Earth Matters

The Newsletter of the Geology Section
of the Woolhope Naturalists' Field Club

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The Geology Section is an Affiliate Member of the Geologists' Association.
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MESSAGE FROM THE CHAIRMAN

WE ARE VERY FORTUNATE to have the Woolhope room in Hereford Library. It dates back to the original founder of the library, James Rankin, who was President of the Woolhope Club. In 1869 he provided the funds for purchase of the land and construction of the building, on one condition: that the Woolhope Club would have a private reading room within it. The opening ceremony was in October 1874.

I'm sure James Rankin would be pleased to know that the Woolhope room is fully used to this day. It holds not just books but also transactions and journals, along with special manuscripts and rare books. As members we have access to all of these. But we cannot take that access for granted. Cuts in the library opening hours have already forced us to hold earlier meetings on Friday evenings, while in our discussion at the AGM nearly all members indicated a preference for a later time. Further reductions are now planned. Will this force us to leave the Woolhope room altogether? There are suitable venues, such as the Kindle Centre at ASDA, but we would have to pay for them. As I write these words I see that there is an emergency closure of the entire building due to asbestos. It starts now. Supposedly it lasts for twelve weeks. But will the library ever open again? And in what form?

Am I right in thinking that part of our identity is related to our meeting place? If we just move around to wherever happens to be cheapest, or wherever has the best car park, then do we actually feel like the same club? Is it even important that we should? Holding on to the past seems unfashionable these days and if we are to attract a wider range of members, especially younger ones, then perhaps a more dynamic image would be an advantage. But I can't help feeling a sense of loss. I wonder what James Rankin would think.

Geoff Steel, *Chairman*

An Excursion to the Lleyn Peninsula

by John Payne, John Stocks, Moira Jenkins and Dave Green

WGS was fortunate to be invited to join the May 2015 visit by the West Sussex Geological Society (WSGS), led by Dave Green, to explore the geology of the Lleyn peninsula in north-west Wales. The group, consisting of five members of WGS and six from WSGS, stayed in a comfortable hotel in Nefyn [Grid ref. 307 405], with good food and good locally brewed beer. (Grid references all refer to the SH grid square.)

The relatively small area at the far end of the peninsula is a classic for the study of the late Precambrian, the Cambrian (of two separate Gondwana terranes), the Monian orogeny and Ordovician sedimentary, intrusive and volcanic rocks.

Figure 1 The Lleyn Peninsula showing places visited.

The first day (9th May) was spent on the cliffs at the far west end of the peninsula. A walk of about 3 km from Mynydd Mawr [139 258] to Pen y Cil [158 241] occupied the whole day such was the range of rocks and features on view. The north coast locally, along with much of Anglesey, is recognised as a major tectonic boundary where an oceanic plate was subducted at the edge of Gondwana in late Precambrian and Cambrian times. (In its early stages, this gave rise to the plutonic rocks of the

Figure 2 The Gwna Melange at Trwyn Maen Melyn [148 245] (British Geological Survey P-007928)

Malverns Complex and others in the Welsh Borderlands and English Midlands.) The detailed development of the area is still the subject of much research and controversy. For example, it has only fairly recently been recognised that some major constituent rock groups are of Cambrian age, rather than Precambrian. There are currently two widely contrasting theories to account for the observed structures and our leader ably identified and pointed out features which are claimed in support of one or the other.

A major element in the geology of west Lleyn is the Gwna Melange. This consists of a chaotic assembly of clasts of all sizes up to at least 500 m and of many rock types, in a mudstone matrix. On one view this has resulted from 2500 km of strike-slip movement on a fault which gradually separated Wales from Nova Scotia. The second idea, derived from a comparison with Pacific geology, is that the rocks of this region constitute an accretion of ocean floor sediments onto the edge of Gondwana with the Melange resulting from the slumping of the subduction trench wall into the trench (an 'olistostrome'). The first theory is supported by the close similarity between north Wales and Nova Scotia in many details of stratigraphy and trace fossils and in the age distribution of constituent zircon crystals, as well as the rock types in the Melange (notably quartzite, which is not an ocean-floor rock). The second theory is supported by the researchers' claimed identification of a number of accreted layers along the coast, including pillow lavas, in the order expected for this scenario. Also in support is the gen-

Figure 3 The Lleyn Shear Zone at Parwyd. The main fault is on the far side of the bay.

eral coincidence of the direction of shearing in the Melange clasts, a feature more likely to appear in accreted layers than in a fault gouge. The Melange as it appears on this coast is shown in Fig. 2, where a large clast of white quartzite is evident with several smaller ones.

In the car park at Mynydd Mawr we closely inspected chert clasts in mudstone which was severely deformed through greenschist metamorphosis. A small quarry in the hillside had no obvious purpose but was later identified by a local person as a source of limestone. Along the path, large clasts (several metres across) of basalt, chert and limestone were seen. A complete sandstone hill 70 m in height is believed to be a single clast. The inlet at

Porth Felen [144 250] is variously believed to be either due to a fault or to be a thrust boundary between accreted wedges. Dave led some of us on a scramble to the foreshore where we saw pillows in basalt with pelagic limestone and jasper in the interstices. At Parwyd [154 244] a large fault zone perhaps 100m wide was seen in the cliffs (Fig. 3). This is the Lleyn Shear Zone, a terrane boundary with Cambrian and Ordovician rocks to the south-east which are believed to form the basement of the Welsh Basin.

Our second day was spent in the Morfa Nefyn area. Excellent rock exposures of the Gwna Complex, the Lleyn Shear Zone, and the Sarn Complex are visible along this stretch of coastline. Due to time constraints, our visits were limited to the eastern limbs of two peninsulas.

Figure 4 Pillow lavas at Porth Dinllaen showing jasper and calcite infilling.

A section across the Lleyn Shear Zone was examined in detail on Penrhyn Nefyn [296 410]. This is a zone of intense ductile shear that converted the wall rocks to mylonite schists. This 'Schist Unit' outcrops within a short 250m length of beach platform. It comprises, on a south to north axis, Tonalitic schist - Phengite schist – Blueschist - Basic schist. The presence of Blueschist is an important indicator of high pressure/ low temperature subduction metamorphism, thus lending support to the accretionary orogenic model. These schists manifested various degrees of foliation and cleavage (a result of ductile shearing) which generally became more intense in a northerly direction. In this area a well-defined dolerite dyke cut across the Schist Unit, showing chilled margins at the contact.

The Gwna Group accretionary rocks outcrop on Porth Dinllaen [275 415]. They consist of pillow lavas, basaltic flows and pillow breccia. The freshest exposure of pillow lavas can be seen by the recently reconstructed lifeboat station. The pillows are largely undeformed, with infilling of coloured jasper and calcite (Fig 4).

Several prominent boss-like granodioritic intrusions outcrop in an arc from Llanbedrog in the south to Yr Eifl in the north. Gwylwyr quarry [318 413] is situated on one of these, Carreglefain, 1.5 km north-east of Nefyn and 6km south-west of Yr Eifl. The hill rises abruptly from the coastal plain. Access to this old quarry is by a stiff 80m climb up a steep haulage incline – the group was not deterred by this. Large rock faces of weathered porphyritic granodiorite dominate the quarry. One outstanding feature was a stack of horizontally lying columnar joints high in the wall (Fig 5). Large blocks lay randomly about the quarry floor. Closer inspection revealed some xenoliths in the grey matrix and occasional granitic layering. The view southward from this vantage point gave a dramatic image of the structure of rocky coastline, flat low peneplain and prominent boss-like monadnocks.

Figure 5 The high face of Gwylwyr quarry with (inset) the horizontal hexagonal columns.

Our last visit of the second day was to an example of the

Figure 6 Porth Neigwl (Hell's Mouth)

Figure 7 Dave Green explains the Cambrian/Ordovician

Sarn Complex. This is separated from the Gwna Melange by the Lleyn Shear Zone. Inland exposures are limited but we gained easy access at an old quarry beside the B4417 road on Mynydd Cefnamwlch [226 347]. This area of higher ground is extensively covered by Arenig sedimentary rocks. Quarry rock samples showed a coarse-grained granite which has been classified as an Ademallitic leucogranite.

On the 11th May our first stop, close to Trwyn y Ffosle, gave us a magnificent view over Porth Neigwl, also known as Hell's Mouth Bay (Fig.6). Here the lowland is backed by a degraded former cliff line. The river in this lowland has been glacially diverted to flow through a gorge [304 286] to Abersoch.

The base of the cliffs to the south of the bay is made up of Hell's Mouth Grits, Cambrian in age. These are turbidites formed by submarine slumps down the edge of the continental shelf. The party spent some time in searching the steep hillside for the angular unconformity between these rocks and the overlying Ordovician rocks (St Tudwals Sandstone). Figure 7 shows that the Hell's Mouth Grits dip at a steeper angle than the Ordovician sandstone. At the end of the Cambrian there was some uplift and faulting. The top of the Cambrian is missing.

At the end of a tombola spit in Pwllheli (Carreg yr Imbill [388 344]), we saw a pale Ordovician dolerite with irregular patches of pegmatite containing euhedral augite and coarse plagioclase crystals (Fig. 8). The pegmatites have the same composition as the rest of the rock and formed in pockets rich in water in the residue of the magma after the rest had cooled. The presence of water lowers the temperature at which crystallisation takes place. The contact with the country rock is not seen.

Figure 8 Pegmatite in dolerite at Carreg yr Imbill

At Carreg y Defaid beach [342 345] is a crystal tuff with feldspar crystals and some quartz. Viscous rhyolitic lava containing a lot of gas erupted explosively and was pulverised into ash. There are layers of large clasts in a matrix of ash as well as some welded tuff. Further along the beach is a small (five metre) roughly circular area full of siliceous nodules (Fig. 9). Fig. 9 inset shows a section through one of the nodules. This was collected in about 1970 from Carreg y Defaid and was cut at the Geology department in Aberystwyth. It was so hard that it blunted the diamond cutter. It can be seen that there has been crystallisation of an agate-like material into a void from the outside towards the inside.

Figure 9 A part of the mass of lithophysae at Carreg y Defaid and (inset) a section through a lithophysa.

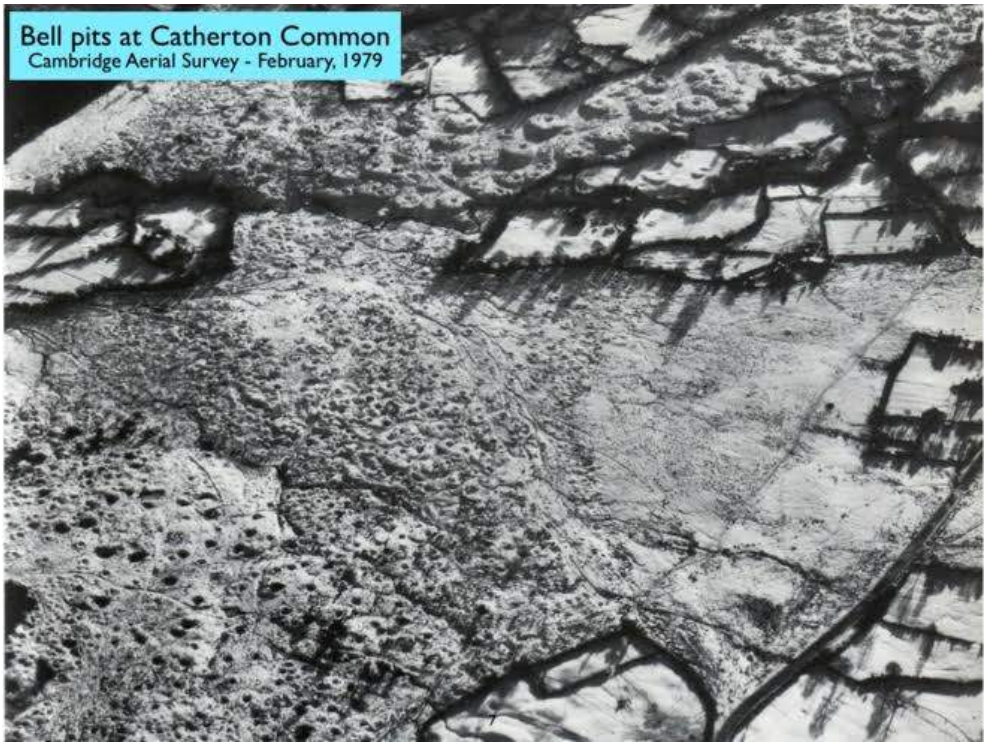
Our leader, Dave Green, having seen the cut specimen, identifies it as a *lithophysa,* which is typical of rhyolitic lava. At this spot there was a concentration of gas bubbles in the viscous rhyolitic lava. If the lava had erupted explosively the bubbles would have been dispersed. The lava must have remained underground in a feeder pipe for long enough for the bubbles to have been trapped and not dispersed and then for crystallisation to take place into the void. There are only a very few isolated such nodules found anywhere else on the beach. Most of the lithophysae are just found concentrated in the one place, which is at the top of the beach.

PIGS TO THE RESCUE

by Gerry Calderbank

THANKS mainly to David Poyner and Robert Evans, the histories of Highley Colliery and similar, albeit lesser mining companies are well documented. Nevertheless, there was also small-scale coal mining in other parts of the Wyre Forest although this has largely escaped attention. These were mostly shallow bell pits, found only where thin coal seams and/or 'smuts' either outcropped or neared the surface. They were probably worked spasmodically, frequently on a family basis, and were mainly intended to serve localised community needs. In marked contrast to the industrialised mines, there are few actual records of such ephemeral sites, it being generally accepted that they once existed 'somewhere or other' in limited areas of this heavily forested district.

Bell pits were rarely more than ten to twenty feet deep, and probably much less in our area under consideration; a shaft was dug vertically until the coal was encountered, whereupon this was mined concentrically from the base of the shaft. Props were not used and so safety issues restricted the working extent, as possibly did flooding, because there were no drains. Normally, the access was by ladder. The coal was raised by rope and bucket, possibly using a portable hand windlass or simple cross beam and pulley wheel, but nothing very sophisticated because of their temporary nature. It has been suggested (K. Hudson) that the average yield would be about eight tons per pit.



This summer the WGS has contributed three guided walks to GEOFEST 2015 and the second such excursion was our annual 'Railway Ramble', co-led by Peter Oliver and myself on Sunday 21st June. Peter explained the coalfield geology, assisted me with the geomorphology, and I handled the industrial archaeology. We took the train from Bewdley to Arley, trudged a short distance up the lane, and then followed an old 'stone road' into the forest. The walk is very familiar, but on this occasion we accidentally detoured before taking a previously unused track that, according to the OS map, would surely intercept with our intended route.

But now for the pigs! The area is thickly forested although I noticed a few partially cleared patches on the north side of the track. Soon we encountered even more freshly disturbed ground on the opposite side. Something caught my eye so I went to investigate. There were slight depressions where the ground was wet and muddy with patches of yellow clay containing coal fragments. I recognised this as mining 'clod' and, yes, we had stumbled upon an area of disused bell pits that continued for some distance along our way. I doubt if they would normally have been recognisable, but then Iris pointed out some electric fencing and soon we were joined by a large herd of nosey pigs – so all was revealed!

The result of such working can rarely be seen in forested areas because of the cyclic tree growth, periodic felling and otherwise natural decay, coupled with the immense quantity of leaf litter generated. However, the none too distant Catherton Common – on the slopes of Titterstone Clee Hill – is barren land and this was recorded to great effect in 1979 by the Cambridge University Aerial Survey, as the picture shows. Here, the snow-covered landscape was photographed in low-angled February sunlight, with the pits cheek-by-jowl, and some having obviously collapsed and fallen in. Incidentally, these Catherton Common workings once produced Herefordshire coal! This is because they were located in the detached 'Chapelry of Farlow' which was isolated from its mother church prior to the nineteenth century boundary commission changes that transferred the parish of Rochford from Herefordshire to Shropshire.

Poyner, D. and Evans, R. (2000) '*The Wyre Forest Coalfield*' – Stroud

Hudson, K (1984) '*Industrial History from the Air*' – Cambridge

A Buried Precambrian Impact Crater in Scotland, or What we did on our Holiday

by Mike Simms, National Museums Northern Ireland

I had never intended to spend years on research into a 1.2 billion year old meteorite impact deposit in Scotland. I had just wanted to visit a couple of sites, pay homage to a remarkable event, collect a few lumps of it, and then on to other things.

It all began early in 2011 when Geoff Steel, an enthusiastic and very knowledgeable amateur geologist, and friend of many years, suggested visiting Scotland to look at some of the geology there. Geoff drew up the itinerary but I insisted on two sites; the anorthosite mountain on South Harris (that's another story) and the recently recognised (2008) meteorite impact deposit of the Stac Fada Member near Ullapool. But within hours of seeing it for the first time the die was cast.

Figure 2. The spectacular exposure of the Stac Fada Member at Stoer, looking north-west, showing huge rafted masses of sand underlain by intruded wedges of impact ejecta. Geoff Steel for scale.

The Stac Fada Member is a distinctive 5-10 metre thick unit within the 1.2 billion year old Stoer Group, which forms a narrow outcrop along more than 50km of the coast centred on Ullapool in north-west Scotland. The Stoer Group is mostly 'red bed' sediments deposited in rivers and lakes but the Stac Fada Member is very different because it is a muddy red sandstone full of angular green fragments of what clearly were once molten rock. For decades it was thought to be volcanic in origin until in 2008 a team of geologists, led by Ken Amor, discovered shocked quartz grains in it – unequivocal evidence for a hypervelocity impact. They published a paper on their findings and suggested the impact crater might be located offshore to the west, deeply buried beneath much younger rocks in the Minch Basin.

It was exciting to see this impact deposit for the first time, but I had no expectations of being able to contribute anything new or startling to the conclusions of this eminent team of geologists. But at just the second site we visited (appropriately called Second Coast) I came across something quite startling that demanded explanation. Embedded in the sandstone surface immediately beneath the impact ejecta layer were large angular blocks of Lewisian Gneiss, some more than half a metre across. There was no evidence of any violent flood that might have carried them there, and no ancient hillslope nearby from which they might have fallen. Subsequently I was able to show that the long axis orientation of these blocks is entirely random – not what might be expected if they had been swept there. Instead they look as if they had fallen out of the sky – which is exactly what I concluded. They are spallation ejecta launched at velocities of 4-5 km/s very early in the impact process, which is why they are found immediately beneath the Stac Fada Member. This in itself was worth a short note but visiting more sites the following day it became clear that there was much more to uncover and that Amor and his friends had not got it entirely right. But the next day we were on a ferry to Lewis, so it would have to wait for another occasion. After four subsequent visits to the area, visiting every site where the Stac Fada Member is exposed, the picture is considerably clearer although many unanswered questions remain.

Figure 1. Large angular blocks of Lewisian Gneiss embedded in the sand immediately beneath the Stac Fada Member at Second Coast. The hammer handle is 37 cm long.

So what has the last four years of research revealed? The Stac Fada Member is composed largely of muddy red sand, with occasional fragments of gneiss, and about 20 to 30% by volume of green angular fragments of what was originally melted rock. Intriguingly the chemistry of these green 'melt clasts' is mafic, like basalt or gabbro, whereas the sandy matrix is felsic and much more silica-rich. Furthermore, the melt clasts contain abundant small mineral and rock grain inclusions that are felsic, like the sandy matrix, and none that are mafic. Impact modelling

indicates that the unmelted sand and rock fragments came from shallower levels in the crust while the melted material was from the deeper levels of the impact, perhaps several kilometres down. Other impact deposits on Earth have two rather than one layer; a lower layer of breccia with no melted material, and an upper layer with >80% melted fragments, but the Stac Fada impact layer is rather structureless and pretty much the same throughout. It seems to have formed through intense mixing of melted rock, from deep in the crater, with unmelted wet sand from near the surface and may point to the processes that generate impact ejecta deposits on Mars, which are mostly single rather than double layers.

The angular blocks – spallation ejecta - immediately beneath the Stac Fada Member show that the main ejecta deposit did not erode the sand across which it was travelling, but must have been buoyed along by a cushion of steam generated by the intense heat. However, at Stoer it seems that steam became trapped beneath impermeable mudstone layers within the sand, causing explosive disruption and allowing large sheets of sand to be ripped up and wedges of impact ejecta to be forced along bedding planes within the sand. These wedges are vital for proving where the stuff came from. They thin out to the west, indicating that the ejecta were advancing from the east, which is the exact opposite of what several previous papers had proposed. Subsequently I found evidence at other sites, such as the orientation of accretionary lapilli and erosional troughs in the upper part of the Stac Fada Member, that all indicate a source – the crater – to the east of the present outcrop. However, just 20 km to the east of the Stoer Group outcrop is the western edge of the Moine Thrust, beyond which any Precambrian impact crater will lie deeply buried beneath the Moinian metasediments carried there by tectonic thrusting during the Silurian. So, assuming it still exists, how might we detect this crater?

Impact craters often have a distinctive geophysical signature. Excavating a large hole in dense rock and filling it with rubble and sediment creates an area of less dense crust that can be detected as a 'gravity low'. Having deduced that the crater that ejected the Stac Fada Member must lie to the east, I consulted the BGS gravity survey map of Britain and was astonished to discover a large, roughly circular, gravity low centred on the town of Lairg, approximately 50 km east of the Stoer Group outcrop. Its location is consistent with the directional data from the Stac Fada Member and its size indicates a crater at least 40 km across.

Intriguingly, there was an abrupt reconfiguration of the entire drainage of the Stoer Group following the impact, with the river systems that became established afterwards showing a radial pattern that appears to be centred on the Lairg Gravity Low. Just a coincidence, or perhaps the result of doming caused by isostatic uplift following the removal of hundreds of cubic kilometres of rock from an impact crater?

Previous structural models, based on observations of surface geology coupled with interpretations of geophysical data, attributed the Lairg Gravity Low to the effect of buried thrusts causing thickening of the Moinian or Lewisian rocks. The suggestion that I have made, that the Lairg Gravity Low is actually a buried impact crater, would be quite unwarranted were it not for the existence of a thick and extensive impact ejecta layer, the Stac Fada Member, just a few tens of kilometres to the west, the evidence within it of emplacement from the east, the radial drainage pattern evident in the post-impact river systems, and similarities between the Lairg Gravity Low and the gravity signatures of other well-documented impact craters. Taking all of the evidence together, the impact hypothesis can explain both the cause and origin of the gravity low and, indeed, its specific location as the consequences of a single event for which the Stac Fada Member provides substantial surface evidence.

When Geoff and I set off to Scotland in 2011 we intended only to pay homage to this remarkable rock and collect a few samples. The subsequent journey has been remarkable, ending with the discovery, probably, of Britain's first impact crater which – at maybe 40 km across – is one of the twenty largest on Earth.

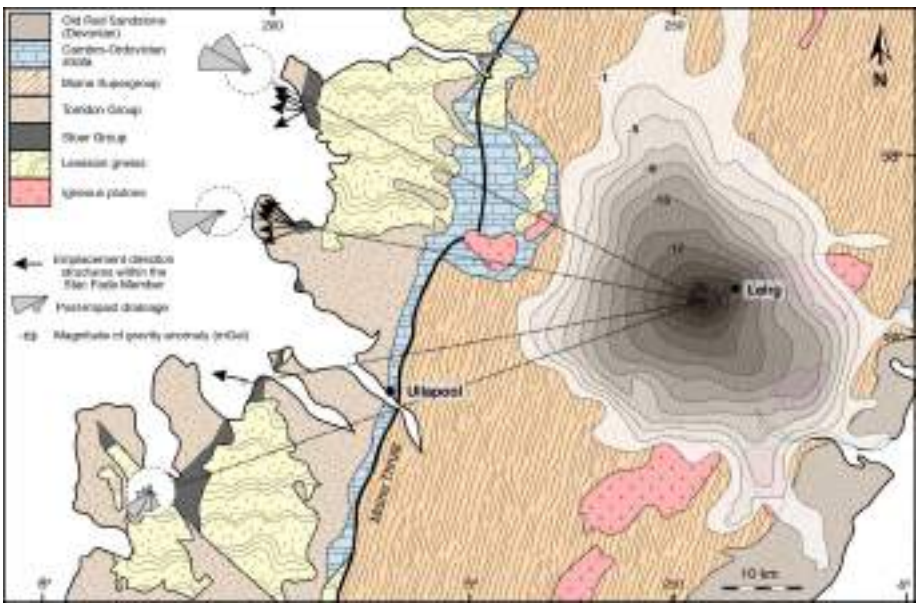


Figure 3. Regional geology of north-west Scotland showing relationship of the Stoer Group, and directional features within it, to the Lairg Gravity low and the Moine Thrust. The radial dotted lines are projected from key Stoer Group sites to the centre of the Lairg Gravity Low.

GEOLOGY SECTION MEETING REPORTS, 2014 -

Friday 17th October 2014: The Origin of Life

This talk was given by our Chairman, Geoff Steel. He showed pictures of fossil bacteria from early Archaean rocks, indicating that a search for life's origin must take us back into the Hadean - huge volcanic eruptions, burning ultraviolet radiation, noxious gases, enormous tides and constant bombardment by meteorites and comets.

No fossils survive from the Hadean. But the biochemistry of our own cells preserves a remarkable record of our earliest times. It has given us a new kind of fossil hunting. In particular the DNA and RNA that store and manipulate our genes can be read like a book, complete with the copying errors that tell so much about their history. They prove that all life on Earth is indeed related, as Charles Darwin proposed, and even allow a reasonable reconstruction of our common ancestor (a simple prokaryote). But where did that come from?

If our quest is the origin of life then we need to think carefully about what we're looking for. What exactly is life? How is it defined? It seems that replication and metabolism are the minimum requirements, and if they are confined within an enclosed space such as a membrane then that object is perhaps 'living'. Could such a thing have formed naturally in the Hadean? Research suggests that conditions were right for RNA molecules to form. And they can act as both genes and enzymes giving both replication and metabolism. Hence the simplest life may have begun with just RNA, wrapped in the lipid membranes that form naturally when oil and water are shaken together. And it is surprising to discover that one of our most basic enzymes, crucial to all modern life, appears to be a remnant from that time.

Friday 21st November 2014: Giant Meteorite Impacts – the evidence from Britain

This talk by Dr Mike Simms is written as a separate article.

Friday 12th December 2014: Members' Evening

Gerry Calderbank started the evening with a video: 'Geothermal Energy and its Origins'. It was made by an Icelandic company and described the underground hot water source near Reykjavik. In that area the Mid-Atlantic Ridge is spreading by 2 cm per year and one of the resulting volcanoes is Hengill which last erupted 2000 years ago. The bedrock beneath it is still hot and is the geothermal source.

We then studied rock samples brought in by members. Jean Hopkinson gave us a puzzle: a strange blue-grey roadstone from Little Cowarne. Some kind of industrial slag maybe? Sue Hay brought a dark, shiny crystalline rock from the Malvern Hills. She interpreted it as a hybrid formed when a dyke intruded the local diorite, with the original hornblende being replaced by biotite to form 'pseudomorphs', i.e. new crystals fitting the shapes of old ones. Moira Jenkins showed us two superb trilobites from the Anti-Atlas Mountains in Morocco. She described the shop they came from and its owner who also leads fossil-hunting trips. Rowland Eustace brought a collection from the Birtsmorton area: a flint, a large fresh water mussel and a sample of the Arden Sandstone. The latter contained some black grains which he suggested may be coprolites.

Gerry followed with a second geothermal video, this time showing how the power station works. It uses water at 300ºC from a 3 km deep borehole and produces 300 MW. The electricity and waste hot water both go to Reykjavik.

Chris Fletcher then talked about iron pyrites. It can form tiny grains in organic sediments which can recrystallise into large cubes if the sediments are compressed.

Finally Iris Calderbank showed an example of *Beaconites*, a fossil burrow in the Old Red Sandstone from Tredomen quarry.

Friday 23rd January 2015: Idar-Oberstein: A Gem (stone) of a Town

In this talk Sue Hay described her visit to Idar-Oberstein. It is a small town in the German Rhineland Palatine close to the French border. Over 500 years of mining and gemstone working is associated with the town. This is due to its local geology. Hydrothermal alteration of local lavas has resulted in agate, jasper and amethyst being deposited. Initially these minerals were mined and polished using local waterpower, to produce cabochons. These are gemstones that have been shaped and polished but not faceted. Later, faceted gemstones from local amethyst and imported stones became much more important. The town has two related museums: a local museum of mineralogy and the German National Gemstone Museum, both of which have large collections of local and other minerals. Today the town, in which the German Gemstone bourse is located, is known for cutting large stones, especially fantasy cuts and the wholesale trade in gemstones.

Friday 27th February 2015: AGM and Dinner

This year's venue was the HALC office at the Berrows Business Centre in Bath Street, chosen because it is close to the Merton Hotel. Our Chairman, Geoff Steel, welcomed members to the 12th AGM and stated that Tony Geeson would act as Secretary as both Paul Olver and Charles Hopkinson were unable to attend. Tony read Paul's report in which he described the success of the 'Old Red Sandstone' symposium at Brecon last October. Beryl Harding reported that the Section now has 53 members and our funds have increased during the year. Sales of the DVD have now reached £845. Sue Hay reported from the EHT where the 'Thousand Years of Building with Stone' project is now 50% completed and a Wye Valley Partnership conservation project is underway. She also let us know that EHT will not continue its membership of the Geopark Forum this year. John Payne described his editing of our Herefordshire Geology book, in which he's moved some sections between different chapters.

The committee were re-elected with no change and the Chairman thanked them for their support and hard work. After the AGM we again held our Annual Dinner at the Merton Hotel, this time being within easy walking dis-

tance.

Friday 20th March 2015: The East African Rift System

Bill Fitches gave this talk based on his work in Kenya, where the Gregory Rift is the local branch of the East African Rift System. It is a line of faulted blocks and volcanoes which started forming in the Tertiary; movement continues today. It represents the early stage of a sedimentary basin and provides important clues about the origin of hydrocarbons and the ways they can be trapped.

Sunday 26th April 2015: Huntsham Hill

Moira Jenkins met us at the Symonds Yat car park. She led us over a footbridge to a viewing platform which is popular with bird watchers. From there we could see the southerly dipping Devonian and Carboniferous rocks at the edge of the Forest of Dean. The area was described by Tom Richards in the 2013 edition of 'Earth Matters'.

We walked down a steep footpath eastwards though Crease Limestone and Lower Dolomite to reach the Lower Limestone Shale which lies at the base of the Carboniferous. There were clear signs of landslips in the woods: one path was closed and trees were leaning at strange angles. At the bottom, by the River Wye, was the entrance to an old railway tunnel where the Lower Limestone Shale was dark grey and thickly bedded. Continuing north along the river bank we saw a large recent landslip which Moira has been recording for several years. She showed us how it has diverted the left bank of the river several metres away from its former course.

The mud cracks preserved at Huntsham Hill.

Further north a path led up to a ridge of Tintern Sandstone near the top of Huntsham Hill. Descending its west side we came to a superb exposure of the Quartz Conglomerate which forms a steep cliff just above the road. An overhang preserved large mud cracks and Moira has recorded them in a plaster cast.

Returning to the top of the ridge we studied the Tintern Sandstone and its gradual transition into the Lower Limestone Shale. Bands of crinoids indicated the change from terrestrial to marine conditions.

Sunday 14th June 2015: The Tortworth Inlier

Our leader, Dave Green, met us at Junction 14 on the M5. He described an anticline and syncline of Ordovician to Carboniferous rocks which are visible in this area. We started at a small quarry near Whitfield where a band of Silurian limestone marks the base of the Wenlock. It is equivalent to the Woolhope limestone but cross-bedded and shelly instead of nodular. Dave used this to demonstrate how the southern Silurian rocks, from Bristol to Cardiff, are very different from those in Herefordshire.

Driving up a hill we crossed the Quartz Conglomerate to reach a high ridge of Carboniferous limestone at Tytherington. This formed a good viewpoint and we studied the steeply dipping strata in a nearby quarry. From there we drove to Wickwar for lunch at the Buthay Inn.

Two miles south of Wickwar we parked at Bury Hill. A footpath led to an old quarry. Here we could see an unconformity where the Dolomitic Conglomerate, of Triassic age, lies above Carboniferous limestone. A mile further south we fought our way through dense vegetation to look into a huge new limestone quarry, working until recently. Minerals such as barytes and celestine occur here.

Finally we drove to Charfield. A new footpath across the railway led to a quarry which has been cleared by the Avon RIGS volunteers. The rock is basalt. It is of Llandovery age. Dave showed us that seismic data indicates 500 metres of Silurian basalt beneath the Cotswolds - a total surprise!

Sunday 12th July 2015: The Goodrich Area

A group of nine members met at the car park near Kerne Bridge for a walk on Coppett Hill and around Goodrich village to see the building stones. The excursion was led by Kate Andrew who heads the current Earth Heritage Trust project on building stones within the county.

Our route led us past the old railway station to Kerne Bridge and then to a second road bridge close to the village with interesting comments from Kate on the history of local buildings seen along the way. At the bridges the nature of the stone used (locally sourced Brownstone) was discussed and the difference in weathering between the red and green varieties was noted as well as the effects of misorientation of the laid blocks. We noted the highly inappropriate use of Portland cement, rather than lime cement, in making some repairs.

Windles Quarry on Coppett Hill has been a source of Brownstone material. Structures seen here include a thin

The party discusses the stone erosion at the Goodrich road bridge

stratum in which the bedding is highly distorted, thought to be the result of an earthquake prior to consolidation, and the effect of Quaternary erosion in forming the hillside with consequent cambering of the near-surface beds. Nearby was a fine exposure of the Quartz Conglomerate with features including upward-fining beds (from coarse conglomerate to sandstone) and honeycomb weathering ('tafoni').

We concluded with a walk through the village, noting geological structures in the stones of the buildings and well as the variety of imported material in the newer houses. The histories of some of the buildings were revealed, including some unexpected previous uses. Last of all was a view of the castle and its moat with comments on the features found during work on the EHT project.

Tuesday 18th August 2015:

Building Stones in Ledbury

Paul Olver led a party of about thirteen, including several non-members, to inspect the stones used in the older buildings in central Ledbury. Interwoven with the geology, Paul related a great deal of fascinating local history.

We started at the old almshouse wall, built of roughly

Cambering in Windles Quarry. The massive beds near the ground surface have acquired a slight downhill slope due to the squeezing out of the less competent soft material between them.

shaped grey Silurian rock with some larger pieces inserted possibly as decorative features. Across the road, the old library was of similar stone, fossiliferous and including a Syringopora coral, but with quoins and windows in Triassic Bromsgrove Sandstone. Various blocks of this were noted laid with the bedding upside down or even vertical. Decayed blocks had been replaced with Grinshill stone from Shropshire. Quoins at the corners of the almshouses were of golden Downton Castle Sandstone, probably from quarries at the edge of the Woolhope Dome.

A couple of modern uses of stone in shop fronts were pointed out. In the old Woolworths shop front larvikite showed its characteristic spectacular reflection due to diffraction from twinned feldspar crystals. Barclay's Bank displays dark pyroclastic rocks of the Borrowdale Volcanics.

Moving on to the magnificent parish church, Paul pointed out the outward-leaning southern wall, the result of being

Contrasting colours of the sandstone quoins in the old library and the almshouses in Ledbury.

built over a stream, and described various subtle features of the architecture. Decorative stones in the font and pulpit are, respectively, green Polyphant stone from Cornwall and multicoloured Ashburton marble. Polyphant Stone is an ultrabasic igneous rock which has been altered so that the original olivines and other minerals are converted to a mixture of talc, chlorite and various carbonates.

In St Katherine's chapel of the old hospital were some good examples of medieval floor tiles and the use of 'pepper and salt' diorite from Charnwood Forest. The meeting ended at the nearby Portland Stone war memorial.

Decorative stone in Ledbury church. Polyphant Stone in the font (left). Ashburton Marble in the pulpit (right).

Sunday 20th September 2015:
Newly Cleared Sites on the Malverns

On a generally sunny day, eight members and a visitor were shown a number of sites which had been recently revived by a team of volunteers working for EHT under a contract funded by the Malvern Hills AONB. John Payne led the WGS tour and had led the clearance work. Of the ten sites so far cleared, seven were seen on this trip.

At the car park by North Quarry we saw a large area of fault plane, an element of the East Malvern Fault system, with an associated Permo-Triassic breccia. Here, the Malvern igneous rock is faulted against soft Bromsgrove Sandstone, a narrow strip of which runs around the hillside to Malvern town centre. The sandstone was originally emplaced at a higher level but slipped to its present position during Permo-Triassic times. The fault seen is a small branch of the main East Malvern Fault. This lies about 100m to the north-west. On the main fault the Bromsgrove Sandstone slipped down a further 600m or more. At this location, slickensides and a breccia of Malverns Complex in a matrix of sandstone grains were seen.

The brecciated fault plane at North Malvern Quarry.

The party studying the Sycamore Tree exposure.

Knight's Quarry at Storridge, in Woolhope Limestone, was in exceptionally good condition, having been cleared only two weeks previously. This is the best of only two good exposures of this rock in the Malvern area. A selection of fossils, mostly small brachiopods, was seen here.

The High Wood playing field at West Malvern showed an unusual terrestrial deposit of red grit and sandstones from the early Silurian and an unconformable junction with the subsequent marine siltstones.

A little to the south, the Sycamore Tree Quarry revealed the old Silurian beach with several features seen on present-day beaches as well as its unconformable boundary with the local igneous rocks. This small pit was dug in the early 20th century and probably has not been seen in its present condition since then.

Moving south, Gardiner's Quarry showed the fault zone where it is thought that the important Colwall Fault meets the Malvern ridge. A small area in the igneous rocks showing mingled patches of pink and grey rock excited some discussion. Here we took our lunch.

In the southern Malverns we visited two old quarries. The orientation of the bedding at the Gullet Pass Pit has been the subject of some controversy. The two possibilities for the bedding are at a right angle to each other! This problem has been resolved, following the clearance, by the discovery of trace fossils which are clearly visible in favourable lighting and define a bedding plane. Despite much searching, these traces could not be found on our visit due to the diffuse lighting from the overcast sky.

The top level of White Leaved Oak Quarry shows the unconformity between the Lower Cambrian Hollybush Sandstone and the Malverns Complex. The historical significance of the site was explained. It is the location of the first demonstrations of the mechanism of 'dynamic metamorphism' and of the Precambrian age of the Malvern rocks. The nearby quarried face of the Malvernian showed 'eyes' of undistorted granite surrounded by the squeezed and metamorphosed main body of the rock.

Trace fossils at Gullet Pass Pit.

NISYROS - AN INTRODUCTION TO GREECE'S MOST ACTIVE VOLCA-

THE ALMOST CIRCULAR ISLAND of Nisyros, with its impressive central caldera 3.8 km wide, is an integral part of the Aegean Volcanic Arc. This region is the site of active plate convergence with associated calc-alkaline volcanism involving the eruption of basaltic andesite and rhyolite lavas and pyroclastics over the last 161,000 years. Activity along the whole volcanic arc was initiated in the Tertiary as a result of the northward subduction of the African plate beneath the Aegean – Anatolian plates. Besides Nisyros, other important centres along the arc include Santorini, the focus of the Minoan eruption of 1645 BC, together with Milos, Poros and Methana. The subduction zone has been proved to lie between 150 and 200 km below the island.

View of the village of Nikia on the caldera rim.

Regular ferries from Kos connect with Mandraki, the main town of Nisyros on the north-west corner of the island. On their way in they pass close to the islet of Gyali whose extensive pumice mining industry sustains the local economy. Mandraki's main attractions are the 14th Century Castle of the Knights of St. John built in 1325 high up on a cliff face. It encloses a later monastery dating from 1600 well known from its finely carved Russian-style altar screen. Good exposures of the initial pillow lavas of Nisyros are seen on the seaward side of this castle and can be reached by a well-trodden path from the medieval quarter of the town.

Nisyros is considered to have developed on the inferred edge of a larger submarine caldera created by the supereruption of the Kos Plateau Tuff (KPT) dated at 161 ka. The original caldera rim is marked out by the islands of Nisyros, Yali, Strongyli, Pyrgoussa, Pahia and Kéfalos on the western end of Kos. The pillow lavas in Nisyros seen beneath the castle in Mandraki are overlain by the KPT event and it is therefore assumed that subaerial activity on the island must have commenced after 161 ka.

The main road from Mandraki runs eastwards towards the popular marina of Páloi where thermal springs, first exploited by the Romans, are found close to the local church. Beyond Páloi, the first subaerial basaltic andesite lavas and tuffs of the Panaghia Kyra series outcrop in coastal and roadside sections. These built up the first large volcanic cone at Nisyros. At this stage Nisyros was probably 7 km diameter and 700 m high.

There then followed the first large destructive event, the Lower Pumice eruption, around 50,000 years ago. This major sub-Plinian eruption, emanating from a central vent, covered the whole island and can be recorded in neighbouring islets as well as on the seabed of the adjacent Aegean Sea. A good section through this deposit is seen beyond Páloi, where the road briefly leaves the coast. Here the darker andesitic tuffs are covered by an orange-brown palaeosol, which underlies the white Lower Pumice pyroclastic fall deposits (Fig.1).

Before reaching Páloi, the main road branches up towards the main cone and eventually along the eastern edge of the present caldera towards the picturesque village of Nikia with its spectacular views into the newest craters (Fig.2). Underlying this village is the Nikia Rhyolite, an obsidian lava showing complex flow folding and spherulite development along closely spaced shear planes. This viscous lava, reaching 150 m in thickness, erupted at the end of the Lower Pumice eruption and represents a degassed phase of the Nisyros rhyolite magmas. Nikia also offers an excellent volcanological museum opened in 2008 in the former village school building.

The Lower Pumice eruption was followed by a second destructive caldera-forming episode about 45,000 years ago. This Upper Pumice eruption of slightly less magnitude than the first and from a more northerly crater is well exposed on the northern slopes of Nisyros, where it overlies the Lower Pumice along a very thin palaeosol in roadside exposures.

View of the main caldera with the late rhyodacite domes and the newest crater of Stephanos at the bottom left.

Succeeding the Upper Pumice eruption, a suite of prominent rhyodacite domes trending NE-SW have been extruded into the caldera (photo above). They occupy about two-thirds of the caldera floor. Currently, the island shows a high level of hydrothermal activity with multiple phreatic eruptions recorded in historical times, the most recent being in 1871-1873 and in 1888. More recently, in 1996-1998, the island experienced a >10 cm ground uplift which suggests some inflation of the sub-surface magma chamber. These movements still need further research and regular monitoring to assess their overall importance.

Temperatures of more than 300°C have been detected at 1700 m depth and have given rise to thirteen phreatic eruptions in historic times, creating distinctive phreatic craters mainly on the southern caldera floor. Sea water and rain water penetrate into the heavily fractured volcanic basement and are heated by the near-surface magma. When the vapour pressure exceeds the load pressure of the overlying volcanic rocks, an explosive hydrothermal (phreatic) eruption occurs. The Stéfanos crater is the largest and its excellent state of preservation indicates an eruption not more than 4000 years ago. From the Nikia road, a steep winding route leads down into the modern caldera and directly to this active crater. A succession of coaches operates every day along the road taking tourists into the caldera. Refreshments and an excellent set of explanatory notice boards are found close to the Stéfanos crater. Good specimens of sulphur and a strong whiff of the customary H_2S await you as well as the experience of observing hot active solfataras around its edges.

The Lower Pumice Series overlying a thick brown palaeosol which in turn sits upon early andesitic tuffs on the Paloi to Lies road, N.E.Nisyros.

Recent studies indicate that Nisyros is the most active crater in the Aegean Arc. Santorini has erupted small scale dacite lava flows over the last two centuries whereas Nisyros is seen as having the potential for a far more damaging Plinian/Vesuvian event. Detailed mapping and regular monitoring are currently underway with a team from the University of Liverpool playing a leading role. Although not as famous as neighbouring Santorini, Nisyros is certainly worth a visit for its variety of geological features displayed along its many geowalks.

MARCHES GEOLOGY FROM MURCHISON TO THE MODERN ERA

by John Payne

A SYMPOSIUM with this theme was held in Ludlow from 2nd to 4th October 2015. It was supported and part sponsored by the Geologists' Association in collaboration with WGS, H&W EHT, Teme Valley Geological Society and the Shropshire Geological Society.

On the first day, visitors had the option of exploring Ludlow with the help of trail guides and of visiting Shropshire Museum's Resource Centre. At the Centre, the comprehensive geological collection could be seen and a workshop on the identification of rocks, minerals and fossils was held. The distressing news was revealed (informally) that the curator and the collections officer had just been given notice of redundancy.

The second day was devoted to three major lectures, a series of parallel workshops, poster displays and exhibits by several bodies (including WGS). The first lecture, by Martin Ruddock, dealt with the legacy of Murchison's work in the Marches. Although Murchison is sometimes considered to have tackled an almost unknown series of rocks in south Wales, Ruddock pointed out several precursors, particularly Buckland, Greenough, Coneybeare and Aikin. In addition, Murchison is well known for his extensive use of the knowledge of local geologists. His work on fossils also to some extent followed the work of others, especially Brongniart. Nevertheless, Murchison clearly systematised the stratigraphy of the area and thoroughly described its fossils, which had earlier been thought non-existent.

The last two lectures both dealt with fossils. Shropshire is one of the few places in the UK which boasts of Precambrian fossils. Alex Liu described structures in the rocks of the Long Mynd. Some were described as fossils by JW Salter in the 1850s. Later, others were thought to be rain drop marks, then body fossils of the Ediacaran period. Most recently it has been decided that most are not body fossils but are the results of water escaping from sand bodies and interacting with microbial mats. Salter's 'fossils' are found to be manganese stains.

David Siveter described the work on fossils from the Herefordshire lagerstätte. This site is one of only two good Silurian lagerstätten worldwide and the only one containing foraminifera. It has delivered a large number of rare or unique fossils; for instance a gastropod, a bristleworm in 3D, a brachiopod with pedicle and an epizoan, a female ostracod with eggs and a parasite. The mechanism by which the extremely rapid fossilisation occurred is still not fully understood. Three thousand nodules have been collected, of which about one third contain fossils and about half remain to be investigated.

The four workshops on Saturday were on varied topics: European geo-villages (French, German and four Portuguese visitors attended), the EHT building stones project, John Cary (the man behind William Smith) and, lastly, a visit to the Secret Hills Discovery Centre at Craven Arms.

Four excursions were arranged for the final day: A visit to the Downton Gorge and Aymestrey Quarry, following the work of Murchison, and then the Mortimer Forest Trail, led by Dave Green and, in part, Bob Williams; Shropshire churches, with emphasis on Anglo-Saxon buildings and what the stonework can reveal of the local geology; the Shropshire scenery in relation to its geology, with an emphasis on the 10km x 10km grid square SJ60, which is put forward as the most geologically varied 100 km^2 square in the world. The fourth trip visited some Ordovician and Cambrian rocks in quarries of historical significance and ended with an 800ft climb to the top of Caer Caradoc. This was led by Paul Olver. David Siveter was one of the group and made useful and informative additions to Paul's commentary.

The view south from Caer Caradoc.

Geology Section Programme for Early 2015

LECTURES are held in the Woolhope Room, Hereford Library, Broad Street, commencing at 5:30pm unless otherwise stated. Members will be notified of any changes. **Non-members should seek confirmation from Sue Hay.**

Friday 15th January: 'Drilling for Oil and Gas'
A talk by Cliff Spooner. Based on examples from his career and the training department of Stag Geological Services Ltd.

Friday 26th February: Section AGM and Dinner

Friday 18th March :
'The Carboniferous under the Southern North Sea'
A talk by Dr John Collinson.

April : Outdoor event to be confirmed

Further information from Sue Hay, 01432 357138 or email svh.gabbros@btinternet.com.

Thursday 3rd March : 'Escaping Snowball Earth'
A talk by Professor Ian Fairchild, Birmingham University. This will be a joint meeting with the Hereford Astronomical Society. 7pm at the Kindle Centre, ASDA Supermarket, Hereford. Cost £2

Editor's Note

WITH this twelfth issue of Earth Matters your editor has, alas, failed in his general aim, achieved last year, of filling the newsletter with articles solely about our local area, Herefordshire and just beyond. This year, only the report of the Ludlow symposium and Geoff's write-up of our talks and excursions fit this category. Nevertheless, I hope that readers will find material of interest to them. Gerry's account of bell pits and other things on the slopes of Titterstone Clee Hill are the next nearest geographically. Beyond that, we're off to 'foreign' parts for the other articles.

I must thank all the authors for their efforts in (very nearly) meeting my deadline for delivery of their articles and in generating items close to my requested size. (And for providing excellent illustrations too.)

As last year, I have again not sought an article about the Section's major research task at the Martley Rock, in conjunction with the Earth Heritage Trust and the Teme Valley Geological Society, with financial input from the latter. The most recent trenching work was conducted about fifteen months ago but activity has continued, particularly by Sue Hay's inspection of the rock samples taken from the excavations. Her results will be included with Bill Barclay's interpretation of the geology in a paper which is to be submitted for publication in the Proceedings of the Geologists' Association. In the shorter term, readers wishing to learn about the project's results may like to attend the meeting of the Teme Valley Geological Society in Martley Memorial Hall on Monday, 18th January 2015, 7:30pm, when Bill Barclay will give a talk about the work at Martley Rock.

Subscriptions

THE ANNUAL SUBSCRIPTION to the Geology Section is currently £7.00. This is due on 1st January (as for all other WNFC subscriptions). Please pay this directly, and on time, to the Section Treasurer, Beryl Harding, 'Bramley', Lugwardine, Hereford HR1 4AE. **Do not** send it to the WNFC Secretary with your WNFC subscription. Cheques should be made payable to 'Geology Section / WNFC'. Members are encouraged alternatively to pay by Standing Order; forms are available from Beryl.

Annual General Meeting

MEMBERS are asked to accept this as notification of the Geology Section AGM to be held on **Friday 26th February 2015** starting at 5:30pm in the Woolhope Room (unless otherwise notified). After the AGM we will retire for dinner to a local restaurant. Booking forms for the dinner will be e-mailed to members in January. The officials and committee for the coming year will be elected. Two members of the present committee will retire at the AGM. Section members are invited to submit nominations for election to the committee. Nominations, with the names of the proposer and a seconder, must be received by the Section Secretary in writing (letter or email) before 27th January 2015.

Fluvial Geomorphology

by Matthew Arnold

THE LINES below form the end of Matthew Arnold's poem 'Sohrab and Rustum'. I think it's not a bad partial description of the stages in the course of a large river, specifically here the River Oxus in central Asia. River terraces don't appear in this extract but do get a mention earlier in the poem.

But the majestic river floated on,
Out of the mist and hum of that low land,
Into the frosty starlight, and there moved,
Rejoicing, through the hush'd Chorasmian waste,
Under the solitary moon;—he flow'd
Right for the polar star, past Orgunjè,
Brimming, and bright, and large; then sands begin
To hem his watery march, and dam his streams,
And split his currents; that for many a league
The shorn and parcell'd Oxus strains along
Through beds of sand and matted rushy isles—
Oxus, forgetting the bright speed he had
In his high mountain-cradle in Pamere,
A foil'd circuitous wanderer—till at last
The long'd-for dash of waves is heard, and wide
His luminous home of waters opens, bright
And tranquil, from whose floor the new-bathed stars
Emerge, and shine upon the Aral Sea.

Members of the WGS Committee

(December 2015)

Dr Geoff Steel, ***Chairman***

Gerry Calderbank, ***Vice-Chairman***

Dr Paul Olver, ***Secretary***

Beryl Harding, ***Treasurer***

Dr Sue Hay, ***Programme Secretary***

Moira Jenkins, ***Section Recorder***

Dr John Payne, ***'Earth Matters' Editor***

Charles Hopkinson, ***Minutes Secretary***

Tony Geeson

H&W Earth Heritage Trust

The Geologists' Association awarded Peter Oliver, the Trust's founder, the Halstead Medal in May this year. The EHT Trustees felt that national recognition for his work in Geoconservation was long overdue. They put forward his name, supported by the Geology Trusts and GeoconservationUK, who between them represent all the local geoconservation organisations. The Halstead Medal is awarded for work of outstanding merit, deemed to further the objectives of the GA and to promote geology.

At this year's AGM long standing trustee and Woolhope member Rosalind Skelton, and Mike Preston both stood down as trustees. I am also delighted to tell you that John Payne was made an honorary Vice President. Since then we have appointed a new trustee with another in the pipeline. Professor Ian Fairchild is Professor of Geosystems at Birmingham University.

Our current main project - the Heritage Lottery-funded 'A Thousand Years of Building with Stone' reached the half way point in its planned project programme in February this year. With support from the project consultants and a continuing training programme, volunteers are working in each of the clusters with one or two new volunteers joining the project every month. Over the past year the building stones team has attended many events, run road shows and given talks across the two counties. To date they have engaged with nearly 14,000 people.

The database has been designed, tested, refined and is now complete but still needs the data to be added. Volunteers can now download their findings directly onto it. The database is one of the legacies of the project and it will be accessible on line for at least ten years after the project ends. The project life has now been extended until 2017 largely due to the prolonged closure of the Herefordshire Archive, which finally reopened in August.

A project, funded by Natural England and undertaken by the Wye Valley Partnership, aims to protect, maintain, enhance and restore biodiversity and geodiversity in the Wye Valley. The third and final phase, which ended in March 2015, focused more on the legacy of this three-year partnership. This included a successful geodiversity tour for B&B and other local business owners in early 2015. The aim was to publicise not only the geology, but also the value that increasing trends for geotourism can bring to local businesses. Working with the landowners, site management plans have also been completed.

At the request of and funded by the Malvern Hills AONB, the Trust continued to undertake a programme of site maintenance by a team of volunteers led by John Payne. Six sites were improved during 2015. In September, the Woolhope Geology Section spent a very interesting day visiting some of the sites.

Other activities in the past year have included a very successful visit by Rock Watch, the junior section of the Geologists' Association, to Whitman's Hill Quarry, hosted by its champions.

H&W EHT did not take part in Geofest this year but ran its own full programme of walks, talks and road shows through country both within and outside the Geopark. This included seven events, nine walks and an exhibition at the Hereford Cider Museum

Finally I am delighted to inform you that EHT has been awarded funding by the Heritage Lottery Small Projects Fund for a project called 'Voyages into Deep Time'. This will involve young people in the development of geological apps. The Bransford Trust, a Worcestershire charity that focuses its work on young people, has also given EHT a grant of £30,000 for the same project. The aim will be to start this early in 2016.

Dr Sue Hay, *Chairman, EHT*

A&MH Geopark and GeoFest

I'm pleased to state that, following an influx of newcomers, the Geopark Forum now has eighteen members. Geofest has once again proved to be a popular and successful public event that will be repeated in future. Major sponsorship was generously provided by West Midlands Safari Park, to whom we are most grateful.

Geopark President, Chris Darmon, launched Geofest and spent a very enjoyable few days with us, during which time he was photographed on Bewdley (SVR) station prior to driving a GWR 2-8-0 locomotive. We've provided a highly acclaimed 'Fossils in the Geopark' exhibition, launched a new Geological Trail - with printed Trail Guide - and staged an innovative Science Project with Bewdley High School. New free geology trail leaflets have been placed at six Forum members' visitor centres – and several fresh initiatives are in hand .

WGS staged three guided walks and these have furnished a modest financial return to both Geofest and our own funds. Following initial concern regarding a potential public liability issue, the Club graciously provided the requisite insurance in accordance with normal WNFC procedure

Gerry Calderbank, *WGS rep. on AMHG Forum*