Cymdeithas Daeareg Gogledd Cymru

North Wales Geology Association

NEWSLETTER

Issue 92

May 2016

Inside this issue:

Front Cover Image:

***Offacolus kingi*, a chelicerate arthropod from the Herefordshire Lagerstatte (Wenlock Series, Silurian). The specimen is approximately 6mm long including the tail. The beautifully preserved appendages project anteriorly from the specimen. See report on LGS talk in this Newsletter. Permission from David Siveter to use the image is gratefully acknowledged.**

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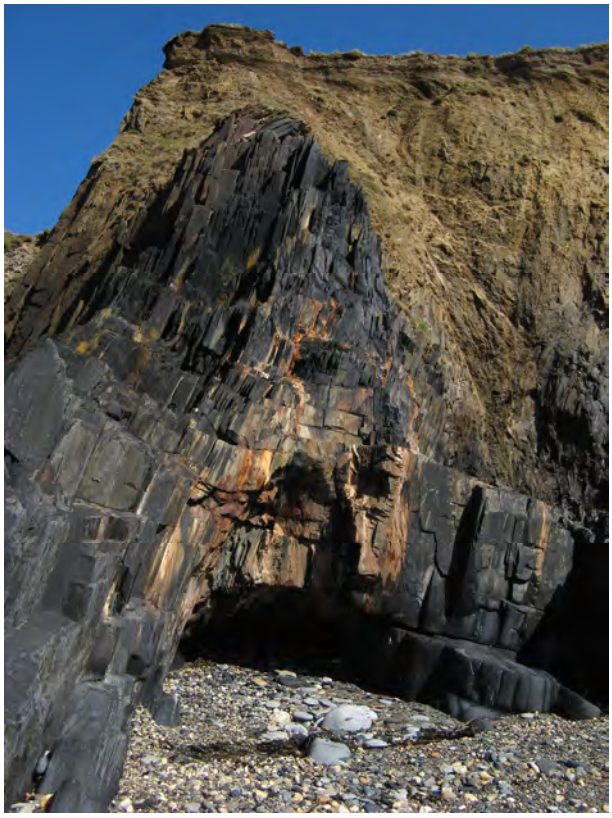
Chairman's Message

At this time of year the focus moves from indoor meetings to the field, and I hope that you have enjoyed the recent lectures. A tour-de-force on the geology of Morocco was followed after Easter by a captivating story of dinosaur discoveries in Wales culminating in a rock-fall that yielded a wholly new species (*Dracoraptor hanigani*), the country's first meat-eating dinosaur, and possibly the earliest Jurassic dinosaur ever discovered. Plenty of excitement there; and also the first meeting on the subject of dinosaurs that we have held.



My own field meeting season has already opened, with a week in North Pembrokeshire. This is an area that my family has visited for holidays in the past, but the focus on children meant that I was not able to indulge myself quite so freely, although my daughter at the age of around 7 years was well able to spot trilobites once she had got her eye in on the seashore outcrops at Abereiddy (see the image above). The geomorphology of the district is a delight, with iconic, rugged uplands formed by intrusions of gabbro contrasting with smoother country underlain by slaty mudstones and all surrounded by magnificent cliff scenery. I was pleased too, to come home with some graptolites collected from a loose cobble on the beach, though they are so numerous that individual outlines are difficult to discern.

While I was away I tried to catch up with some reading, and would like to share with you a story that featured in the account of a lecture to the Petroleum Exploration Society of Great Britain (PESGB) in Aberdeen. The Forties oilfield in the North Sea was the first major find and remains the largest, coming on stream in 1975 and making major profits for BP and the UK Exchequer. Nevertheless BP sold 95% of its stake in 2003 as production declined, but Apache Corporation who bought in were able to re-appraise the prospects and plan for extending the life of the field by 20 years. And there's the problem. Gas which is produced alongside the petroleum liquids is used to power the production platforms and pressurise seawater to inject into the lower parts of the reservoir to drive the oil upwards, and it is running out - meaning that diesel would have to make up the shortfall and the productive life of the field would be at risk. The area is well-known for shallow gas blowouts from within Pleistocene deposits at relatively

shallow depths, so an audacious plan was hatched to explore for similar, productive reservoirs, resulting in the discovery of the Aviat field in strata of the Early Pleistocene, and the reinterpretation of the glacial history of the area to suggest that grounded ice reached the Central and Viking Grabens between 1.9 and 1.6 million years ago. The Aviat stratigraphy indicates an advance and retreat of a fast-flowing ice stream with changes in the grain-size of deposits leading to a well-connected and deliverable gas reservoir extending over an area of 35km2 (presumably charged by gas leaking from deeper reservoirs). And, there is the potential for developing more of these curious and troublesome little reservoirs, which is important now that “King Coal” is dead and “Gas is Good”. Quite the most off-beat and fascinating article that I have read in quite a while! (PESGB Magazine Jan-Feb 2016, Abstract of Aberdeen evening lecture February 2016, pp10-11). Link: https://issuu.com/pesgb64/docs/jan_feb_2016

Another story, this time from The (Manchester) Guardian the other week: "innovative beach huts designed by viewers of George Clarke’s Amazing Spaces on an unspoilt stretch of Dorset coastline have infuriated local people". Apparently Christchurch Borough Council is more concerned by potential publicity than potential or actual damage to the fragile cliffs, or despoliation of the area. "The huts will not require planning permission under “permitted development” rules which allow garden sheds but the council does require the permission of watchdog Natural England for construction on an SSSI. Development would not normally be permitted if the cliffs were protected for flora or ground-nesting birds, but Highcliffe is an SSSI for its geological value and beach huts would not impact upon these features." Another quote now, from the SSSI citation: "Within the sands of Friars Cliff and Highcliffe there is a particularly fine assemblage of plant fossils. These cliffs are the only known locality with a diverse flora from the Boscombe sands. Over fifty species have been recorded from these beds and this is the type locality for fourteen of these species and two genera; eleven species and three genera are unique to this site within the British Tertiary. Fruit, seeds, coniferous remains and fern pinnules found here represent wetland plants, but there are also lianas, herbaceous climbers, trees and shrubs. These are forms typical of early and early middle Eocene strata in Britain, but they were still surviving in late middle Eocene times at this site." Exactly how construction of, and occupation of the cliffs by beach huts, does not impact upon the geology can only be imagined, and I am hoping for a robust defence by Natural England.

We look forward to your company at our meetings over the Summer. Happy geologising.....

Jonathan Wilkins

Articles:

The Chilean Nitrate trade

Figure 1: In a previous life I worked in sugar beet breeding research, this had to go in!

For your delectation, something which has been looked into with a quality of research that makes a Wikipedia fuelled undergraduate essay look like a seminal textbook. My interest in this subject comes from a lifelong interest in maritime history, and the shipping of nitrates from South America to Europe has been a part of this. The nitrate industry saw the final development of sail powered ocean trade, some half a century after the much more famous tea clippers. I will try very hard not to dwell too long on them. Let's have an overall look at the whole picture, which I found to be a very interesting story about which I previously knew absolutely nothing, until the product arrived at the ports of Iquique or Taltal ready to be shipped to Europe.

<u>The Atacama Desert</u>

The setting for this tale is a plateau in South America, covering a 1,000-kilometre (600 mi) strip of land on the Pacific coast, west of the Andes Mountains. The Atacama Desert is commonly known as the driest non-polar place in the world. The average rainfall is about 15 mm (0.6 in) per year although some locations, such as Arica and Iquique, receive 1 to 3 mm (0.04 to 0.12 in) in a year. Moreover, some weather stations in the Atacama have never received rain. The Atacama may be the oldest desert on earth, and has experienced extreme hyper-aridity for at least 3 million years, making it the oldest continuously arid region on earth. Geological research suggests that in some sections of the Atacama, such as in today's Chile, hyper-aridity has persisted for the last 200 million years (since the Triassic), competing only with Africa's Namib Desert for such a title. This desert is so arid; many mountains higher than 6,000 m (20,000 ft) are completely free of glaciers.

Geographically, the aridity of the Atacama is explained by it being situated between two mountain chains (the Andes and the Chilean Coast Range) of sufficient height to prevent moisture advection from either the Pacific or the Atlantic Oceans, a two-sided rain shadow. In 2003, a team of researchers published a report in the journal Science in which they duplicated the tests used by the Viking 1 and Viking 2 Mars landers to detect life, and were unable to detect any signs in Atacama Desert soil. The region may be unique on Earth in this regard, and is being used by NASA to test instruments for future Mars missions.

Coastal cities originated in the 16th, 17th, and 18th centuries during the time of the Spanish Empire, when they

emerged as shipping ports for silver produced in Potosí and other mining centres. During the 19th century the desert came under control of Bolivia, Chile, and Peru. With the discovery of sodium nitrate deposits and as a result of unclear borders the area soon became a zone of conflict and resulted in the War of the Pacific. Chile annexed most of the desert, and cities along the coast developed into international ports, hosting many Chilean workers who migrated there.

Because of its high altitude, nearly non-existent cloud cover, dry air, and lack of light pollution and radio interference from widely populated cities and town, this desert is one of the best places in the world to conduct astronomical observations.

Figure 2: An ideal place to set up a mining camp

The resource

Economic deposits of mineral nitrate, mainly sodium nitrate (NaNO3), are found only in the Atacama Desert of Northern Chile. Strangely, and contradicting the initial ideas of both myself, and my igneous petrology consultant, the mineral deposition has little to do with the tectonic situation of South America. We had assumed that it was all to do with the correct cooking of a subducting ocean plate, and that hydrothermal fluids and subsequent precipitation were responsible, as they are in the case of Andean silver and copper deposits.

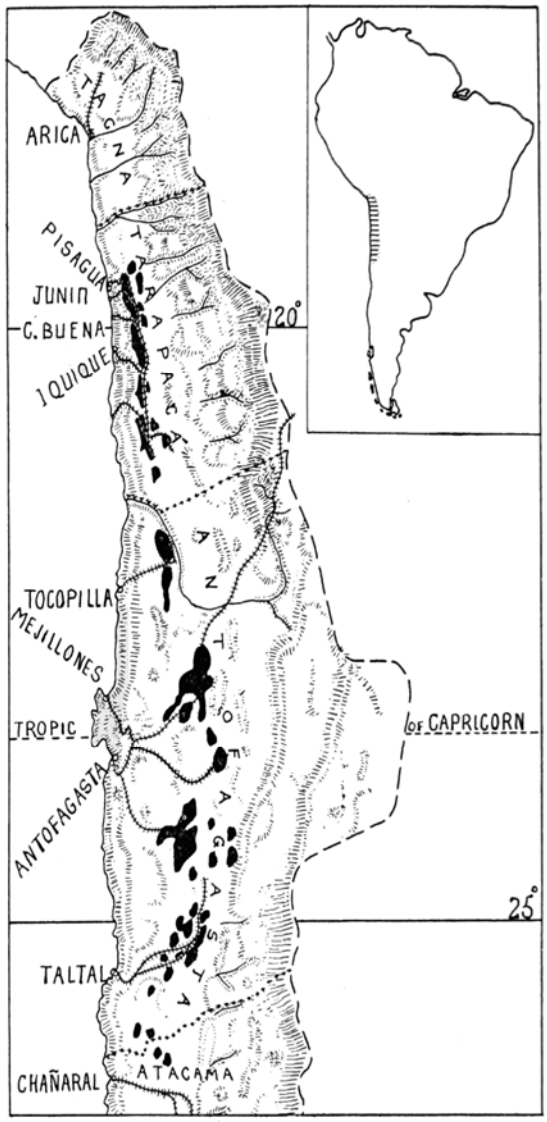


Figure 3: Location map

In fact, the bulk of the nitrate, sulphate and other soluble salts in the Atacama Desert are the result of atmospheric deposition of particles produced by gas to particle conversion, with minor but varying amounts from sea spray and local terrestrial sources. Over the last 2.0 m years, marine-fog precipitation and sea-spray oxidation/desiccation

followed by gravitational settling of airborne NaNO3, KNO3, NaCl, Na2SO4, in the hyper-arid desert atmosphere has accumulated in layers of caliche both on slopes and in playa basins. The crystallized salts fill in the interstitial spaces of the alluvium, cementing the material together to form the caliche. The incredible dryness of the desert is in all likelihood the reason that the nitrate beds have been preserved—nitrate is easily dissolved in water and any significant rainfall would wash away the nitrate beds. Although nitrate is found throughout the alluvium it is concentrated into a more easily extractable form in the caliche. For the entire 19th century this was the main source of nitrate for both fertiliser and gunpowder, until natural nitrate was supplanted by the application of the Haber-Bosch process of producing ammonia from the atmosphere, which could then be converted to nitric acid.

Figure 4: Just a nice slab of caliche

Production and Processing

The caliche, in effect a raw ore which needed to be refined, existed as a surface hard pan, which could be up to 3 m thick. The industry started in the early 19th century, and initially the caliche was broken up and taken to processing locations by horse carts, where it would be crushed before being dissolved in heated water. The nitrate rich liquor was then run out to drying pans where the nitrate crystallised out.

As the industry grew through the Victorian era, so mechanisation increased, with a lot of parallels with our own North Wales slate industry.

Figure 5: Nitrate Production Plant in action

During the boom period of the industry over a hundred processing plants or *oficinas* were built, many with British money. Operations at the *oficinas* steadily increased in size to take advantage of scale economies. The processing plants included steam driven crushers to improve the efficiency of the leaching process, and large boilers to provide the water.

In the mid 1920s further improvements in processing continued with additional capitalisation so that high grade ores now offered a 90% recovery rate, and ores of as little as 15% became economically viable. However, the steady growth of the whole enterprise had faltered at the start of the First World War, and never recovered afterwards, with wildly fluctuating prices, and a slow decline, such that an aerial survey in 1939 reported "*…the nitrate district was a sorry spectacle. Most of the plants were closed … and the nitrate towns were truly 'ghost' towns, rendered particularly unattractive by the barrenness of their surroundings.*"

Figure 6: Humberstone processing plant, now an UNESCO world heritage site

Transport

The transportation infrastructure was fairly substantial, and is related to the difficulty of moving nitrate from the pampa to the ports. Although movement in the interior is fairly easy, hampered only by the severe dryness, movement between the interior and the coast is blocked by a nearly vertical cliff face approximately 300 m high. The earliest rail lines in the region were constructed in 1870 to connect the mines to Iquique. As the industry expanded, rail lines connecting the mines to the ports at Pisagua, Junin, and Caleta Buena were built. The railways actually reached the ports by building a series of switchbacks to bring the rail lines down the steep cliff face. In the case of Iquique a 180 degree turning-tunnel and two straight tunnels were constructed to accommodate the trains coming down the cliff. Rail service stopped on the cliffs overlooking Junin and Caleta Buena, and nitrate bound for these ports was taken down-slope on inclined planes. The rail line from Caleta Buena to the pampa was over 30 km in length to cover a straight-line distance of only 14 km with curve radii as little as 130 feet. Given the circuitousness of the routes through the coastal range, small but powerful articulated locomotives (e.g. Kitson-Meyer and Farlie) were employed to haul 125 ton loads of nitrate over the metre-gauge rail lines.

During the nitrate boom era, over 500 miles of primary, and thousands of miles of secondary and temporary lines were constructed. Some 25 stations and yards were built to accommodate the rail lines, several of which appear to have had shops to repair the rolling stock. With the exception of the Longitudinal rail line to Iquique, all of this transportation infrastructure was abandoned.

Figure 7: Bayer Garrett narrow gauge locomotive, similar to those on WHR.

Shipping

At the peak of the industry in 1912, Chile was exporting two million tons of nitrates a year. With a bulky and relatively low value cargo, sailing ships were still economically viable as the preferred form of shipping to Europe. The development of bulk carrier sailing ships was led by the Germans and continued until the beginning of the First World War. These were the culmination of five millennia of the evolution of sail, made possible by modern materials and industrial methods. They were designed to withstand carrying heavy cargoes around Cape Horn, and were steel built, with steel masts and spars. The majority of their rigging was steel wire, which had been initially been developed for mining applications. Up

to 120 m long, the rigs towered 60 m above the water – twice the height of the road decks of the bridges across the Menai - and up to twenty four square sails were each the size of a tennis court. They could carry up to 6000 tons of cargo and were worked by a crew of 30 to 40, mainly young men and teenagers. These were the articulated lorries of the sea, making the tea clippers of a previous generation look like small delivery vans.

Figure 8: *Potosi* moored, warehouses and figures in small boat at stern give the scale of the ship

Coal, (or railway lines, or general cargo) went out, and was shovelled by hand (did I say 6000 tons?) into lighters as the ships lay moored off the coast. The lighters would then return with the nitrates, made up into 90kg bags which would be loaded aboard by the ships own steam cargo winches before being individually carried and stowed (some 60000 bags) in the holds.

Passages to Europe would last for 90 days on average, with 60 days being achievable. As before mentioned, the main uses were:

- Fertilizer (feeding the booming populations of industrial age Europe) and,
- Production of explosives.

This meant that there was a well fed and well-armed European population just in time to have the First World War.

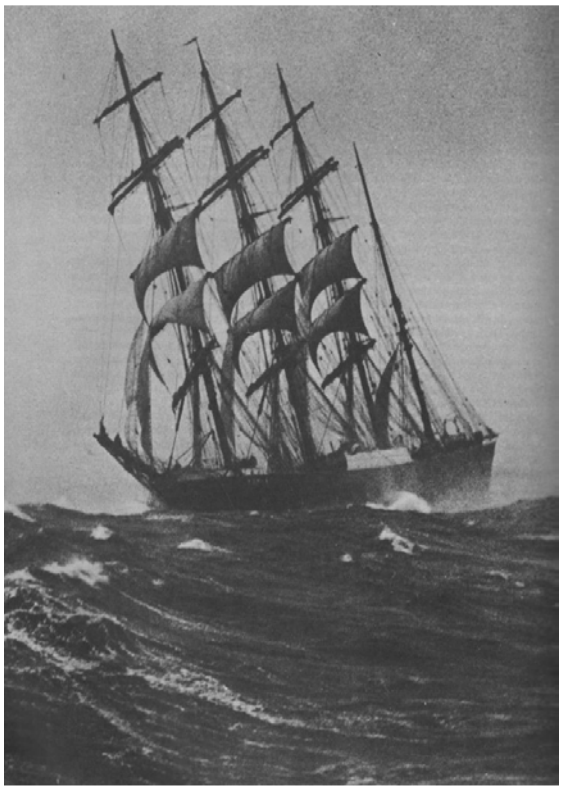


Figure 9: *Pamir* at sea, under reduced sail in a gale

Julian Bridges

Editor's Note:
It is always a joy to receive something from Julian for the Newsletter, but rarely is it quite so involving on a personal level. The following is from a book "The Swansea Copper Barques & Cape Horners" by Joanna Greenlaw and relates to my Great Great Uncle on my father's side:

"Henry Nicholls is as good an example I have come across of the best type of Swansea seaman…

He apparently served on the *Ottawa, Tacna, Glanafron, Llewellyn, Hinda, Rosyn* and *Uncas*.

"He… died in Swansea in 1923 at the age of 69 after serving for many years as a Swansea boatman, and later, dock policeman. His obituary describes him as a man of superior education, and a first class speaker, and knew the origin of dock troubles better than most men…Once he was shipwrecked in the Southern seas, but rarely spoke of it."

KHN

And yes – the "H" is for Henry – from my father's side!

What's this then?

Whilst out looking for Trilobites with Richard Birch near Betws-y-Coed, I happened upon an intriguing ringed structure see photograph below:

Figure 1: The Caradoc mystery (copyright Gary Eisenhauer)

On close inspection this appears to show a concentric cellular structure.It was recovered within Ordovician (Caradoc) sediments while looking for trilobites at the Cae'n y Coed site near Betws-y-Coed, just south of the A5. According to the Geological Maps of the area, it is from within the outcrop of the Cwm Eigiau Formation.

I have shown this specimen around to a few people as I'd never seen or found anything similar previously. Keith kindly provided a photographic image of a museum specimen he had seen (Oxford Natural History Museum – *Stromatopora concentrica* from Glyn Ceiriog – so more or less the correct age) which shows similar concentric rings around a brachiopod. Thereby suggesting my specimen could be a *Stromatopora* (a concentric sponge).

I also took the opportunity to send a few images by email to Joe Botting, who visited our group a few years back to talk about exceptional preservation in the Welsh Palaeozoic sediments. He replied:

"Curious! There are Caradoc *Stromatopora*, but not many... and the Cwm Eigiau seems unlikely for them, as they were really focussed in carbonate platforms. To be honest, it's hard without seeing the specimens under a lens, since distinguishing *Stromatopora* from stromatolites, or domed bryozoan colonies, is far from easy. There are also inorganic options like deformation (including soft-sediment) or concretionary structures... My preliminary hunch, in this case, would be bryozoan; but to be certain, you might need to saw it open and polish it!"

Other suggestions have included a distorted impression of a brachiopod, potentially *Orbiculoidea*? A colleague at work (Simon Purvis) also reckons he

found something that looks remarkably similar within the Coniston Limestone (Ordovician – Ashgillian) which at the time he put down as being a coral or bryozoan. He also found a Jurassic calcareous sponge, via the internet, which shows similar radiating growth rings on its underside:

http://woostergeologists.scotblogs.wooster.edu/2012/04/08/woosters-fossil-of-the-week-a-calcareous-sponge-with-a-crinoid-holdfast-matmor-formation-middle-jurassic-israel/.).

He also considered bracketing corals that may present similar growth rings on their undersides. Another colleague (Brian Pedder) thought my specimen reminded him more of stromatolites, with the layered structures observed on the side being very stromatolite-like.

Anyone else found anything similar, have any thoughts anyone?

Gary Eisenhauer

The Answers are…

Who is the author?

Charles Darwin, so famous we don't need any elaboration, except to say that he studied under Adam Sedgwick, with whom he travelled to Wales in 1831.

Who is Mr X?

Charles Lyell, also famous, and a close friend of Darwin; and the author of "Principles of Geology". The Lyell Medal for important and clever geology shows an illustration of the 'Temple of Serapis' near Naples and we have been there! The reason that this was worth putting on a medal is another story worth investigation.

Who is the Captain?

Robert Fitzroy, he of the well-known shipping forecast area. He was the commander of the Beagle, and later developed the science of practical meteorology, partially as a result of the wreck of the Royal Charter off Anglesey.

Where are we?

Concepcion, Chile, nice subduction zone, with the Pacific plate subducting under the Andes.

And when was the earthquake? February 20, 1835, one of many!

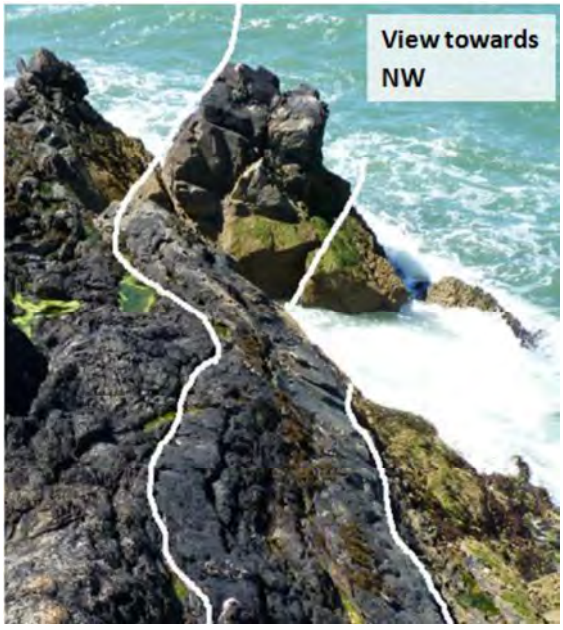
For more details go here:

http://www.geo.cornell.edu/geology/faculty/RWA/research/current_research/chile-m-88-earthquake-page/darwins-description-of-the-.html

Julian Bridges

Abstracts:

Field Visit 1 2016
"Llanbadrig" led by Philip Firth



The main purpose of this outing will be to investigate the relationship between the Llanbadrig Dyke and the Gwna Melange into which it is intruded. Philip believes the "dyke" may actually be a "sill".

There is much else in the vicinity of course. The Gwna Melange is a veritable smorgasbord of geological food to be devoured. The Geologists' Association Guide (Bates and Davies) records the following:

"…Gwna Melange, containing sandstone, phyllite, quartzite, limestone, diabase and jasper 'producing a many coloured melange that is really indescribeable' (Greenly, 1919). There are also some later igneous dykes, and silicification, pyritization and ferrification. Greenly described this as an autoclastic or tectonic breccia, but a crude stratification can be seen, and it is probably of sedimentary origin."

Field Visit 2 2016
"Cadair Idris" led by Graham Hall

This will be a follow up to the summer field trip of 2013 (written up in Edition 78 of this Newsletter – see image below - let's hope for another day like that).

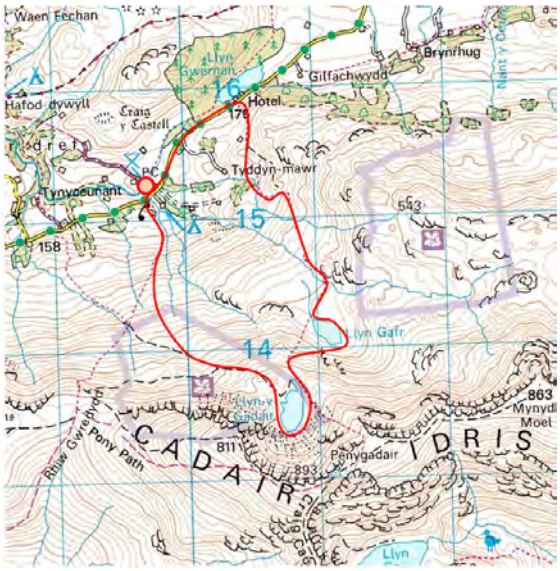
Starting from the National Park car park at Ty Nant, we will follow footpaths up past the lakes of Llyn y Gafr and Llyn y Gader to the foot of the Cader Idris escarpment. On route, we will examine intrusive and extrusive rocks of the Ordovician volcanic succession, excellently exposed by glacial erosion. Please bring a packed lunch to eat in the spectacular setting of the Llyn y Gader cirque basin.

Our return route will take us past slate mines worked in Victorian times. During the excursion we will investigate a number of interesting issues relating to the Cader Idris volcanic centre:

- Why are the igneous rocks of extreme basaltic and granitic compositions, with little material of an intermediate silica content present?
- Why do the mafic intrusions appear as narrow sheets, whilst the granitic intrusions have a huge vertical thickness?
- Why were the basaltic rocks erupted on the sea bed, whilst

rhyolitic rocks appear to be sub-aerial in origin?

There are many strands of the geological story for us to unravel.



As an emergency plan if the weather happens to be bad, there are alternative sites we could visit on a lower level in the Abergwynant valley.

Please note that this itinerary involves in excess of 400m ascent / descent, much of it in rough open country, in a quite remote location. Please all ensure that you are appropriately kitted out with food, fluids and clothing for the day.

Field Visit 3 2016

"The Palaeoecology of the Llanberis Slate" led by Richard Birch.

Culturally, historically and scenically, the Llanberis Slate defines Caernarvonshire, but its palaeoecological significance is little known. The walk will start at the car park in Y Fron (SH 509 549) and look for the (conformable?) boundary with the overlying Bronllwyd Grit in Cilgwyn Quarry, which defines the upper age limit. We will have lunch in Ty Mawr Quarry East, where the scree contains large quantities of green slate suggestive of anaerobic conditions, and in which some bizarre fossils have been found. Afterwards we will return through the quarries to Y Fron, stopping to look at some lichens which colonise slate spoil, and which provide an indication of its chemistry.

Figure 1: Hyolithids from Ty Mawr Quarry (Copyright Richard Birch)

The walk covers a distance of about 3½ miles, some of which is up and down a fairly steep incline. For those who wish to avoid this, it is possible to return to the cars after Cilgwyn and drive down to Talysarn. Be aware that there are no public toilets or shops in Y Fron or Talysarn.

Book Review:

"Urban Geology in Wales: 4"
Bevins, R.E., Nichol, D. & Solera, S.A. (eds), 2015. National Museum of Wales Geological Series, No. 27.

That a volume relating to "Urban Geology" should have on its cover an image of the summit of Snowdon shows just how wide the scope of the subject is, though the title might more descriptively be "Engineering Geology". If you have ever sat at temporary traffic lights on Welsh roads awaiting some activity or progress, then this book might tell you just what was happening and why. It contains 25 papers which document ground investigation, piling, excavation, reinforcement, and remediation, and shows the care and diligence which is applied to engineered structures that we take for granted in the 21st century. It also contains a number of highly objective papers relating to failures, and thus acts as an object lesson to those who may be inclined to cut corners or ignore established wisdom.

Whilst this volume is a valuable reminder of how things can go wrong, and a reference work, it is also a surprisingly good read (for a moderately informed user) into how structures are designed and implemented, and how strategies for mitigating risk can and should be incorporated. I am not an engineering geologist, so the discovery that landslide hazard is not only high in many areas due to the post-glacial failure of slopes that were buttressed by ice pressure, but that houses are being built on sites where landslides have claimed their predecessors; and that slope failures are not included in the Flintshire development structure plans despite 25% of the designated development area lying on areas prone to landslipping in the "very high" category, and a further 37% in the "high" risk category - a level of hazard consciousness that suggests that the plan is hardly fit for purpose. Further, it is documented that a dwelling so damaged by structural failure that demolition was required in 2003 had been replaced on the same site in 2008; subsequent inspection in 2010 showed cracking of walls due to foundation movement. I think this story tells us something about the regard in which some classes of specialist are regarded by determined and aspirational developers brought up on "Grand Design" and "Escape to the Country".

There are some delightful and remarkable tales here, too: the use of Willow saplings for soil reinforcement and the comparison of rooting and growth rates of native and hybrid species in different soil media, for example. The story of the remediation of the site of the Ebbw Vale Steelworks (nothing there for industrial archaeologists of the future!), and of the Ffos Las opencast coal mine were poignant at a time of discussion over the future of the Port Talbot steelworks. I recall working on borehole logs recovered from Ffos Las in the late 1980s, seeking to establish the geometry and disposition of the seams, and in particular to survey the actual trajectory of the exploration boreholes which may be assumed to be straight, but which proved to be anything but, when overenthusiastic drillers piled on the top-pressure and the drill-bits followed discontinuities in the ground. Now the site is an award-winning racecourse!

Still with fossil fuels, I was surprised to see an assessment of the potential for Underground Coal Gasification in the proven and postulated coal-bearing strata of Wales, though ultimately the resource was considered to be fairly minor - and the paper did not consider the position of the fuel gas within the context of low-carbon energy sources. The story of the Nantymwyn Lead Mine and its potential for pollution of the Afon Tywi which is

used for drinking water, albeit at some remove, was fascinating.

A couple of papers relate to the almost legendary failure of slopes on the Glyn Bends section of the A5 trunk road, a site of fond memory because the NWGA were welcomed on the site and we spent a very interesting morning examining the cutting while construction was in progress. That the very slopes and anchoring strategies have failed subsequently and so spectacularly is another salutary lesson. That the principal reason appears to have been an abuse of the technology is remarkable, and I took delight in the dry narrative with its inevitable conclusion, and the innovative use of a 6mm diameter endoscope to probe through the grease ports of selected rock anchors (a procedure only possible because the grease ports were dry - i.e. missing their vital grease). I am sure that T. Telford would have had something to say had he been with us today.

Some papers did not fulfil their potential, for example the foundation geology of Pont Briwet gave us chapter and verse upon the geological interpretation of glacial outwash succeeded by clay and silty alluvium, but after telling us that piles of 2m diameter and 23 metre total length will carry the design loads when founded in the underlying coarse alluvium the story closes. It's what happened next that was really interesting! The old bridge was so de-stabilised by the piling works that it was shut permanently in December 2013 and the railway line remained closed north of Harlech until service over the new bridge became possible in the following autumn. I was disappointed that only the foundations engineering of the Hafod Eryri structure on the summit of Snowdon was described in detail, considering the political and technical problems that came to the fore when the materials for the new building were specified and sourced, and the stretching of terminology to allow local sourcing of "granite" for part of the work.

At a technical level I wonder whether the outcomes of the assessment of the rock mass in the A470 straightening project at Tan Lan near Llanrwst might have been more realistic if the metamorphic grade of the materials had been taken into account. Classing the sandstones, mudstones and siltstones of the Denbigh Grits Formation as poor or very poor on the Norwegian 'Q' system seems exceptionally conservative when they are turbidites and slates cooked at low green schist facies and of considerable integrity, but what do I know? Wait - an experienced engineering geologist supervised the works and he said that slopes way steeper were fine! Delightful exposures they are too, and nary a rock anchor in sight.

Overall this is a well-produced volume, with an abundance of good, clear diagrams and a few spectacular photographic images, but clearly there is simply not space for the early, lavish illustrations to continue for long. Some of the photographs are rather muddy and indistinct, particularly as the majority are printed within the layout columns and are of strictly limited size. Another problem is that many were taken under imperfect lighting, as you might expect under ambient conditions during site visits.

However, this gripe aside, this is a fascinating book and a great antidote to those whose grasp of the geology of Wales is limited to the effects of subduction processes on the sediments and igneous interludes of the Palaeozoic Welsh Basin. I am informed by one of the editors that great difficulty and delay have attended the publication of this book, and that they may multiply to the extent that volume 5 might never appear, which would be a pity since the conclusion is that we would not be able to read and learn from the experience of others trying to maintain our crumbling

heritage, mediate in matters of pollution, or create the structures that we will need in the future.

Jonathan Wilkins

Reports:

NWGA Evening Meetings

"Morocco: a geological paradise!"
Jonathan Redfern
Professor of Petroleum Geoscience
University of Manchester

Food for thought perhaps, for those of us who argue that holding meetings at Pensychnant doesn't impact on our attendances? This meeting was a joint meeting with GeoScience Wales (but we have had them before)… Perhaps it was the subject matter? Perhaps it was the reputation of the speaker? Whatever the reason / reasons this was standing room only (almost) in a room set for 60!

Jonathan proved an open and engaging speaker, singing the praises of Morocco as a land of geological plenty; especially as political events within its neighbours' borders mean much of the rest of North Africa is essentially off limits for the foreseeable future.

Jonathan's description of the cottage industry that has sprung up around the "fossil mining" trilobite and orthocone lagerstatte that we are all familiar with from New Age Gift Shops, as well as Richard Fortey's TV documentaries, was particularly warm - and illustrated his respect for the local people, and their hospitality.

Mention of Hirnantian Glaciation drop stones and tillites had me on the edge of my chair of course, before the inevitable "pull of the recent", or perhaps more accurately "pull of the hydrocarbon" brought us to back to things Upper Palaeozoic, Mesozoic and Caenozoic.

No tea on offer afterwards at Coleg Llandrillo, and so, following our Chairman's fulsome Vote of Thanks; friends old and new drifted off into the evening. Perhaps not fed and watered, but as the saying goes - considerably better informed.

KHN

"Wales' Newest Dinosaur"
Cindy Howells, Curator / Collections Manager Palaeontology, National Museum of Wales.
All images used in this article are copyright Cindy Howells, National Museum of Wales, reproduced with permission.

We were treated to a fantastic presentation on the dinosaurs of Wales from Cindy Howells of the National Museum of Wales, Cardiff. She told us of the history of dinosaur finds in South Wales together with details of the recent finds at Lavernock Point, and the displays now showing in the National Museum of Wales, Cardiff.

The deposits in which the dinosaur tracks and bones of south Wales are found are of the Upper Triassic to Lower Jurassic ages lying unconformably on Devonian "Old Red Sandstone" and the Carboniferous Limestone. The environment where the sediments concerned were deposited was one of shallow, tropical coastal seas with islands of Carboniferous Limestone off the southern shore of the then land. The shore line roughly coincided with the northern boundary of the Vale of Glamorgan local authority. It was an arid land of rocky slopes with scree slopes and alluvial fans.

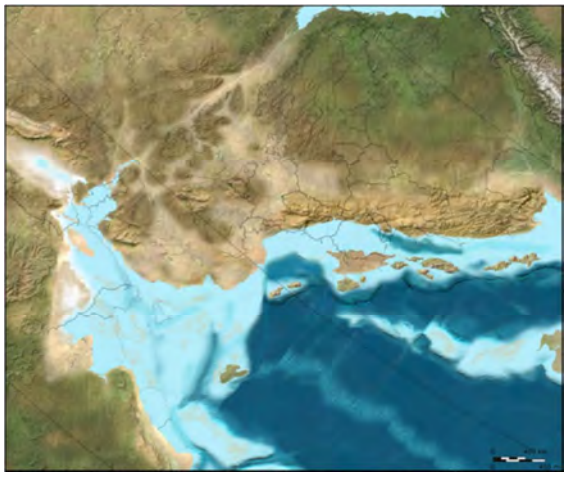


Figure 1: Paleo-environment (Triassic, Lower Norian) 225 million years ago

The seas then deepened and broadened in the Jurassic, *planorbis* zone 200 million years ago with a few islands remaining in the area of the Vale of Glamorgan. The sediments show ripple marks, shoreline deposits on erosional surfaces, deposits from flash flooding and fissure fills.

A slab of sediment containing fossil footprints was noted in 1878 at Newton Nottage, Porthcawl and described by W.J. Sollas of Bristol, T.H. Thomas of Wales and J. Storrie, of Cardiff but this slab is not in-situ and may have come from a nearby quarry. There is another such slab again not in situ in a wall by Nottage Court, Porthcawl in c.1879. These slabs contain footprints of three and four toed dinosaurs Anchisauripus & Otozoum dinosaurs, the three toed dinosaurs have likeness to those of flightless birds. Similarly, footprints have been described at Bendricks Rock, Barry in 1974 containing footprints of *Anchisauripus, Grallator, Otozoum, Tetrasauropus* and *Pseudotetrasauropus* dinosaurs, in conglomerate type rocks.

There was also the find of a jaw bone in Rhaetic sediments found in 1898 it was of '*Zanclodon*' *cambrensis* (Megalosaurid) from Triassic sediments in Porthcawl, this specimen is held by the British Geological Survey

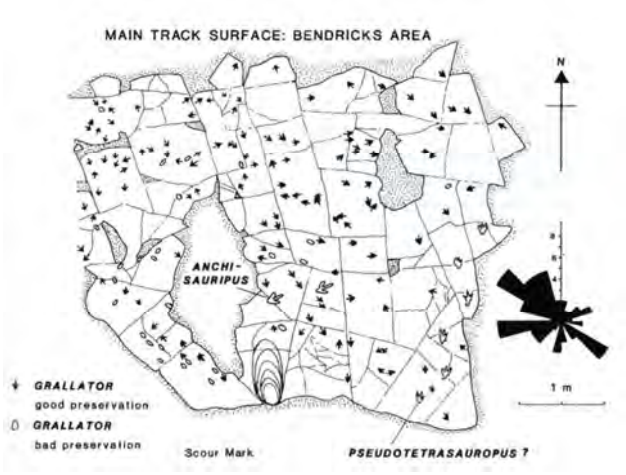


Figure 2: Diagram of the footprints at Bendricks Rock with direction of travel rose diagram.

It may have been '*Zanclodon*' *cambrensis* that made the three toed footprints, the body would have been about about 5 ft. long with a 10 ft. tail.

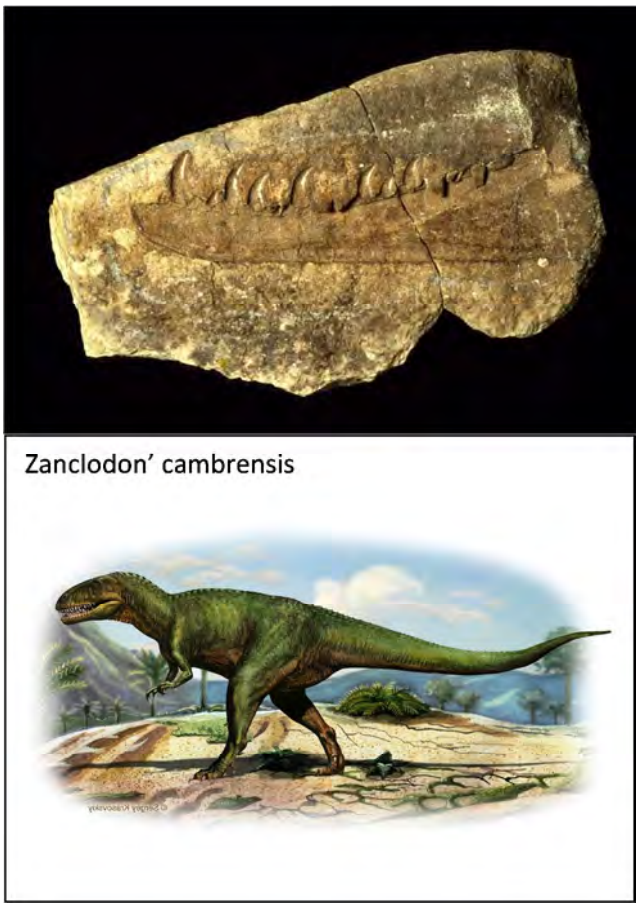


Figure 3: Jaw bone of '*Zanclodon*' *cambrensis* (Megalosaurid) from Triassic sediment in Porthcawl and reconstruction of how it may have appeared in life

In 2012 a finger bone, or 'Megalosaurid' phalange, was found in Rhaetian conglomerate of Triassic age in Lavernock, Penarth. In 1952 a Prosauropod skeleton of *Pantydraco caducus* was found in a fissure fill sediment of probably Rhaetian age in Cowbridge,

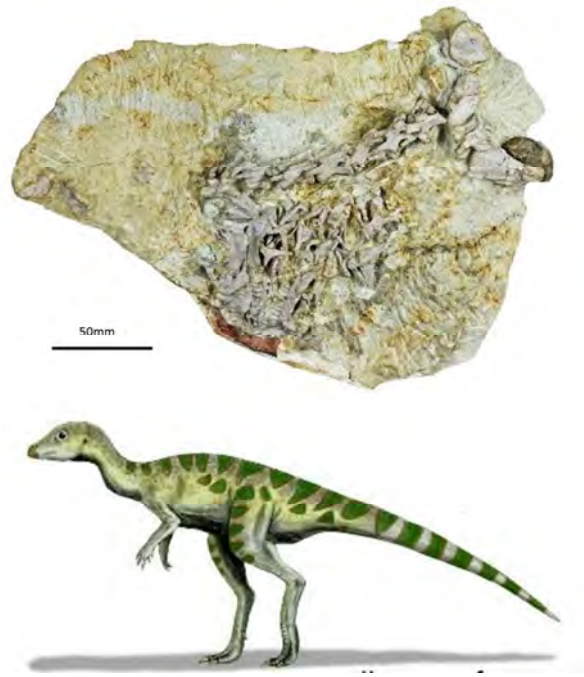


Figure 4: Skeleton of *Pantydraco caducus* from fissure fill, possibly Triassic, (Rhaetian) at Cowbridge, and reconstruction of how it may have appeared in life (NB – the scale bar showing 50mm relates to the fssil – not the reconstruction)

The recent find of *Dracoraptor* was in the cliffs at Lavenock Point and found by brothers Nick and Rob Hanigan. The initial specimens were found in a rock fall not long after the fall happened, it was almost complete but additional bones have been found subsequent to the initial discovery, so the search continues to see if the entire beast can be recovered, but the cliff is unstable so close examination has to be done with circumspection and a hard hat!

The rocks that this fossil was found in is Lower Jurassic in age and thinly bedded sandstones and shales hence the instability of the cliff. There is some uncertainty as to whether this sequence is within the lower Jurassic or upper Triassic but carbon isotope measurements indicate that the top of the Triassic beds is just above the top of the Lilstock Formation..

(http://www.bgs.ac.uk/lexicon/lexicon.cfm?pub=LTK)

.. so it is possible that this fossil could be either Lower Jurassic or just at the top of the Triassic, (see Fig 5, below).

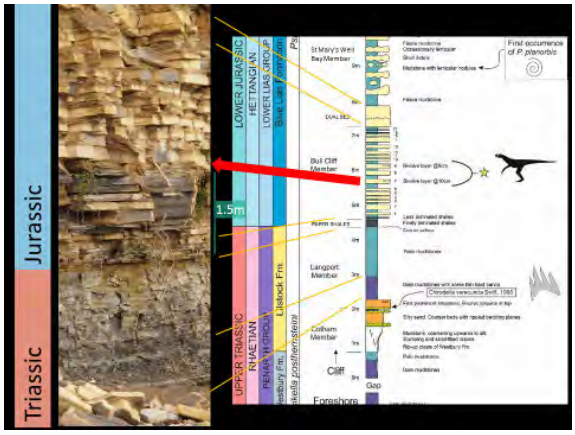


Figure 5: The succession within the cliff and time line

The creature concerned is very definitely a meat eater rather than a vegetarian as it comes fully equipped with meat slicer teeth, (see Fig 6) and claws. Its' bones suggest it is a smaller, earlier ancestor of the well-known *Tyrannosaurus rex*.

Figure 6: The prepared tooth of the fossil

The creature may have been hairy or scaled, but similar fossils found in China have been clearly shown to have had hair.

In terms of dinosaur evolution, it is quite early in the evolutionary tree of dinosaurs.

Figure 7: Samples as collected

Figure 8: Some of the prepared specimens

The specimens from the beach were collected by the Hanigan brothers, and prepared by a professional fossil preparation specialist. The whole fossil has been loaned to the National Museum of Wales and is now on display in Cardiff.

Figure 9: The display of some of the slabs containing the bones of *Dracoraptor* in Cardiff.

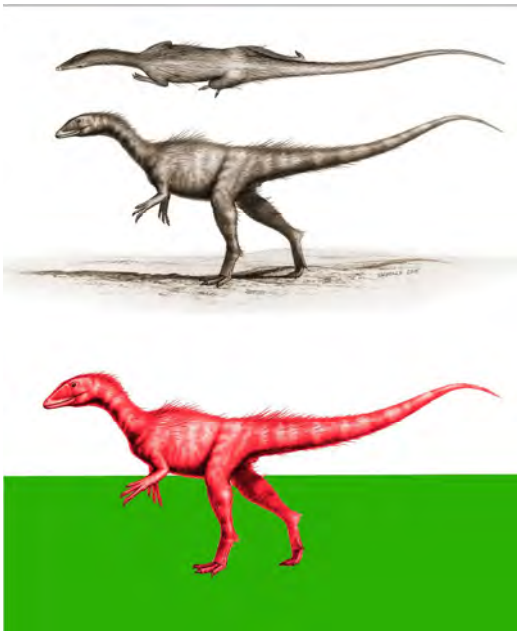


Figure 10: A reconstruction of the dinosaur (and an alternative!)

Cathy O'Brien

Other Organisations' Events

GeoScience Wales

"Can we keep the lights on?
Energy, hydrocarbons & climate change in the 21st century"
Jonathan Craig, Senior Vice President, Exploration, Eni Upstream & Technical Services, Milan, Italy.

An audience of 30 or so gathered at the RCA to hear Jonathan Craig give his view of the looming energy gap. With no immediate sign of an end to society's love affair with the internal combustion engine, and no immediate indication that governments are capable of addressing the issues, this is a problem that is not going to go away any time soon.

The extent to which the oil price appears to driven by Geopolitical machinations of governments, willing and able to turn up the supply side of the equation to make a political point came as more of a surprise to me personally that I suppose it should have. The extent to which hydrocarbon production is increasingly reliant on unconventional plays was also notable, as was the investment hit that exploration takes whenever the upstream oil price drops.

The aspect of Jonathan's talk that I found particularly depressing was a slide which showed how, with some long term strategic thinking, some joined up government action, and with (at least some) global synergy, there could be ways out of the problem involving mixed sources of energy production, "technofix" solutions, energy storage and energy efficiency. Unfortunately for us all, the need for these actions is, as far as I can see anyway, coming at a time when governments are pursuing "small government" agendas, when politics is becoming increasingly fractious, and when action is appearing ever more remote.

KHN

Liverpool Geological Society

1) "The Cambrian Explosion and the evolutionary origin of animals – insights from the far North"
Professor Paul Smith, Oxford Museum of Natural History

This talk centred around the remarkable period of earth history around 541 Ma which saw the rapid establishment of ecologies and trophic relationships we would recognise today, with burrowing infauna and predators being added to the oceans, alongside primary producers and filter feeders.

Paul's ultimate thesis was not that there was likely to be one single causal factor, but a long list of potential impacts, building on feedback loops and global climate change.

This talk was built around the remarkably preserved fauna being discovered from the Sirius Passet Lagerstatte in Greenland. A particularly odd image was that of the exploration team sitting around one summer evening (if that word means anything in this context) only about 400 miles from the North Pole, in shorts and shirt sleeves. Tales were told of building your own landing strip, and the opportunity to work in a location where only a dozen or so geologists had ever been previously.

2) "The Herefordshire Lagerstatte – Silurian soft bodied fossils from a 425 million year old volcanic ash"
David Siveter, Emeritus Professor of Palaeontology, Leicester University.

The exquisitely preserved soft body fossils being systematically described from the Coalbrookdale Formation of the Herefordshire Silurian lagerstatte have been making waves in the palaeontological community for a number of years. The Siveter brothers have been at the forefront of that work, and are revolutionising our understanding of the anatomy of soft body taxa and, by extension, the paleoecology and evolutionary processes.

David Siveter explained the detail of the techniques used in grinding away fossil bearing nodules, taking digital images of the 50 micron thick slices, and then digitally stitching them back together to reveal in extraordinary detail the three dimensionally preserved animals, entombed in a bentonite ash (sourced from a volcano in the Dingle Peninsula apparently). The fossils have apparently been dated by the co-occurrence of Monograptid graptolites to the Homerian / Sheinwoodian of the Silurian (Wenlock).

There are some considerable philosophical issues that arise out of this method of "treatment" of the fossils, not least being the fact that the specimen is completely destroyed by the process – so once the description is done, there is no type specimen to deposit in a museum drawer for other to work on subsequently.

Equally of concern to me however, and now increasingly obvious as details of more and more soft body lagerstatte are published, is the apparent legacy of bias in the fossil record, and our understanding of what exactly mass extinctions are? Our assessments of these mass extinction events (such as the "Big 5" Phanerozoic crises) have been based on extinction metrics arising from counts of taxa from the hard body marine fossils. It is the case however that in typical marine ecosystems the shelly fauna may only represent 30% or so of the standing biodiversity. How representative a sample of the whole ecosystem is the 30% we see in the fossil record?

KHN

Editor's Note – is it just me? – but are *lagerstatte* becoming ***de rigeur,*** or are they merely reflections of the ***zeitgeist***?

Publications related to the Geology of Wales:

Jeremy R. Davies, Richard A.Waters, Stewart G. Molyneux, MarkWilliams, Jan A. Zalasiewicz and Thijs R.A. Vandenbroucke, (2016) "*Gauging the impact of glacioeustasy on a mid-latitude early Silurian basin margin, mid Wales, UK",* Earth-Science Reviews, **156**, pp 82–107

Natural Resources Wales (2016), *"The State of Contaminated Land in Wales"* available on line at: https://naturalresources.wales/media/677708/nrw26759-contaminated-land-in-wales-pdf_english-1.pdf

Dates for Your Diary:

NWGA: 2016 Summer Programme

Sunday 12th June, 2016
"Llanbadrig"
Led by Phillip Firth
See itinerary earlier in this Newsletter.
For detailed Joining Instructions please confirm attendance in advance to Gary Eisenhauer / Jonathan Wilkins

Sunday 3rd July, 2016
"Cadair Idris v2.0"
Led by Graham Hall, Coleg Meirion Dwyfor
See itinerary earlier in this Newsletter.
For detailed Joining Instructions please contact Jonathan Wilkins well in advance of the day.

Sunday 14th August 2016
"The Palaeoecology of the Llanberis Slate"
Led by Dr Richard Birch
See abstract earlier in this Newsletter.
For detailed Joining Instructions please confirm attendance in advance to Gary Eisenhauer / Jonathan Wilkins

Winter Evening Meetings

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

Wednesday 5th October 2016
TBC

Thursday 10th November 2016
"Landslides and Engineering Geology" – working title TBC
Stephen Parry
Parry Engineering Geology Services

4th Annual Joint Meeting with the Geological Society of London (NW) and the University of Chester.
University of Chester (Room to be confirmed)
7:00PM for 7:30PM start (tea and coffee available from 7:00PM).

Wednesday 7th December 2016

"Annual Member's Evening"
Please contact Keith Nicholls with offers of short talks, slide shows, "you show me yours" etc. A selection of drinks and nibbles will be available.

Saturday January 21st 2017
"Annual General Meeting"
Location and Speaker to be confirmed

Other Groups Events:

Geo-Science Wales
Cluster Group Meetings

Thursday May 26th
"Microbes in Soils: using molecular approaches to better understand soil biodiversity"
Robert Griffiths - NERC, with the usual talk start time of 18:30 and refreshments from 18:00, at the RCA in Conwy.

Thursday 16th June
"Escaping from Snowball Earth"
Ian Fairchild, Professor of Geosystems at the University of Birmingham.
Both talks start at 18:30 and refreshments from 18:00, at the Royal Cambrian Academy in Conwy.
Please confirm attendance in advance by e-mail to: admin@geoscience-wales.co.uk

National Museum of Wales (Cardiff)

Until 31st December
Exhibition *"Wales's Newest Dinosaur"*

Wrexham Museum

30th January forward
Exhibition *"Brymbo fossil forest"*
Museum Opening Times:
Monday to Friday: 10am - 5pm
Saturday: 11am - 4pm

Web Site and Social Media:

Up to date information on our activities is posted regularly on the Association web site at:

http://www.ampyx.org.uk/cdgc/index.html

A much more informal way of keeping in touch with an eclectic mix of NWGA events, and other geological News items is available on the NWGA Facebook page at:

https://www.facebook.com/groups/northwalesga/

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