Earth Matters

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

No. 15 December 2018

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MESSAGE FROM THE CHAIRMAN

ONCE again, it's my duty (on your behalf) to thank the Committee for their various contributions to the Woolhope Geology Section. I hope that it has become clear that the Section is now financially part of the WNFC as a means of being able to develop and encourage a wider clientele as it is clear that our numbers are declining. We are able to make full use of the Club's new website (which is a work in progress) and we hope that you will regularly log on and so be informed fully of all the activities which may be of interest to you. You will also be apprised of the activities of other like-minded groups throughout the region via internet links and other advertising, especially as we are now formally affiliated to the Herefordshire and Worcestershire Earth Heritage Trust. The key to this development is to get people to know about it and use it!

As detailed in this edition, you will note some changes, building both on the success of our book 'Herefordshire's Rocks and Scenery' and the promotion of Woolhope geology. During this last year we have been meeting in the Shire Hall, which has been highly convenient. However, with the re-opening of the Woolhope Room in the City Library, our intention is to use this cheaper and better facility. Watch this space (or rather the website). In collaboration with the Abberley and Malvern Hills Geopark, an extension to the geopark was launched to incorporate more of Herefordshire including the very significant Woolhope Dome. It is anticipated that geological guides, walks and exhibitions will eventually be developed. Also, with building sites proliferating and the opportunity for spotting new (and likely temporary) exposures is increased (rather like all those small quarry sites of long ago), Moira is always willing to come out to record them. This is something whereby the Club can refine our previous knowledge – so let her know.

Very importantly, as from 2019, 'Earth Matters' will be communicated via the internet. Those wishing to receive a 'hard copy' may still do so by replying to John's instructions in due course. He will indicate its cost. In the light of this proposal, the Committee felt it right to cancel the additional subscription you all pay to the Geology Section. Our Treasurer, Ian, has already set this in train.

The whole Club has been reminded by Paul (currently its President) that field meetings are an essential part of our raison d'etre and a requirement of The Rules. We are, therefore, especially grateful to Sue for all her efforts in providing opportunities for us.

Dr Chris Fletcher, Chairman

MALVERN'S SPRINGS—A GEOLOGICAL PERSPECTIVE

by John Payne

THE SPRINGS of the Malverns were first discussed scientifically in the 17th century, the interest lying in the curative properties of the waters. Publications in the 18th and 19th centuries gave chemical analyses of the spring waters. Only in the early 20th century was any attention paid to the geological conditions which give rise to the springs but, after Richardson's 1930s 'Wells and Springs' series for the Geological Survey, very little was forthcoming except for the writings of the Malvern Springs Association (MSA) and books by Weaver and Osborne. (The widest interest in the springs today centres on the annual well-dressing festivities.) An MSc project report of 2002 is the most comprehensive account of the hydrogeology of the Malvern Hills.

An account of the geology and basic hydrogeology of the Hills and their immediate surroundings appears on the website of the MSA. A wide variety of rock types is present locally, with ages ranging from 700 to 220 million years and with much more recent erosion products as a thin layer on the surface.

Igneous rocks consisting of interlocking crystals of various silicate minerals form the body of the Hills. These very hard rocks are quite impervious and almost insoluble in water. The Malvern rocks lie essentially as a slab of rock several hundred metres thick sloping downwards to the east at about 30° to a depth of many kilometres. The top edge of the slab forms the ridge of the Hills. Since their solidification from molten rock 700 million years ago, the rocks have been subjected several times to major tectonic events, essentially continental collisions. In these very slow but violent events the rocks were broken and the resulting network of fractures allows the storage and transmission of water within the Hills. The earliest and often large fractures have since been filled with rock fragments which have been cemented into an impervious mass. The most recent breaks, about 300 million years old, have generally remained open and connected and form the Malvern Hills aquifer of today. This crack network extends probably throughout the whole of the rock body so that rainwater will have penetrated to large depths and now fills the aquifer to somewhat above the level of the surrounding terrain. This situation gives rise to the many springs which lie around the Hills at the surface junction of the Malvern rocks with the generally impervious clays and sandstones which border them. This junction is known as the 'spring line'.

Figure 1 shows a map of the Hills north of the Wyche. Marked are all the recorded water sources that can reasonably be identified as springs and not spouts deriving their water from distant springs. Some of these springs are now permanently dry.

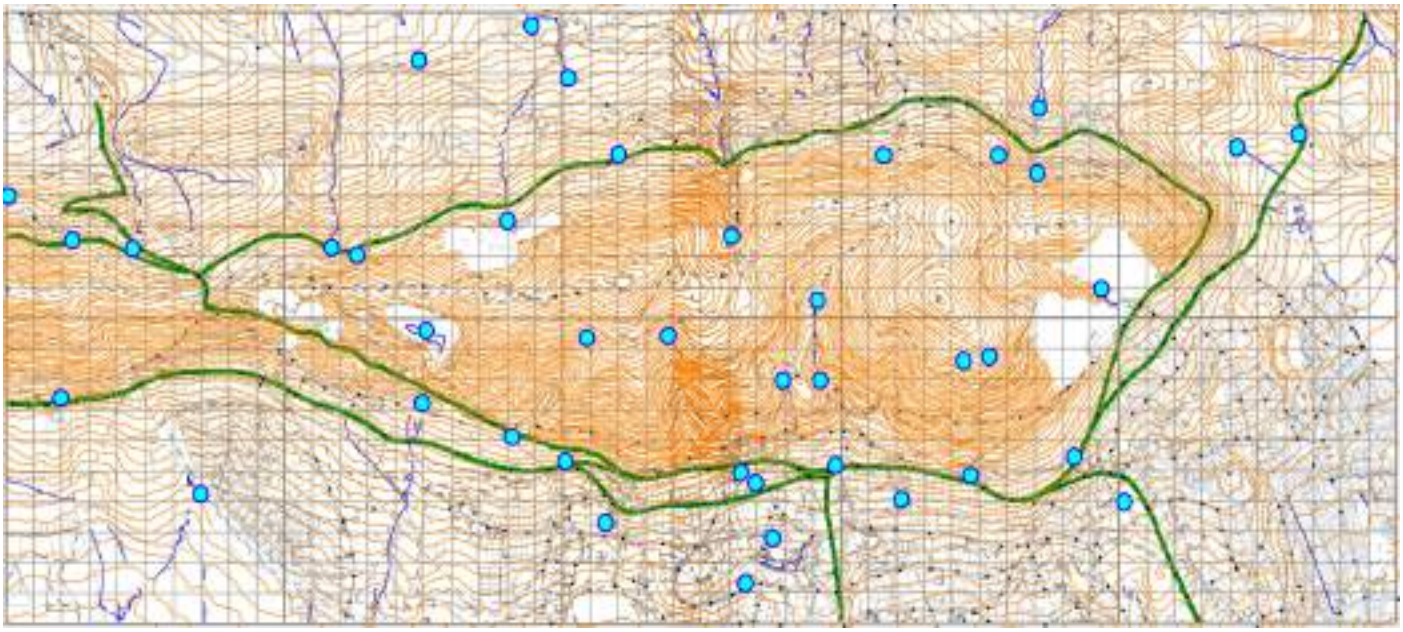


Fig 1 The northern Malvern Hills showing positions of the known springs. (North is to the right. The main roads are shown. Great Malvern is at the bottom centre of the map. The Wyche Cutting is toward the left side. The many brown lines are contours. The grid is at 100m spacings.)

Figure 2 shows the general geology of the area. The spring line is the boundary of the mauve area, which indicates the Malvern rocks. The main road around the northern hills generally is close to the spring line and many springs are found near it. However, it is clear from the map that a number of springs lie higher and lower on the hill.

The sources which lie high on the hill are of two types. The first type issues on the open hillside; the second on valley floors. Examples of the first type are the Dripping Well, not far below the Worcestershire Beacon, and the spring in the Dingle (also see Fig.3). These springs are sourced from aquifers of fractured Malvern rocks where the system of fractures is not connected to that in the main rock body thus forming a separate isolated aquifer. Probably any connecting cracks have been filled and

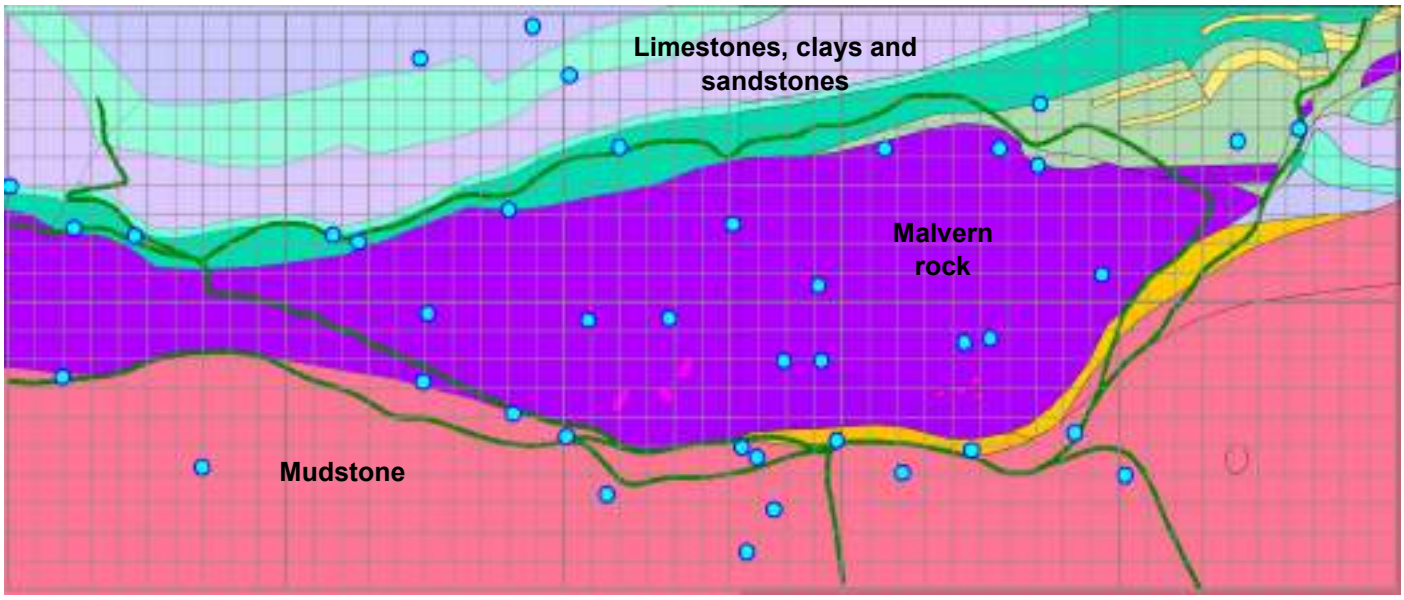


Fig 2, The north Malvern springs in their geological settings.

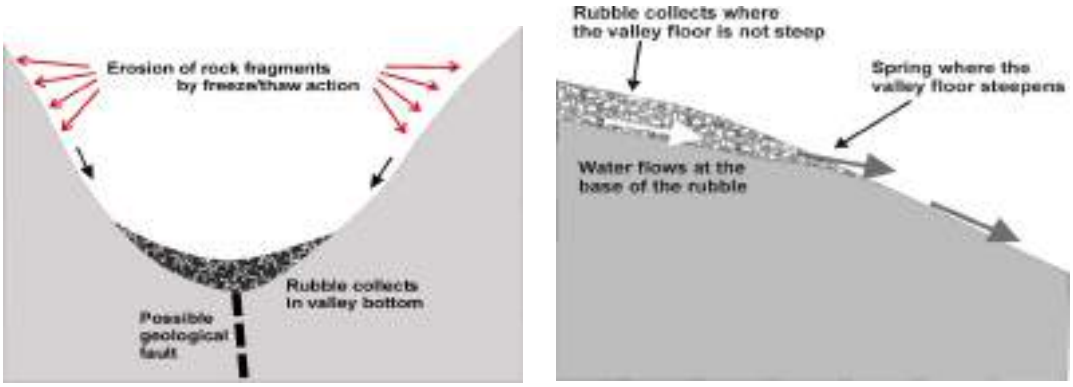


Fig. 4 Diagrams of the valley floor springs. Left diagram is a section across a valley. Right diagram is a section along the valley floor.

blocked by eroded material over long time periods.

The valley floor type of spring is depicted in Figure 4 and is exemplified by the source of the stream in Green Valley, above Great Malvern, and the now-enclosed spring in Rocky Valley which fed the North Malvern tank at the clock tower. Here, rubble eroded from the hillside above has collected on the valley floor. Rain falling in the valley or issuing from the adjacent fractured rock flows in a channel at the base of the rubble to emerge where the valley floor becomes steeper so that the thick rubble layer cannot be maintained. The visible valley floor is of rock fragments and soil; the open channel below is kept open by the flow of water. In some places, such as in Rocky Valley, the underground flow can be heard after periods of wet weather. The large valleys on the Hills, such as Green and Rocky Valleys, are believed to have formed on the lines of major geological faults. These faults are very ancient and are believed to be now blocked to water flow by consolidated debris..

Figure 2 shows several springs on the impervious mudstone rock below the spring line. These have sometimes been attributed to issue from below via faults in the mudstone. It seems to this author to be more likely that these springs are similar in nature to the valley floor springs described above. Much of the land adjacent to the Hills is covered in eroded material and, probably just after the Ice Age, flow channels were established which have been maintained during the subsequent accumulation of soil and vegetation

Little is known of the details of water flow within the Hills. It is a topic difficult to investigate. Even the length of time which water spends in the aquifer between rainfall and emission at springs is not well known and of course varies with location and recent rainfall history. A typical value is about thirty days. Such aspects are the subject of some current research by the author. A second important parameter of the hydrogeology is the fraction of the rainfall which emerges from the springs. A few estimates by various authors lie between 20% and 25%. The remaining large fraction is lost by evaporation, transpiration and small-scale seepages from the aquifer in amounts not large enough to generate springs.

Fig 3 The highest spring on the Malvern Hills after a rainy period. It is located at SO 7712 4652, only 42m lower than the summit of North Hill. The water runs downhill for a few metres before disappearing underground.

MALVERN'S SPRINGS – WHAT'S IN THE WATER?

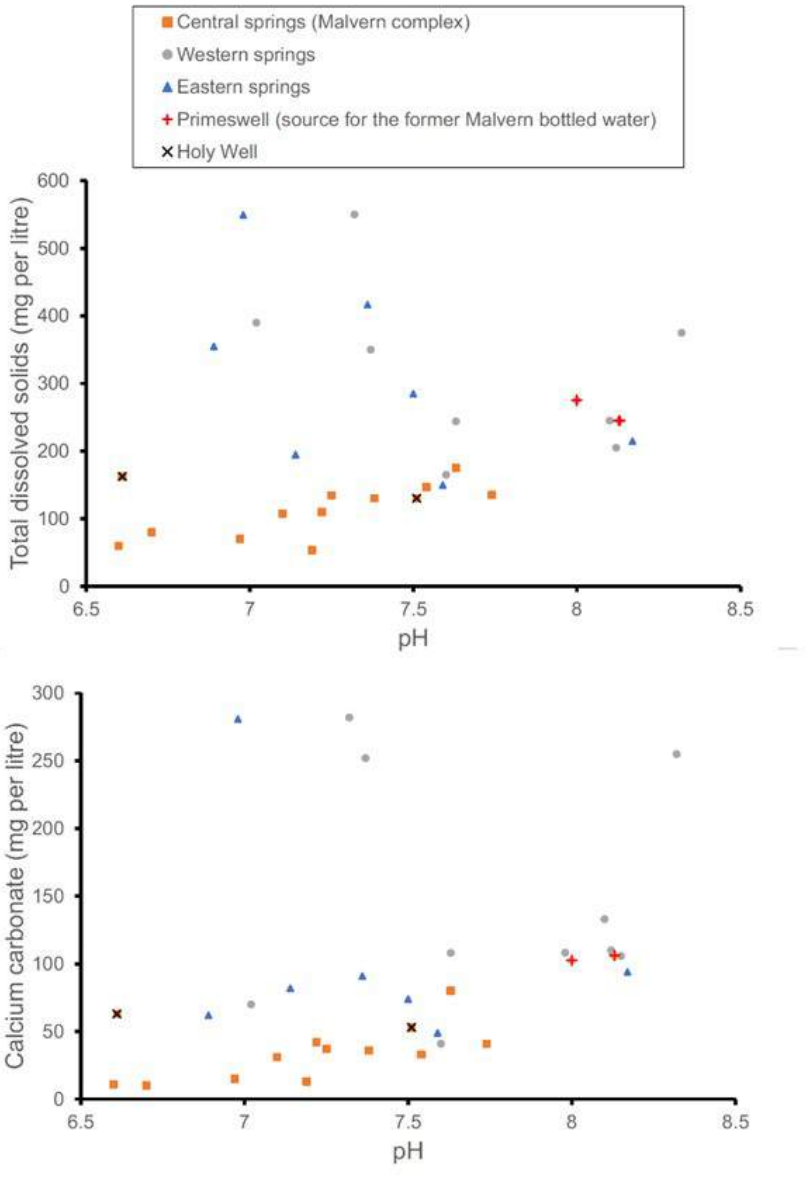
by Ian Fairchild

MANY PEOPLE go to some trouble to collect spring water for use at home, but what is special about Malvern's water? Perhaps you have heard that our local springs actually show quite a variation in composition, maybe enough to taste the difference. The previous article by John Payne explains the geological framework: the substrate through which the water has flowed underground. I pulled together various (mostly unpublished) water analyses available to me to try to make sense of the variation in their composition and was pleased to see that a nice pattern does emerge. Thanks to Professor Jon Blundy for many of the analyses.

To demonstrate this pattern, I have used a series of crossplot graphs. These show interesting differences between typical streams emerging from the crystalline Malverns Complex rocks in the core of the hills versus those that have flowed through the sedimentary rocks on the west and the east of the hills. I have also differentiated analyses of the Primeswell Spring near British Camp, which was the source of the water formerly bottled by Cadbury-Schweppes at Colwall, and the Holy Well water which is currently being bottled at source. in Malvern Wells

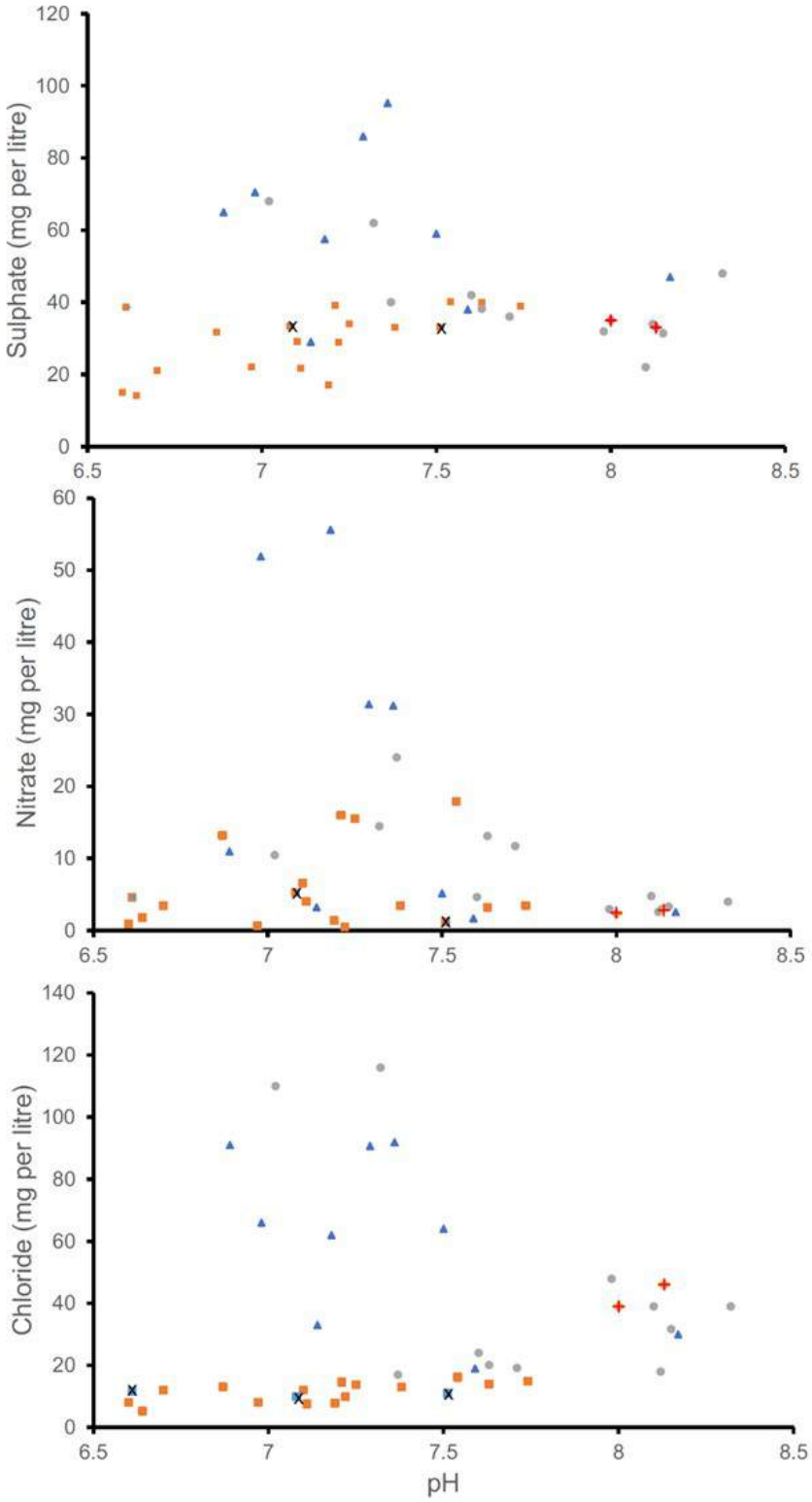
Each of the plots is against pH on the x-axis. Waters lying to the left are acid and those further to the right are alkaline. The weak acidity of rainwater is neutralised by dissolved minerals. Acidity is also generated in soils, leading to more dissolution of minerals, but this is typically neutralised by expelling carbon dioxide at springs.

The first plot shows the total amount of 'dissolved solids' on the y-axis. The springs based on the Malvern Complex rocks stand out as containing little dissolved matter and for some folk historically this purity is a much sought-after feature. The Holy Well water belongs to this group and the water at St. Ann's Well is even lower in dissolved solids. In contrast, the late-lamented Malvern Water does not have a distinctive composition, being more typical of tap waters generally.



The second plot shows the hardness of the water expressed as the equivalent amount of calcium carbonate dissolved in the water, although some hardness also comes from magnesium. Calcium carbonate dissolves more readily than other common minerals apart from certain salts and its concentration tends to increase as pH rises. There are some exceptions where pH is lower than expected and these correspond to springs that have not yet degassed excess carbon dioxide. Traces of calcite are found in most rocks including granites. Nevertheless, dissolved calcium carbonate tends to be higher in the western spring waters as expected because of the presence of limestone in this area.

The third graph plots sulphate on the y-axis. Again the purity of the Malverns Complex springs stands out. High sulphate occurs more often in the eastern springs than the western ones. This could be because of traces of calcium sulphate (gypsum) in the Mercia Mudstones to the east, but sulphate also forms by oxidation of iron



sulphides (pyrite, or fools' gold) which is widespread as a trace mineral.

The fourth plot shows nitrate on the y-axis. It is good to report that hardly any waters are above the EU suggested limit of 50mg/litre and most are below 10mg/litre, particularly on the Malvernian rocks. Nitrate in lowland areas in general tends to be high because of fertiliser application, whereas livestock are the main source on the hills.

The final plot shows chloride on the y-axis. Most of the Malverns Complex springs have very low chloride and these values are probably close to the small amount of sea salt found in the rain in our area. What is interesting is how large the chloride values are in many other springs, being many times higher. This is likely to be due to concentration of salt by evaporation in soils and unconsolidated sediments near the ground surface and is an indicator of the residence time of water close to the surface. Unconsolidated slope deposits are widespread to the east of the hills where most of the highest values are found

I haven't touched on another aspect of water quality – the presence or absence of harmful bacteria. Monitoring by the Environment Agency shows that this is not normally a matter of concern except at one or two vulnerable sites which are not normally used as water sources. Nevertheless at times of exceptionally high or low flow the risk is heightened and, unlike tap water, the water is not continuously monitored for drinking purposes.

Annual Subscription

THE annual subscription to the Geology Section has been cancelled as detailed elsewhere. Any standing orders for payment from bank accounts should be stopped before 31st December 2018. A form for this was included with the last WNFC newsletter. The subscription for WNFC remains payable on 1st January as usual.

Annual General Meeting

MEMBERS are asked to accept this as notification of the Geology Section AGM to be held on **Friday 22nd February 2019** 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

FROM January 2019 the regular section meetings will be held once again in the Woolhope room in Hereford Library in Broad St. The previous limit on finishing our meetings by 7pm has been removed so the meeting timing forthwith will be a 6:00 for 6:30 start and an 8:00 (or later if needed) end. This should be generally more convenient.

ANNUAL SYMPOSIUM OF THE OPEN UNIVERSITY GEOLOGICAL SOCIETY

University of Worcester — August 2018

Summary by John Payne

THE ANNUAL SYMPOSIUM of the Open University Geological Society was this year held at the University of Worcester over a weekend in August. The meeting was attended by about 200 members of the Society. Eight of the eleven presentations featured specifically Worcestershire geology. Eleven excursions offered delegates the chance to explore the Lickey Hills, the Malvern Hills, Martley and the building stones of Worcester.

Professor Ian Fairchild opened the meeting with an introductory lecture. He gave a brief description of the topography and geology of the area, commenting that Herefordshire and Worcestershire (H&W) jointly held some of the most varied geology in the country, with the admitted likely exception of Shropshire. He then spoke particularly about the work of the Earth Heritage Trust (EHT), describing seven current or recent work areas and showing examples of the computer apps generated by Mike Brooks. Prof. Fairchild has played a large part in the 'Lost Landscapes' project concerning the effects of the Ice Age on Worcestershire. This is currently the subject of an exhibition in Worcester. Especially interesting aspects of this are the large glacial erratic rocks found in northern Worcestershire and the famous river terraces of the Rivers Severn and Avon.

Kate Andrew spoke about the recently completed Building Stones project of EHT. She too noted the great diversity of the geology of H&W seen in the use of local stones from nine geological periods. The earliest are the Malvern rocks, which are widely used in the older parts of Malvern, and the Cambrian sandstone seen in Hollybush church. The youngest are the Jurassic rocks of eastern Worcestershire (e.g. in Littleton tithe barn) and the Quaternary tufa used in Worcester cathedral and elsewhere. The project surveyed buildings up to 1000 years in age. Attempts to link buildings to particular quarries had some success but proved to be generally not possible. There are at present just three active quarries in H&W; this programme identified 733 abandoned ones. Details of all of these and the buildings investigated are held on a publicly accessible database which will remain active for several years.

The following three presentations concerned the work at Martley. Sue Hay described 'The Influence of Martley Rock', mentioning the initial visit by Murchison who was followed by a succession of well-known Victorian geologists. In the 20th century, visits by geologists of the British Geological Survey added to knowledge of this small quarry site which was later filled in. A visit by Paul Olver in 2004 established that the landowner was willing for further research on the site but it was only in 2010 that exploratory trenches were dug. Over the next few years several more trenches were excavated. As a result, our understanding of the site's geology has been much improved; Bill Barclay (ex-BGS) has analysed the structure of the site and Sue has undertaken work on the petrology. Sue studied thin sections of the igneous and Carboniferous rocks and the quartzites from the site. The igneous rocks were found to be mostly diorite similar to those of the Malvern Hills. The rock from the old quarry showed low-grade dynamic metamorphism. Both tectonised and fresh quartzites were found. The quartzite grains were sub-spherical, similar to the Cambrian quartzite of Malvern rather than the Ordovician quartzite of the Lickey Hills. The Carboniferous rock is believed to be from the Halesowen Formation although the composition is like that of the Pennant Sandstone but the grain size is much smaller.

Bill Barclay described the structure of the Martley site. It lies immediately west of the East Malvern Fault and falls into two parts, divided by a newly discovered minor fault (the Martley Rock Fault). It is notable that the very small area of the site exhibits rocks from five geological periods (Precambrian, Cambrian, Silurian, Carboniferous and Triassic) and, more so, that these appear in successions (e.g. Precambrian at the top with Silurian at the bottom) which are far from the normal order and are different in each of the two site areas. Bill discussed his interpretation of the structure as a series of stacked thrust sheets with the thrusts as 'footwall shortcuts' to the East Malvern Fault. As such, they represent a small version of structures seen elsewhere in the Malverns, for example, the overthrusting of the Precambrian of the Herefordshire Beacon on to the adjacent Silurian strata.

David Cropp, Chair of the Teme Valley Geological Society (TVGS), spoke about Martley, its role as a 'geo-village', the geology of the parish and the activities of TVGS. The abstract (modified) of his talk follows.
"Contrary to popular belief, not all geology is on a grand scale; not all geology exists in Geoparks; and not all geology has to be climbed, abseiled, or white-water rafted, to be of interest. The community of Martley lies fortuitously at the centre of an area of significant geological interest. The formation of a local group (TVGS), with the support of professional geologists, led to a successful bid for £k23 of European LEADER funding to enable site exploration (particularly at Martley Rock), with analysis and publications to follow (described ironically as "the first time a hole in the ground has received EU funding"). This talk describes our local geology from a community-led perspective, and, from that, the move to establish an international

template for similar, small communities to use as a way to appreciate and develop their local geological assets as Geo-Villages. Martley is linked to geo-villages in the Vosges mountains, Germany and north-east Turkey. This talk also shows the wider economic and infrastructure gains that can follow."

Tim Pharaoh's talk on the evolution of the Malverns was delivered from apparently insubstantial notes (in his absence due to illness) by a member of the OUGS organising committee. The presentation material was generally complex. The Malverns lie on a boundary between the Wrekin and Charnwood terranes. The calc-alkaline chemistry of the rocks indicates an island arc origin, while the pillow lavas at Clutters Cave represent mid-ocean ridge basalts. The various data sets for deep-lying strata were discussed (gravity anomaly, magnetic anomaly, borehole data, seismic data). The Cambrian-Tremadoc basin on the east side of the Hills was inverted in the Variscan orogeny, later forming the Worcester graben as the result of crustal extension in the Permian and Triassic Periods. Subsequent tectonic activity has been small but observations from the Malvern railway tunnel indicate possible 'Alpine' movements.

The following lecture, on Malvern hydrogeology, by John Mather was cancelled due to his illness. Prof. Ian Fairchild filled the gap with a lecture of two parts, on Malvern springs and Southstone Rock. The first section largely followed the material shown in the two 'Malvern springs' articles in this issue of Earth Matters – the various types of spring and the minerals dissolved in the water. Prof. Fairchild noted the skill of those promoting the Malvern water cure in the 19th century in selling spa water which, they said, contained 'nothing' in distinction to the usual emphasis of spas on the benefits of the minerals found in their waters. The data presented in the talk showed the 'nothing' claim to be inaccurate.

Southstone rock is a tufa deposit from Holocene times. Large by British standards, it is small compared to some elsewhere, notably those in the Yuntaishan geopark in China. It has been proposed for designation as an SSSI. It is unusual in not being formed directly on a limestone outcrop although its lime material does stem from a limestone deposit, the Bishop's Frome Limestone, as well as the cement of the sandstones of the Freshwater West Formation. The tufa is deposited via changes in acidity, pressure and temperature at springs of lime-laden water and Prof Fairchild showed graphs in illustration of the process.

David Ray described his work to provide a correlation between outcrops of Silurian strata locally with those now remote, for example in Sweden and the USA. A number of methods have been used; fossils, extinction events, sea level changes, measurements of isotopic carbon and age determined from bentonite deposits. The aim is to set up a well-defined 'type region' in a similar manner to type sites. Bentonites are particularly useful; 150 bentonite layers are known in the Wenlock sequence. These may be dated accurately and also show systematic variations in contents, for example in the amounts of rare earth elements. Correlation by the methods of sequence stratigraphy has been achieved using inferred sea level changes. From this, it appears that the rocks of Scutterdine Quarry are equivalent to those at the top of the Niagara Falls.

'The geological history of Wales and the Borderland' was discussed by Nigel Woodcock, in particular with the questions 'Why is Wales an upland?' and 'When was the uplift?'. The abstract (modified) of his talk follows.

"The Malverns form the eastern geological boundary of Wales, famous for its uplands and its coastline. These attributes are intimately related to the underlying geology of the country, as is its wealth of mineral and coal resources. This talk tracks the plate tectonic history of Wales through Phanerozoic time. We track the northward drift of Wales as a passenger on successive palaeocontinents, its stratigraphic record punctuated by major unconformities marking continental amalgamations and separations. Its coastline and eastern boundary with England get determined by surrounding Mesozoic rift basins. Its uplands are created by Cenozoic uplift above a mantle plume. (The resulting uplift of the Malverns is estimated to be about 100m.) These uplands in turn provide the template for the Quaternary glaciation that shaped the present landscape. The mineral and coal resources of Wales may now be less economic, but the country's geological history has produced a landscape rich in renewable energy potential."

Prof. Richard Butler of Birmingham University spoke on 'The Triassic Rise of Dinosaurs'. Dinosaur palaeontology is in a good phase at present. New dinosaurs are being discovered at the rate of about one per week. Most work is centred on times when dinosaurs were at their peak. Much less research is undertaken on the origins of the creatures in the Triassic Period but this is Prof. Butler's field. He described the difference between the Archosauria which developed to, for example, crocodiles and those which led to dinosaurs and, in turn, to birds. The former have legs at the side of the body, the dinosaurs have them underneath the body. The first dinosaurs appeared at 247Ma and Butler's research covers the period 247 to 235Ma, using samples mainly from the Ruhuhu Basin in Tanzania.

The final presentation was by Dr Oliver Wakefield (BGS) on 'The importance of water in aeolian systems; an example from the Sherwood Sandstone of the West Midlands' This concerned mainly the manner of formation of the dunes which form the Sherwood Sandstone (which underlies Nottingham Castle) and the good properties of the stone as a principal aquifer and as a potential offshore carbon store. Its good porosity is important for fluid flow for gas or oil.

THE CROFT CASTLE GEOLOGY CHAMPIONS

by Robert Williams
(on behalf of the Croft Castle Geology Champions)

TWO QUARRIES on the Croft Castle estate, a National Trust (NT) property in north Herefordshire (SO 450656), have been the focus of work for a group of the Herefordshire & Worcestershire Earth Heritage Trust (EHT) 'Geology Champions' since 2010[1]. During this period, the group has engaged with the NT to introduce groups of visitors to Lime Kiln Quarry and Highwood Bank Quarry in the Fishpool Valley of the estate. The valley itself was formed during the last ice age as an 'incipient glacial overflow', which never fully developed, on the south side of the Ludlow Anticline. One main event per year has been the pattern, with occasional supplementary events linked to these. Specific groups have included the Woolhope Club's Geology Section, the Teme Valley Geological Society, the Leominster U3A Geology Group, a local WI group and Croft Castle staff and volunteers. Other events have been for the general public, arranged through the National Trust.

On arrival, groups are issued with a 'hand-out' to keep, featuring four main sites on the itinerary and a geological timescale. EHT display boards are set at the two quarries and other items are available during and after the walk for participants to study.

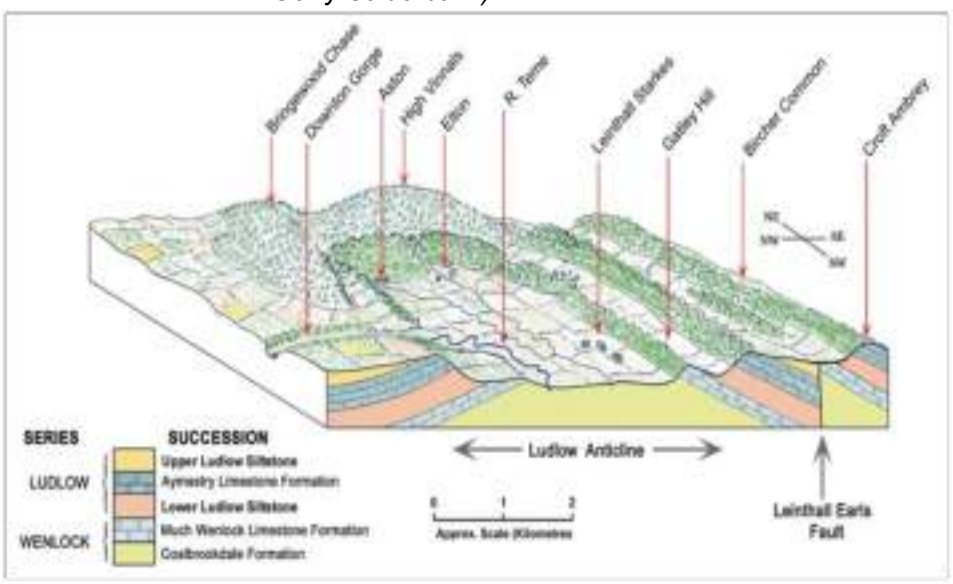
Figure 1 Lime Kiln Quarry

The main focus of attention is the Aymestry Limestone from the Silurian Period. This takes its name from the nearby village of Aymestrey, in the 1830s the parish of the Rev. TT Lewis, who was later to be one of the founders of the Woolhope Club in 1851. It was so named by Sir Roderick Murchison in his pioneering work *The Silurian System* (1839), following his field visits in the area from 1831 onwards. As the EHT board at Lime Kiln Quarry (Fig.1) says, the quarry "displays the bedded nodular clay-rich limestone and calcareous (calcium-carbonate-rich) siltstone that are typical of Aymestry Limestone exposures". At Highwood Bank Quarry

Figure 2 Highwood Bank Quarry

(Fig.2), which illustrates well the dip of the strata, the nodular nature of the limestone is more pronounced than at the lime kiln, since here weathering has eroded away much of the lime cement. Fossils to be found in these rocks include brachiopods such as *Kirkidium Knighti*[2], crinoids and corals. At the lime kiln an interesting and much appreciated focus has been to demonstrate how limestone was formed under the Iapetus Ocean (c. 400m years ago) - "most of the carbon on our planet" being "locked up in rocks such as these" - and the more recent release of that carbon back into the atmosphere in historical time when the limestone was quarried for building stone or for burning in the kiln for limewash, cement and the neutralisation of acid soils. Such soils are seen locally

Figure 3 Block diagram of the Ludlow Anticline/Vale of Wigmore (Drawn by Peter Thomson with further work by Gerry Calderbank)



to the south of Croft Castle and were formed of glacial drift Old Red Sandstone material. Details of this local geology are included in a recent article about the current National Trust restoration work within the Fishpool Valley in the Woolhope Club's Spring 2018 Newsletter[3]. This also includes a block diagram of the area (Fig.3), which is made available to 'Champions' visitors to the quarries.

One happy outcome of a Champions event for the general public in 2011 was having a visitor from London, Mary Harris, who was engaged in writing the biography of her mother, Elizabeth Alexander (nee Caldwell). During the 1930s, Elizabeth Alexander did her Cambridge PhD research in north Herefordshire (including the Croft Castle estate) and southern Shropshire, investigating specifically the distribution and exposure of the Aymestry Limestone. In 1935 a summary of her PhD thesis was read on her behalf by OT Jones, Professor of Geology at Aberystwyth University, to the Geological Society of London as 'The Aymestry Limestone of the Main Outcrop'. Elizabeth then took questions from members of the audience[4]. The paper and the accompanying map and cross-sections are of particular interest, since they represent one of the key pieces of geological research done in this area between that of Murchison in the first half of the 19th century and the work of the Ludlow Research Group since the 1960s. The Champions have since hosted Mary Harris on a personal visit in the Aymestrey area and, on receipt of copies of her mother's article and field-work maps, it has become clear that some of her walks in the area were over the very footpaths and at the same sites now visited by Champions groups. As a result, it appears that those 2011 participants (and others since) had, indeed, been walking "in the footsteps" of a significant geological pioneer.

Figure 4 Sir Roderick Murchison (Prof. Hugh Torrens) and RW. Banks (Mr. Lawrence Banks) in conversation during the 2006 re-enactment.

And speaking of footsteps, it is good to be able to draw to the attention of participants at Champions events copies of the DVD 'Picnic in Siluria', produced by the Woolhope Club's Geology Section, some of which was filmed on Croft Ambrey and where (weather permitting) present-day groups have their picnic lunches. As many readers of Earth Matters will know, this DVD was produced in 2007/8 (preceding the formation of the Champions Group) to mark the bi-centenary of the Geological Society of London and featured a field visit to Aymestrey and Croft Ambrey, re-enacting the visit in 1852 by early members of the Woolhope Club. Professor Hugh Torrens took the part of Sir Roderick Murchison and Mr. Lawrence Banks of Ridgebourne, Kington, that of his forbear, RW Banks, a friend of Murchison and President of the Woolhope Club in 1860 (Fig.4). It has therefore been apt on two occasions to have a showing of this DVD to participants at introductory events set up before the field visits. On these occasions, the Champions have also been able to set out a display, including a first edition of The Silurian System and some early Transactions of the Woolhope Club.

Figure 5 The Editor of Earth Matters (aka Sir Charles Hastings for the day) and friends at the 'picnic in Siluria'.

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1. This Champions Group is a group of six people with varied specialisms, including geology, botany, chemistry, geography and history and ranger-links with the Croft Castle Estate.

2. The name *Kirkidium Knighti* is derived from Murchison's acquaintance with Thomas Andrew Knight (1758-1838) of Downton on the northern side of the Ludlow Anticline. Knight was a distinguished horticulturalist, a Fellow of the Royal Society, one of the founders of the London Horticultural Society in 1814 (later the Royal Horticultural Society) and the author of Pomona Herefordiensis (1811), a splendidly illustrated volume on cider apples and perry pears. The Knight family had close links with Croft Castle in the latter half of the 18th. century and Richard Payne Knight (1751-1824), TA's brother, was an influential contributor to Picturesque thinking, which influenced some of the developments in the Fishpool Valley.

3. Conservation at Croft Castle: the Fishpool Valley Project The WNFC Newsletter No. 35, Spring 2018 by Imogen Sambrook, Project Manager Croft Castle & Parkland, and Robert Williams.

4. In 1935, Elizabeth Alexander went to Singapore. Following the fall of Singapore in 1942, Elizabeth did significant research in radar and radio astronomy in New Zealand before returning to do geology again in Singapore and, in due course, Nigeria. Rocks, Radio and Radar: the Extraordinary Scientific, Social and Military Life of Elizabeth Alexander by Mary Harris is being published by Imperial College Press.

A Visit to Hergest Croft and the Banks Archive
Saturday 30th June 2018

by Susan Olver & Robert Williams

FOURTEEN Club members and a group from the Teme Valley Geological Society were welcomed to the Archive by Heather Pegg (Archivist) and were joined soon after by Lawrence and Elizabeth Banks, our hosts for the day. Lawrence Banks CBE is the great-grandson of Richard William Banks who actively supported Roderick Murchison on his famous and geologically important visits to the Welsh Marches.

Heather then set the scene by explaining the historical background to the six generations of the Banks family in Kington. She outlined the important links forged by both Richard Banks and his son Richard William Banks with early geological pioneers and supporters such as Murchison, the Lewis family at Harpton Court, Rev. TT Lewis and Rev. W Symonds. These friendships ultimately led to the formation of the Woolhope Club itself in 1851.

Heather then covered the establishment of Hergest Croft house, the gardens and the seventy acres of garden with more than 5000 rare trees and shrubs.

Heather had prepared an excellent exhibition of selected items from the archive and its geological collections. Four tables contained items relating to the main themes and there were opportunities after the talk to study many documents, photographs and other items carefully . Geological specimens collected by RW Banks in the early 19th Century could be studied in their display cabinet, some drawers of which had been set on the tables for easier access. Drawers of minerals were also available to view.

A starfish from Church Hill, Leintwardine

Haywood Common Quarry

After lunch the group visited the estate quarries in Park Wood close to Haywood Common, ably led by Geoff Steel. Here Silurian siltstones, which were largely worked for walling, dip at low angles to the south-east. Their Upper Ludlow age was confirmed by the collection of a diverse brachiopod fauna including *Shaleria ornatella, Leptaena depressa* and a variety of rhynchonellids. One of the older quarries exhibits cross-bedded sandstones which were used in the late 18th and early 19th century for farm building materials on the Ridgebourne estate.

These younger Silurian strata are noticeably less fossiliferous but yield a sparse fauna of brachiopods and more commonly, gastropods which testify to the increasingly shallow sea and major changes to the environment. Although unknown to the Woolhope members at the time of the first geological visits, these changes were driven by the closure of the Early Palaeozoic Iapetus Ocean at the onset of the continental environments of the late Silurian/early Devonian Old Red Sandstone.

The Geology Section members would like to thank Lawrence for granting us access to his estate and archive and his continued support for the Club. On the day, he was ably supported by his archivist Heather Pegg who gave an excellent talk and laid on a very informative exhibition.

(Photographs by Moira Jenkins,)

Geopark Extension Launch Event by Paul Olver The extension of the Abberley & Malvern Hills Geopark to include the Woolhope Dome and new areas of south Herefordshire including Ross-on-Wye was launched by Jesse Norman, the local MP, at a special event in Hereford's Museum Resource Centre on Friday 25th May 2018.

The Woolhope Club played a large part in getting this geologically important area included within the Geopark. As the official hosts, Gerry Calderbank, Vice Chair of the Geology Section, welcomed the guests before Jesse Norman officially opened the extension. It is particularly appropriate that the extension should occur this year as the Woolhope Club has Dr Paul Olver, a geologist, as its President.

John Payne then gave a talk about the rich geology of this part of Herefordshire and why it is so significant. The new geology gained by the Geopark is described by Moira Jenkins's elsewhere in this issue. The early research in the area by Woolhope members in some cases laid the foundations for modern geological research. The Club's 170-year involvement in geology made it very appropriate for it to host the launch. It is a significant addition to the Geopark in terms of the special landscape and in introducing Hereford as a new gateway city to the Geopark. With the cathedral cities also of Worcester and Gloucester, the opportunity exists to build on a 'Three Counties' theme.

The event also launched GeoFest, the annual programme of varied summer activities for all ages from beginner level upwards, organised by Geopark Forum members. Representatives from Merlin Energy, GeoFest sponsors, were on hand to do the honours and declare GeoFest open for 2018. (see photograph on p.13)

GEOLOGY SECTION REPORTS

by Sue Olver

Friday 27th October 2017 Andrew Jenkinson - Offa's Dyke: a political boundary determined by geology

Andrew Jenkinson showed us the landscape and today's remaining features and areas where you can still see the large earthworks from the past. In some areas the water levels would be a barrier to an enemy and here there was no need for large earthworks. Any hilly upland acted similarly.

Friday 24th November 2017 John Lonergan - Canals and Railways in the Weald

John Lonergan from West Sussex Geological Society presented an historical as well as a geological view of the area called the Weald. Roads were not only hazardous for goods and people but sometimes impassable due to clay conditions. Canals and, later, railways were the solution. Focussing on the London & Brighton Railway, a route was drawn up cutting across the strike of the Cretaceous strata. The railway eventually reached Brighton on 21st September 1841. Permission had to be sought from Parliament; this was not always given and led to inevitable delays.

Friday 15th December 2017 Christmas rocks and nibbles

A few members enjoyed showing their specimens and eating mince pies. Local rocks showing ripples from the Upper Triassic of South Wales and fossil plants from the ORS were joined by schists from the Douro river in Portugal and shatter cones in granite from Santa Fe in New Mexico.

Friday 26th January 2018 Dr. Sue Hay – The lifestyle of an oceanic volcano

Sue initially defined the two main types of oceanic basalt and related them to their specific plate tectonic environments. She then developed her theme with an illustrated discussion of the structures and rock types seen in the lesser known Canary Islands of Fuerteventura, Lanzarote and Hierro.

Friday 23rd February 2018 Annual General Meeting and dinner at The Bunch of Carrots – Chris Fletcher welcomed members to the AGM.

Friday 23rd March 2018 Prof. Ian Fairchild – The start of the Cryogenian : "Let the Ice Age begin"

This talk was very interesting and showed how dates are defined for geological periods and the complexities of finding the actual precise area in the world for a geological 'Golden Spike'.

Saturday 24th March 2018 Croft Ambrey visit

Robert Williams and his Champions geo-conservation team organised a visit to Croft Ambrey which was very successful and showed what has been happening at Croft Castle and in the Fishpool Valley. During afternoon tea, members were able to inspect a copy of Roderick Impey Murchison's famous treatise on the 'Silurian System'.

Monday 26th March 2018 A Worcester Day viewing specimens in the archives with Rosemary Roden of Worcester Natural History and Arts Museum followed by a lunch and then a visit to Worcester Cathedral led by Dr. Paul Olver.

Saturday 21st April 2018 GEOLAB day for adult beginners in geology, organised by the Geologists' Association, which took place in the Village Hall, Martley. Prof. Chris King illuminated all to the wonders of geology and everybody enjoyed the practical workshop. This was followed by a geowalk to the 'Martley Rock' and the surrounding area.

Saturday 30th June 2018 Hergest Gardens visit

This visit is described elsewhere in this issue.

Sunday 5th August 2018 Woolhope Dome excursion

Rowland Eustace led a field trip to the Woolhope Dome which was joined by members of TVGS. The party saw the famous landslip known as 'The Wonder'. The weather was very good and lovely views were enjoyed across this Silurian landscape from the various limestone scarps.

Friday 28th September 2018 Dr. Bernard Besly of Besly Earth Science Ltd. – Unravelling the youngest Coal Measures: the Mamble coalfield in its regional context.

This talk explained in great detail the strata of various coal deposits and how each area differed. The last working mine in the Mamble coalfield was Hunthouse which closed in 1973. The high sulphur content coal was mined for drying pots. Names of the beds had become confused but boreholes from 1975 onwards had produced a series of accurate geophysical wireline measurements. More work still needs to be done even though Bernard has been working on the late Carboniferous since his doctorate days at Keele University.

Friday 26 October 2018 'Professor Fred Shotton'. Shotton's work was described by Prof. Peter Worsley of Reading Geological Society.

November 2018 No meeting

Geology Section programme for early 2019

Meetings will be held in the **Woolhope Room in Hereford Library**, Broad St., Hereford, at 6:00 p.m. for 6:30 to 8:00 meeting

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

Friday 22nd February 2019 Annual General Meeting at 6:30pm.at the Bunch of Carrots Inn at Hampton Bishop, Hereford, followed by dinner at 7:30.

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

The Formation and Evolution of the Abberley and Malvern Hills Geopark

by Peter Oliver

FOLLOWING a lengthy period of discussions and preparations amongst interested individuals, six organisations came together in 2003 to form the Abberley and Malvern Hills Geopark (AMHG). These members formed the first management committee which then set about developing a strategy for an area covering over 2500 square kilometres. With the new global interest in the geopark concept, the committee agreed to make an application to join the European Geopark Network (EGN). This application was successful and the Geopark was officially launched as a European Geopark in 2004. The event took place in Ledbury when many people attended a two-day festival to mark the occasion. A plaque marking the launch still resides in the Heritage Centre.

The Geopark's first president Professor Aubrey Manning (on the left) on the Malvern Hills with Les Morris in 2004.

The location and boundaries of the Geopark were based on two very significant geological and landscape criteria. Firstly the structural geology of the region and the resulting distribution of strata is based on the Malvern Axis - illustrated majestically by the great Eastern Boundary Fault which marks the western edge of the Worcester graben. Secondly and partly as a result of this structure, the middle line of the geopark marks the junction between lowland and upland Britain. And in this mix are some of the oldest rocks in England, the impressive valley and estuary of the River Severn, the Wyre Forest coalfield and some of the best fossiliferous limestones in Europe. Thus there exist considerable variations in topography and rock type, with all the interesting research and education around geomorphology and stratigraphy that follows. And, linked with all that, there are the impressive associated archaeology, social history and wildlife.

The launch of the Geopark Way long distance geology and landscape trail, in 2009 with Natalie Watkins, Gerry Calderbank and Professor David Dineley.

From the start AMHG was significantly different to other EGN geoparks, where the over-riding criterion for membership was one of economic development in deprived areas. EGN rules stipulate that a "European Geopark must be managed by a clearly defined structure able to enforce protection, enhancement and sustainable development policies within its territory.". Despite this rule, AMHG never sought to operate this way. The EGN model is a structure that most geoparks operate because they do not have the breadth of expertise and operation already in place. AMHG operates a very different model where there is already a wealth of large, long-standing, experienced, influential and strategic organisations; all across a wide range of geological and associated heritage.

This difference of approach plus the associated costs and bureaucracy resulting from EGN membership became a significant discussion matter amongst the Geopark members. In 2008 the partnership decided to withdraw from the EGN. Following this decision a firm new arrangement was developed in the form of a forum of organisations. Since 2008 the number of Forum members has steadily increased and some very successful partnership working has developed.

The vision is 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. This approach resulted in the GeoFest programme that started in 2010. Every year since, for the months of June, July and August, there has been a comprehensive programme of activities and events. Walks, talks, exhibitions, education and fun days, rock and fossil hunts and challenges and trails for all age groups have been provided. Tens of thousands of visitors are now participating in events across the disciplines and across the Geopark.

From 2010 onwards attention was turned to building on the successes by concentrating on the best ways to take the message to the public. The Geopark website - www.geopark.org.uk - now has an enormous amount of information available to search through. It is constantly updated as is the associated Facebook account. One of the main aims of these information delivery systems is to make available details of what each Geopark member is

The official opening of Huntley Quarry Geology Reserve in 2007. One of a few such reserves in the Geopark, this site is managed by Geopark member Gloucestershire Geology Trust.

doing, especially events that the public can attend. On the website a 'Calendar' lists all these throughout the year.

Another important development over the last few years has been the introduction of Geopark Visitor Information Points (GVIPs). The biggest of these is at Bewdley Museum where posters, specimens, an interactive touch screen, trails and exhibitions all provide an excellent visitor experience. The Geopark gets similar publicity at the GVIPs of Severn Valley Country Park, Forestry Commission Wyre Forest and Cob House Country Park. In addition, eleven members offer geology and landscape trails, many of them free.

There is a need for GVIPs in Herefordshire and Gloucestershire and hopefully the Woolhope Club will be able to encourage this. Another desirable change would be to bring the cathedrals at Hereford and Gloucester into the Forum. Worcester cathedral has been a member for many years and has furthered the story of geology with great success. As well as its building stones story, it is now incorporating geology into its education programme.

The principal participants at the launch meeting for the Geopark extension in Hereford, 2018. Jesse Norman MP – Susan Olver (Field Secretary – Woolhope Club) – Dr Bill Wilks (CEO: Merlin Energy) – Dr Paul Olver (President – Woolhope Club)- Dr Tony Loy (Chief Geologist: Merlin Energy) – Jean O'Donnell (Vice President – Woolhope Club) – John Payne (Woolhope Club) – Paul Hudson (Worcs Archive & Archaeology Service) and Gerry Calderbank (Vice Chairman, Geology Section Woolhope Club). (Photograph by Derek Foxton)

During 2017 and 2018 attention was turned to the extension of the Geopark further into Herefordshire. It had become clear over the years that an important area of geology had not been considered in 2003. This was put right at the launch of the extended Geopark in Hereford earlier this year. Now the Geopark includes the Woolhope Dome thus adding to the significant and internationally important Silurian geology that now resides within the Geopark. In addition the River Wye with all its geological history now marks the western boundary of the Geopark.

Also in 2018 two new organisations joined the Forum - the National Trust with its eleven venues across the Geopark, and the University of Birmingham School of Life and Environmental Sciences. This brings the number of members to eighteen and makes even more science and heritage available to the public. The potential for sharing and rolling out of joint initiatives on natural and man-made landscapes has increased further.

The American group of 'Women in Geoscience' visited the Geopark in 2018. Here they are with Geopark President Chris Darmon (seated centre row) at the Miners Memorial at the site of the old Highley Colliery in the Severn Valley Country Park.

Financing is always in the minds of the Forum members. Each member makes an annual contribution and one of the members, Merlin Energy of Ledbury, makes an extra annual donation to the Forum. Together these funds allow the Forum to engage the services of another member, Worcestershire Archive and Archaeology Service, who act as the administrative centre for the Geopark. From here the website and Facebook are maintained, GeoFest is organised, meetings and agendas are arranged and leaflets are distributed. Materials for use by members are housed at Bewdley Museum and include two pull up banners showing the new Geopark and its geology. There is also an informative port

Finally it is important to mention the President of the Geopark, Chris Darmon. He followed the first Geopark President, Aubrey Manning, some ten years ago. Chris has supported the Geopark in many ways. He visits each year, usually during GeoFest, and frequently places an article in his magazine 'Down to Earth'.

FEATURES OF THE GEOPARK EXTENSION

by Moira Jenkins

THE ABBERLEY and Malvern Hills Geopark follows the line of the Malvern axis from Bridgnorth to the Severn estuary and this year has been extended further into south-eastern Herefordshire to include Shucknall Hill, the Woolhope Dome, Ross-on-Wye, Penyard Park, Howle Hill and the east side of the Wye

Figure 1 Rudge End Quarry

Valley as far south as Goodrich. The Geopark extension adds an area researched by Victorian geologists in the early days of the Woolhope Club. It includes almost thirty designated Local Geological Sites (LGSs) and three geological Sites of Special Scientific Interest (SSSIs). There are representatives of most of the rocks of the marine Silurian laid down in warm tropical seas, followed by the Old Red Sandstone rocks deposited on an arid land surface after the joining of two tectonic plates. Special features new in the Geopark are the fine exposures of the well developed Woolhope Limestone and Downton Castle Sandstone and some spectacular Old Red Sandstone rocks, notably the Brownstones at Ross-on-Wye and the Quartz Conglomerate of the northern Forest of Dean. Geomorphological attractions are the Woolhope Dome with its landslips, and the meanders, both incised and abandoned, of the River Wye.

In the Woolhope area, Silurian rocks were folded up into the form of a dome. The resistant May Hill sandstones in Haugh Wood now form the highest land in the centre of the eroded dome and there are concentric ridges of limestones around this, separated by lower land on siltstones and shales which are more easily eroded. (Nearby Shucknall Hill is also an area of uplifted Silurian rocks.) The sandstones (Haugh Wood Beds) are not well exposed locally but are seen in a river cliff along the Pentaloe Brook. The sandstones, limestones and shales there are cut by a fault.

The May Hill sandstones are overlain by the Woolhope Limestone, for which this is the type area, being particularly well developed here. This may be seen in Rudge End Quarry, a nature reserve managed by Herefordshire Wildlife Trust. Rudge End Quarry is one of the Champions sites, part of the Earth Heritage Trust's Champions Project which involved local communities in looking after interesting sites and organising events to explain them to the general public. There is an information panel on the track above the quarry describing the geological features. The quarry shows a softer bentonite clay band, a layer of chemically altered volcanic ash, in a notch between the much harder limestone layers.

Figure 1 shows a fault cutting through the limestones, some of which are nodular. The upfolding of the dome caused a pattern of faults radiating from the centre like spokes of a bicycle wheel. Above this is the Coalbrookdale Formation, occuping a lowland area around the centre of the dome. There are some exposures in stream valleys. Around this is a ridge of Much Wenlock Limestone, which is highly fossiliferous in places as is the overlying Lower Ludlow Siltstone. Above them lies the Aymestry Limestone forming the distinctive Marcle Ridge in the east, on which the television transmitter is visible from miles away.

The Upper Ludlow Siltstone follows. Towards the top of this sequence the deposition was in shallow water and ripples can be seen in Prior's Frome Lane (Figure 2). Nearby, at Old Sufton, is a fine exposure of

Figure 2 Ripple marks at Prior's Frome

EDITOR'S COMMENTS

I am pleased to present this 15th issue of Earth Matters. All of the articles concern local geology and/or Section activities, with articles on the springs of the Malverns, the Geopark and its new extension, the work of the Champions group on the Croft Castle estate, section visits and the Open University Geological Society annual symposium. Some of the papers in the symposium dealt with the research at Martley Rock, which is work, with others, of WGS. The results of this research are expected to be published in two papers in the coming year.

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. Note that next year, Earth Matters will generally be distributed by e-mail; see the Chairman's Message.

Figure 3 Downton Castle Sandstone at Old Sufton

yellowish Downton Castle Sandstone (Figure 3), also deposited in very shallow water.

Above this there is a change to the first of the Old Red Sandstone rocks, laid down on a land surface from which the sea had withdrawn. These sandstones and mudstones are generally reddish in colour with occasional burrows of creatures which lived in the arid conditions.

Figure 4 Brownstones at Wilton Road, Ross-on-Wye

The cliffs by Wilton Road in Ross-on-Wye are a well known SSSI for geology, containing fine examples of the Lower Devonian Brownstones Formation showing current bedding (Figure 4) and lenses of sandstone infilling former river channels.

There are no Middle Devonian rocks locally as these were either never deposited or were eroded away. The Upper Devonian starts with the Quartz Conglomerate (now renamed the Huntsham Hill Conglomerate Formation), a flash flood deposit containing quartz and other pebbles eroded from the newly formed Welsh mountains and swept down into the lowlands after a storm. These rocks are found around Penyard Park and Chase Hills. Figure 5 shows a crag of Quartz Conglomerate in Penyard Park and the inset shows quartz and one jasper pebble in a sandy matrix. At Coppet Hill there is another Champions' site, with a splendid example of the Quartz Conglomerate. A booklet has been produced to explain the geological and other features.

Howle Hill has some rocks of the succeeding Carboniferous Period, including the Trenchard Formation with a small coal seam.

Figure 5 The Quartz Conglomerate in Penyard Park

The Geopark extension also includes one of the few igneous rocks found in Herefordshire, the dolerite dyke at Bartestree, which has been dated as Permian in age. Most of the dyke has now been quarried away.

Around the edge of the Woolhope Dome, the rock layers are dipping down the slope. The beds of limestone are in places separated by clay bands which are impervious to water percolating downwards. Slippage on these wet clay layers has taken place at many locations. Perton Quarry was closed for a few years after a land slip. Another example is the Wonder, near Much Marcle. On the evening of the 17th of February 1575, there was a massive landslip on Marcle Hill. This landslip, estimated at 60,000 cubic metres, took place over three days, taking with it full-grown trees, cattle and buildings. The results of this are still visible as hummocky ground. Figure 6 is taken from the landslipped material itself looking down the slope towards the slipped mound on the opposite side of the field below.

The River Wye shows both incised and abandoned meanders. That near Ross-on-Wye has both features. The river used to flow, in a meander at a much higher level than today, past Weston under Penyard and then to the south of Penyard Park and Chase Wood. Along this route it incised the present deep valley. Later, the Wye shortened its course by cutting through the neck of the meander. abandoning the incised valley which is now drained by a small brook.

Figure 6 View over the area of the Wonder landslip

Members of the WGS Committee

(December 2018)

Dr Chris Fletcher, ***Chairman***

Dr Paul Olver, ***Secretary***

Ian Porter, ***Treasurer and Membership Secretary***

Sue Olver, ***Programme Secretary***

Moira Jenkins, ***Section Recorder***

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

Don Evans, ***Minutes Secretary***

Gerry Calderbank, ***Geopark Representative***

Margaret Flint

H&W Earth Heritage Trust

THE Earth Heritage Trust has recently started to send each month a summary of its current programmes and other activities. These summaries are circulated to WGS members. In view of this there is now no need for a further summary in Earth Matters and so this is now discontinued.

However, one very important change in the EHT organisation took place at its AGM in May. This was the retirement of Chairman Sue Hay, who had served for about nine years, and her replacement by Professor Ian Fairchild. Ian retired recently from the School of Geography, Earth and Environmental Sciences of the University of Birmingham and continues there as Emeritus Professor.

Abberley and Malvern Hills Geopark and GeoFest

DURING the year the Geopark continued to be very active as a result of considerable input from the 18 member organisations of the Forum.

The significant event of the year was the extension of the Geopark further in to Herefordshire to include the Woolhope Dome, parts of the northern edge of the Forest of Dean, the Ross-on-Wye area and a new stretch of the River Wye; all have added much to the diversity of the Geopark. A well attended and dedicated launch event took place at Hereford Resource Centre; all made possible by generous support from Geopark members Woolhope Naturalists Field Club and Herefordshire Heritage Services.

Linked with this, two new maps were produced. Much help for the design and printing of these came from members Brooks Design and Geologists in the Geopark. Large pull-up banners of these two maps - one location and one geology - are now available for use by members. Collectively the Geopark is successfully promoting major programmes of conservation, education and tourism across geology, wildlife, archaeology, history and landscape.

One of the highlights of the year has been the presence of the National Trust as a new member. There is already work underway on new geological interpretation at three of the eleven NT sites in the Geopark. The University of Birmingham College of Life and Environmental Sciences also joined in October.

There was much going on in GeoFest which again ran throughout June, July and August. Visitors and participants to GeoFest events, temporary and permanent exhibitions and the general varied programmes of members must now add up to hundreds of thousands. On a national level the Geopark got much publicity from President Chris Darmon via his magazine Down to Earth. In addition to GeoFest members have provided hundreds of days of events and activities throughout the year covering wildlife, archaeology, history and geology. Some geological highlights were:

Severn Valley Country Park added the new maps to its Geopark Visitor Information Point (GVIP) and offered some well attended rock and fossil hunts during GeoFest.

The Forestry Commission at Wyre Forest is improving access, rock exposures and interpretation at its GeoChampions quarry.

Worcester Cathedral hosted two very well attended geology craft days in GeoFest.

Bodenham Arboretum upgraded its geology trail.

The Cappuccino Geology Trail is underway at the cafes of five Forum members.

Throughout the summer Worcestershire Archive and Archaeology Service put on a very well attended 'Lost Landscapes' exhibition.

Geologists in the Geopark provided six days of activities for Forum members in GeoFest.

Cob House Country Park extended its displays with new panels to create a mini-GVIP.

National Trust at Croome Estate began developing a self-led geology and buildings stones trail.

Malvern Hills GeoCentre which is also the Geopark Way Visitor Centre, continued with permanent Geopark displays and information.

Bewdley Museum completed the upgrade of its GVIP with an interactive touch screen and a great display of posters and specimens.

Peter Oliver,