Earth Matters

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

No. 16 December 2019

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MESSAGE FROM THE CHAIRMAN

THE WOOLHOPE CLUB has always represented a 'broad church' of interests ranging from geology and natural history through to archaeology and history, all focussed on the county of Herefordshire. During 2019, the Presidential Field Meeting organised and led by Rachel Jenkins aimed to include all these interests in one day around Bredwardine and Moccas Park. Hopefully, the natural history aspects of the Club's research will be strengthened by the focus on the kettle hole ponds formed during the last phases of the Quaternary Ice Age and their invertebrate inhabitants, as well as the local ancient oak trees. Geological studies were the foundation of the embryonic Woolhope Club in 1851 and that history of early research and the first field trip to the Woolhope Dome in May 1852 was covered in the day of 'drop-in' lectures in the Woolhope Room on Saturday 16th November. Again all aspects of the Club's interests were covered during the day.

By continuing to offer these multi-interest events, we hope to encourage more involvement by new and current members of the Club in the geology programme for 2020. We are now in the mainstream of the Club's programme and in an ideal position to spread the word to all Woolhope Club members.

Field meetings have always been a key part of our programme and the recent incorporation of Hereford city and more of eastern Herefordshire, including the Woolhope Dome, into the Abberley & Malvern Hills Geopark has given us new opportunities for local field meetings. This is the best way to introduce new members through 'Geo-walks' or 'Geo-ambles' (as offered by our neighbouring Teme Valley GS). Longer weekend excursions are also possible and allow members to get to know each other better as well as studying some excellent and wide-ranging geology.

None of this can be achieved without the efforts of our hard-working Committee who I would like to thank for their valued contributions over the past year both in Section events and in whole Club activities, Let us make 2020 the year when the Section takes up its rightful role in the whole Club programme.

Dr Paul Olver. Chairman

THE KNIGHTON GEOLOGICAL MAP – AN UPDATE OF PROGRESS

by Dr Arthur Tingley

Readers may remember an article in the 2017 issue where I described the background to the geological survey of the Knighton Geological Map (Fig.1). The survey is being undertaken by some members of the Teme Valley Geological Society, Earth Heritage Trust and the Woolhope Club. This short article brings you up to date with our progress.

Between 2013 and 2018 we have undertaken a complete primary survey, by exposure and feature mapping. This has been done mostly on public access areas and, with permission, on some private land, aided by supplementary observations using LIDAR, air survey, BGS borehole data, etc. Thus, I have now been able to interpret all of the data to create a set of four 1:25 000 scale maps, with a lithological key and cross sections. [You can see these on the Knighton Project Page at https://www.geo-village.eu/]

We have taken nothing for granted. Earlier research was taken into account but checked and revised. Much of the area had not been surveyed before and there has been a need to reconsider the interpretation of facies. It has

Figure 2 A part of the Woolhope team of graptolite huntes enjoys a break for lunch.

helped that there have been new exposures due to very recent excavations, whilst those older than 50 years or so have often disappeared. Hence it was important to work through this survey without preconceptions of the anticipated result, for we can always see what we are told to look for.

The four maps are now [2019] the basis of testing, so we are researching detail to ensure that interpretation on the maps fits with what can reasonably be seen on the ground. I had initially worked on the assumption that the most recent BGS maps to the north and west would only require me to adjust and calibrate against them, However, it is clear that even here we need to be very cautious in-

Figure 3 Graptolite fossil and a composite drawing made from microphotographs taken by John Payne — Saetograptus tumescens.

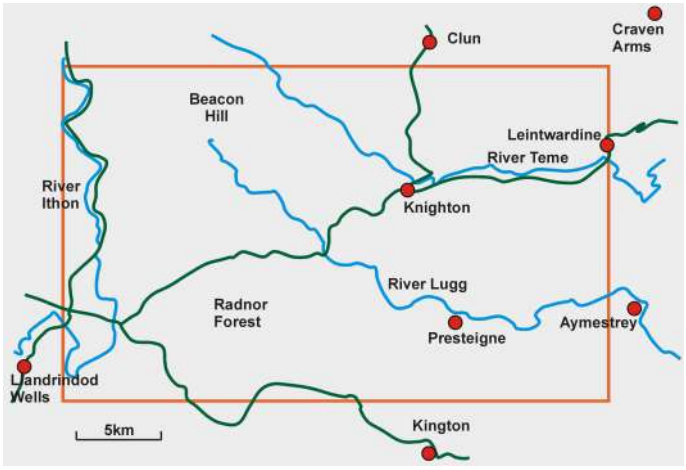

Figure 1 The area of the Knighton sheet

deed. Furthermore the sheets to the east [Ludlow] and south [Hay on Wye] need significant review in future as there is no evidence that BGS has ever actually surveyed all of those.

Examples of where we are carrying out detailed research include:

The Woolhope/U3A group (Fig.2), working under the leadership of Moira Jenkins, has undertaken a search for zone fossils on the NW quadrant of the map, to cover initially the boundary between the Gorstian and Homerian (Silurian) (Fig.3). This follows on from a find by Geoff Steel around Fron Goch [SO 155 605] of a *Cryrtograptus lundgreni,* implying a dramatic thinning of strata at the base of the Gorstian in this area. This demonstrates how a chance observation can lead to a significant change in interpretation.

Work has also been continuing to clarify the relationships between a variety of facies at the Telychian – Sheinwoodian boundary (Silurian) in the vicinity of Llandewi – Crossways. Here there is a series of faults which seem to separate rocks of different types but of a similar age. This may be an artefact of classification method or a real environmental indicator.

Likewise, we have to review and redefine some of the

Figure 4 Broken ripples in a microbial mat. Typically found in conditions of very low oxygen levels at the water - sediment boundary, mats of this type are sometimes indicative of methanogenic bacterial activity. (Photo by Paul Bate)

published definitions of facies. An example is the rock name Knucklas Castle Formation [of Holland modified by Cave]. This is replaced by the Radnor Forest Formation because the facies is exposed well around the Radnor Forest, and can now be seen as a dysaerobic hemipelagite, quartz silt. There is abundant trace evidence of scavenger activity and microbial mats (Fig.4). Hence there are virtually no hard fossils (they have been consumed) whilst the previous rock classification relied on the existence and non-existence of fossils to prove boundaries.

Faulting is ubiquitous across the sheet, and a previously unrecognised feature is the frequency of normal=with-thrust fault duplexes with the thrust and significant folding on the eastern side (Fig.5). The overlap of faults from the Montgomery sheet [to the north] does follow on in a south-westerly direction. My working hypothesis is that each of the small vales crossing the Teme in the vicinity of Knucklas lies on a fault, so we are looking for the evidence for this. Furthermore, there are also mismatches of rock classification along the northern boundary which also are in the process of being resolved.

Figure 5 Illustration of a fault – thrust duplex typical of those seen in this area. This example is taken from the field notebook for Wax Hall (SO 297 759).

Figure 6 A slightly puzzling section - this implies turbidite flutes, typical in anoxic Nant-ysgollen Mudstones around Llanbister [here at SO 076 689]. One might be tempted to take the upper surface as the bedding plane. Instead it must be a joint but the surfaces are not smooth. So are those 'flutes' really packets of layering instead? Very careful observation shows that bedding layers are parallel to the flutes. (Photo width is c.1m)

The area around Knill Wood - Burfa Bank – Evenjobb, to the south of Presteigne, is being examined in more detail where the Church Stretton and the Leinthall Earls Faults mesh. Work along the whole of the Church Stretton Fault to the north was carried out by John Moseley; thus he is following on with the checking of the survey. Additionally, we have been working with researchers from Birmingham University to assist their work on the Coalbrookdale Mudstone / Dolyhir / Nash Limestone environmental interpretation.

A good deal of the year has been taken up with the cartography, assessing methods of reproduction and, most importantly, colour testing. I have set out to try to use a colour scheme for the lithology which reflects an aspect of the natural colour of the rocks and the environmental interpretation. Thus. dark blues and purples are used for anoxic rock, buff and yellows for sandstones and the obvious reddish ochres of 'Old Red Sandstone' for the Pridoli.

At the time of writing the next steps will be to redraw the entire map, at 1:50 000 scale along with all the necessary paraphernalia to compile a map in the style of the BGS series.

Once the process of building the 1:50 000 sheet is complete, we shall follow on with a sheet explanation with environmental interpretation. The process of publication will then need to be considered. We are also feeding our work to the BGS survey team [led by Rhian Kendal] which started work in 2018. Their eventual interpretation is likely to have to comply with existing BGS constraints. We hope that this process will stimulate a good deal of follow-up research, and indeed I rather hope that this survey might perhaps re-energise the Ludlow Research Group, A geological survey always throws up new information and intriguing observations which nobody else has ever seen before; we now have a large body of evidence in photographic form (e.g. Figs.6 and 7), samples and other data which all can be considered further and re-interpreted. There may be other interpretations of course, so our task from now on will be to provide access to that material so that future researchers can review the evidence for themselves.

Figure 7 Turbidite flutes in mudstone. This is an impression on the upper bed.

IT IS ALL IN THE ROCKS

by Sue Hay

Introduction

A small Victorian gravel pit, now called Martley Rock, 1km west of the Worcestershire village of Martley exposed part of an inlier (older rocks completely surrounded by younger ones) of Precambrian and Lower Palaeozoic rock, when first recorded by Roderick Murchison in 1839. Many eminent geologists followed him through the 19th and 20th centuries, comparing and contrasting it with the exposures in the Malvern Hills to the south. The pit was completely in-filled by the late 1980s. A chance meeting in 2004 led to an extensive programme of trenching between 2010 and 2014. In total 12 trenches and several pits were temporarily excavated across the pit and the field in which it is located (Fig.1).

The geology of the site comprises rocks from five geological periods, ranging in age from the Late Precambrian (Malverns Complex) to the Triassic (the Helsby Sandstone Formation) (Figure 1). The location of the old pit is shown in the lower central part of Figure 1 between Trenches 1 and 2. Although many authors have made comparisons with the rocks found in the Malvern Hills and elsewhere, clear evidence for these comparisons has been lacking until this work was undertaken.

The research was a combined effort by professional geologists and amateurs from the Woolhope Naturalists' Field Club, the Herefordshire and Worcestershire Earth Heritage Trust and the Teme Valley Geology Society, led by Bill Barclay (British Geological Survey). The early part of this work was described in the Woolhope Club Transactions in 2012. This article is largely taken from a talk given to the Open University Geological Society's annual symposium held in Worcester in 2018 and subsequently published in their Proceedings. A paper on the complex structural aspects of the site uncovered during this research is currently in preparation.

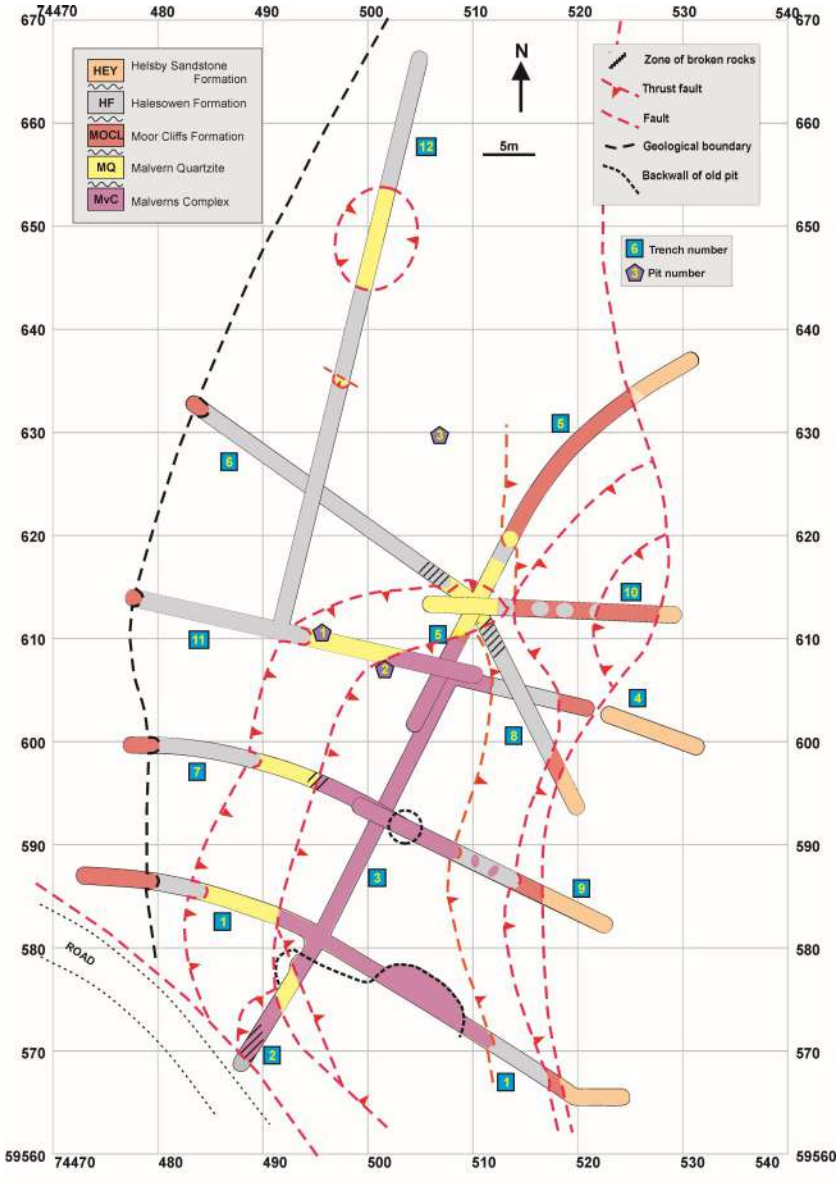

Figure 1 Plan of the trenches dug at Martley Rock.

This article concentrates on the results of examining thin sections from Martley Rock. Also included are two Palynological analyses (fossil spores) undertaken by a colleague of Bill Barclay. These support the findings.

Thin Sections

Thin sections are, as their name suggests, very thin slices of rock cut from samples and glued to glass plates that can then be studied under a polarising microscope. Rocks are largely composed of minerals which all have slightly different optical properties, allowing the identification of common minerals. A more detailed study of the minerals within any rock and their exact compositions requires the use of highly technical equipment such as an electron probe.

Thin sections can only be cut from rocks that are competent and will not fall apart when cut into thin slices. This means that only three of the rock types found at Martley Rock could be sectioned. These were of Precambrian, Cambrian and Carboniferous age.

Precambrian – Malverns Complex

The Precambrian rocks are all meta-igneous, that is igneous rocks (solidified underground from a magma) that have been altered to some extent, in this case largely by mechanical deformation with little long-term temperature change, such as during thrusting and shearing. Whilst the rocks within the old pit are all highly altered, the igneous rocks uncovered in Trench 3 become less altered further away from the old pit, with crystal size increasing to a maximum at about 15m before decreasing slightly towards the faulted boundary. For these reasons, a sample taken at 15m (MR13) was selected for detailed study.

This sample is a dark grey-pink-coloured, medium-grained diorite (Figure 2) comprising andesine plagio-

Figure 2 Diorite from the Precambrian Malverns Complex

clase (54%; average An_{45}), amphibole (18%), biotite mica (14%) and minor quartz, oxides, zircon and apatite (Figure 3). Alteration, which probably occurred during the metamorphism, includes plagioclases that are fractured with corroded ends and variably altered to sericite. The amphiboles are extensively chloritised, such that the exact amphibole cannot be identified, but the mineral group can be by its characteristics under the polarising microscope, six-sided crystal shape and the obtuse angle between its two cleavages (some 120°) that has been highlighted by the alteration.

In addition to the mafic varieties, altered felsic (light-coloured) meta-igneous rock samples taken from the pit were also examined and are marked by their lack of alkali feldspar, suggestive of a tonalitic composition. Together with the diorites they appear to form the majority of the Precambrian rocks at Martley Rock. A very similar proportion of rock types has been found in the northern Malvern Hills.

The meta-igneous rocks of the inlier have been variously described as rotten or badly altered syenite, diorite and by various metamorphic terms. However, few early authors provided detailed mineralogy, making comparison with closely constrained modern rock types difficult. All later workers have also correlated the meta-igneous rocks of the inlier with the north part of the Malverns Complex of the Malvern Hills where hornblende-bearing amphibole has been found in several quarries. The rocks previously described were all taken from within the former pit. This study gives the first description of a relatively unaltered amphibole–bearing diorite, allowing better comparison with the diorites found in the Malvern Hills.

Cambrian – Malvern Quartzite Formation

Highly tectonised and shattered quartz arenite has been reported from the pit itself but during the excavation of Trench 12 a previously unknown small area of fresh quartz arenite was exposed (Figure 4). Some 10m of fresh, massive, largely pale-coloured uniform sandstone was exposed in the trench. Three small areas, each some 10cm long, of alternating millimetre-scale pale-coloured (3 to 5mm) and mid-grey-coloured (10 to 15mm) laminae were also noted in the exposure.

A quartz arenite is very mature pure sandstone, with over 95% quartz grains, usually well-rounded. The massive sandstone is a medium-grained quartz arenite comprising medium-rounded to very well-rounded quartz grains (97%) some with silica overgrowth, minor (1 to 2%) lithic grains (rock fragments), altered mafic grains, oxides and silica cement. There are two types of lithic grains (>0.1mm diameter), both sub-rounded, polycrystalline and quartz rich. In one group, the grains have variable straight extinction while in the other the extinction is aligned and undulose, suggestive of an igneous and a metamorphic origin respectively.

In the laminated sandstone, the pale laminae are similar to the uniform sandstone, but the darker layers are largely composed of well sorted but very much smaller quartz grains (up to 0.2mm in diameter). No lithic grains are present in either layer.

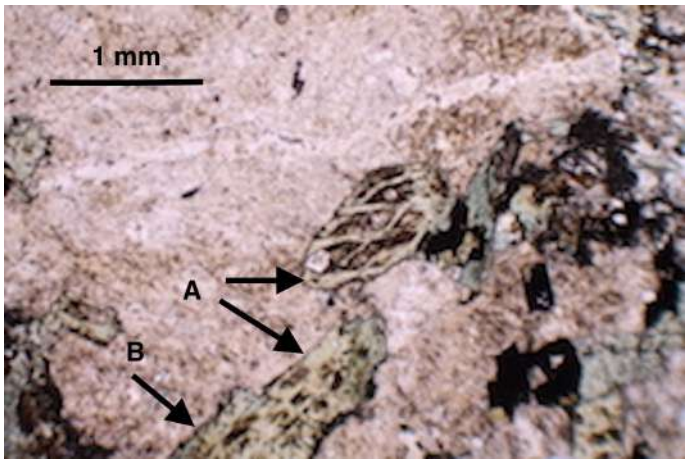

Figure 3 Photomicrograph of a diorite from the Malverns Complex. Sample MR13. A - amphibole, B – biotite. The rest of the image is composed of altered plagioclase and largely cubic iron oxides.

Acritarchs are hollow, organic-walled microfossils. They are one of the oldest groups of fossils and are believed to represent cystic stages in the life cycle of marine planktonic algae. A sample (BGS Sample MPA 61989) from Trench 1 yielded a single specimen of a possible acritarch attributed to *Lophosphaeridium*? sp. This is a long-ranging genus not diagnostic of age, but it is more prevalent in Early Cambrian assemblages than in Early Ordovician, which supports the correlation with the Malvern Quartzite Formation.

The Cambrian Malvern Quartzite in the Malvern Hills contains large amounts of very rounded, almost spherical

Figure 4 Exposure of Malvern Quartzite in Trench 12.

grains of clear quartz of quite uniform diameter and polycrystalline, quartz-rich igneous and metamorphic lithic grains. Similarly laminated quartzite has also been found near Gullet Quarry in the Malvern Hills, whilst the Ordovician Lickey Quartzite is compositionally more variable (quartz arenite to lithic arenite) and the quartz grains are not so well rounded.

The work at Martley has allowed the first description of fresh quartz arenite and the collection of a sample for palynology. Both the petrography and the palynology very strongly support correlation with the Malvern Quartzite rather than the Lickey Quartzite.

Carboniferous - Halesowen Formation

The Carboniferous rocks at Martley Rock were formerly referred to as the Highley Beds. They are correlated with the Halesowen Formation of the Midlands, which is of Late Carboniferous (Asturian) age. The Halesowen Sandstone in turn has been correlated with the Pennant sandstones of the South Wales Coalfield. Both sandstones were derived from the Cornubian – Armorican highlands to the south. This work has allowed both the first petrographic description and palynology analysis of the Halesowen Sandstone at Martley Rock.

The Halesowen Formation at Martley Rock comprises multi-coloured mudrocks interbedded with hard, fine-grained, green and grey tabular sandstones. The mudrocks are pale grey, pale green-grey, orange, dark grey and black, the darker lithologies being coal-rich. The colour-banding reflects differing oxidation states of the mudrocks. The sandstones are grey coloured and fine grained. Much of the Halesowen Formation at Martley is now unconsolidated, i.e. it has lost the cement that was holding the constituent grains together. It is most likely that this occurred during the thrusting that also altered the Precambrian and Cambrian rocks at Martley Rock. Blocks of the sandstone were found *in situ* during the trenching.

A thin section was cut from a representative sandstone block (MR 11) taken from Trench 12. It is a medium-grey coloured, very fine-grained, arkosic arenite comprising quartz (70 to 75%), chloritised mafic mineral(s) (10 to 15%) and oligoclase plagioclase feldspar (5%) with minor muscovite mica and oxides (Figure 5). The matrix (approx. 5%) is locally iron-stained. Texturally the sandstone is immature, the quartz grains are sub-rounded to angular and some have silica overgrowths. The oligoclase feldspars are largely well shaped and fresh. The muscovite flakes are bent around the surrounding grains and are partially chloritised. The mafic grains are unidentifiable because of their extensive alteration and very small size but may well represent altered lithic grains that are very common in the Halesowen Formation.

Palynological analysis of a dark grey clay from Trench 1 (BGS Sample MPA 61990) yielded a palynological residue comprising large and numerous opaque fragments and scarce miospores. Five definite and two possible miospore specimens were recorded. Preservation is fair to good and all the specimens are small and relatively simple. One specimen is identified as *Lycospora*, probably *L. pusilla*. This species is not particularly diagnostic of age as it ranges from the Mississippian into the Permian but is consistent with a Carboniferous age.

Acknowledgements and Further Information

Much of the trenching at Martley Rock was funded by the European LEADER programme. Grateful thanks are due to John Nicklin for organising the 2012-2014 trenching; also to Elliot Carter for his assistance with the petrography. The site owners Helen and Rob Taylor and farmer Richard Bray are thanked for their willing cooperation. Public access to the site will be available until the end of 2022 but parties of over 10 people should book in advance by contacting the landowners at Cob House Fisheries.

Further information can be found in the following papers and the references therein:

Barclay, W.J. *et al.* 2012. The Precambrian inlier at Martley, Worcestershire: Martley Rock rediscovered. *Transactions of the Woolhope Naturalists' Field Club*, Vol. 60, 1-15.

Barclay, W.J. *et al.* 2019. Martley Rock, Worcestershire – a Victorian gem unearthed. *Proceedings of the Open University Geological Society, Vol.5, 21-28*

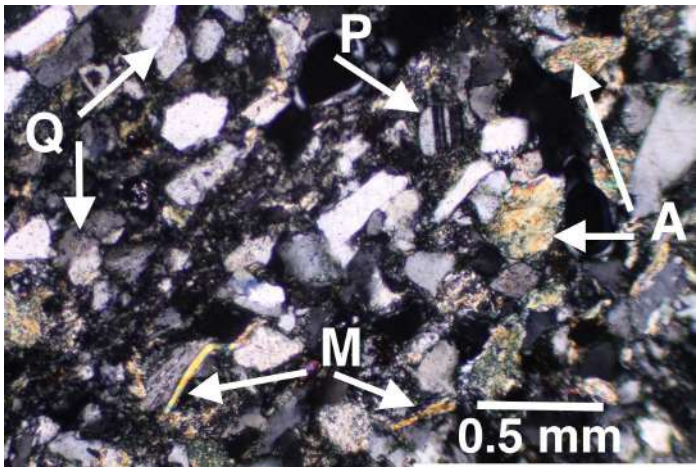

Figure 5 Photomicrograph of an arkosic arenite from the Halesowen Formation. Sample MR11. Q – groups of quartz grains, P – a plagioclase, M – muscovites, A – altered mafic grains

Annual Meeting

MEMBERS are asked to accept this as notification of the Geology Section AM to be held on **Friday 21st February 2020** starting at 6:00 for 6:30pm at the Bunch of Carrots Inn, Hampton Bishop. The officials and committee for the coming year will be elected. Dinner will follow the AGM at 7:30pm.

Meeting Venue

THE regular indoor meetings of the Geology section will be held in the Woolhope room in Hereford Library in Broad St., Hereford The meetings will open at 6:30 with talks starting at 7:00 and ending before 9:00.

Annual Subscription

READERS are reminded that the annual subscription to WNFC is payable on 1st January.

FOSSILS IN SHROPSHIRE …. AND HEREFORDSHIRE!

by Daniel Lockett

THE WELSH BORDERLANDS have long been known as a great place to study geology and as a place to find fossils. Indeed, since the founding of the earliest UK museums, their collections have often included material from the region. Given Ludlow Museum's proximity to the border of Shropshire and Herefordshire it is no surprise that specimens from some classic localities in both counties have been collected.

The History of Ludlow's collections

In 1833, a handful of Ludlow residents met with the intention of forming a Natural History Society. One of their chief aims was to establish a museum in the town. The stimulus probably came from the formation in April of that year of the Worcester Natural History Society, and its own plans for a museum, together with the frequent visits and ongoing research into the strata of the area by Roderick Murchison.

By 1834 Ludlow Museum was set up in a room over outbuildings at Dinham and at its heart were collections of Geology. By 1835 the Museum had moved to larger premises and again in 1840, to a purpose-built Museum in Mill Street, which still stands. Donations by the Rev. Thomas Lewis, who had helped Murchison in his research into the rocks around Aymestrey, helped to fill the gaps in the displays and the collections were increasingly recognised as having scientific value. Through the latter half of the 1800s the Museum and its collections continued to improve. Catalogues of the collections were produced, and they began attracting study by researchers and geologists from all over the country.

Fig.1 Ludlow Museum in 1910

From 1900, whilst the Museum's reputation for its Silurian fossils continued to attract interest, the Society's fortunes changed. The minutes of the group record many possible reasons, including the death of its subscribers, economic hardship, war, and even the weather. Whatever the reasons, by 1930 there were only a handful of members left. In a bid to save the collections, the group offered the contents of the Museum to Shropshire County Council, who took over in 1940, and in 1941 Ludlow Natural History Society disbanded. Over the next few years, the Museum was run by individuals who showed less interest in the collections and on the advice of the British Museum, many were transferred to other institutions. A list of around seventy of the most important geological specimens shows they were sent to the British Museum itself.

In 1959, John Norton who had been interested in the geology since he was a boy, became the first paid Curator at Ludlow. It was with his passion that the geological collection, with emphasis on the local Silurian rocks grew rapidly. Once again it began to gain national and international interest.

The Fossils in Shropshire project

In 2016, the significance of the geology was key to The Friends of Ludlow Museum securing funding to begin a new project. *Fossils in Shropshire* (FISH) set out to digitise, catalogue and make available on-line, the most important specimens now held by Shropshire Museums at its Collections Centre in Ludlow. Run by a small team of geologists and supported by an invaluable group of volunteers, the project's main goal is to ensure anyone with an interest in geology is better able to access this material.

Work began by examining the collections. With an estimated 40000 specimens, undertaking a full inventory was quite time consuming. However, by doing a specimen by specimen check, information from object labels was recorded and it helped to identify the most important objects to concentrate on for digitisation and research.

Initially, we selected objects based on the following criteria.

- Material regarded as scientifically important such as those specimens figured in scientific journals.
- Specimens that show the variety of a species or lithology or the best examples of their type.
- Objects from specific localities.
- Objects collected by notable people.

Experts were also brought in to check for unusual specimens and to update identifications. A series of publications on the collectors and collections were produced and several more academic papers are currently being written.

The team initially tried out a range of equipment and techniques for digitisation. This included meeting with a video game designer to look at technology used in Xbox video games as well as a dedicated laser scanner used by researchers at Birmingham University. In the end however, high resolution photography with digital SLR cameras yielded the best results and modern software even allows these images to be pulled together to create 3D models of the most interesting specimens.

We were also lucky to be supported by the Natural History Museum in London, who kindly offered to host the

images and the data that the project was producing on their publicly accessible website, whilst 3D models of key objects appear on Sketchfab, a website increasingly used by museums to show their collections (Fig.2).

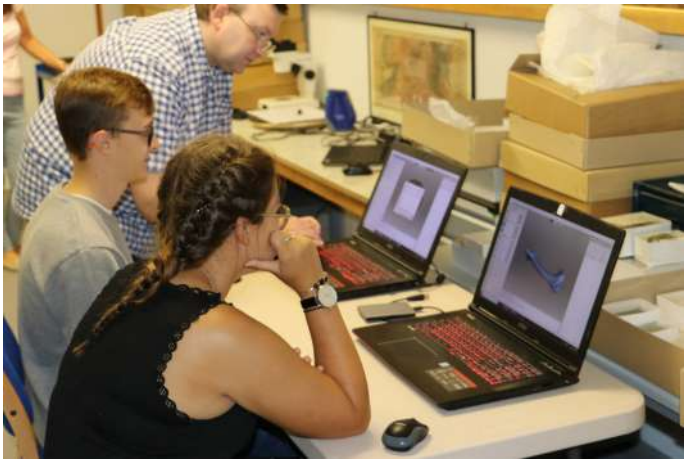

Fig.2 Project volunteers working on digital images to produce 3D models online.

Discoveries

From the beginning, we hoped that we would discover things that we didn't already know. Perhaps new species of fossil would be found among the thousands of specimens? As the project progressed, we learnt a great deal. A lovely example is a fossil some of our experts spotted when we looked at the material from the Leintwardine area. It appeared to be the remains of a trilobite (Fig.3).

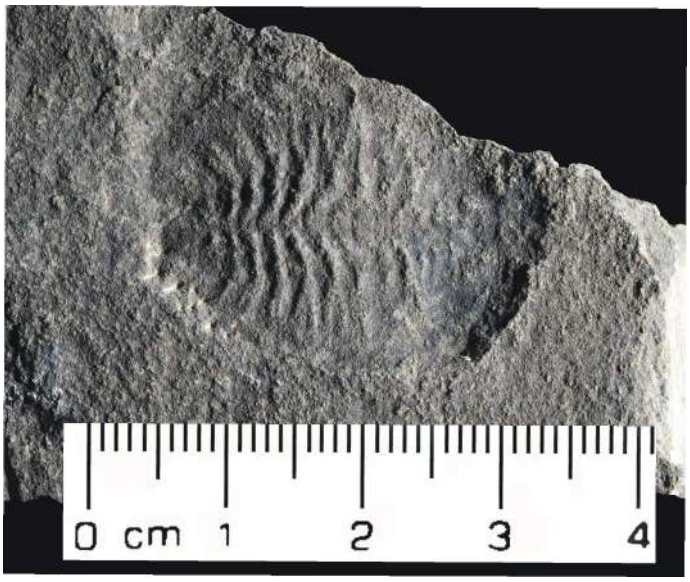

Fig.3 Arthropod, with preserved limbs, a rarity from Mocktree.

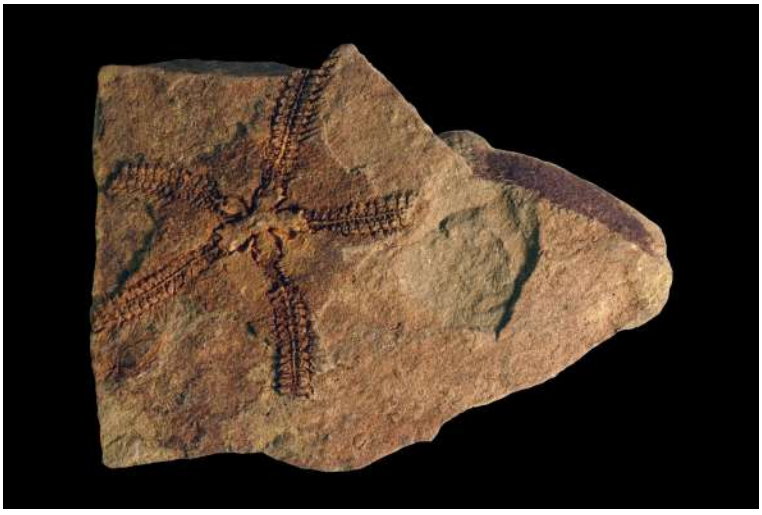

Fig.4 Lapworthura miltoni: a Silurian starfish from the Church Hill area near Leintwardine

Usually, the hard carapace of these invertebrates is all that is fossilised, and those are quite common. However, in this case we had the impression of the legs and other soft parts from the underside of the animal, which is something previously unknown from these rocks. Originally collected in 1926 from the Mocktree area, it had still sat unnoticed for years among a collection of other fossils from the area. In the 19th century, exquisite starfish were discovered in these rocks and the collection includes several of them which were also high on the list to digitise (Fig.4). As for new species, our experts also found what may turn out to be a new species of graptolite (Fig.5), this time from rocks over the border in Wales, but that will require a little more research and we await their results.

One of the questions we also wished to answer is, what happened to the original Ludlow collection? In 2016, the team visited the Natural History Museum to look for the seventy or so Ludlow fossils which we already knew were sent there in 1940. The distinctive labels used by Ludlow's curators made them easy to spot but, on our visit, we were delighted to find many more specimens! In doing a bit more research it seems that almost all of Ludlow's original collection was in fact sold off by the Council in 1947. An inventory of the collection made in 1928 listed around 2400 specimens, which formed the basis of the Natural History Museums purchase and includes some of the most important type material collected from Shropshire and Herefordshire during the 19th Century. This re-discovery, in a way, highlights the importance of a project like this. The uncertain future of museums in the UK means it is more important now than ever to know what we have in our museums and to capture as much information as we can, in case future financial or political decisions mean that it is lost.

Certainly, as a result of this project we have a much better understanding of what is in Shropshire's collection and how it relates to other collections in the

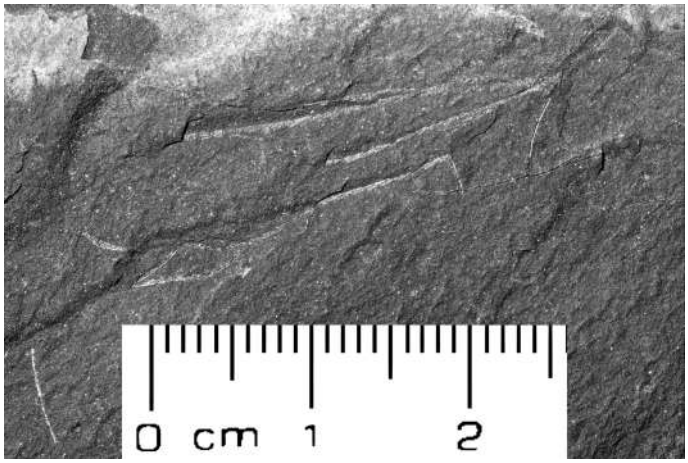

Fig.5 Possibly a new species of graptolite discovered in the Ludlow collection.

UK. We are now able to share some of this information, and by the time the project concludes early next year, over 4000 high resolution images of some of the most interesting and important specimens will be available on-line, with over a hundred of these accessible as 3D models.

You can find out about the project, see objects we've digitised and learn about the collectors we have researched via our project website

http://fishproject2020.wix.com/news

All our images (e.g. Figs.6, 7 and 8) are also available via the Natural History Museum's data portal at the following address.

https://data.nhm.ac.uk/dataset/ludlow-museum-fossils-in-shropshire-project-data

And you can see our 3D models (e.g. Fig.9) on the Sketchfab website at

https://sketchfab.com/Fossils_in_Shropshire

(Images of the fossils are published here under a Creative Commons license.)

Fig.6 Hemicyclaspis murchisoni, a Devonian jawless fish from Ledbury (presumably the railway cutting SSSI)

Fig.7 A cephalopod, Orthoceras ibex, from Shobdon, showing septal suture divisions

Fig.8 A gastropod, Bellerophon sp., from Aymestrey Quarry

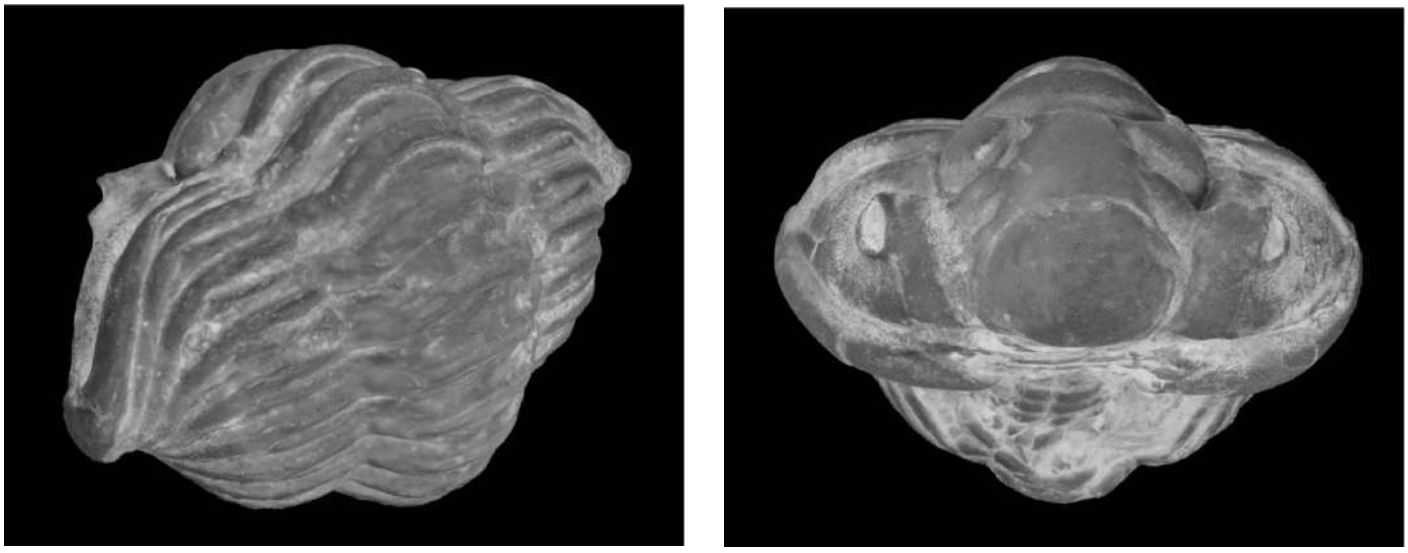

Fig.9 Two views of a three dimensional image of a fossil trilobite (Calymene) seen from different directions

Geological Site Maintenance in Herefordshire and Worcestershire

by John Payne

MANY readers will be aware that for some years a volunteer team has been busy each winter working to maintain some of the important local geological sites in good order so that they may be usefully visited by interested geologists, both amateurs and professionals. Many sites are in continual danger of losing their value, be this scientific, educational or aesthetic, sometimes through mistreatment by the owner but, much more often, simply by becoming overgrown. The impression is that the rate of growth of unwanted plants is increasing over time, perhaps as a result of a warming climate.

The volunteer team is about twenty-five strong. It is organised by the Earth Heritage Trust (EHT) and draws its membership from all of the local geological groups; the Woolhope Club, the Geology section of the Malvern U3A and the Teme Valley Geological Society and a few individuals. New volunteers are always welcome, of course; contact the author of this article via EHT. We are fortunate in having strong support, managerially and financially, of the Malvern Hills AONB (MHAONB) and the Malvern Hills Trust (MHT). Both are backed, for SSSI sites, by Natural England,

Since beginning this work in 2014, about thirty-three important geological sites have been worked on, a few more than once. This has had a major impact on site quality in the area. Because of our funding sources, the sites have been mostly in the Malvern area, within the AONB, particularly in the SSSI. However, requirements from other agencies have occasioned work in the Mortimer Forest, Wyre Forest, the Martley area, the Avon valley and the Forest of Dean.

Some recent results of this effort are described below.

Coneygree Wood Quarry

This site near Ledbury shows two of the five typical rock types of the Much Wenlock Limestone (of Silurian age) locally. These are the nodular-bedded limestone and the massive limestone. Both are to be seen in other local quarries but the present exposure shows additional important features. These are the presence of, firstly, a layer of volcanic ash (bentonite) and, secondly, a well-defined fold (Fig.1) which is an element of the 'Ledbury Anticlinorium' (the complex folded structure of the Ledbury Hills). The anticlinal bedding appears to be concentric about a point just below the frame of the photograph. The competent limestone bands maintain a constant thickness so have not been squeezed and stretched by the folding. Relative movement of the beds occurred on the thin layers of clay or shale between them. The required bending of the limestones has been accommodated by the generation of radial joints, marked on the picture.

Fig.1 The anticline in Coneygree Quarry. The righthand frame shows the radial jointing between the bent bedding surfaces.

Blackhouse Wood Quarry

Another site in the Much Wenlock Limestone is this quarry in the Suckley Hills. The quarry follows the strike of the steeply dipping limestone band and so is long and narrow.

Much of the face on the west side of the quarry is in nodular limestone. The target of the quarry men seems to have been a particular horizon of more massive limestone without nodules. This is seen on the face at the northern end of the quarry. (Fig.2) Overlying it were the

Fig.2 The band of massive limestone with nodular beds above and bentonites in the slots.

Fig.3 A tabulate colonial fossil (Syringopora bifurcata) from Blackhouse Wood Quarry. (Scale is 10cm long.)

nodular limestones which included three bands of bentonite clay, formed by chemical alteration of volcanic ash which fell and settled on the sea bed about 425 million years ago. The softer clay weathers out forming slots on the rock face. The bentonites were each roughly 3cm thick.

Underneath the overhang on the west face is a horizon which is rich in fossils and a block of this fossiliferous limestone had fallen to the quarry floor. A coral from the quarry is shown in Fig.3.

North Quarry

This well-known large quarry in North Malvern has been called a "petrological museum" because of the wide variety of rock types, plutonic, metamorphic and intrusive, which outcrop there. Unfortunately, none of the rock faces except for the very lowest ones are accessible today due to the large screes which have developed since quarrying work ceased. However, the screes themselves offer excellent samples of the Malverns Complex rocks, including some unusual types, and this is the main attraction of the site at present.

Fig.4 A variety of rock samples from the scree in North Quarry. Small intrusions are common.. (Frame width is about 12cm in all cases)

Gullet Pass Pit

This well known site exhibits a Cambrian beach deposit (which may have extended continuously at least between here and Martley). It is described in the Geological Conservation Review so is regarded as a key site in British geology. It is frequently visited by geological groups but requires regular clearing due to the persistent growth of brambles and other plants and the deposition of falling leaves and soil. After clearance as part of the MHAONB programme in October 2014 it was again cleaned in January 2019.

The site condition prior to and during the latest work is shown in Fig.5; little of the geology could be seen.

Digging at the previously unexplored east end of the site uncovered a fault zone complete with fault gouge but no sign of the expected junction with the Malverns Complex rocks.

Berington's (Little Malvern) Quarry

Berington's is a quarry of major size in the Malvern Hills but is little mentioned in the geological literature. The rock is mainly sheared diorite. The presence of lime-loving plants in the quarry was noted by members of the Malvern U3A Geology group. This observation was reinforced by the report of the existence of calcite masses in the southern face of the quarry. This is the so-called Malvern Marble.

Fig.6 One of the calcite masses is folded. (Photo, Peter Bridges)

The southern face of the quarry was densely covered by vegetation but eventually the clearance work resulted in the exposure of two large *in situ* areas of calcite (Fig.6) and a few calcite veins in loose rock fragments.

Calcite is an unusual mineral in the Malverns Complex although the main rock body contains a good deal of calcium within the various silicate minerals. The origin of the calcite is unknown. It has been suggested to be

1) an alteration product from the metamorphism of the Malverns Complex rocks
2) the remains of an algal deposit, Precambrian or early Palaeozoic, incorporated within the rock body, or
3) fragments of Permian or Triassic minerals incorporated into the rock body.

The folding of the eastern outcrop (Fig.7) is consistent with the Variscan thrusting from the east in the late Carboniferous. This clearly occurred after emplacement of the calcite. The third possibility is thus rendered unlikely.

Fig.5 The Gullet Pass Pit before and during the January clearance.

Tank quarry

Tank Quarry is a well known location in North Malvern. It is excavated into End Hill. Following the end of quarrying it was used for the town rubbish

Continued on Page 13

Voicing the Soil in Herefordshire during the Anthropocene

by Moira Jenkins

AN INTERESTING PROJECT has been carried out at Hereford College of Art this year by Marie-Pierre Leroux. The project, entitled *Voicing the Soil in Herefordshire during the Anthropocene,* showed the factors that drive processes of change in soil and the influence of humans on the soil. The Anthropocene is the period during which humans have disrupted the planet. The project includes an art work based on William Smith's 1817 geological cross-section. Figure 1 compares Marie-Pierre's work with Smith's section.

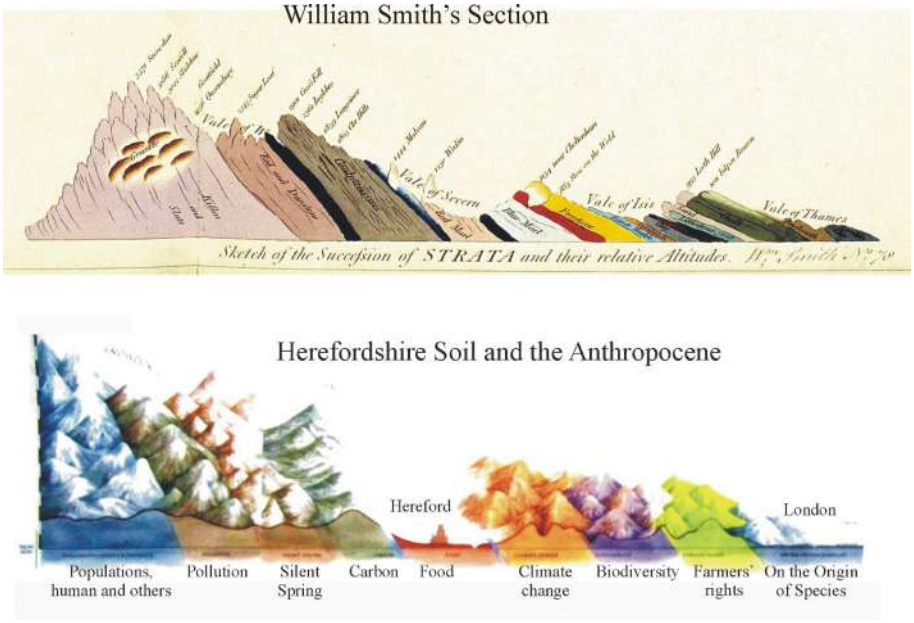

Fig.1 Marie Pierre's depiction compared with William Smith's 1817 section

Describing her project Marie-Pierre said, "Soil and rocks were transformed into an object of scientific study by William Smith (1769-1839) who produced a nationwide geological map. Smith's 1817 cross-section of the country from Snowdonia to London was a tool for industry and agriculture. It showed the different rocks, and hence soils of different types, and helped to locate coal. Soil, real or imagined, is at the centre of domestic and political life. It represents both humble allotments and nations' boundaries. Soil feeds us and also reveals the social status of land owners as the art critic John Berger, in his book *Ways of Seeing* (1972), comments on an oil painting by Gainsborough, *Mr and Mrs Andrews* (1750). He says that they are 'not a couple in nature as Rousseau imagined nature. They are landowners and their proprietary attitude towards what surrounds them is visible in their stance and expressions.' (Fig.2)

Soil also came to be understood as finite in the 19th Century, leading to an outcry in the 1960s because of its exploitation by intense extractivist farming practices post-war. The earth is now often represented by the Earth system sciences with the Anthropocene concept as a tangible, plundered asset in need of management."

Marie-Pierre's project was co-produced with the contribution of "creatures unheard living under our feet and local artist-makers". Contributions to the project have been made by a geologist, a soil biologist, farmers, a councillor, a gardener, an agricultural chaplain and someone running a bio-digester. Marie-Pierre said that the installation, shown at the Maylord Shopping Centre in Hereford in July 2019, appraised the nature of the Anthropocene as well as that of soil. "It asked, from worms to the United Nations, who makes soil, how to understand it, and how to represent it? Is it through objective maps and facts or through imagination, future scenarios and stories?"

"The first artefact from the project is a large hand painted geological map, based on William Smith's cross section. (Fig.1) The use of local Old Red Sandstone, rubbed into the map, gives soil equal prominence with watercolours and calligraphy, the other elements of the map." The headings under the map are factors which have effect on the soil and below that (not shown in Fig.1) are groups of organisations which influence soils for better or worse, such as scientists, farmers or government organisations. "

"The effects on soils in the Anthropocene Period are considerable. As well as the art work, there are four soundscapes, including Moira Jenkins talking about Herefordshire soil. There is a word-hoard (shown at the Cider Museum in Hereford in July and August 2019) for which the public were invited to contribute terms and expressions connected to soil and its produce. There are also guided climate walks and a newspaper dated 2119. The final two of these both provide possible future scenarios. For example, along the climate walks people are asked questions about what behavioural changes they will make, such as whether they are prepared to give up flying and drink dandelion coffee."

Fig.2 Mr and Mrs Andrews by Thomas Gainsborough

The climate change walks and the word-hoard both continue into 2020. In the climate change walks, groups travel eighty years across a venue such as their local pub from 2019 to 2099 by answering questions. The combination of choices made and blind chance will determine

Fig.3 Marie-Pierre Leroux and Elizabeth Pimblett, Director of the Cider Museum, at the launch in July..

the climate for 2099 for each group.

The word hoard on display at the Cider Museum includes such lovely words as :-

Quod, a quicksand or shaky bog,

Wonky tump, a molehill,

Warth, a flat meadow close to a stream

Mirk shut, twilight.

The idea of every part of the project was to make people think about how much we all depend on healthy soils and to encourage us to take better care of them. Marie-Pierre says, "The variety in these artefacts is intended to provide a way in for everybody. The tone is gently provocative."

Some of the other words in the word hoard. –

Skith – a thin layer of snow: **Scud** – a light, quickly passing shower: **Mayblobs** – kingcups, marsh marigolds: **Ross** – a morass: **Banky piece** – a field on a steep slope: **Nurped** – freezing: **Fuddle** – to potter around: **Lugger** – a broad, green lane: **Cay** – a stump of a branch protruding from a tree: **Dumble hole** – a derelict clay pit or quarry: **Raith** – weeds, sticks, straw and other rubbish in a pool:

SITE MAINTENANCE — CONTINUED FROM PAGE 11

dump. This filled the deeply excavated quarry floor and created the present level surface of the car park and most of the adjacent area.

The waste fill was kept away from the quarry face on at least the west side, creating a trench abot 3m deep adjacent to the face. This was presumably done to retain access to the scientifically important geology of this rock face. Access to it is restricted by a fence and locked gate except near the car park area,

This face is of much interest in exposing two large intrusions. One is a dolerite, black with invisibly small crystals and several metres in width. The second is a horizontal vein of granite aboyr 30cm thick which is seen to extend for about 7m in the host diorite. More of its structure has been revealed by removing some of the surface material and roughness using an angle grinder. This shows the vein to have the expected fine-grained (chilled) margin and also that it cuts through a vertical vein of the hydrothermal mineral epidote. (Fig.7)

Elsewhere but nearby a previously unknown breccia was found by using the angle grinder (Fig.8). This probably shows a small branch of the major East Malvern Fault which lies about 10m to the east.

Fig.7 Ground and polished surface of a red granitic intrusion (above) in contact with a small inclusion of green epidote (below). (Frame width is about 15cm.)

Fig.8 Rock surface ground and polished surface to reveal its brecciated structure, undetectable on the surrounding unground rock. (Frame width is about 15cm.)

GEOLOGY SECTION REPORTS — 2018-9

by Sue Olver

Friday 26 October 2018 Prof. Peter Worsley of Reading Geological Society – 'Professor Fred Shotton'

This lecture was unique as not only Peter was taught by Fred, but also Paul Olver was one of his students at Birmingham University. We were introduced to Fred Shotton's early days and his continued interest in geology. He wrote many papers including the geology of the Cross Fell Inlier and notably on the dune bedding in the Permian Bridgnorth Sandstone (1937). He served with distinction in the Royal Engineers during WWII and was part of the team planning the assault on the Normandy beaches. During his time at Birmingham (1949 to 1974), he was well known for his extensive Quaternary studies which included defining a clear sequence of glacial, interstadial and interglacial ice age events.

Friday 14 December 2018 Christmas nibbles and rocks and fossils –

Members enjoyed being back in the Woolhope Room in Broad Street Hereford at last, for our annual display of rocks and fossils and later, after locking up the gates, having a drink in the Green Dragon.

Friday 25 January 2019 Bill Barclay – 'From Martley to Mozambique – a tale of two coals'

This was a fascinating insight into the contrasting countries and their coal deposits.

Friday 22 February 2019 AGM for 2018 plus Dinner at The Bunch of Carrots Inn.

Our Chairman Chris Fletcher stepped down and Dr. Paul Olver was elected to that role.

Friday 22 March 2019 Dr. Tony Loy of Merlin Energy Co. – 'Oil and energy resources in the UK'

Coming from a local firm in Ledbury, Tony, who is in the business of finding oil and gas in the UK, introduced us to the intricacies of the world of tiny microfossils of both marine plants and animals from core drillings. With this databank of knowledge, his firm is able to advise on drilling programmes - drilling in the wrong place can cost oil companies many thousands of pounds.

Saturday 30th March Coppet Hill Field Meeting.

Rosamund Skelton took nine TVGS and four WGS members to Coppet Hill. On a fine day we set out from Goodrich Castle, noting the use there of Quartz Conglomerate rock. A visit to the church revealed other rock types being used for building. On Coppet Hill were fine outcrops of the Quartz Conglomerate (Fig.1) as well as good views. The group visited the local quarry in Silurian rocks with the remains of a nearby lime kiln.

Fig.1 The local rock (Quartz Conglomerate) used around Goodrich and seen here on Coppet Hill.

Saturday 1 June Woolhope Dome Field Meeting.

The second field meeting of the year was held in good weather and enjoyed by several new members plus a few guests from TVGS. It was led by Rowland Eustace. We first visited the Pentaloe Brook where the stream had eroded a fine section in the Haugh Wood Formation, the oldest rocks in Llandovery Series, made up of sandstone and shale bands. (Fig.2)

Further along the Pentaloe Brook. Rowland showed us a

Fig.2 The Llandovery Sandstone section on the Pentaloe Brook

Fig.3 The bentonite band

15cm-thick band of bentonite clay in the stream bank in rocks of the Coalbrookdale Formation. (Fig.3) This is a white fine clay deposit formed from a volcanic ash fall.

A fine outcrop of Woolhope Limestone (Silurian: Lower Wenlock) formerly quarried for building was seen.

Throughout the walk, Rowland explained the landscape in terms of the stratigraphy and faulting.

Saturday 8 June Moccas area Field Meeting

WNFC President Rachel Jenkins led the Third Field Meeting with Woolhope experts John Eisel, Keith Ray, David Whitehead, Alice James (Natural England), Will Watson, Paul Olver and Duncan James.

The trip included Bredwardine Bridge, Bredwardine Church (Fig.4), Moccas Church, Moccas Deer Park (Fig.5) with the Estate Manager, Francis Chester-Master, followed by tea and cakes at the President's house, 'New House Farm'. Later some members went on to Arthur's Stone near Dorstone. This was another day with good weather and was enjoyed by thirty members plus five guests.

Fig.4 The use of Tufa and local Old Red Sandstone in Bredwardine Church

Fig.5 Will Watson explains rare species of pond life in The Ponds in Moccas Park, formed from the remains of a Devensian ice age kettle hole 150,000 years ago.

Wednesday 11 September 'Bring out your Trilobites and Graptolites' with Paul Olver at Herefordshire Resource Centre Hereford

This event was attended by nine members plus two guests. Paul gave an excellent explanation of how trilobites and graptolites lived and died in our country and noted the good quality of specimens in the Hereford Resource Centre.

Friday 27th September 2019 Geology of Snowdonia - Paul Gannon

A fascinating talk on North Wales from its volcanic caldera origins in the late Ordovician to the major changes wrought in the last Ice Age. The history of this important volcanic are was also covered in terms of plate tectonics with the key aspects of the subduction zone beneath the area being included in a wide ranging and well illustrated talk.

GEOLOGY SECTION PROGRAMME FOR EARLY 2020

Meetings will be held in the **Woolhope Room** in **Hereford Library**, Broad St., Hereford at 6:30 p.m. for 7:00 to 9:00 meeting

Friday 24 January Dr. Sue Hay – 'The Canaries Part 2: El Hierro and magmatic pluming problems.'

Friday 21 February Annual Meeting and Dinner.

Friday 27 March Dr. Pete Jeanes, Oil and Gas Consultant – 'What makes an oilfield?'

Tuesday 14 to 16 April Field trip to Snowdonia and Anglesey — led by Paul Gannon and Paul Olver (Dates are to be confirmed)

Thursday 7 May Prof. Bill Leatherbarrow—'Craters of the Moon—making an impact'. (Joint meeting with Herefordshire Astronomical Soc., 7 p.m. **at the Kindle Centre**, ASDA, Hereford. Cost £3 to WNFC members.)

Saturday 9 to 17 May Geologists' Association Geoscience Action Week

Wednesday 8 July WNFC trip to the Cotswolds

EDITOR'S COMMENTS

I am pleased to present this 16th issue of Earth Matters. Much to my satisfaction, all of the articles are concerned with local geology, with articles on the new mapping of the Knighton area, the petrology of rocks at the Martley Rock site, fossils in the Ludlow Museun collection. site clearance work around the Malverns and elsewhere, a 'different' view of local soils and the usual reports on Section activities and Geopark operations. Presentations of WGS members' work at last year's symposium of the Open University Geological Society (OUGS) appeared in shortened form in Earth Matters no. 15. The full papers and much else of local interest are now published in the OUGS Proceedings. This is available on-line, .

I would like to offer my grateful thanks to the contributors to this issue for providing me with their material in good form and before the deadline.

THIS ISSUE IS AVAILABLE IN PRINTED FORM,

Earth Matters is distributed on-line to all WNFC members in December and will appear on the WNFC web site. Printed copies will be available on request (and payment of the costs of printing and postage). If you require a printed copy, please apply to the WNFC Treasurer, Ian Porter, by 31st January 2020, with payment of £4.50 for printing and postage. Authors in this issue will receive a free copy automatically, as will bodies such as the Herefordshire Records Office, the WNFC library, the British Library, etc,

Members of the WGS Committee

(December 2019)

Dr Paul Olver, ***Chairman and Geopark Representative***
paulolver@hotmail.com; 01432 761693

Dr Chris Fletcher, ***Vice-Chairman***
chris.fletcher@cslmail.co.uk; 01432 273149

Sue Olver, ***Secretary and Programme Secretary***
susanolver@hotmail.com; 01432 761693

Ian Porter, ***Treasurer and Membership Secretary***
ikpgmp@gmail.com; 01981 540388

Moira Jenkins, ***Section Recorder***
jenkins.moira@gmail.com; 01684 569815

Dr John Payne, ***'Earth Matters' Editor***
john.payne71@gmail.com; 01684 575527

Don Evans, ***Minutes Secretary***
donald.evans8@btinternet.com;
01544 319142

Rowland Eustace
rowlandeustace@yahoo.co.uk; 01531 670748

H&W Earth Heritage Trust

THE Earth Heritage Trust generates monthly summaries of its current programmes and other activities. These summaries are circulated to WNFC members so there is little need for repetition here.

Major events in the past year have been research into the 'kettle holes' in Herefordshire, the publication of the second edition of the guide to the Geopark Way and a number of training sessions in the use of EHT's facilities held for members of local geology clubs.

Abberley and Malvern Hills Geopark and GeoFest

THREE new organisations have joined the Geopark Forum bringing the number of members up to twenty-one. This continues the strong and varied approach for a Geopark that can be enjoyed by everyone and allows people from all walks of life the opportunity to experience and learn about its impressive natural and man-made landscape and all to be found within it - geology, wildlife, archaeology, art and heritage.

All members operate professional and successful organisations. Many run very popular visitor facilities and programmes for the public. There are specialist educational establishments and land managers whilst others concentrate on providing geological expertise and initiatives.

Collectively the visitor centres of Geopark members attract over two million visitors each year. Visitor centres and experiences are to be found at Malvern Hills GeoCentre, Severn Valley Country Park, Dudmaston Estate, Croome Estate, Kinver Rock Houses, Bewdley Museum, Hartlebury Castle, Severn Valley Railway, Forestry England at Wyre Forest, Land of the Living Dinosaurs at Bewdley, Worcester Cathedral, Lapworth Museum, Worcestershire Archive and Archaeology Service and Cob House Country Park.

Adding to the mix are educational establishments at the University of Birmingham School of Environmental Sciences, Bewdley School and Hereford Sixth Form College. Conservation and geology group members include some of those listed above plus Gloucestershire Geology Trust, Woolhope Naturalists' Field Club, BrooksDesign, Transport in the Landscape and Geologists in the Geopark. The major sponsor of all the Geopark work is member Merlin Energy, an international geotechnical consultancy specialising in the oil industry and based in Ledbury.

The combined efforts of members provide significant experiences for visitors including an increasing number of self-led geology trails plus hands-on activities, museum collections, research projects, education courses, and information panels, displays and exhibitions. A new visitor centre at Severn Valley Country Park provides an excellent display of geology, coal mining, sandstone quarrying and wildlife. There is also a new Geopark-wide geology wall trail - *The Les Morris Memorial Trail* - available as a free download from the website. Continuing support for the Geopark is given by President Chris Darmon. He makes regular visits and frequently prints articles about the Geopark in his national magazine *Down to Earth.*

GeoFest, which runs throughout June, July and August each year, continues to be very successful with many people participating. This year the geology craft days at Worcester Cathedral and Wyre Forest proved very popular as did rock and fossil hunts at Severn Valley Country Park. Also proving a success is the *Cappuccino Trail*. This comprises Geopark centres to visit which provide both good coffee and a geology trail.

Much more information is to be found on the website and Facebook together with current news and events.

Peter Oliver

A visit to Huntley Quarry, an important Geopark site