Earth Matters

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

No. 17 December 2020

The Geology Section is an Affiliate Member of the Geologists' Association.
The Woolhope Naturalists' Field Club is a Registered Charity, No. 52100

CONTENTS

Members of the WGS Committee

(December 2020)

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

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

EDITOR'S COMMENTS

OUR Geology Section Chairman, Dr Paul Olver, usually fills this space with a message for the Geology Section members. Unfortunately, Paul is indisposed at present so your Editor is temporarily using the space for his comments. In the mean time, we all send our best wishes to Paul.

The past year has been a strange one. From the start of the Covid-19 lockdown in March our section of the Woolhope Club has largely ceased operation. We hope that it will spring back into activity when conditions allow. However, the generation of this newsletter has not been affected by the pandemic and, as usual, I have managed to persuade several good authors to write about their work. All of the articles are of local interest, either within Herefordshire or not far outside it.

Geoff Steel's research on an area last studied in the 1940s is valuable in adding significantly to the details shown on the current Geological Survey map. Beth Andrews describes the current state of the research into the county's kettle hole ponds, a project involving several local naturalist organisations including the Earth Heritage Trust for geological aspects, as well as a number of Club members as volunteers. Don Evans provides an excellent and comprehensive account of the origin and current topography of the moraine at Staunton. The interesting geology and fossils from Stonesfield in the Cotswolds are described by Paul Olver; this location was the destination of a Club visit some years ago. Peter Oliver has detailed the activities in the Geopark and its associated organisations over the last year and Ian Fairchild has done likewise for EHT. Sue Olver has written about the events which our group mounted prior to the pandemic. Lastly, your editor has added two items, one about some geobotanical observations on the Malvern Hills and the second to indicate a panorama-generating web site which may be of use to Club members.

John Payne, Editor

Stonesfield Slate – A Local Building Stone and Its Fossils

by Dr. Paul Olver

The Stonesfield Slate forms the lower part of the Taynton Limestone Formation. The Stonesfield area has been providing quality stone throughout the Oxford area since the beginning of the 11th Century. The light brown stones, well known as Taynton Stone, show up as denser bands of shell fragments which are harder and more resistant to weathering, resulting in a banded appearance. Lens-shaped bodies of finely bedded calcareous sandstones, known as the true Stonesfield Slate form the characteristic tile stones. These tiles were split to their narrowest form by using frost action during cold winters. This frosting process was developed in the 16th Century.

The seams of stone, less than two metres thick at the most, were reached by adits driven into the valley sides or by vertical shafts, some of which are still accessible. The slate miners realised that within the blocks which had been exposed were some wonderful examples of early fossils. These appealed to the early Oxford fossil collectors.

Particularly good examples were found of ammonites, oysters, bivalves, sharks, bony fishes, turtles and crocodiles together with fossils washed out from the nearby landmasses, such as dragonflies, pterosaurs, large dinosaurs, very small mammals and leaves of conifers and cycads. Four examples of these Middle Jurassic (Bathonian) fossils found in the Stonesfield area are displayed below.

The newly found vertebrates found in the 1820s provided a vital window into the early mammal and reptile pasts. Especially important were the early shrew-like mammals found in Oxford along with an example of an eight-metre long carnivorous dinosaur. The famous Oxford geologist, Rev. Dr. William Buckland discovered giant bones of Megalosaurus in 1824. Megalosaurus now has a prominent position in the Oxford University Museum of Natural History.

The Oxford area has also provided a unique insight into fossil insects. One particularly famous specimen is shown as the first butterfly alongside further extinct insects such as giant beetles and important dragonflies. Another major find featured a diverse fossil flora of over twenty species including the first angiosperm leaf found in the world together with a series of Conifers, Ginkgoales and Cycads making this an important site for the Middle Jurassic palaeobotany.

The western side of the village of Stonesfield features the most fossiliferous, on the way towards the village of Fawlet. These areas, west of the High

Continued on Page 6

Pinna sp. (Bivalves) Stonesfield Slate (Great Oolite) - Bathonian

Eomesodon trigonus (Ganoid Fish) black series of tooth on palate Stonesfield Slate - Bathonian

The Geology of Weythel Common

by Dr. Geoff Steel

Introduction

One day in 2017 I joined Richard Edwards on a U3A walk over Hergest Ridge. Our aim was to learn about the Church Stretton Fault using BGS Sheet 197 (reference 1) as our guide. Looking across to Weythel Common (SO235565, in Wales) and comparing it with the map, Richard asked "How is it that such a prominent hill is shown as soft and easily eroded Raglan Marl?" I did not know the answer. Walking along the footpaths during the next few weeks, combined with a small knowledge of local geology, was enough to give a rough idea. The Raglan Marl, of Pridoli age (latest Silurian), is mostly a soft red or purple mudstone but it does have some bands of very hard sandstone. These often form prominent features, including the tops of hills, and are clearly visible in several places on Weythel Common.

It would be easy to stop there. Perhaps I should have done. But Richard's question intrigued me and I wanted to know more. Work commitments prevented further study until recently when I've been lucky enough to have some time. The following is an account of what I've found.

The Church Stretton Fault

There has been a long series of movements on a zone of faults running approximately along the Welsh border and named after the town of Church Stretton. Figure 1 is a sketch of the zone near Kington. The figure combines information from references 1 to 3, all of which show Pridoli rocks on Weythel Common but differ in their details. A short distance further north the Precambrian rocks are well known (reference 3), being of economic importance in the quarries at Dolyhir and Gore, and of geological interest on Hanter Hill and Stanner Rocks. But the area around Weythel Common, and further south, seems to have been largely neglected and disagreement between the references adds a spark of interest.

Description of the Survey

In my logbook, and in this article, I've used the old descriptive names 'Raglan Marl' and 'Wenlock Shale' because they are easy to apply. The modern BGS equivalents are 'Moor Cliffs Formation' and 'Coalbrookdale Formation' respectively.

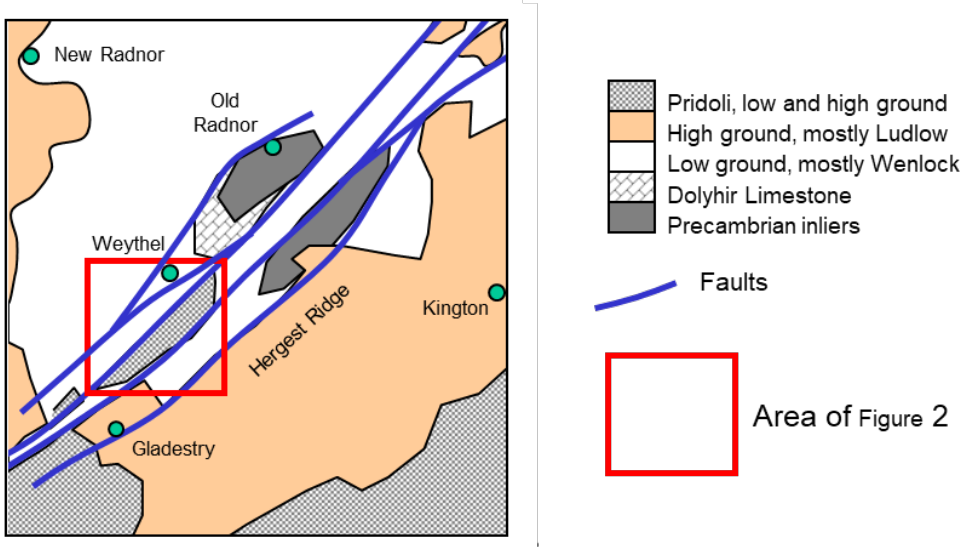
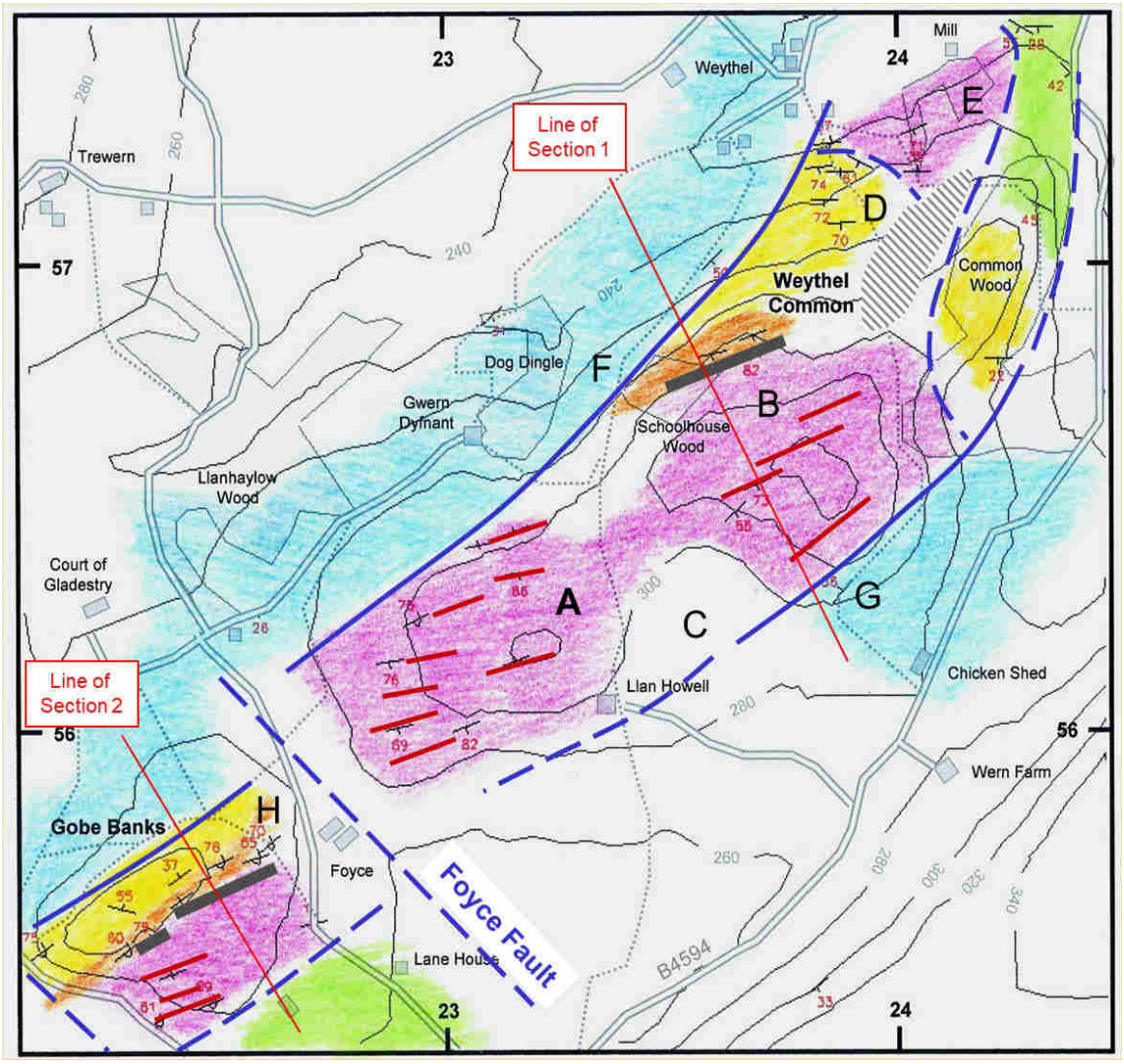


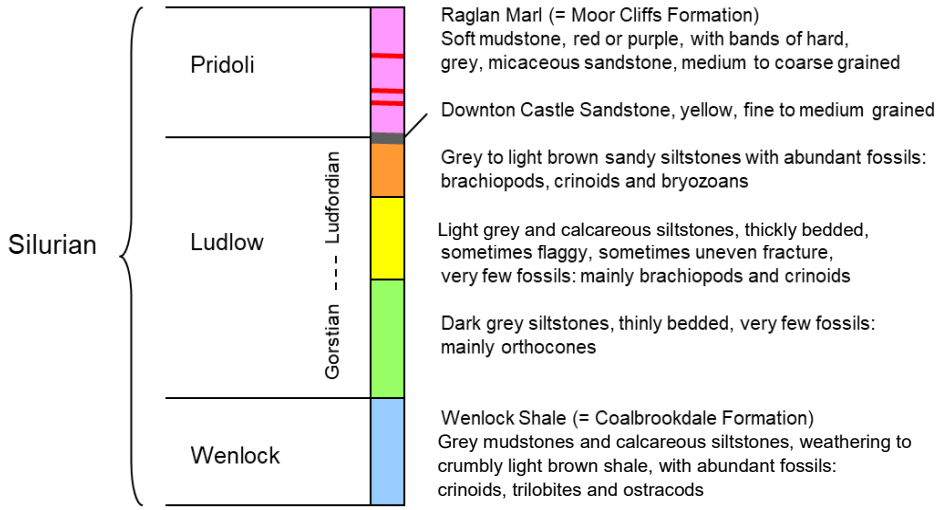
Figure 1 The Church Stretton Fault near Kington

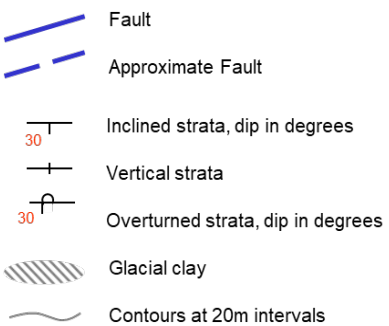
Figure 2 shows my progress so far. And figure 3 shows the view from Hergest Ridge which helps to understand the area. I can give a tour by following the letters.

A and B. The hill is a long ridge with sandstone bands visible on top and sometimes lower down. I was surprised to find that nearly all are vertical. They have a remarkably consistent strike of about 70º which is not parallel to the ridge so they cross it diagonally. Most are less than 2m thick and lines of small quarries follow some

Figure 3 Weythel Common seen from Hergest Ridge







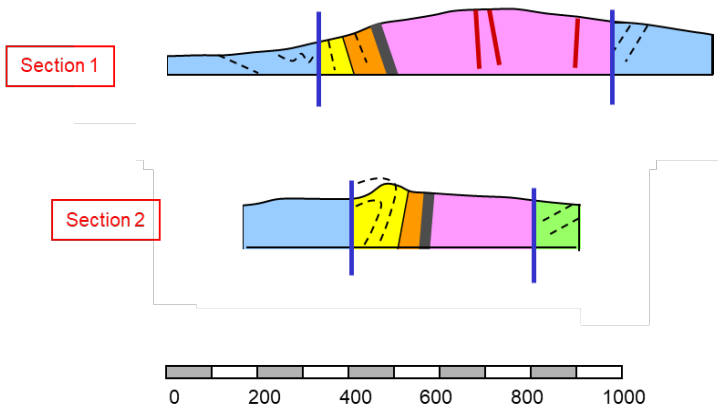


Figure 2 Detailed survey

of them. Figure 4 shows an example. At the eastern corner of Schoolhouse Wood the Downton Castle Sandstone is visible. It is an important marker which can be recognised near Kington and beyond, and indicates a conformable transition from Ludlow into Pridoli strata.

C. On the south side of the ridge there is a hollow with flat boggy ground and ponds at the bottom. It looks rather like a glacial cwm but facing south makes that unlikely.

D and E. I have described the whole hill as Weythel Common (it has no other name) but the actual common land is only on the northern flank. A layer of grey clay, probably of glacial origin, makes the ground damp and boggy and may explain the historical difference in land tenure. Several streams cross the clay then cut deep gullies into the steeper ground to the north. Ludlow strata are visible in the gullies at D, then Raglan Marl at E which is contorted with rapid changes of dip over short distances. In Common Wood, and also in the fields to the north, there are more strata of Ludlow age.

F. All along the track below Schoolhouse Wood there are exposures of Wenlock Shale. There are many similar exposures in quarries and streams to the north and west so the whole region appears to be the same.

G. On this side of the hill Wenlock Shale is again visible in a quarry above the new chicken shed. There are no further exposures to the south; the low ground suggests Wenlock Shale but stream sections show only a cover of glacial till.

H. The ridge of Weythel Common continues to the small hill of Gobe Banks (pronounced G'banks by the locals). A conformable transition from Ludlow to Pridoli is again visible, similar to B, but the structure is more complicated with some strata overturned.

Glacial Erratics

The whole area is littered with erratics. They would be a fascinating study in their own right but for this survey it's just important to avoid confusion with local strata, specially in the stream beds where they tend to accumulate. In order of abundance they are:

1. Coarse mixture of dark brown and yellow volcanic clasts - Llandrindod Tuff
2. Light grey coarse-grained quartzitic sandstone
3. Conglomerate similar to above with rounded white quartz pebbles
4. Very hard, very fine grained, light grey volcanic ash

I am not sure where the sandstone and conglomerate have come from but the volcanics are clearly from the Builth Inlier. The Llandrindod Tuff is easy to recognise and there are large boulders of it on Castle Hill a few miles to the west. Interestingly I have found no Dolyhir Limestone nor any Precambrian rocks despite their cropping out just a few hundred metres to the north. This implies that the latest glacial movements were not from that direction.

Interpretation

My blue lines in figure 2 are an attempt to trace the faults. Those at F and G show clearly and agree with Figure 1 as branches of the Church Stretton Fault. Between them the Pridoli rocks are faulted down as a block. In the northern area, at D and E, the structure appears to be more complicated and is partly obscured by clay which makes interpretation difficult. It is here that the earlier surveys show their greatest differences. At the southern end the rocks at H are a continuation of the down-faulted block but are offset by what I've called the Foyce Fault. Reference 2 shows this and also a parallel fault through C which is quite possible although I have not been able to confirm it.

Figure 4 One of the vertical sandstone bands

In the cross sections I have shown the faults as vertical. They are probably not. Reference 4 shows a peak gravity anomaly to the west of the high-density Precambrian rocks, indicating that they may be detached from the basement along faults dipping to the west. These would be a continuation of the faults at F and G. My survey is not accurate enough to reveal an angle but the faults are not straight which hints that they may not be vertical.

Both sections show the down-faulted blocks to have steeply dipping strata younging towards the south-east. In section 1 the rocks are the right way up. Section 2 required more effort as the area around Gobe Banks is confusing. There appears to be an asymmetrical anticline plunging towards the north-east with its southeastern limb overturned.

Some idea of vertical displacement is indicated by the fault at G where all of the Ludlow is missing, a thickness of at least 0.5km. However most of the Church Stretton Fault zone has been dominated by even greater strike-slip (horizontal) displacements. Reference 3 describes the main NE-SW faults as

sinistral with smaller conjugate faults between them having dextral displacement. With this in mind it is interesting to look at the Foyce Fault: it is sinistral yet is one of the conjugate faults so dextral might be expected. Using the Downton Castle Sandstone as a reference suggests a total of 0.6km offset between B and H, some of which may be due to rotation rather than linear movement.

Further Work

In the longer term I hope this survey can add to an overall understanding of the Church Stretton Fault and its history of displacement. In the Weythel Common area my impression is that working out such a history is bit like trying to solve a Rubik's cube. Information from further afield would certainly help. In particular a more detailed picture is needed towards the south, so it is to that direction that I plan to turn my attention.

Acknowledgements

I would like to thank the land owners for their kind permission to visit the woods and fields, many of which are not on public footpaths: R. Griffiths, M. Jones, J. Lewis, J. Ormond, G. Powell, D. Squire, M. Twiddy, R. Watson and T. Williams.

References

1. British Geological Survey 2004, Hay-on-Wye, England and Wales Sheet 197, Bedrock and Superficial Deposits, 1:50000.

2. British Geological Survey 1994, 'The Rocks of Wales', 1st Edition Solid, 1:250000.

3. Woodcock, N.H. 1993, The Precambrian and Silurian of the Old Radnor to Presteigne area, pp 229-241. In Woodcock, N.H. and Bassett. M.G. (eds), 1993, *Geological Excursions in Powys central Wales*, University of Wales Press, National Museum of Wales, Cardiff.

4. Coster, D., Milsom, J. and Livermore, M. 1997, 'Gravity field variations around the Old Radnor inlier: a a preliminary study', Radnorshire Society Transactions, Vol 67, pp14-19

****

'Stonesfield Slates' — Continued from page 2

Acrodus (Fish) black dentition tooth Stonesfield Slate - Bathonian

Brachyphylla expansum – a conifer plant Stonesfield Slate - Bathonian

Street, lead down towards St. James Church. The church is built of Taynton limestones and a local ironstone called the Blenheim Ore. The ore appears in its mainly weathered orange state in many of the gravestones.

South towards the river the local cart track descends towards the River Evenlode. Outcrops are seen on the left-hand side and show the Taynton Limestone and Chipping Norton Formations – with coarse oolites with oysters and brachiopods. The Stonesfield Slate is absent here, showing how locally its outcrop occurs. The limestone strata show cambering down towards the river where the former clays have been squeezed out. These solifluction processes were caused by heavy rainfall under low temperatures during the final stages of the Pleistocene Ice Age.

Stonesfield is particularly famous for its early dinosaurs and is an important site in the evolution of geological thinking during the early 19th century.

Reference

The Geology of Oxfordshire by Philip Powell - pp33 -35.

GEOLOGY SECTION EVENTS 2019-2020

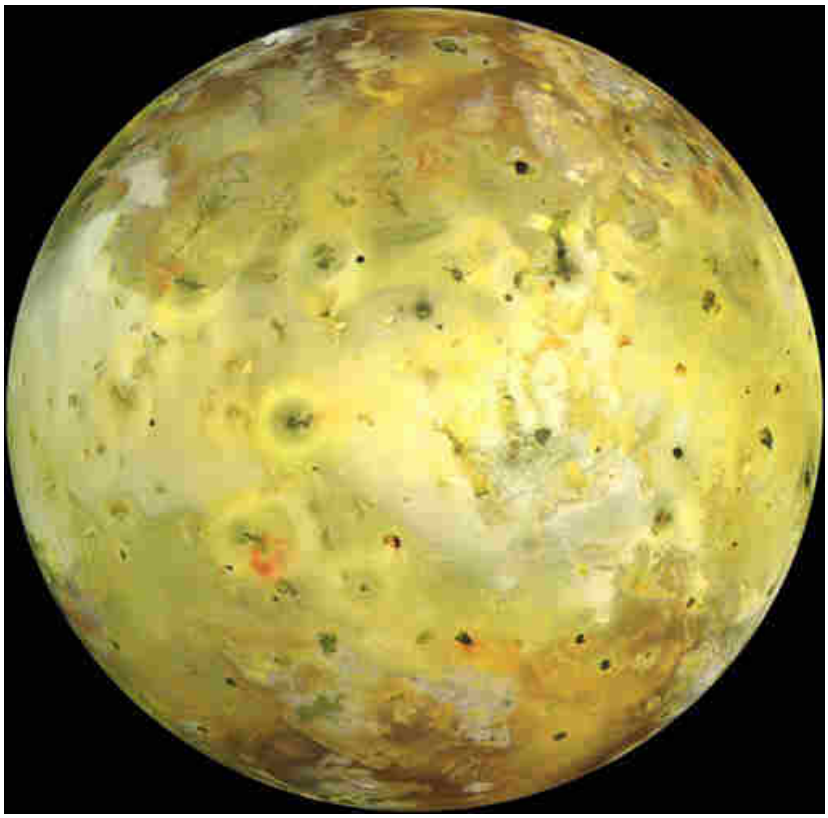
by Sue Olver

Friday 25 October 2019 'Rock Along the Cut.' Andrew Jenkinson, Shropshire Geological Society, gave an illustrated talk to fourteen members. He described how the construction and development of the British canal system from 1760 to 1825 provided the raw material for William Smith, canal engineer, to draw up the first complete geological map of England and Wales. This map was republished in 1820 by John Cary explicitly to illustrate the mineral cargoes of each canal. Discussing the transfer of minerals from source to point of use, Andrew took us on an excursion along the canals and locks in Shropshire and the Midlands pointing out the various routes and the difficulties of the varied terrain that the navvies had to cut through. We could all appreciate the difficulties they had before the coming of the railways.

Friday 22 November 2019 'A Tale of Five Magmas: A review of Planetary Volcanism' with Dr. Paul Olver, Woolhope Club. This was enjoyed by sixteen members who saw some of Paul's specimens. Paul discussed not only the chemistry of the magmas on our planet Earth but also our Moon, Mars, Venus and Jupiter's satellites. The multicoloured (black, white, red and yellow) surface of Io arises from the allotropes and compounds of sulphur produced by its strong volcanic activity, giving it the appearance of a flying pizza!

Friday 13 December 2019 Twelve members came to the Rock and Fossil evening and displayed their rocks and fossils, before visiting the Green Dragon Hotel.

Friday 24 January 2020 'The Canaries Part 2: El Hierro and magmatic pluming problems' with Dr. Sue Hay. The talk was attended by sixteen members. This made us all keen to visit the Canaries to see all the sites and pick up a few volcanic specimens.



The multi-coloured surface of Jupiter's moon Io. (Photo Galileo Project, JPL, NASA)

Friday 21 February 2020 The Members' Annual Dinner at the Bunch of Carrots had to be canceled due torrential rain that caused the road to the venue to be impassable and as well as some flooding in their kitchen. This was postponed until a later date.

Friday 27 March 2020 The postponed talk by Dr. Pete Jeans, a Petroleum Consultant, on 'What makes an oilfield' had to be canceled due to the LOCKDOWN because of the Covid-19 pandemic.

Obviously no field trips have taken place due to the pandemic restrictions. The April 2020 field trip to Snowdon and Anglesey, to be taken by Paul Gannon and Paul Olver, may take place later but nothing has been decided as the second wave of Covid-19 strikes.

Some of the members at the Rock and Fossil evening.

Conserving Herefordshire's Ice Age Ponds

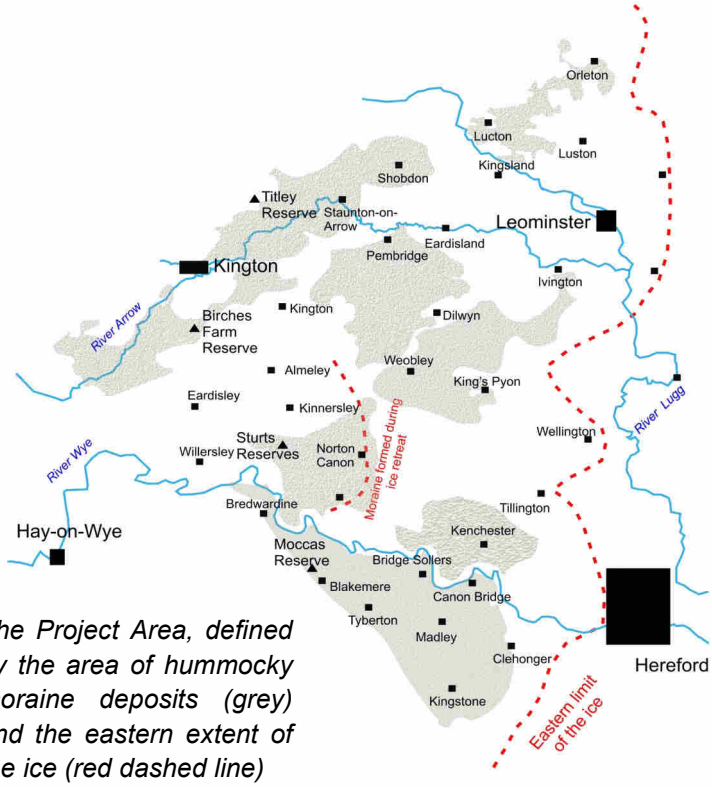
by Beth Andrews

The 'Conserving Herefordshire's Ice Age Ponds' project started its delivery stage this year with funding from the National Lottery Heritage Fund. This joint project between Herefordshire Wildlife Trust, Herefordshire and Worcestershire Earth Heritage Trust and Herefordshire Amphibian and Reptile Trust aims to research, promote and protect the area's unique glacial ponds.

Background

Around 25,000 years ago, western Herefordshire was invaded by a thick lobe of ice flowing down from the Welsh mountains. The eastern limit of the ice in Herefordshire is marked by a ridge of moraine lying roughly north-south along the line of the A49.

Typical hummocky moraine in Herefordshire



The Project Area, defined by the area of hummocky moraine deposits (grey) and the eastern extent of the ice (red dashed line)

About 22,000 years ago, the ice lobe started to melt completely and retreat. As it retreated large blocks of ice became detached from the main glacier. Debris within the ice, formed from the material torn from the rocks the ice has passed over, was dumped, burying the blocks of ice and creating 'hummocky' moraine. These chunks of ice then melted slowly over hundreds of years, leaving behind a hollow, known as a 'Kettle Hole'. Today these hollows, some filled with water to form ponds, and the gentle bumps of the hummocks, form the distinctive landscape found in west Herefordshire.

These natural ponds, formed in closed depressions, are not linked to streams or ditches. Instead they fill with collected rainwater and often dry out during summer or are fed by groundwater. They have survived for thousands of years, from a time before modern farming techniques, when our countryside was richer in wildlife. This may explain why they appear to have more rare and unusual species not found elsewhere.

In Herefordshire, the nationally rare aquatic plant Tubular water dropwort, is confined to the Ice Age ponds, preferring sites with a history of stable land use and fluctuating water levels, just as is found in many Ice Age ponds. Also discovered during detailed ecological surveys were a number of rare water beetles, including the ice age relics, *Agabus undulatus*, and *Graphoderus cinereus*.

Project Aims

We are now building on the success of the development stage, which ran through 2019 and trained 57 volunteers, who went on to survey 55 ponds. During the next 18 months

Graphoderus cinereus ©Will Watson

we plan to work with our existing volunteers and train new ones to survey more ponds over a larger area. This will enable us to try and record the full extent and condition of this important habitat within Herefordshire.

We will be raising awareness of the value of these ice age features both ecologically and geologically, with landowners, communities, conservation bodies and the general public.

Dr Warren Eastwood, University of Birmingham and volunteers taking a peat core from a kettle hole near Norton Canon.

Results so far

Three student projects took place during 2019, with more planned for 2021. One projects studied peat cores to examine pollen records and establish changes in habitats and environment since the end of the last ice age. Another compared the biodiversity of Ice Age ponds with more recent ponds found in the same area. This demonstrated that Ice Age ponds generally have greater biodiversity than more recent ponds, even when located in similar areas and surrounding habitats

Using LiDAR (a technique based on firing lasers onto the ground from aircraft) detailed maps have been produced of the hummocky moraine. These have highlighted areas where the ponds are likely to exist. Some of the depressions have ponds mapped by the Ordnance Survey; others have ponds shown on satellite images and some have been mapped as part of the project. Combining these data sources reveals that there are many ponds for potential study..

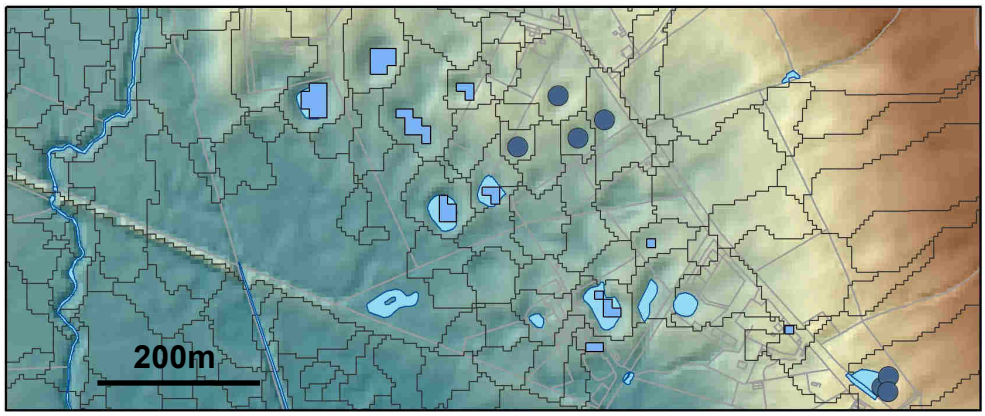
Catchment topography is often very subtle and varies greatly between ponds. Using LiDAR to map these catchments helps with future management, as the water within these ponds is often the result of collected rainfall inside the catchment. Any land management within the catchment can have a significant effect on these, often seasonal, water bodies.

As with every part of life during 2020 we have had to alter our plans as a result of the Coronavirus pandemic. We were unable to carry out our proposed season of site surveys and training sessions but our ecologists have been able to undertake more detailed surveys in late summer. We are carrying out site management on several ponds over the winter season, including excavating a now dry ice age pond, to see what plants and species will recolonise this site.

The Ice Age Herefordshire exhibition at Hereford Museum, produced with the Herefordshire Museums Service, was able to open in a modified format from August until the end of November. The highlight of the exhibition was the life-size mammoth replica in the centre of the space. For those unable to visit Hereford Museum, the project work is available to view on the project website.

During Spring and Summer 2020, several volunteers identified over 1300 ponds that are in our area of interest and are shown on the 1st edition Ordnance Survey maps, produced between 1885 and 1891. Not all of these ponds will be Ice Age, and not all ponds made it on to the maps but this gives us an indication of how many ponds there were at that time and where they were located.

We have developed a more general 'Walking Pond Survey' for volunteers. This is a simple survey that can be carried out within existing guidelines, with training available online. Volunteers will be walking public rights of way across the whole project area over the coming months. The results should provide a better picture of how many of the ponds identified from maps by volunteers are still present and



LiDAR image of land in the Norton Canon area showing detailed topography, overlain by pond catchments (black) and field boundaries (grey). Ponds mapped from satellite images (light blue), OS topographic maps (mid blue) and through volunteer surveys (dark blue dots). © Edina LiDAR Digimap Services

Continued on page 12

The Staunton Moraine

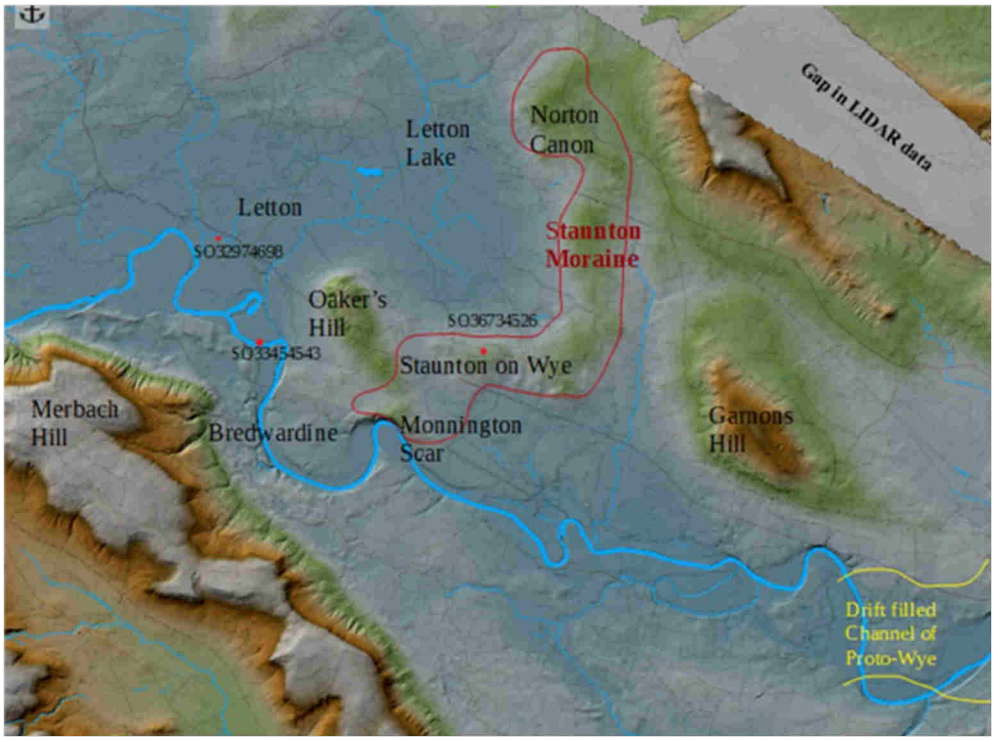
by Don Evans

The main stage of the last ice age in Herefordshire, the Devensian, was prior to 20,000 years BP (before present). During this time the depth of upland ice cover in Central Wales was up to some 600 metres, and was the source of the Wye Valley glacier which spread eastward as a sheet over north west Herefordshire. In the 1905 transactions the President of the Woolhope Club, Rev H E Grindley[1] wrote, "*It is earnestly to be hoped that the Club will take up the enquiry into modifications in the scenery of Herefordshire produced by Glaciation*." and amongst other observations recorded striated glacial deposits at Woolla quarry on Merbach Hill, Bredwardine, at a height of 294 metres, although the summit at 318 metres remained ice free. Similarly, on the northern side of the present Wye valley, the summit of Burton Hill, Weobley, at 294 metres was covered by the ice, with ice in the adjacent valleys being over 230 metres thick[2]. The glacier reached its maximum extent in a line roughly from Orleton in the north to Hereford in the south, defined in places by a terminal moraine.

By 19,000 years BP the ice was thinning and the ice cover receding[3]. The retreat of the glacier from Hereford westwards can be seen in the superficial layer of glacial deposits along the A438 road towards Staunton on Wye. This glacial drift was sufficient to fill some valleys, including the channel of the pre-Devensian proto-Wye at Stretton Sugwas.

Between Staunton on Wye and Norton Canon, and curving back towards Sarnesfield, there is a significant ridge, the Staunton Moraine. This is not immediately obvious from the main road, but the country roads through Staunton and from The Portway inn to Norton Canon go along the crest of the ridge giving views upstream and downstream of the glacial valley. Easterward towards Hereford the undulating terrain left by the glacier's retreat can be seen. This flank of the ridge drops away to the Maddle brook, probably an ice age marginal channel running parallel to the front of the moraine. To the west the slope is steeper, falling up to sixty metres (~200ft) to the flat bed of a large glacial lake two kilometres wide and extending over ten kilometres upstream past Winforton. This is the most obvious section of the moraine. As it curves around to the north-west it merges into the flank of Burton Hill. To the south-west the moraine extends through Staunton village and then on to the red sandstone cliff at Monnington Scar, which it overlies with two to three metres of hummocky glacial deposits[4].

The BGS describes the main part of the moraine as poorly sorted gravels with silts and sands. At Norton Canon, the line of the old Hereford to Brecon railway runs through a cutting some ten metres deep where the gravels are poorly exposed[2]. The fill from the cutting was used to build the railway embankment, up to three metres high, that runs around the northern edge of the old lake bed towards Kinnersley, and where in places these grey gravels, albeit not in situ, can still be seen. The moraine's overlying soils are classified as the Dore series[5], a brown earth with a deep silt loam profile, in stoneless outwash silts. At Lower House farm in Staunton (SO 3673 4526), the 1952 borehole log[6] recorded 1.2 metres of soil, below which were 47 metres of running sand before reaching bedrock, the Raglan Mudstone (now Moor Cliffs) Formation of the Old Red Sandstone. It was noted that the bedrock was at about 47 metre OD (Ordnance Datum; above sea level), and suggested that it was the proto-Wye channel between Oaker's Hill and Garnons Hill. Evidence of running sand has also been noted on other parts of the moraine.



The Staunton Moraine outlined on a LIDAR image of the Wye Valley. Red dots denote boreholes. (LIDAR base image courtesy D. Lovelace)

Heterogeneous mix of gravel, sand and clay from the Staunton moraine used as fill for the railway embankment.

The climate at the end of the last Ice Age was not one of a gradual amelioration of temperature but rather of phases of cold and warm periods. Such changes in temperature could occur over quite short time frames of thousands of years or less. Thus the Wye Valley glacier had an erratic retreat. At times this led to still-stands or oscillations of the ice margin. The moraine at Staunton is possibly a push moraine. Today these are typically found at the margin of active temperate glaciers (such as those found in southern Norway and Iceland) that experience brief periods of ice-front stability or advance despite a general pattern of recession. The ice receded somewhat further upstream than the present moraine, but a cold spell then caused a resurgence that enabled the glacier to literally bulldoze the main ridge of the moraine into place. This was followed by a relatively rapid ice retreat to Hay, where another similar moraine was emplaced.

After the ice retreat the Staunton moraine formed a dam across the Wye valley, the wide floor of which was covered by a large proglacial lake[7] of over 25sq km. Ice Age ponds subsequently formed where dead ice was marooned on the periphery of this lake. The flat topography of the lake bed is still evident, with minimal fall to the river at Bredwardine, 5km away. Grindley recorded lacustrine deposits at Letton. However the area is still an active floodplain and the surface deposits are more usually alluvial. In medieval times this was still wet ground, mostly common land. Drained in the 1800s, the stream through the floodplain is still called Letton Lake. Although somewhat off the course of the present day River Wye, with minimal fall even minor flood events will inundate the old lake bed. In the 'Great Storm Dennis Flood' of February 2020 the water covered all the hedges between Staunton and Norton Canon, leaving a vista of isolated trees standing above the surface. This extensive floodplain, both in area and depth, is a significant buffer to flooding further downstream at Hereford.

From Monnington Scar the terminal moraine joins a lower lying lateral moraine area of well developed kame and kettle topography under Bredwardine hill. It was in this area that the glacial lake overflowed and carved a new course for the Wye. With the Welsh Ice Sheet melting, the quantity of water flowing in the Wye was much greater than now, and hydraulic forces cut down through the overlying drift and into the Raglan Mudstone rock which can be seen at Bredwardine bridge and a little further downstream at the 30 metre sandstone cliff of the Scar. The alluvial plain at Bredwardine bridge is still less than 200 metres wide.

In 1984 the BGS drilled a borehole (SO 3345 4543) adjacent to the river at Bredwardine to test for the presence of foraminiferous clay (marine clay) that had been reported by Grindley in the 1905 WNFC Transactions. Drilling through 7.18 metres of overburden, Raglan Mudstone was recorded at 55.62m

The view from the Staunton moraine at Norton Canon looking west over the Letton Lake floodplain. Oaker's Hill and Merbach Hill are on the left hand side. (February 2020)

above OD, some eight metres higher than the bedrock recorded in the suggested proto-Wye course at Lower House, Staunton. Another borehole at Letton (SO 3297 4698) strikes Raglan Mudstone at 51.52 metres above OD. This is also lower than at the Bredwardine borehole and together with the one at Lower House implies that the course of the pre-Devensian proto-Wye was from Winforton via Letton, then to the north of Oaker's Hill, sweeping around through Staunton and to the south of Garnons Hill towards Bridge Sollars. It should be remembered that around Stretton Sugwas and Hereford there are many boreholes that have allowed the proto-Wye to be confirmed there[8]. For the Staunton moraine, although the lie of the land supports the suggested course, it needs more than two boreholes to prove this, and even to confirm where these two lie on the proto-Wye channel.

By 17,000 years the ice sheet was confined to the high ground of Central Wales, and was gone by 16,000 years. But as Grindley hoped '*enquiry into modifications in the scenery of Herefordshire produced by Glaciation*' continues.

References

[1] GRINDLEY, HE. 1905. 'The glaciation of the Wye Valley'. Trans Woolhope Nat Field Club, for 1905-7, 160-167.
[2] BRANDON, A. 1989. 'Geology of the country between Hereford and Leominster'. Mem Geol Surv GB, Sheet 198, 62pp.
[3] The BRITICE project
[4] RICHARDS, AE. 2005. 'Herefordshire'. in LEWIS, CA and RICHARDS, AE (EDS), 'The glaciations of Wales and adjacent areas', (Almeley: Logaston Press), 129-144.
[5] BGS borehole records, Reference: SO34NE1, SO34NW5, SO34NW6
[6] Rothamsted Research
[7] BRITICE Glacial Map v2.0 University of Sheffield (2017)
[8] Hereford and Leominster BGS sheet 198 (1989)

****

'Herefordshire's Ice Age Ponds' — Continued from page 9

how many have been lost over the last 120 years, the condition of the existing ones, as well as eliminating those that appear to have been man-made.

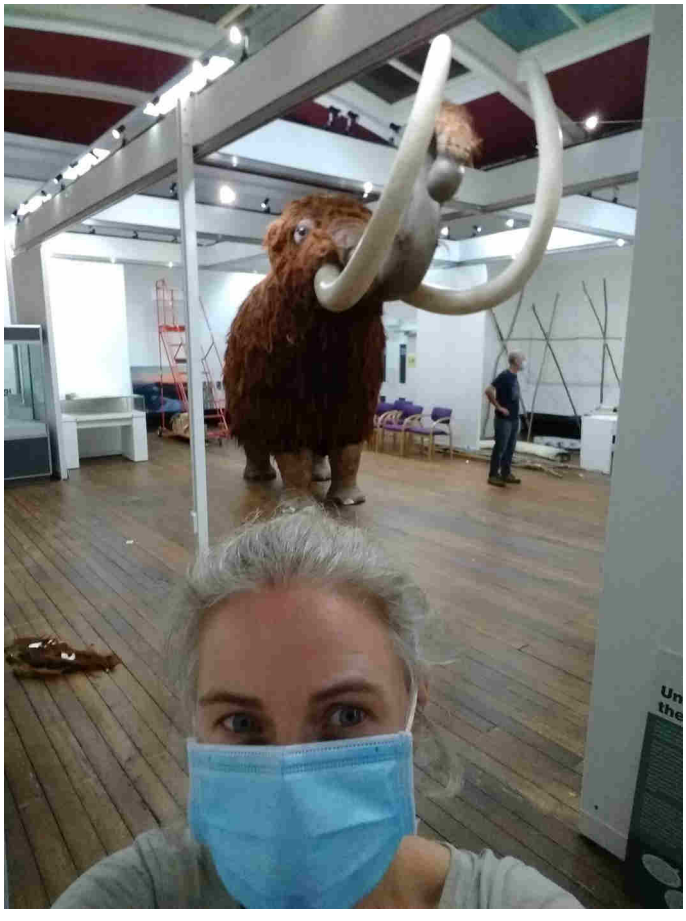
Next steps

Using the results from the Walking Pond Survey, we will decide which areas and ponds we would like to survey in more detail during the 2021 survey season. We hope to run volunteer training sessions again and we will be looking for new volunteers to get involved.

As soon as we are able we will be running school and community events, guided walks and open days. We are also developing apps and leaflets to encourage people to explore and discover this wonderful landscape and these unique sites.

To find out more about our work and keep up to date on volunteering opportunities, please visit our website *www.herefordshirewt.org/iceageponds* or contact Project Manger, Dave Hutton on *d.hutton@herefordshirewt.co.uk*.

Volunteers doing pond survey training in 2019 ©Will Watson



Mammoth selfie taken at the Ice Age Herefordshire Exhibition

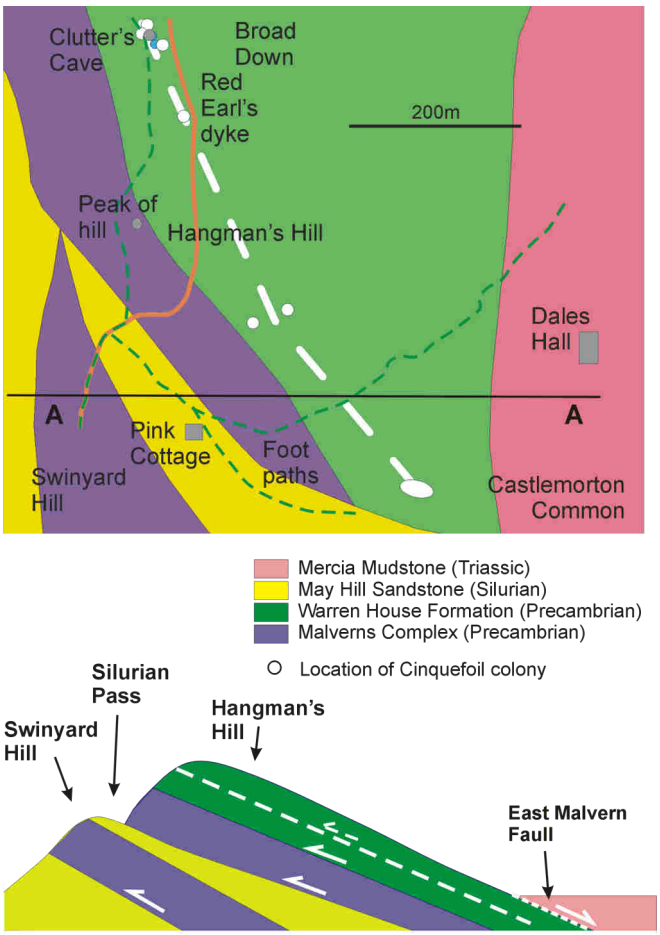
A Geobotanical Observation on the Malvern Hills

by John Payne

The thin soils on the upper parts of the Malverns are acidic in nature and support a corresponding flora, mostly small plants including some which are rare. It is therefore surprising when lime-loving plants are found here. A notable such occurrence is the appearance of the Spring Cinquefoil on the Warren House volcanic rocks, in one case in very close proximity to lime-hating plants. These locations occur on a line, shown on the map in dashed white, which essentially parallels, at a distance of about 100m, the mapped junction of the volcanic rocks with those of the plutonic Malverns Complex. (The plant locations are marked by white circles.) This junction represents a thrust plane from the Variscan Orogeny when the rocks of the Malverns were emplaced in their present position. The volcanic rock was thrust over the plutonic rock as shown in the section diagram opposite. It appears likely that the line of the flower patches indicates another thrust plane or an extensive fault entirely within the Warren House rocks and roughly parallel to the main thrust. Calcite in veins and vesicle fills has been noted as a secondary mineral in these rocks by John Platt in 1933 and attributed to infiltration by calcium-rich fluids. Such fluids could be particularly mobile along a zone of shattered rock on a thrust plane.

Multiple thrusts occur in several places on the Malvern Hills. They are generally revealed by double peaks such as at Raggedstone Hill, Midsummer Hill and, probably, North Hill. Another example is the thrusting of the Warren House rocks here and on the Herefordshire Beacon/ Tinkers Hill. A possible section through the Silurian Pass (line A-A on the map) is shown opposite. Movement on a possible oblique fault (NW to SE) across the ridge through the Silurian Pass may also play a part.

I wish to thank Peter Garner for showing me the Spring Cinquefoil locations.



Photographs below : the Spring Cinquefoil in flower on

No activities by the Geology Section are in the offing for the immediate future while COVID-19 restrictions are in force, including the Annual Meeting. It is hoped to arrange some lectures via Zoom in due course. In the mean time some very good lectures are available on the internet. Recommended are the many talks recorded over several years by the Geologists' Association (*geologistsassociation.org.uk/galecturesforall*). Look for one by Mike Simms which he gave to our group several years ago. It contains some very nice comments about one of our members, Geoff Steel. Otherwise, many of the local clubs offer their recorded talks; you will need to register your interest in advance.

Abberley and Malvern Hills Geopark (2019-2020)

by Dr. Peter Oliver
Chairman, Geologists in the Geopark
AMHG Forum Representative

All activities and projects have been affected by the Covid-19 crisis. But much has still happened. This year the report looks at the work of a few of the nineteen organisations that make up the Geopark Forum.

Bewdley Museum closed to the public on 19th March and reopened on the 20th July. The events that were planned over the summer were not able to take place except the children's activity programme with pre-booked places. The 'Worcestershire in the Ice Age' exhibition, on loan from Museums Worcestershire, went ahead as planned but without any hands-on activities. The exhibition received just over 5,500 visitors. Schools bookings are down as expected and the education team is developing outreach and digital engagement programmes as alternatives.

Severn Valley Country Park (SVCP) facilities closed from 21st March, but the park itself has remained open throughout. From May onwards, when the Government announced that people could use parks for picnicking and the travel restrictions were lifted, the Park became incredibly busy. Only since the children went back to school in September have visits become more normal. The Visitor Centre remains closed. Volunteers returned on 10th August. Nordic walking sessions have begun again, but the usual children's events are still on hold. There were some self-led trails for the children over the holidays with a lot of nice feedback about the dinosaur trail.

The SVCP Lives in the Landscape project deadline has been extended until Christmas. It has looked at different ways of delivering the outcomes so a lot of information has gone online; the geology programme has been revised; and a webpage has been created detailing some of the research.

Although the forests were still officially open for the public to visit during lockdown, **Forestry England** made the decision to close all car parks from March and asked only people who could walk to the forest to visit. Wyre Forest re-opened earlier than expected, at the end of May. Since the gates opened the site has been full nearly every day. Now the public toilets, play area, Go Ape, bike hire and the café are all open.

Like so many other places, **National Trust Croome** was closed for a period of several months from the end of March. It reopened in June with a limited number of bookable places per day; that number quickly increased. The café and shop have now reopened, along with Croome Court. Visits still have to be booked to guarantee admission although people are now allowed to just turn up and enter if space permits. The garden and park are open.

Unfortunately, all Croome events, walks and eye-catcher open days have been cancelled. This means that the geology information sheets that were produced for visitors at the monthly Panorama Tower open days have not been used much this year. Panorama Tower open days will hopefully run again next year, as well as a new Geology Trail.

Worcestershire Archive and Archaeology Service (WAAS) operates the Geopark Secretariat and also manages GeoFest. The normal GeoFest did not take place, but regular news from members was on social media and the website. A number of children's activities were uploaded and promoted for families to do at home. For half-term there will be a list of events being offered by partners; all are listed on the website.

A small part of the area of old colliery spoil at Severn Valley Country Park that is designated for rock and fossil hunts as part of the Lives in the Landscape project. Peter Oliver, John Stocks, Andrew Jenkinson and Mike Preston of Geologists in the Geopark investigate.

Archaeologists have been out on site, apart from a month at home, and have been very busy with work for developers, and specialists have continued to work at home for our own projects and for other companies. The Historic Environment Record and Planning team has continued to do a lot of its normal work, but at home since March. The archives reopened in a limited way at the beginning of September. The Outreach Team has been carrying on with some projects, although talks/tours/workshops

A large piece of ironstone found in the spoil of the former Alveley Colliery. The mine closed in 1969.

are on hold, and some projects have been postponed.

Victoria Bryant, who was Head of Service, retired recently. Carol Brown, Head of Libraries, also took on management for WAAS.

Geologists in the Geopark (GG) members have carried out all group discussions via email since the Spring of 2020. This is likely to continue until the epidemic restrictions subside.

Before the lockdown GG managed to carry out site surveys for SVCP as part of its Lives in the Landscape project. GG provided site interpretation; mining, quarrying and geology reports; as well as teaching material. A full set of mine abandonment plans for Highley and Alveley Collieries has been obtained from the Coal Authority. A lecture and practical session was delivered just before Lockdown, to a newly formed amateur geology research group taking part in the same project. A programme of further research has been developed for this group.

For the modified GeoFest, a series of web-based activities for children and a programme of self-guided walks and trails for individuals and families were produced. These were posted by WAAS on the geopark website.

Aside from members, other Geopark work this year included a remote Forum meeting; development of a new five-year project idea covering the whole of the Geopark; and planning for GeoFest 2021.

****

Herefordshire and Worcestershire Earth Heritage Trust 2020 activity

Prof. Ian Fairchild, Chair

Since late March, activities have been restricted by Covid-19 regulations and this has particularly affected our participation in public-facing events. However, following the completion of the development stage of Conserving Herefordshire's Ice Age Ponds in later summer 2019, the bid for the delivery stage, funded by the National Lottery Fund Heritage Fund, was successful and the work programme has gone ahead. The main change is that volunteers have been sent out over a wide area to check, from public rights of way, the current state of pond sites visible on maps rather than doing pond surveys in groups. Work on planning a landscape tour by bike or car and walking trails in the ice age landscape of western Herefordshire has gone ahead and an app is in a testing phase. We also contributed in various ways to the Ice Age exhibition, organised by Herefordshire Museum service, although the launch was delayed. Although visitor numbers were restricted, 2000 attended before closure at the start of the second lockdown in November. John Payne has had another successful season co-ordinating hard-working volunteer groups working on site maintenance in the Malvern Hills area and local Champions group likewise at other sites in the two counties. Sadly, we note the passing of our oldest Friend George Bennison, a well-known textbook author, and Alan Cutler, one of our founders, who has made huge contributions to Earth science conservation more widely. Julie Harrald undertook a placement with the Trust in order to develop a rationale for inclusion of geodiversity in the Natural Capital Assessment, which is a national development to value assets in the natural environment. Undergraduate Alex Jones undertook a Spring term placement on the ponds project. Local interest groups and Trustees have been making good use of the maps and GIS training that took place in 2019 and we are also working on different approaches to updating our databases of sites. The most prominent outward facing development this year has been our new website, created in conjunction with local web-developer Paul White.

PANORAMA SOFTWARE

In the field, readers may occasionally have wished to identify distant hills. The web site of Ulrich Deuschle can often help with this.

(https://www.udeuschle.de/panoramas/makepanoramas_en.htm)

The site will generate panoramic views of the topography seen from (apparently) any point on the Earth's surface and above it (up to about 5000m). A couple of local examples are shown below; views over Herefordshire from the Worcestershire Beacon, with x2 vertical exaggeration. In the web site, clicking on a summit label will show the peak's altitude. The most distant point visible in principle in the view is marked.

The effects of optical refraction in the atmosphere are taken into account. For distant sites the optical path is bent from a geometrical straight line because the altitude varies along the path. The refractive index of air depends on its density and so varies with altitude. The atmosphere thus acts like a giant refracting prism.

Links to Google maps and Google Earth are built into the web site.

View to the west from the Worcestershire Beacon