fizzled out because the organisation in charge of the derelict Cwmorthin Quarry could not be persuaded that what I wanted to do was sensible or in their interest. Since then the vogue for adrenaline-fuelled leaps, slides, bounces and falls off or into any part of the North Wales coast or mountains has grown, and with it the confidence of the providers.

I therefore count the meeting inside Cwmorthin Quarry as a personal success as well as a success for the Association, and the combination of an enthusiastic group, excellent guides and perfect (if rather hot) weather as the ideal combination and fulfilment of the Association’s brief to bring geological appreciation to its members. We should also remember that the legacy of our industrial past is fragile, and without the dedication and largely unpaid endeavours of organisations such as the Friends of Cwmorthin we would not only be unable to visit and appreciate such locations, but would be much the poorer as a society. I think we owe a great deal to visionaries such as LTC Rolt (1910-74), who as far back as World War II realised that the structures and way of life that had long sustained society were in danger of being lost in the headlong rush to modernisation. He started on the canals, became disaffected and moved to industrial railways, albeit in the bucolic wilderness of mid-Wales. The term Industrial Archaeology was coined in Britain, and thankfully we remain good at conserving our past, increasingly as paying tourists perhaps, but based on a strong recognition

that the working life of our forebears is history and worth studying. What the disprited and financially-broken men who walked away for the last time in 1930 from the Rhosydd Quarry high in the Moelwyns would say about the fervent 21st century exploration of their former workplace can only be conjectured. I am sure that the popularisation of these concepts in contemporary literature and their illustration by unsung artists such as John Kenney (1911-72) planted many a seed, certainly with me.

Now, here's the rub. Some of you, and exclusively those reading a physical, paper-based newsletter will not have even heard that the meeting was taking place, which is a poor state of affairs and one for which I have to apologise. I have long maintained that equal rights for members who do not rely upon electronica for information and communication must not be disadvantaged, but that principle has not stood up to the multiple-whammy that has disabled the effective organisation of the Association in recent months. Please remember that all bar one of the people who fulfil necessary functions on the committee are in full-time employment, and not necessarily close to home. By the time research for a PhD, normal family life, holidays and other extra-curricular commitments are factored in there might be very little opportunity to deal with the time consuming business of writing for and editing the Newsletter, or contacting and negotiating with speakers and guides within useful timescales for publicising meetings. So we did our best, but could not get the necessary details finalised in time to go out on paper by post. Indeed, some critical details were not finalised until Thursday before the Sunday meeting. If anybody is aggrieved at this, please let me know and I promise that you will be first in the queue for the return visit to Cwmorthin Quarry.



In the meantime, two further field meetings are planned for the summer, and details are inside in their usual place. Both are of easy or only slight difficulty for access, and we hope that they will be attractive to members who do not fall into the categories of die-hard rockers or re-enactors of the travels of Frodo's company in Moria and Middle Earth. We look forward to seeing you there.

References:

Awdry, W., (1959), *The Little Old Engine*, pp 8-12. Edmund Ward, London.

Rolt, L.T.C., (1971), *Landscape with Machines*. Longman, London.

Jonathan Wilkins

Articles:

Anglesey’s Coral Paradise

As far-fetched as the title may sound, there is truth in it, evidenced by the limestone cliffs between Penmon and Lligwy. This limestone was formed when Wales was part of an archipelago of islands in a tropical sea during the early Carboniferous, 345 to 360 million years ago. A simplified stratigraphy of the Carboniferous is shown in Figure 1. On Anglesey, the marine limestone is all within the Viséan and lowermost Namurian Series, as defined by the occurrence of the solitary rugose coral, genus *Dibunophyllum*,

CARBONIFEROUS		
European Stage Boundary		International Boundary
Series	Subsystem	Subsystem
Autunian	SILESIA	PENNSYLVANIAN
Stephanian		
Westphalian		
Namurian		
Viséan	DINANTIAN	MISSISSIPPIAN
Tournasian		

Figure 1: Carboniferous stratigraphy

On Anglesey, there are four geological Sites of Special Scientific Interest (SSSI’s) designated for Carboniferous marine sedimentology (Anon, 2004), all of them being coastal. Inland, the once numerous small quarries for excavating local building stone have all been filled in or grown over, and good examples of in situ reef are now scarce. Much of the limestone quarried today is devoid of fossils, save for the brachiopods *Daviesiella llangollensis* and *Gigantoproductus latissimus*, which are often abundant and can be seen weathering out of limestone walls across Anglesey, particularly around Benllech.

Modern exposures frequently arise as a result of civil engineering works, and one such example has taken place as part of development at Coleg Menai Llangefni. This has involved construction of a ring road, east of the college, joining Penmynydd and Talwrn. At the time of writing, this is now operational, and works are underway to develop access to the College from this route. It is these works that have exposed a remarkable reef system a mere 600mm below the overlying drift, as shown in Figure 2 below.



Figure 2: 600mm of topsoil overlying a karst type weathered limestone pavement

This exposure won’t be visible for long, so in my capacity as site ecologist, I took the opportunity to make some basic

observations. The exposure is nearly horizontal and not subject to the distorting tectonic forces which affect so many early Palaeozoic rocks in North Wales. It consists of at least two sedimentary cycles: hard limestone reef formation, giving way to dark laminated mudstones forming thin layers, themselves resting on another hard limestone reef, and so on. The strike is to the south-east as shown in Figure 3, disappearing under the relief road.



Figure 3: Tape laid out along strike

Original vegetation & hydrological survey of the fields indicated that water pooled at this, the lowest corner, before draining away through the limestone. The effect of water percolating through the overlying soil was to act as a weak acid, eating away at the limestone marginally faster than on the fossils (both of which are formed primarily of calcium carbonate). The result has been to pick out the fossils in sharp relief, much as if the reef had just died.

The reef displays examples of fossil corals known elsewhere from the Carboniferous limestone of Anglesey, which serve to correlate it with limestones across South Wales and western England. These include the eponymous *Dibunophyllum bipartitum* which defines the *Dibunophyllum* Zone. Commonly referred to as a ‘horn coral’, to

look at *Dibunophyllum* resembles an ice-cream cone. Internally it has a reticulate structure, and when an individual coral is sectioned horizontally this netted structure is clearly visible. Vertically, it reveals a network of cells providing support, like the internal framework of a plant stem (see Figure 4. Sectioning the hard limestone requires a rock-saw and hours of polishing with wet-&-dry sandpaper, but at Llangefni, the percolating water has taken the labour out of this.



Figure 4: *Dibunophyllum* (Horn Coral)

Other species include various species of *Lithostrotion* – a colonial coral resembling crazy plumbing – *Amplexus coralloides* and *Lonsdaleia floriformis* (Figure 5). *L. floriformis* is another colonial species where the individual coral polyps fitted together like a honeycomb. Amongst the debris there are also many brachiopods, and the particular interest of this site is that these have been weathered clear of their limestone matrix & can be picked up like pebbles. Usually they are impossible to extract. Thus we have genera which include tongue-twisters like *Schellwienella*, *Pleuropugnoides*, *Dielasma* and *Daviesiella*. All are Viséan, and typical of reef limestones across Anglesey. The uniformity of this fauna is a result of the seas encroaching much later on Anglesey than elsewhere in east Wales (NERC, 1961) and representing just a small temporal window of biodiversity. Elsewhere there were several cycles of

marine transgression & regression, linked with glacial cycles in the polar regions of the day*, and different fauna are representative of each cycle.



Figure 5: *Lonsdaleia floriformis*

Only shelly faunas are preserved, including crinoid ossicles (sections of the stem that look like polo mints) and very rare trilobites. Like the brachiopods, these are scattered about among the coral blocks, and while collecting these, several bones appeared. These were dismissed as sheep bones; reinforced by finding teeth obviously attributable to sheep. Then a pig tooth was found (Figure 6).. then one that belonged to a horse.. and suddenly a section of jaw with five teeth that were obviously human (Figure 7). Immediately the site becomes a crime scene, and the beautiful exposure of coral is eclipsed by police tape and an inquisitorial trip to the police station.

Not for long though. The site has archaeological “form”. In 2016, during construction of the link road, a total of 42 bodies, buried in ‘cist’ graves, were uncovered. The site was confirmed as a 1500-year-old early Christian graveyard of National Importance, and several weeks or archaeological works were undertaken to excavate the remains.



Figure 6: Pig tooth

Archaeology obviously trumps geology! However, the shallow depth of soil above the limestone pavement, and the field’s subsequent use for agriculture (evidenced by ridge-and-furrow profiles detected during the vegetation survey) long after its use as a graveyard had been forgotten, scattered these graves and their bones far and wide when it was ploughed.



Figure 7: Not pig’s teeth!

A disjunct between 350-million-year-old limestone overlain by 1500-year-old drift? ..even I can recognise that as an unconformity!

Naturally, none of this is considered sufficiently important to disrupt progress and the site will be soon enough be buried beneath tarmac and concrete. But the College has committed to displaying a selection of reef limestone blocks in the entrance, with a permanent display board describing this ancient tropical sea. It is very rare to get geology into environmental mitigation, so we might regard that as a good result.

References

Anon (2004), “British Lower Carboniferous Stratigraphy”, Geological Conservation Review Series, No. 29, Joint Nature Conservancy Council

NERC (1961), “North Wales” British Regional Geology: 3rd Edition, Institute of Geological Sciences

Richard Birch

Editor’s Note:

See the Abstract for the Benllech Site Visit in August for more related to the Carboniferous “cyclothem”.

Slate Mining at Cwmorthin, some observations relating to roof fall

The lack of any modern approach to Health and Safety by the mine owners during the late nineteenth century was a key discussion point of the recent field trip written up by JW elsewhere in this newsletter. Also discussed at length was the relationship between cleavage and bedding seen underground. Mulling these elements over and reading Graham

Isherwood’s book on Cwmorthin (Isherwood, 1982) I have concluded that these two elements may well be related, as described below.

Firstly some comments relating to the death rate at Cwmorthin. Isherwood lists a number of fatalities described in an 1895 enquiry, relating to the period between 1875 and 1892. In total 21 deaths were reported over a period of 17 years, i.e. averaging somewhat over 1 a year.

5 of these deaths can be attributed to what might be considered “misadventure” or “error” – such as man riding in a slate wagon, or being struck by a windlass handle. That leaves 17 deaths and these were all related either to falls from height (6 cases) or roof / rock falls (11 cases).

Many of these deaths related to roof or rockfall were considered as, without any hint of irony, “*natural causes*”, and a function of the presence of “*bevels*” in the rock. Isherwood records the following statements from the inquiry:

“..there are so many bevels in the rock, and the rock is small in several places, and liable to break. There are many small joints, especially the bevels.”

“I attribute the high average of fatal accidents to our ground being very disturbed, having a good many faults and bevels and so on....and we have a great deal of trouble with our roofs”

What then is a bevel in this context? In order to come up with a possible answer we need to reconsider this question of bedding and cleavage. Bedding reflects the original sedimentary environment of the sea floor at the time of deposition and in early diagenesis, prior to the rock being deformed by tectonic forces. In this case we are dealing with mudstones of the Nant Ffrancon Formation. The primary bedding feature in this case will be near horizontal

(given the natural variability of a sea bed subject to current movements, tides etc). It would entirely reasonable to anticipate two further joint sets to develop during diagenesis at mutually orthogonal angles to the bedding aligned with the intermediate and minor principal stresses (the vertical direction is the major principal stress (Figure 1).

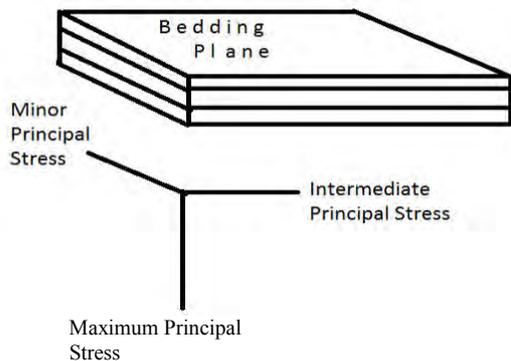


Figure 1. Orientation of Principal Stresses during early diagenesis of sedimentary sequences

The Nant Ffrancon Formation is mid to late Ordovician in age and early diagenesis would have taken place, during latest Ordovician and Silurian times before the onset of Caledonian tectonism (generally considered to have occurred during the Devonian). The onset of tectonism imposes a new stress regime on the sedimentary pile, during the process of regional scale folding. This new stress regime involves considerably higher pressures, and in particular a much greater imbalance between the major principal stress and the two minor principal stresses. The major principal stress dominates the developing stress conditions, and results in formation of the primary cleavage that gives rise to the slaty fabric that made the rock so amenable to use as roofing slate, and dictates the shape of the chambers below ground.

A consequence of the discrepancy between the orientation of the sedimentary and tectonic stress regimes, is the

misalignment of bedding and cleavage observed in the rockmass. In the general case it could be seen underground that the dip of the bedding was typically 10-15° less than the dip of the cleavage.

In attempting to work the slabs of best prized slate, what would be the significance of the earlier defined bedding? It is my contention that the “bevels” represent the line of intersection between the bedding surfaces and the cleavage planes, and coupled with the presence of the primary minor and, or intermediate stress joints this gives rise to the potential for stepped planar surfaces. Once the initial failure occurs it is likely that the cleavage then becomes involved, but in an uncontrolled manner as shown in Figures 2a-2d below.

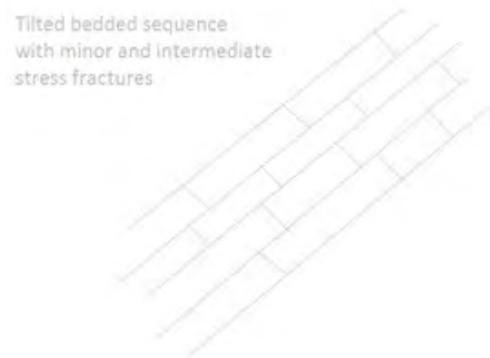


Figure 2a: Bedded sequence, folded but not cleaved

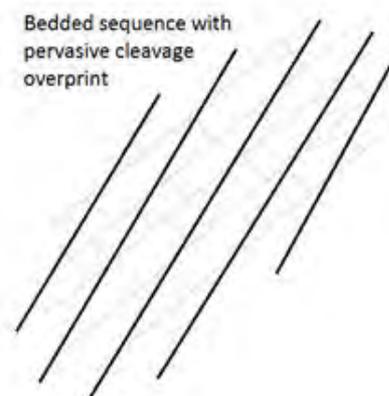


Figure 2b: Cleaved sequence

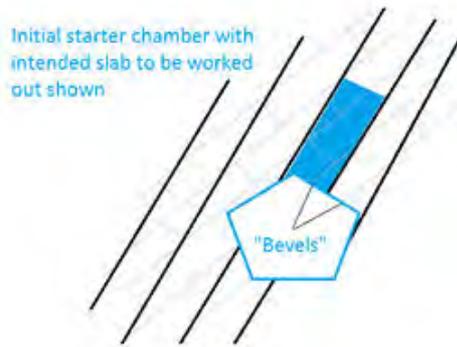


Figure 2c: Chamber starter tunnel dug

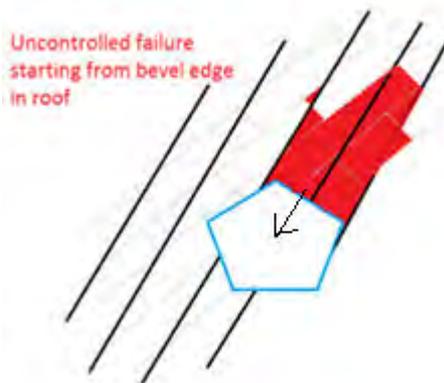


Figure 2d: Unplanned roof fall, due to initial failure of “bevelled” bedding / cleavage intersection

Unfortunately few of the photographs taken underground came out well, and I was concerned that I might not be able to illustrate the difference between the bedding and cleavage, until I remembered “The Kitchen Stupid!”

Two years ago I had spent a small fortune on insisting that I wanted the very best Welsh Slate surfaces in our new kitchen, “and none of that Berwyn Silurian rubbish, I want the good Ffestiniog stuff”. So Figure 3 below shows a slab of best Ffestiniog slate. The cleavage has been used to split the rock, and provide the work surface. The flat dark grey / grey banding represents the original bedding, although clearly disturbed by bioturbation (Ordovician trace fossils...!).



Figure 3: Bedding intersections with cleavage exposed in slate worktop

It is these features, along with the many other more randomly oriented faults, joints and shears that I believe form the “bevels” described by the Victorian miners. I consider it likely that the origin of the bedding plane bevels, in an ordered geological process, gave rise to the widespread presence of “problem roof conditions” that were a constant source of danger to the workers. The “management” process espoused by the managers of the day of removal of the bevelled pillars is contrary to today’s good practice, and probably caused a significant number of the fatalities during the late nineteenth century. Modern practice would involve leaving the pillars in place, and pinning in any problematic kinematically unstable wedges.

Reference

Isherwood, G. (1995), “Cwmorthin Slate Quarry”, Adit Publications, Mold.

KHN

Reports:

NWGA Field Meeting

*“Thrills and Chills, Cwmorthin Quarry”
1st July 2018*

Sunday 1st July dawned bright and fair, but after two months without significant rainfall some of us were beginning to regard the cloudless sky and hot sunshine with trepidation – but the prospect of plunging into the cool depths of the Cwmorthin Quarry was a great incentive to overcome the first and most challenging hurdle of the day. Cwmorthin, which gives its name to the quarry, is a hanging valley of remarkable beauty situated above Tanygrisiau near Blaenau Ffestiniog and thus within the Ordovician slate belt of southern Snowdonia. The Vale of Ffestiniog is already spectacular, with the rugged peaks of the Moelwyns rising to 770m from the floor of the vale which is incised deeply at just 20m elevation to the south of Tanygrisiau. Here the twin sentinels of Craig yr Wrisgan and Craig Nyth y Gigfran guard the entrance to Cwmorthin with its lake at 320m, suggesting that there is a stiff climb involved at some point. Fortunately, much of the climb can be made by car to the uppermost car park, but it is still a stiff walk to the lake, barracks and former quarry manager’s cottage, especially when burdened with additional clothing, lunch, wellies etc.

Taking the climb steadily gave us ample opportunity to tune in to the locality. Above, on the eastern side of the river which cascades noisily down its steep course are stacked layers of waste which correspond with the levels of the upper adits of the quarry. On the western side there is a great deal of bare rock exposed and showing superb glacial smoothing and plucking, with occasional erratic boulders of great size perched on ledges on the

hillside. The river banks are built-up with walls of slate, which are beginning to deteriorate seriously. While we were there the flow was very feeble, but pictures that I have seen of floods after heavy rain are quite scary and the surprise is that the walls and road survive at all!

A levelling of the path brought us to the location of the first of the mill complexes which once sat at the foot of the main incline from the workings and astride the river. Water power was critical to the operation and there are the remains of wheel pits and some foundations, but sadly most of the major buildings were destroyed for no good reason during the later 20th century working of the site. Nowadays there is a small run-of-river hydro-electric power scheme in operation with an annual design capacity of 1350 MWh, and it is interesting to note that the pipeline runs beneath the steep track which we ascended. This was not the main route for exporting product, of course, and the incline and tramway linking with the Ffestiniog Railway lies to the east of the lower tip and is completely hidden. After a breather and familiarisation talk the party ascended the remains of the Lake Incline to Cwmorthin Cottage where Go Below have their kit-stores and the underground adventure commenced after suiting-up, testing lamps and a short walk to the Lake Adit.



Figure 1: Suited and booted

The Lake adit was the principal access for much of the working life of the quarry so there was quite a long section where tipped material formed the walls of a narrow

canyon along which blew a most extraordinary, cold wind caused by warm air entering the upper levels of the quarry and sinking as it cooled and flowing out of the lowest exit that could be found. The cold blast was much appreciated, although we were in deep shade already and awaiting the unlocking of the gate.



Figure 2: Feeling fresh!

One feature of the quarry that ensures its fame is the spectacular collapse (1895) which rendered most of the southern part of the workings out-of-bounds. The veins or slate strata belong to the Nant Ffrancon Sub-Group of mudstones, but there are also useless siltstones and sandstones, which dip at around 45 degrees to the north. Rhyolitic tuffs and intrusions (the outcrops which form the craggy hills at the lip of the cwm) lie stratigraphically below the slate veins, so all of the southern workings are above the Lake Level, and northern workings are below it.

The systematics of naming the levels are simple: floors at and above the lake are numbered 1-8, while those below are lettered A to G. Individual caverns which were excavated to exploit the slates are numbered outwards from the main underground inclines e.g 1-8W and 1-9E. If that is confusing, consider that the layout is replicated (at least partly) in each of the Old, Stripy, Narrow and Back Vein and to travel between them you move horizontally in a north-south direction. The Old Vein is the lowest stratigraphically. To follow the veins you must move on one of the inclines on its dip slope, or to move along the strike you move horizontally in

an east-west direction. It's easy when you have constructed an adequate 3-D mental map, and the bedding direction can usually be detected and used for orientation.

The floors are supported by pillars which the quarry surveyor ensured were placed in the correct position beneath or above each other, so travelling along the floors brings you through tunnels in the pillars to the lower end of a chamber which developed up-dip as the slate was worked, but this is where things begin to go awry. The pillars are made in part of the very material which was being won, which was considered wasteful and offered an easy way of raising profitability at the expense of sustainability. Allowing a down-dip chamber to grow through the floor of the next level was a simple expedient, as all that was needed was a wooden bridge to replace the floor of the level, and some chambers in both the Back and Old veins extend across four levels. There is a common caution against entering any old workings without due care and equipment, and here the sudden transition from sensible tunnel to the non-existent deck of a wooden bridge was quite enough to induce an 'Oh-shit!' moment* of cold fear in me, especially when the lack of a comforting echo indicated a hole that might be 40m deep in front of you. It is these transits by zip-wire, abseil or 'Tyrolean' which constitute the 'adventure' element of the experience offered by Go Below, our hosts.



Figure 3: Bridge to nowhere

Anyway, back to the pillars and the comfort that their presence endows. The other way of making a quick profit is to thin the pillars down. This was done with gay abandon by the corrupt and culpable** quarry managers of the late 19th century, to the extent that a massive collapse of the southern workings occurred in 1884, rendering a large part of the quarry inaccessible or dangerous and creating such significant ground movement that slip-scars can still be seen on aerial imagery of the surface above. The reservoir which fed part of the Oakley workings drained into the Cwmorthin quarry and compounded the disaster.

Although production was continued, the venture was severely damaged and by 1888 had ceased completely when the New Welsh Slate Company took over and started to work downwards from the Lake Level until financial difficulty caused them to give up in 1900 and sell-out to Oakley. The new chambers were left untouched and the workings flooded to the Lake Level. Eventually, the Oakley Quarry developed below the level of Cwmorthin's deepest chambers and the standing water was recognised as a serious hazard, so a drainage adit was driven westwards from the Oakley and the water was lowered. Chambers at depth on the Back Vein were worked from the east. A new floor G was opened before in 1970 the whole Oakley Quarry enterprise was bankrupted by the expense of pumping the water from its labyrinthine workings. Thereafter, small-scale working by teams of local men working entirely for themselves continued until they were effectively evicted by McAlpine's (2000) unsuccessful attempt at un-roofing the complex to work the remaining pillars. When viewing the scene from afar it is easy to look at the mountain as a solid entity, but the abandonment surveys suggest that as much as 60% of the mass between the Old and Back veins has been quarried away and the remnant is a virtual honeycomb.

Our party then proceeded to explore the remnants of the most recent aspects of underground quarrying and saw the principal man-entry to the lower workings which was a zig-zag wooden stairway (no longer safe for access) descending Chamber 1 West. Instead we descended the Back Vein incline for two floors, which would not be permitted during the working period of the quarry. The incline was later reconfigured for electrical haulage and retains the rails of its single line, as well as two overturned wagons which appear to have been launched down the incline without restraint during an attack of vandalism. Inaccessible as they are, they have evaded the stripping for scrap that would normally be the final act. From below we gazed in awe at the size of the chambers on each side of the incline, and learned how the chambers would be developed following the striking of a bargain for its product. It was very strange to arrive at the base of the wooden stairway by an alternative route and look upwards.



Figure 4: Stairway to heaven?

We also descended to the next floor via a beautifully-made slate stairway which has been exhumed from all the accumulated junk of ages, and it was salutary to think of all the boots that had passed up and down over the years. Water, of course, was everywhere. The incline was deliberately set at the foot of a slight gradient along the floors so that it became a drain and its base formed a sump for the pumps – though nowadays it all trickles out of the Oakley Quarry on the opposite side of the mountain. A strange feature in many places were strata that collected condensation as large drops which reflected torchlight and made brilliant reflecting jewels over quite wide areas at times. We also found areas of bad rock permeated by pyrite which had oxidised to ochres which stained the rock in brilliant reds and yellow colours, and white crusts of jarosite which is a well-known secondary mineral formed by reaction between the rock and acidic water arising from the same oxidation. All the time, our guides kept up a constant stream of information, anecdote and history which amounted to a veritable A to Z of slate quarrying – just what we had hoped for, in fact.

Eventually we were beginning to feel hungry and were forced to make our way reluctantly back up the incline for a brief visit to the Old Vein and a period of reflection in complete darkness and silence. Here I was pleased to be able to sample the pristine material where a pillar had collapsed and deposited massive blocks of highest-quality slate on the floor of the adjacent chamber. Cathy was captivated by sparkling mineral deposits on the wall of the chamber, so a small poly-bag was deployed and the trip was thus completed by collecting a mystery mineral sample for analysis by XRD. The sample of the Old Vein will also become an XRD and XRF target, but more of that later perhaps. The Lake Level adit isn't straight as it reaches the surface, so it was

only at the last moment that we were aware of reaching the end with its low, timbered ceiling and suddenly it was bright sunlight again with a cold draught behind us and a wall of raging heat in front. Extraordinary...

After lunch the party broke up, with the less enthusiastic members descending to the café for cakes, and a small, determined group that set out to explore some of the surface workings and try to fill in some geological details. Of great interest were large boulders of flow-banded and flowage-folded rhyolite which appeared to be the remnants of a layer capping the area unroofed during McAlpine's most recent work (see the front cover of this Newsletter). We proceeded as far as the limit of the tips below Craig Nyth y Gigfran and were able to examine the rhyolite tuffs in-situ, and marvel at the view over the Vale of Ffestiniog and Trawsfynydd. By complete coincidence we were pleased to watch a steam train climbing past the power station on its way to Porthmadog, alerted by the slightly mournful sound of its chime-whistle. For me that sound is part of the scenery of the Moelwyns, and finished the trip perfectly.

Our thanks go to Go Below (<http://www.go-below.co.uk/>) who facilitated the visit and to our guides, particularly Peter Knight who worked so hard and enthusiastically on our behalf, while displaying complete professionalism and patience alloyed with extraordinary erudition on every aspect of mining, quarrying, caving and safety.

My personal thanks go to all the participants without whom my mad idea for a meeting would still be just that. Finally, without the determination of the Friends of Cwmorthin Quarry (<http://www.cwmorthin.org/>) over decades none of this would have been possible. We look forward to a return visit.

Postscript:

The sparkly mystery mineral turned out to be gypsum, which isn't entirely simple to explain. The source of sulphur is oxidising pyrite, of course, but the source of calcium is obscure since the chemistry of the slate includes very little and none of it in the form of calcite. Answers on a postcard please.....

Jonathan Wilkins

Editor's Notes:

* Technical term obviously

** Interviews recorded by Isherwood for the 1895 enquiry make it clear that such "pillar robbing" was presented by the management team, perhaps somewhat disingenuously, as a necessary safety precaution to remove the "bevelled" pillars.

Abstracts:

"Halkyn Quarry, Flintshire"
Chris Twigg and Tom Hughes (NEWRIGS) and Keith Nicholls

This field trip is a follow up to Tom Hughes short article in Newsletter 97, and to the brief "taster" visit a number of us made to the western quarry high wall last summer.

There is a lot to see here, in spectacular exposure. The site is an abandoned quarry, with open public access, and opportunity to park nearby. In the quarry itself, there are the usual precipitous walls, spoil heaps etc, but it is only a short walk from the car park area, into the quarry, and this should not be considered an arduous trekking visit.

As would be expected in an old quarry the underfoot conditions are far from ideal, and there are the usual dangers from rock fall, falls from height etc. There are also substantial bodies of standing water (although this year probably much diminished). Hard hats are recommended for those approaching the faces.

Please note hammering should only be limited to breaking up existing fallen debris (there is plenty of it). As well as the usual brachiopods and corals there have been a number of sharks' teeth, and a coelacanth jaw recovered from this quarry. News hot off the press, Chris Twigg has promised to bring along the coelacanth jaw!

Once we have finished fossicking there are plenty of interesting outcrops of limestone, and old mining archaeology in the surrounding landscape to walk about in.

“Carboniferous karstification - Benllech”

Jonathan Wilkins NWGA

This meeting is designed to appeal to members who do not relish arduous upland or subterranean rock exposures; instead we take to the traditional Welsh seaside for a look at the Carboniferous Limestone of south-eastern Anglesey.

Cyclic sedimentation is well-known in this formation, where thick beds of limestone are interrupted periodically by mudstone beds representing deeper water. However, emergence of the limestone surface due to lowered sea level allowed the development of a Carboniferous karst surface which has been exposed to modern view as a result of erosion. Subsequent to the development of the karst surface, renewed sedimentation as the relative sea-level rose once more resulted in sandstones being deposited into the features of the karst surface. The modern exposure of these features include in-filled pipes and isolated sandstone columns where limestone has eroded from around them. It is claimed that these exposures are unique in the British Carboniferous!

Join us for a very gentle rocky-ramble, whose maximum elevation is around 5 metres and whose maximum length is around 1000 metres, depending upon where you park your vehicle. Full facilities are available in nearby Benllech, and we have checked that low tide is at mid-day.

Dates for Your Diary:

NWGA:

Summer Field Meetings

Sunday 29th July

“Halkyn Quarry”

Chris Twigg, Tom Hughes (NEWRIGS) and Keith Nicholls

Please register your interest with the Keith Nicholls by email or telephone.

See Abstract earlier in this Newsletter

Sunday 19th August

“Benllech”

See Abstract earlier in this Newsletter

Please register your interest with the excursion leader, Jonathan Wilkins by email or telephone.

Autumn Evening Meetings

“Wednesday October 10th”

“Title to be confirmed”

Dr Mike Roberts Bangor School of Ocean Science

All meetings 7:00PM for 7:30PM start, at Pensychnant, Conwy, unless otherwise noted.

Other Groups' Meetings

Mid Wales Geology Club

The Hirnantian Type Area – the Hirnant Valley, Bala

To be led by Keith Nicholls

Sunday 9th September

NWGA Members are welcome –
contact Keith for joining instructions

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