Earth Matters

Newsletter of the geology section of the Woolhope Naturalists' Field Club

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The Club is an Affiliate Member of the Geologists' Association.

Editors Introduction

Conspiracy theorists, populists, politicians and scientists remain embattled on the world's stage and at various United Nations venues; whilst at the local level we continue to strive to understand how the earth's systems affect our own lives. On a day to day basis 2025 was yet another roller coaster of temperature and moisture extremes, and so I found myself pondering over how the climate, weather and geology interact and how we experience that in Herefordshire.

This is a two way process of course, our activities, the geomorphology that surrounds us and the weather patterns born near the equator, each play their part to deliver water. It can be a salutary experience to watch the daily heartbeat of the earth, pumping water around the globe due to the interplay of diurnal heating, albedo and rock thermodynamics in the tropics [https://www.youtube.com/watch?v=d54cM3d-Qbk].

All aspects of the historical development of Herefordshire and the Welsh Marches have been shaped by the availability or unwelcome arrival of water; the ability to establish settlements, farming and routing of transport networks has required new knowledge and technology to adapt to fast changing environments. Whilst acknowledging that these activities have also had unintended effects.

So, I thought that this year I might try to encourage authors to describe how the practical interaction between weather and geology expresses itself: To this end, John Lonergan has written up his talk on the Geology of Herefordshire's Railway system, this was given on the 24th October at a Friday Geology Meeting; I have written an article which summarises the Hydrogeology of Herefordshire and the Welsh Marches, Adrian Wyatt has drawn our attention towards the relationship between botany, rock type and critical soil moisture conditions taking Vipers Bugloss as an example. Looking further back to potentially understand the development of the landscape and life at a time when water was over abundant in the post glacial world of the Devensian, Kate Hughes has contributed a preçis on the subject of sedaDNA, never heard of it? read on. Whilst Moira has taken the subject of perception a step further, and describes how she provides geological field trips for the visually impaired and Sue Olver reports on a visit to see the Ashmolean Museum at Oxford.

There is no space here to go beyond a tiny scratch of the surface of the subject; but consider for a moment that the tectonic compression between the Asian and Indian Plates threw up the Himalaya Mountain Range only within in the last 50- 10 Ma https://www.geolsoc.org.uk/Plate-Tectonics/Chap3-Plate-Margins/Convergent/Continental-Collision.html

The resulting mass of rock became high enough to divert cold stratospheric air down into the lower atmosphere causing destabilisation over the hot seas of the Indian Ocean. The rising humid air is further heated over Africa, forming a 'river of air' which when it meets the Equatorial Atlantic currents then form into vigorous hurricanes. These travel towards the Caribbean and then due to the Coriolis effect, curve towards north east over the colder north Atlantic seas, generating trains of cyclonic activity,

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https://weather.metoffice.gov.uk/learn-about/weather/atmosphere/global-circulation-patterns which is why County Councils and the Environment Agency have strategic a flood resilience plans, but serendipitously Monmouth was flooded in December but Tenbury Wells escaped this time, to name just two practical outcomes.

We have yet further examples for you to consider in the talks and field trips for 2026 which are listed below.

Arthur Tingley

Geology Section Talks

Friday Evenings –Hereford Town Hall 18.00 to 20.00 hrs

6 January	The fate of ocean oxygenation in a warming world	Dr. Babette Hoogaker
20 February	Ice tipping points and the geological record	Dr. Claus Dieter Hillenbrand
20 March	Geology & Landscape of the Woolhope Dome	Dave Green

Woolhope Club Saturday Meetings 14.15 hrs

24 January -	'The ecology of the River Teme: a unique river'	Will Watson

Teme Valley Geological Society at Martley Village Hall 19.30 hrs

27th Apr	Ledbury Railway Cutting and the 'Passage Beds'	Rosie Watkin

At the time of going to press the field program for 2026 had not yet been finalised , however as this is the year of the 175th celebration the program is likely to be substantial. Please keep an eye on the Woolhope Club Website for up to date information.

https://www.woolhopeclub.org.uk/club

How geology influenced the railways of Herefordshire,

by John Lonergan

This talk was given on the 24th October 2025, to the Woolhope Naturalists Field Club and outlined the geological context, transport before the railways, then the development of the railways, and finally a comparison with the railways of the Weald, which were very different.

First the geological context, both bedrock and drift influenced the development of railways in Herefordshire. The landscape is dominated by the Old Red Sandstone formations—primarily the Raglan Mudstone [*Moors Cliff Fm]]*, St Maughans *[Freshwater West Fm*], and Brownstones formations. These sedimentary rocks, laid down during the Silurian and Devonian periods, vary in hardness and permeability, which directly influenced engineering decisions for railway construction. The Malvern Hills, Woolhope Dome, and glacial deposits from the Ice Age added further complexity. Glacial moraines and river diversions created hummocky terrain and unstable ground in some areas, requiring careful route planning and foundation engineering.

The impact on railway alignment of geology by the Old Red Sandstone, which influenced tunnel placement and embankment stability. In contrast glacial deposits often required reinforced foundations and more drainage. River terrace deposits affected bridge design and station siting. The two major civil engineering structures were for Dinmore Hill, which necessitated tunnelling to avoid steep gradients, and Ledbury Viaduct, brick built to span the River Leadon.

Transport in Herefordshire before the railways: "While the rich, clay soils of much of Herefordshire have been beneficial for agriculture they have in the past proved a hinderance to communication." (Herefordshire's Rocks and Scenery, ed. John Payne).

The roads were seasonal and slow, though improved by the Turnpike trusts from the 1780s, as the River Wye is fast flowing and liable to flooding. The canal age arrived in Herefordshire with the Kington, Leominster and Stourport Canal in 1796, which was an attempt to connect the limestone quarries at Kington with the Wyre Forest coalfield, via Leominster and then on to the River Severn. This canal system was never as successful as had been hoped and the arrival of the railways in the county signalled the end for this type of transport. In 1838 the Gloucester Canal was extended from Ledbury to Hereford, but again this never really got off the ground before the railways were developed.

Next were the tramroads, as from the 18th century coal was moved with horse drawn wagons along tramroads from collieries to the nearest canal, port or town. The railways of Herefordshire started with three of these tramroads. The first tramroad to open in Herefordshire was the Hay Railway, which opened in 1816 and was extended west in 1818, then the Kington Railway opened in 1820, which meant that Herefordshire was served by 36 miles of tramroad railway, bringing cheaper coal to West Herefordshire. In 1829 the tramroad from Abergavenny reached Hereford, linking the county with the coalfields of South Wales.

The coming of the railways included thirteen different lines – an unusually large number for one county. These faced most of the key railway challenges of the period and brought a new era for rural counties such as Herefordshire. Goods such as coal, iron and lime were now be brought in more cheaply, improving local improve industry, and goods such as corn, cattle and oak could be exported out, bringing increased wealth to the agriculture county.

All ended up owned or operated by three companies, the Great Western, L&NW and Midland Railways, then at grouping the Great Western and London, Midland and Scottish Railways. And while the thirteen lines are discussed below only in relation to their engineering or geology.

The Dinmore Tunnel on the Shrewsbury & Hereford Railway Company had twin bores, at slightly different

levels in, the first tunnel (currently the 'up' tunnel, required over 3.25 million bricks) was built in 1853, with the second tunnel (the 'down' tunnel) being added in 1891. The tunnel cuts through hard Old Red Sandstone, which provided stability but difficult excavation. These tunnels were recently upgraded for structural integrity and drainage.

The Hereford, Ross and Gloucester railway has four tunnels of 771, 540, 1210 and 110 yards long, and also four viaducts over the River Wye, originally timber on stone piers.

The Ledbury Viaduct on the Worcester & Hereford Railway, includes 31 arches, 280m long and 20m high, over the River Leadon. It was probably designed by Stephen Ballard; the contractors were Ballard and Thomas Brassey. The bricks were made by Robert Ballard on site from the clay dug out for the foundations.

During the digging of the railway cutting and tunnel at Ledbury in 1858–1860, a complete section from below the Aymestry Limestone to the Old Red Sandstone was exposed. Downtonian strata were exposed in the station yard and were actively collected during the digging of the tunnel and during the expansion of the station yard in 1898. At the time, this was regarded as the finest and most complete section through this group of rocks. Most of the route of the Woofferton and Tenbury Railway, ran along the disused canal bed of the Kington, Leominster and Stourport Canal, which had been intended to link up a route to the River Severn as well as the industrial Midlands.

The first section of the Leominster and Kington Railway, from Leominster to Pembridge, opened at a cost of £7,000 a mile. The Hereford, Hay-on-Wye and Brecon Railway reached the Three Cocks Junction on 19th September 1864, and the remainder of the line to Brecon had been taken over by different railway companies before construction had even begun.

The Ross and Monmouth Railway included stations and halts at Ross-on-Wye, Walford, Kerne Bridge, Lydbrook Junction and then out of Herefordshire to Symonds Yat and on to Monmouth. Kerne Bridge was a popular station for tourists wanting to visit Goodrich Castle, and Symonds Yat was a busy station a popular tourist and leisure area.

Three hundred navvies worked on the Kington and Presteigne railway, which involved steep gradients and twenty bridges, plus cuttings, culverts and embankments (and all within five miles). The worst setback suffered during the work on this line was the collapse of the Forge Crossing Bridge over the River Arrow in 1873, which was caused by heavy floodwater.

The Worcester, Bromyard and Leominster Railway cost £17,000 a mile and was worked by the Great Western Railway Company. The Kington and Eardisley railway used and adapted lengths of the old 3ft 6in horse-drawn tramway, which had at one time been intended to link up with the Hereford, Hay-on-Wye & Brecon Railway.

The Golden Valley railway was intended to create a route from Puntillas to Hay-on-Wye within the county boundaries, being promoted in an isolated area in the hope that it would lower the cost of goods. The River Dore had to be crossed and re-crossed several times. Notably, on Ledbury and Gloucester Railway, all the intermediate stations on this line were in Gloucestershire

There are many examples of local field trips, most by train, for example in The Excursionist's Guide to the Neighbourhood of Hereford" (1867) includes itineraries, geology, and railway routes.

By way of a comparison, the London to Brighton Railway, which was built earlier, in 1838-1841, required 6206 navvies, 960 horses and five locomotives for £2.63m – over £57k/mile (compare London & Birmingham £51k/mile) and heavily constrained by topography. Herefordshire was in the second and third generation of railways, and many lessons had been learnt.

This used part of the route of the Surrey Iron Railway and former canals and was constrained by

high ground transversely crossing the planned route (the North and South Downs, and the High Weald), and the low power of early locomotives (and opposing ideas on how to use that power, and confidence in how it would increase). It was built before the 1845 Railway mania, all to standard gauge, at a very high cost per mile, and the main traffic was from the termini. By good fortune the leisure and day trips unexpectedly developed, as this could never be a through route due to geography - there was little consolidation of the railways after construction.

In contrast, in Herefordshire, there was more extensive use of former tramway and canal routes, and the alignment was mainly constrained by rivers and flooding, not high ground. Their railways were developed after the railway mania of 1845 and mostly after banking crashes of 1860s, by this stage lessons had been learnt on the design of railways and the traffic to expect, and there was more confidence in locomotive technology and ability. As it was primarily rural, the construction cost per mile was lower, more typical. The railways were a mix of standard and broad gauge, with a planned largely of minerals and agriculture, and some became part of longer through routes for coal, etc. Again, there developed a significant tourist market, and from an early stage the lines were consolidating, all of the individual railways ended up as part of three major pregrouping companies

In conclusion the development of Railways in Herefordshire demonstrates the influence of geology, both in constraining routes and in exploiting and distributing resources, and in enabling the increase in knowledge from the excavations and tourism to the geological features, for example the incised meanders at Symonds Yat.

This area displays many of the key influences of railway development; building on past technologies, becoming part of future transport routes, with eternal optimism leading to increasing costs and construction durations – but leaving us with a system carrying more traffic and heavier trains than were ever imagined in the early nineteenth century.

The Ashmolean Museum OXFORD UNIVERSITY MUSEUM of NATURAL HISTORY[1]

https://oumnh.ox.ac.uk/learn-museum-highlights

Woolhope Club Visit 10 September 2025 by

Sue Olver,

[edited by ACT with additional material]

The Woolhope Club joined the Cheltenham Mineral and Geological Society on 10 November 2016 to visit the Oxford Natural History Museum Archives, where we were shown a wide range of exceptional fossils. This was my second trip to see the stores and each visit has brought a diverse range of material to see such as Italian marbles and ink sacks from Squids fossils plus how to catalogue and access the collections. All specimens in the store are now all digitised so it should eventually be possible to view the material remotely, although nothing beats seeing the real thing.

Twelve members of the Woolhope Club travelled by train or car from far flung places such as Clyro, Hereford and Froxfield Hampshire, meeting up at the Oxford Museum where we were welcomed by Dr. Emily Swaby the Assistant Collections Palaeontologist who was our guide.

After each of us giving a donation for the "Behind the Scenes" tour we followed Emily though down to the labyrinthine basement where the collections and archives are held. After a general introduction to the collections available and how they are collated then we went on to looking at specific specimens.

In the past fossil remains used to be collected without any of their surrounding material, and even without much reference to their precise

location or relationship with strata. A lot of material in museum boxes caused a lot of collation work because of this. However, in recent decades it is often the matrix or surrounding rock which can be dated by electron scanning and fluorescent microscopy to determine the most likely age of the fossil, with auxiliary material used to verify the analysis.

Some fossils had been put into wooden trays previously used for old fruit storage. this apparently has helped to preserve the fossils although why is a bit of a mystery ! On the other hand whilst processing the material, little details emerged such as finding a note on the bottom of a tray, written by Mary Anning, the famous great lady fossil 'fossiker'.

The impressive specimens that we were shown and handled by us include :

Emily Swaby introduced us to the oldest fossil specimen in the collection of a *Megalosaurus*, jaw which was handed around and *Megalosaurus* bones; These being as tall as the average height of a man in the 19th Century!

Dapedium politum, Lower Jurassic 200-198 m.y. Lower Lias from Lyme Regis

Ammonite *Phylloceras* collected by Buckland, Upper Lias from Whitby

Emily extended her tour to show us her favourite fossil fish in the Yorkshire fossils collection from the Whitby area . This fossil fish was collected by Miss E. Phillpot in Lyme Regis and identified as a new species by Agassiz, a geologist in 1834.

During lunch the party were looking out through the polished British rock columns to admire the exhibits below, and then afterwards we visited the ''Breaking Ground" Exhibition. This exhibit explained how the geologist William Buckland, and his wife Mary (nee Mary Morland)2 who became his palaeontological illustrator, and how they went on to become a famous couple in 19th Century due to their development of the scientific method and publications on fossils as described below.

Scientific description and naming of a new plant or animal requires a physical specimen, called a 'type specimen' which is used as a benchmark, that has to have a unique group of recognisable features, Although all *Megalosaurus* bones illustrated in the Buckland 1824 paper are referred to to as 'type series', it is only the dentary that exhibits the defining features of the animal. As *Megalosaurus* was the first dinosaur ever named, this Oxfordshire jawbone therefore represents the very start of global dinosaur science.

William Buckland and Mary Morland married in 1825 and both helped to establish new scientific methods and ideas. In 1824 William Buckland working with a French naturalist George Cuvier in Oxford published the first description of a *Megalosaurus* using Mary's notes and illustrations. The published pictures have similar bones to those of a modern reptile which hunts its prey in the fresh water area hence inferences can be made about the fossils' probable palaeoecology.

Mary and William Buckland visited Mary Anning at Lyme Regis who made a living from finding and selling specimens found around the Dorset area. She showed them the sample of Ichthyosaur with fish bones and scales still visible inside the ribcage, which proved this was a marine reptile. Also squid (cuttle fish) fossils with their ink sacs still attached; which incidentally was the same type of ink which had been used in describing and drawing the fossils.

On display was a plaster cast of *Archaeopteryx* from Upper Jurassic Solnhofen Limestone (152 – 146 m.y.) which exhibits features similar to modern birds with feathers and ability to perch.

This method of deduction laid down the foundations for modern science today , including the recent excavations of Rutland Ichthyosaur fossil of 10 metres long and fossil foot prints of *Temnodontosaurus trigonodon* (180 m.y.) in Anglian water Leicestershire.

A number of our members then went onto visit the Pitt Rivers Museum which is in the same building, founded in 1884 which houses over 500,000 objects from the collection of General Pitt-Rivers born as Henry Lane Fox 1827. He became a Grenadier Guard and collected rifles at first and inherited an estate of Pitt-Rivers in 1845. His passion for archaeology and travel was positively immense.

Both museums are well worth a visit and we were informed that in 2026 a special exhibition would set up to illustrate the Oxford area over geological time with a special focus on the Ice Age. Although a quick look at their web site shows a considerable amount of other material to see as well.

Readers might be interested in further reading

1 A story in stone, Nina Morgan in Geoscientist Winter 2022 https://geoscientist.online/wp-content/uploads/2022/11/GEO08_WINTER_2022_WEB.pdf page 32

2 See Distant Thunder – Beauty and Brains, Nina Morgan in Geoscientist Vol 29 No 4 2019 https://geoscientist.online/wp-content/uploads/2022/10/Geo_MAY2019_WR.pdf page 27

The Rutland Ichthyosaur

The Woolhope Stand at the Geologist's Association Festival of Geology – Burlington House London with Roz Raha in attendance

The hydrogeology of Herefordshire and the Welsh Marches

Arthur Tingley

Hydrology is the study of water flow over a surface or in pipes, whereas when water flows in the ground through granular and fissured rock this is the study of hydrogeology.

The visible water networks are the rivers and streams, but the invisible network is groundwater, which can only move where there is sufficient void capacity [porosity] between rock particles and connectivity [permeability] between grains or fissures. The velocity and direction of flow is related to the energy [hydraulic pressure] at a specific height [head]. In a flat lying equal granular rock; this would have a sub-horizontal flow direction down a gradient towards a river, at a speed called the seepage velocity.

However that is in the ideal case because generally speaking rock and soil is a very complicated medium so that flow is impeded by variable porosity, permeability, fissuring and gradients. Meaning that in a very fine grained granular material flow will be impeded whilst the hydraulic pressure may be high, but if pores are not connected there will be little flow. Whilst in clean open fissures considerable flow will result because there is less resistance. Complexity arises because the types of rock which exist in and around Herefordshire are very layered and imperfect, so the passage of water would be diverted along the flowlines of least resistance.

This layering of the soil and rock gives rise to a condition known as anisotropic flow where streamlines are is constrained to move in one direction. This type of lithology gives rise to perched water tables, and multiple spring lines where the less permeable rocks outcrop at surface. The opposite can also occur where vertical fissure flow occurs in otherwise dense relatively impermeable rock, which impedes horizontal flow.

Artesian flow in an aquifer occurs when the hydraulic pressure is greater than the confining pressure and so a vigorous 'upgradient' movement would exist, for instance where intercepted by a fissure or borehole.

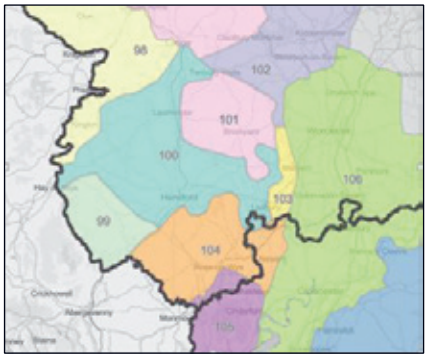
The depths to which all voids are filled with water under hydrostatic pressure is termed the saturated zone, and the upper boundary of that zone, where the pressure is zero, is the water table; [aka: phreatic surface or ground water level]. In granular rock the water table tends to loosely follow the geomorphology.

In the confinement of layered rock under artesian conditions, water can flow uphill, and emerge as a spring against an impermeable rock perhaps caused by a fault line. Where the water table reaches the surface a spring, stream or pond will arise, and where an otherwise dry valley exists there is the potential that after unusual amounts of rainwater recharge, the water table suddenly rises above ground level, and so an apparent 'flood', ford or bourn might appear.

Herefordshire and the Welsh Marches are characterised by a diverse landscape which has been classified by Nature England https://nationalcharacterareas.co.uk/ as -

- 98 Clun and North Herefordshire t
- 99 Black Mountains and Golden Valley
- 100 Herefordshire Lowlands
- 101 Herefordshire Plateau
- 102 Teme Valley
- 103 Malvern Hills
- 104 South Herefordshire and Over Seven

These characters are fundamentally based on the complex geological history including Precambrian, Ordovician, Silurian and Devonian strata overlain by



a patchwork of glacial deposits, which is well documented in Payne 2017. Dwr Cymru have created a water supply network, based upon eight supply zones covering Herefordshire

https://www.dwrcymru.com//media/Project/Files/digdat/HardnessData/2058H52

Based up on the hardness of the supply sources, it is apparent that water is extracted mainly from Boreholes in the East, where water is hard, and surface waters, including from Welsh reservoirs, in the West where the water is soft.

For the purposes of hydrogeology the source types of Herefordshire can be simplified in the following general terms:

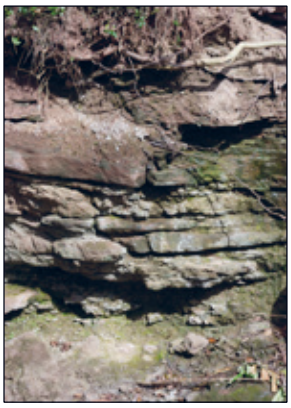
- Deep rock aquifers : In the east and central area the main water supply aquifers are hybrid granular- fracture rock zones of the Silurian and Devonian Sandstone, which are still known locally as the Old Red Sandstone, despite various re-namings by BGS. [*Earth Matters No 8 2018]*

- Shallow groundwater: Local groundwater flow occurs through the intensely fractured rock network, providing a source for local rural water supply via springs and boreholes. The extent is considerably more variable but best developed near the main fracture zones associated with fault complexes, but finding a sustainable supply of water is generally a hit and miss process.

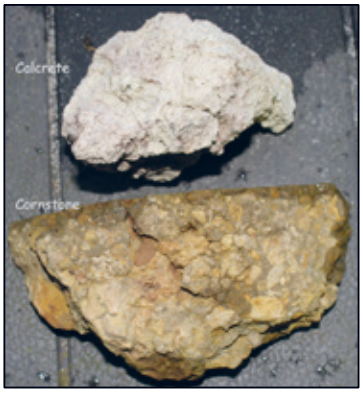
•Surface water, sources include streams and springs that contribute to the River Wye and Lugg formed by the interaction of topography and geology. Mostly this relates to recharge developed within the post-glacial sand and gravels deposits. This augments the larger quantity of water transported into the county from the various water catchment reservoirs of Mid Wales.

The majority of Herefordshire is underlain by The Old Red Sandstone, which would be better considered as a lithological 'super group' because the characteristics are similar [which is why it was so named in the first place], but subsequently reclassified using different criteria for international correlation.

However, taking a long view over the skyline of the County we see that the lower ground is made up of impersistent layers of siltstone, marls and thin sandstones, which is presently called the Freshwater West Formation [Silurian, Ludlovian],. Above this, forming the lower slopes and hill tops, including the Pyons, is the Devonian, Pridoli, Moor Cliffs Formation - consisting of thin mudstone, siltstone, with multiple thin calcrete layers and some thicker sandstone bands. The boundary between the Silurian and Devonian is marked by a very thin seam of the Bishops Frome Limestone; which at points of issue calcine rich water forms a tufa deposit such as might be seen around the base of Dinmore Hill and Southstone Rock. https://earthheritagetrust.org/southstone-post/



The Hydrogeological difference between the two types relies upon the degree of continuity [transmissivity] and depth to the saturated zone. The primary porosity is generally low, but because of heavy fracturing and jointing, permeability can be quite reasonable in the Freshwater West Formation [LORS], which at about 5 metres deep is usually within the saturated zone, whilst the strata of the Moor Cliffs Formation [UORS] are very variable, often within the phreatic or unsaturated zones, thus any permeability is very localised so



there are only small areas of perched water tables, often sitting on impermeable calcrete and cornstone horizons. [Photo 3] In many cases, in the hill and dale terrain of the Plateau land, there are stacked horizons of impermeable rock sandwiching the more fractured soft siltstone strata; this leads to multiple spring lines at different levels on the same hill and frequent semi-permanent ponds even at high level. [Cover Photo] The practical result is that high altitude water resources can exist, which has allowed remote settlements such as hill-forts and hamlets to develop, contributing to the National Characteristic of area 101 for instance.

In the upper valleys of the Rivers Wye and Lugg there are localised shallow water resources developed within the areas of post-glacial sand and gravel. These are considerably more porous and permeable than in the rock strata. However the residence of time of water in the stratum is low [ie fast flowing] and so resources are susceptible to drought, sudden recharge, sources of pollution and excavation. In the latter case for instance, stream straightening projects can accelerate surface water flow, which in turn would accelerate the drawdown of the water table, resulting in the sudden drying up of water-wells in the vicinity

In summary, this is a very simplified description of a complicated set of variables, the movement of water in rock has shaped the ability of people to settle and defend Herefordshire and the Welsh Marches, and continues to influence how the land may be used safely. Environmental changes have changed the availability of water over the past 8000 years since the last ice age, and this will continue to evolve but the groundwater response, whilst invisible, is very sensitive to those changes.

Reference materials used to write this article included: *John Payne [ed] 2017, Geology of Herefordshire; Hydrogeology of Wales, Robins and Davies, BGS report 2016; Frome Valley Discovery Guide HWEHT 2007*

Photos by ACT: 1 Waterfall at Pudleston formed on a Cornstone horizon; 2 Fractured sandstone and mudstone layers in Freshwater West Formation; 3 Hand specimens of Calcrete and Cornstone.

Evidence for the influence of geology on specific plant species

Adrian Wyatt

When many of the well-known quarries and rock exposures are disappearing under a camouflage blanket of brambles and saplings, it's nice to come across an exception where the overgrowing plants unwittingly help the geologist find what may be of interest!

As followers of a science subject we probably are all familiar with some of the indirect evidence used by our friends in Archaeology. After lengthy periods of drought, the position of the remains or site of building walls etc that lie close to the surface can readily be identified by the change in colour of the grass. Likewise the presence of non-porous rock close to the surface can be highlighted in a similar way. However, the difference in rock type can be further enhanced by the presence of certain types of flowering plant. An interesting example turned up for me recently when I had ascended to the top of a small hill on a walk in the southern Malverns and the striking scene of contrasting colour appeared before my eyes. In the centre of a large grass meadow there was the end of a narrow ridge, receding away, and this ridge was festooned with a drift of bright blue flowers. Noticeable, even at a distance, this was a spectacle to behold under the strong afternoon summer sunshine. Getting up close, the flower was identified as the Viper's Bugloss, *Ethium vulgare,* shown in full bloom in Fig.1. Figures 2 and 3 show the ridge and the swathe of blue flowers on it, in their prime last year.

Figure 1 Viper's Bugloss

Figure 2 The ridge

References are unanimous in stating that the plant thrives mainly in southern England, in sandy soil, on banks, walls, cliffs and is common on chalk grassland. This indicates that it thrives in thin, dry, well-drained soil. The fact that the plant is growing only on the raised ridge suggests that the drainage conditions differ to that on either side and in turn that either the soil depth varies or the proximity of solid rock is closer to the surface. Indeed the geology map of the area concurs with the evidence by showing that the ridge is a narrow intrusion of hard rock and that the surrounding rock is relatively soft with probably a deeper, clay-like soil layer above. The ridge in view is one of several north west to south east trending dykes that cut through two marine deposited mudstones (also called shales). The earlier, Cambrian Whiteleaved Oak Shale (Merioneth age, about 541 – 485 million years old) surrounds this dyke at outcrop but a swarm of other dykes and sills to the west have the later Ordovician Bronsil Shale (Tremadoc age, about 485 – 477 million years old) surrounding them at outcrop. The intrusive rock of the ridge has been identified as being a spilitic olivine diabase containing albite-oligoclase feldspar, chlorite and epidote with a few phenocrysts of oligoclase-andesine. The black Whiteleaved Oak Shale shows evidence of the 'bleaching' effect of heat where in contact with the dyke. Only a small area of the above rocks occur at outcrop here. A larger area of varied thickness may still be present below ground to the west and further south since these deposits accumulated during the early stages of the formation of the Welsh basin.

Figure 3

Figure 4

The occurrence of the Viper's Bugloss is unusual this far north and is the largest patch recorded in the area, according to the Malvern Field Club president, A. Bennett, in the 1930's. As a perennial the same plant has been seen often at this location since at least 1860, its unmissable features having been described in the notes published by a local vicar, the Reverend W. S. Symonds in the Transactions of the Malvern Field Club, during a field trip to the area.

The moral of the story is always be on the look-out whilst on field trips for subtle signs that may be of use to confirm the presence and extent of the hidden rock units shown on the geological map. Careful though, when exploring unknown areas without a geological map, you might find an undiscovered Roman road or the foundations of a Medieval building instead!

Postscript: Worryingly, on a visit to the same location in August this year there was no sign of the Viper's Bugloss anywhere to be seen; see Fig. 4 and compare with Fig. 2. The normal flowering period is mid-to late summer so it is strange for there to be nothing at all. Some varieties are biennial but is this the reason or are we seeing the onset of climate change here? There has been an extended period of drought this year and as noted above the location is on the extremity of the northern limit for this plant. Was this the last time to see this view? [*ed. We note that it was a hot dry year up until mid August, but then what happened, a deluge. So what will be the effect of that by next year ? We await an update*.]

Location: Eastnor Castle Estate, Eastnor, Herefordshire.

References:

BGS Memoir – Barclay, W. J., et al (1997), Worcester sheet 199

BGS Memoir – Worssam, B.C., et al (1989), Tewkesbury sheet 216

Abberley and Malvern Hills Geopark. Report for 2025

www.geopark.org.uk

by Andy Harrison and Peter Oliver.

The highlight of this year has been the continuing programme of creating Geopark Visitor Information Points (GVIPs). These are dedicated areas within the existing visitor centres of Geopark Forum members. A new GVIP was established at Severn Valley Country Park in Shropshire, adding to those already in existence at Bewdley Museum and Malvern Hills GeoÇentre. Each GVIP tells the story of the Geopark with particular reference to information about local landscape and history. A plan is underway to have a fourth one up and running at Forestry England's Wyre Forest within the next few months.

Funding for the Geopark was again generously provided by donations from Merlin Energy and Oracle Environmental Experts.

Throughout the year there were wide ranging programmes of events and activities provided by the Geopark members covering geology, landscape, wildlife, archaeology, heritage, science and art. The flagship event GeoFest, again ran over June, July and August with plenty of events and activities, all drawn from the summer programmes of members, enabling a very comprehensive GeoFest programme to be delivered.

Geopark President Chris Darmon commented: *I'm always amazed at how many events the Geopark puts on each year, I'm sure that with the 3-month GeoFest programme this is way more than any other UK Geopark. Remember that each event involves ordinary folk, individuals and families, who would otherwise probably have no other source of geological education.*

The Geopark has also pioneered innovative ways to include geological topics in craftwork and the arts generally which brings in people who would not profess to be in any way scientific. I have to say, "carry on and keep up the good work", it's really appreciated.

Reports from some of the 24 Geopark Forum Members:

The **Malvern Hills GeoCentre** has continued to operate throughout the year alongside Café H2O. On display are wall maps, iPad information, fossil samples, rock samples and the video wall showing information about the local and regional geology, geography and history. Fossil samples are on show alongside an example School Fossil Box. Information on long and short distance walks are available from the centre, including the 109 mile Geopark Way and the 80 mile Wyche Way. Plenty of shorter trails and walks near the centre provide good opportunities to explore the Hills, admire the views and walk to local villages in the valleys. The centre have also produced two interesting self-guided tours in collaboration with the Malvern Hills Area of Outstanding Natural Beauty and the Malvern Hills Conservators. The hidden geocache at the site remains popular, attracting treasure hunters as they explore the area. The small shop area continues to sell souvenirs, books and guides, including the popular geology series that accompanies sections of the Geopark Way.

At **Bewdley Museum** visitor numbers were131,662 between April to the end of September. Over the past couple of years our 'Currents of the Past' project has collected the photographs, film and oral histories of people whose lives were impacted by floods in Bewdley. These were displayed in an exhibition during the summer. Our annual Cherry Fair took place on 19/20 July and received just over 3000 visitors. Ask the Expert and Create our Own Geology Collection days on took place in July and these with other activities saw 674 children take part over the Summer holidays. To commemorate Jane Austin's 250-year anniversary the museum held a Georgian Weekend on 20/21 September, we hope for this to become a regular annual event.

At **Hartlebury Castle** it has been a pleasure to be a member of the Geopark Forum for the last twelve months. We've loved having a wide range of Geopark information boards on display in our Old Kitchen since September. Visitors have been learning about fossils, dinosaurs, wildlife and the local landscape, as well as following a fascinating Geology trail around the Castle.

Geology and Landscape Displays of Worcestershire County Museum at Hartlebury Castle.

Thanks to funding from Natural Networks this year, we were excited to be holding a community event in November to plant 6000 native wild bluebell, daffodil, wild garlic and snowdrop bulbs down the Castle driveway. We're looking forward to working with green-fingered members of the community and seeing the area transformed by colour in the spring. As always, we've enjoyed a jam-packed year of events, including several celebrating National Children's Gardening Week – such as a new May bank holiday event called 'What's in Your Garden' and a free community event where local families got stuck into discovering nature. We also put together a new 'Alice's Adventures in Wonderland Day' where the Castle team had fun dressing up and getting children engaged with the beloved story. During GeoFest, we saw a successful return of the Beer and Bat Walk, two well-attended summer theatre performances, and a thrilling Battle of Hartlebury re-enactment with The Sealed Knot. Everyone at the Castle looks forward to another year of celebrating the world around us – thank you to fellow Geopark Forum members for their support.

Geologists in the Geopark Group provides geological expertise, ideas and activities to other Forum members. All are provided free of charge. During GeoFest this year contributions included sessions based on geocrafts, 'Ask the Expert', make your own geology collection, specimen displays, detective trails, textile displays, colouring and information sheets, and table top panel displays. All this was supplied to seven fellow Forum members; sometimes as single day

events but also as longer sessions covering many weeks. Free Geopark information leaflets were made available at all locations. Specimens for 'Make your own geology collection' included pyrite (fools gold), gypsum, granite, oolitic limestone, red sandstone, grey sandstone, dolerite, slate, mica schist, quartz, ammonites and brachiopods. It has proved to be a very popular activity and hopefully has started a lot of young people on a quest to find out more.

One of the many locations in the Geopark which are described in various geology information leaflets. In this case the quayside at Arley on the River Severn; constructed with red Carboniferous Alveley Sandstone.

Worcestershire Archive and Archaeology Service Field team has been extremely busy! We recently finished 14 months of excavations at Broadway and continued uncovering 8000 years of human occupation. Tours and talks relating to the site are still proving very popular. We are also running a series of blogs and talks relating to the evidence found at the Southern Link Road site that shed light on the last battle of the English Civil War. We have taken part in the British Festival of Archaeology with storytelling and finds handling, focusing on the excavations at New Farm Nature Reserve, Evesham. In addition, we attended an event showcasing Archaeology at the

Blaise Museum, Bristol. It was great to meet so many people who were very interested in all aspects of Archaeology.

On the Explore the Past floor on level 2 of The Hive we were lucky to have an exhibition relating to the Worcestershire Hoard of coins. Many images have been put onto our interactive touch table and is still available to view. We currently have a display about St Martin's Quarter in Lowesmoor with a leaflet to accompany it available to pick up at the Hive. The cataloguing of the Sandys of Ombersley Archives is continuing a pace and the public events, for both adults and children, are proving very popular. We are working very hard to put our collections on our online catalogue making them easier to search for.

Forestry England at Wyre had the annual GeoFest visit by Geologists in the Geopark which was well received from start to finish. As usual, Forestry England staff helped us to set up the 'Geo-craft' activities and facilitated the running of the forest trail to the quarry. Many families stayed quite some time so that they could experience all of our arty activities. Children enjoyed getting messy, creating colourful wildlife themed artwork using paints, stencils and gel plates. Further fun was had, decorating larges pebbles and wooden discs, and colouring our geology themed sheets. Finally, the ever-popular stamping activity, saw people of all ages, getting busy making greetings cards, bookmarks and pieces of art to hang on walls.

At **Severn Valley Country Park** we secured the funding from Tomlinson Brown Trust to install a Geopark Visitor Information Point (GVIP). This year we were able to complete the project. The information point contains an informative interpretation panel with a hands-on collection of rocks, leaflets for the Geopark, Country Park Geology Trail and descriptions of the hands-on rock collection. We have also re-sited a monitor so that our 'A Changing Landscape' video can play. This shows the development of the landscape at Severn Valley Country Park from the Carboniferous Period to today.

Thank you to Brooks Designs for the use of his very eye-catching geology map of the Geopark. Thanks to Geologists in the Geopark for guidance with the text on the panel and also the provision of the hands-on rock collection. Our geologically themed textile art workshops continue to be popular. Once again, we were able to hold a summer exhibition on the visitor centre from the works completed by the ladies who

The new Geopark Visitor Information Point (GVIP) at the Severn Valley Country Park.

take part in the workshops. This year's theme was 'My Map'. The group found inspiration from the Park, where they live and other places they enjoy and stitched representations of places they love. Our school visits continue to go from strength to strength with our Rock and Fossil Hunt and River Study being among the most popular session for the children. We have recently looked at updating the river study by adding flow rate experiments.

Geological Society West Midlands Regional Group. Inaugurated at the Freemason's Tavern, Covent Garden, on 13 November 1807, the Geological Society of London (GSL), is the oldest geological society in the world and a registered not-for-profit charity. Today, from its base at Burlington House, Piccadilly, the Society acts as a leading voice in the geosciences for both industry and academia through publishing, library and information services, cutting-edge scientific conferences and training, education activities, and professional and academic accreditation. The Society also provides impartial

scientific information and evidence to support policy-making and public discussion about the challenges facing humanity.

The group covers all Society fellows living in post code areas within Birmingham and the Black Country, Herefordshire, Mid Wales, Shropshire, Staffordshire, Warwickshire and Worcestershire. Like all regional groups, WMRG organises scientific, technical, professional and social events locally. Professional matters are high on the group agendas and are an essential means of disseminating information and gathering opinion. Since joining the Geopark Forum in 2021, we have held stalls aimed at promoting the GSL and other local geological societies, in conjunction with other events. In 2025, we had a display at Bewdley Museum along with the 'Ask the Expert' and 'Make Your Own Geology Collection' team. We also had a display at the Severn Valley Railway Engine House, along with Georgia Jacobs - whose geologically inspired fabric artwork added to the steam locomotives on show. Once again, we managed to choose the weekend when the Engine House was holding its annual choir competition.

Sense Adventures geowalks on the Malvern Hills.

Moira Jenkins

Sense Adventures is a charity which gives visually impaired people the chance to take time out to explore the countryside in a safe and secure environment. The aim is to offer day activities and short breaks, in mixed groups, in a friendly and relaxed atmosphere. Each participant is accompanied by trained, one-to-one guides to assist for the duration of the activity. Founder Dee Jones is herself visually impaired and aims to offer the activities that she sought for herself, but could not find. https://www.senseadventures.co.uk/

Moira Jenkins has helped with two Sense Adventures walks in 2025 on the Malvern Hills.

To introduce the walkers to some of the varied rocks in the area, they were first given specimens of Precambrian Malverns Complex, Silurian limestones and Triassic sandstones to feel the differences between them.

Figure 1 shows the gathering before the walk where the participants had the chance to feel the differences between the rocks of the area.

Figure 2 shows a tray with examples of hard, heavy, crystalline Precambrian rocks of the Malvern Hills

The Malverns Complex rocks feel heavy and have sharp irregular edges. These rocks are Precambrian in age and cooled at depth from molten magma, with larger crystals where they cooled more slowly. The rocks, resistant to erosion, form the steep sided ridge.

Figure 3 shows a tray with the sedimentary Silurian rocks

Some of the Silurian rocks contain fossils including brachiopods and others contain trace fossils such as burrows. They were deposited in layers in tropical seas. These are the rocks which have been unfolded to the west of the hills, forming ridges and valleys.

Figure 4 Triassic sandstone

The third tray had specimens of the poorly cemented and easily eroded Triassic sandstone. The sand grains which have rubbed off the rock have collected in the tray. These sandstone and mudstone rocks underlie the low land to the east of the hills in the Severn Valley.

These very different rocks and their structure underlie and shape the very different scenery of the hills and the land to the west and east.

After meeting at Sally's Place, we all set off to walk around the ramparts of British Camp. Descriptions were given of the views along the walk. Some of the guides showed people how steep the ramparts are by helping them to climb up them for a few steps or to feel the slope with their sticks. The building of the ramparts required a huge effort of many people using only hand tools.

Figure 5. Moira described the scene as the group walked round the ramparts of British Camp. It is complicated to describe the features in a way to fully paint a picture of the scene for those who cannot see it. Sight is such an important sense to have.

The walkers have a range of sight problems. Some have lost peripheral vision, some can see blurred shapes, some can cope better in bright light, some in dim light and some are completely blind. Many travelled to Malvern by train and were met at the station. Some were given a lift by friends to the start of the walk. All appreciated the chance to get out on the hills in good company. They were given as much help as they needed.

We walked around the ramparts as far as the entrance to the hill fort and from there climbed to the summit of British Camp.

Figure 6. The picture below looking south from the summit of British Camp shows the group relaxing. The 2 guide dogs had a day off duty. It was a very sociable occasion where everyone had a chance to talk and get to know each other.

On the walk, the views on each side of the hills were described. The igneous rock of the ridge has been intruded along a major line of weakness in the Earth's crust as molten magma which crystallised as it cooled and has been pushed to the surface by numerous earth movements. To the west of the hills are the marine Silurian rocks, the layers of which have been folded as tectonic plates collided. Then there was a period of extension. There is a major fault, the east Malvern Fault, running down the east side of the hills. The land to the east has dropped by a total of 2,500 metres and with the smaller Inkberrow fault, forming the opposite side of a rift valley, a graben, in the Worcester Basin which is now the valley of the River Severn.

Then we descended from the hill fort heading south and walked as far as Clutters Cave to look at the pillow lavas, where submarine volcanoes erupted in an island arc. Moira described how British Camp had been thrust to the west out of line with the northern Malvern Hills. We returned along the east side of the hill above the reservoir.

After lunch at Sally's Place, we walked round Black Hill and visited Berington's / Little Malvern Quarry, quarried for road stone.

Each person with sight problems was able to hold the arm of their guide and was told where the ground was uneven and where there were steps. The route chosen kept to the main paths on the hills and was safe and enjoyable for all. There was a change of guides part way on the route which enabled the walkers to get to know more people. This is such a lovely event giving the chance for exercise in the fresh air in a beautiful part of the countryside. The people who come on these walks are amazing, finding ways to cope with all the difficulties that they encounter. They were interested to learn something about the geology of the Malvern area.

SedaDNA: Environmental DNA in the geological record

Kay Hughes

Geoscientist [1] *has introduced to the amateur geologist the new and important topic of Sedimentary DNA. The article, written by* ***Prof Tony Brown****, Professor in Physical Geography at the University of Southampton, is the basis of this brief summary. It provides further technical detail and references to primary sources.*

Environmental DNA

The way that scientists assess biodiversity has been transformed in recent years by sequencing of DNA from the environment. Living things shed fragments of tissues such as skin, hair, scales, faeces, urine, pollen. These leave a trace of their DNA that can now be analysed. Sequencing of DNA from the environment uses a variety of complex techniques that can now reveal the presence of numerous organisms of all shapes and sizes, including micro-organisms. This way of assessing species diversity is invaluable. Sampling from the environment is quick and easy and it causes little or no disturbance.

SedaDNA takes this to the next level

SedaDNA (or Sedimentary DNA) brings in the dimension of time. It is DNA that has been rapidly sequestered into sediment that is then preserved over hundreds, thousands or even a couple of million years. Analysis of this material, can reveal how species have evolved and can provide evidence of climate change, provided that the sediment itself can be dated. The method relies on geological dating techniques such as radio carbon, luminescence and amino acid racemization, as well as the fossil record and perhaps archaeological records too for the most recent deposits.

SedaDNA has other limitations though. Its occurrence is very much the exception, not the rule. DNA is typically destroyed within hours of its release from a living body, as it is consumed by ever-present bacteria. The conditions for sequestering and preserving DNA in sediment are very limited.

The mineral content of the sediment is crucial. DNA binds readily with some clays, particularly smectites, and can become trapped within them. Then it can be preserved over very long periods of time, but only under specific, stable conditions. Low temperature, low oxygen content, low moisture content, low acidity and minimal disturbance are all important in protecting this organic material. Such conditions can occur in quiescent lakes and sea beds as well as some land environments including some soils, caves and the middens created by human activity. The conditions can also be met in surprising circumstances. For example, SedaDNA, if present in the original sediment, has been found to preserved in thin section slides! Hence the vast archive of thin sections could hold a wealth of evidence just waiting to be discovered.

The DNA found in sediments consists of very short sequences, typically about 200 base pairs. This is tiny compared with the millions or billions of base pairs in complete genome sequences. The fragments are much smaller than the DNA found in 'fresh' environmental conditions, so different techniques are needed. These involve massive, number-crunching computer power to piece together the available fragments and find matches with the known sequences of 'genetic markers' that are specific to a genus or species. This method can therefore only find lifeforms whose genome sequences have already been decoded and held in DNA databases. Such records are very extensive and growing rapidly, both for extant and extinct lifeforms, although records for bacteria, archaea and viruses remain very limited.

How does SedaDNA contribute to Quaternary geology and archaeology?

When SedaDNA is used to build records of whole wildlife communities preserved over time, the paleogeography of a region can be better understood. Differences in the living populations of the time can show where and when water bodies were isolated, sea ice has encroached, or a community has been affected by chemical changes such as methane from gas hydrates. The evidence however is limited to very specific sediment types and much more can be learned when combined with evidence from other sources.

SedaDNA analysis can build on fossil evidence of all kinds, from massive vertebrates to pollen, foraminifera, algal mats and trace fossils. Fossils can be found in a greater variety of sediment types, they can provide information about the structure and behaviour of the whole organism and some can be used for full genome sequencing. When matched to the DNA in a sediment sequence this magnifies knowledge of the organism, its place in the environment and its evolution over time.

For example, the rare find of a mammoth in a peat bog can reveal much about the animal itself, including its genome sequence, but very little about the species distribution over space and time. Where SedaDNA is found to match this genome, it can reveal much more about where such mammoths had lived and over what time periods, as well as tracking its evolution history through small genome changes.

SedaDNA can also fill in entire gaps in the fossil record. A great many modern lifeforms have no hard parts that persist in the environment, and there may be no trace fossils either, but their DNA might be preserved in sediment. This DNA can be matched to a modern family, genus or species, and reveal much about how and under what conditions the lifeform has evolved. Soil health depends on many soft invertebrates and micro-organisms, and is an issue of great concern at present, so understanding how these lifeforms have evolved is a matter of much importance.

Archaeologists can also learn from SedaDNA. Ancient ports that have silted up over time can preserve DNA in their sediments, and reveal much about both the wildlife of the time and the human inhabitants. Caves and middens are often important features for ancient people and may provide the right conditions for DNA preservation.

Such evidence complements records from the physical items recorded in a dig, magnifying our understanding of the past.

In conclusion, SedaDNA is a valuable addition to the tool boxes of geologists, palaeontologists, palynologists and archaeologists, especially when the different specialists work closely together.

[1] https://geoscientist.online/wp-content/uploads/2025/08/Geoscientist_Autumn-2025.pdf page 28

Where have all the geologists gone ?

In the light of anecdotal evidence that the Earth Sciences are suffering a drop in student numbers, university places and job opportunities, The Geological Society carried out a survey in 2024 to establish some facts. The results were far from negative, succinctly stated:

- Some universities have withdrawn courses, but most others are adapting to modern needs for the broad scope of Geoscience subjects.
- Student numbers did dip around 2016- 2020 but have recovered to strong demand, about 1% of the total student population in the UK studying for a geoscience related degree. This is higher than in Europe, and much higher than in Germany for instance.
- Job opportunities are not obvious as specified skills are rarely matched by job title, but the demand for graduates is growing and pay is higher than average for a graduate, and considerably higher after 5 years
- Work in this sector is growing by around 5% per year, these roles being mostly in economically critical sectors.
- The Geological Society has produced a campaign called 'ThisIsGeoscience' to support teachers, students and the wider public to appreciate the scope of the Earth Sciences
- https://www.thisisgeoscience.com/home
- My favourite bit is https://www.thisisgeoscience.com/the-resources/careers-profiles
- And a competition for college students

Epilogue

At the Hay Festival this year my dear friend Jane bought Gareth Howell-Jones's delightful little book called 'Your Lowly Hedgehog Knows' for my birthday. The content took me by surprise but made me more relaxed as a result. It's not actually about hedgehogs as such, but a much wider concept. If I may be allowed to paraphrase; the concept is simple, that nature is just there, and is indifferent to whether I like it or not. Nature is not asking for my feedback like 'Trustpilot'. It is neutral to my existence, [not unlike humanity but which is considerably more transactional]. But whilst I am still here I had better enjoy it, and not damage it in the process, so " *Sta et considera miracula*, stand still quietly and consider the wonderous things".

So, in this spirit my admiration has increased for some samples of Silurian mudstone from Radnorshire, which show ripples and pits, patterns reminiscent of textile art. Which according to the 'Atlas of Microbial Mat features in sedimentary rocks' [Schreiber et. al. Elsevier 2007], are often indicative of the presence of bio-slimes which developed on an anoxic sea bed. The range of possible features is enormous from degassing pits to disturbed crusts, and stress ruffles just like those seen when blowing the surface of a cooling custard. They are useful evidence of specific environments and more abundant than body fossils in the right circumstances, but one has to be open to seeing them to find them.

So, how long could it be until we find evidence of biofilms having developed on surfaces on extra terrestrial bodies ? This is the most likely form of life that ought to have existed elsewhere in the solar system or even universe. The Precambrian on earth lasted for ~ 4000 Ma during which time microbial [including bacterial, fungal and algal forms] life developed, no doubt in the normal environments of the Paleoproterozoic they would have been thermophilic in anoxic conditions and perhaps hidden away from the photic zone. So what biochemical evidence would we need to look for to find such evidence? The building blocks for RNA and DNA perhaps ?

Well, talk about a long shot, NASA sent one mission OSIRIS-Rex [1] to chase down Asteroid Bennu in 2016 it got there in 2020, and has returned a sample to earth in 2023. New Scientist at Christmas reports [p17[that all the 'essential ingredients' to kick start life have been found in just one 121 g sample; including lyxose, xylose, arabinose, glucose and galactose, but not yet deoxyribose. The double helix consists of the ribose sugars in RNA and deoxyribose of DNA. [Oxygen, Nitrogen, Hydrogen, Carbon and Phosphorous presumably derived from the slow breakdown products of rock and gas, and recombined in solar heat.].

So, perhaps I am looking at this through 'the wrong end of the telescope', may be it is we who are the living fossils in a universe, which would consider us to be the extremophiles - exotica, living in a pressurised oxygen rich [therefore toxic] thin atmosphere, on an environmental refugium, which we call The Earth.

Time to go and feed Boume Boume, the hedgehog, who is quite likely to be arriving soon for his evening meal.

[1] https://www.manchester.ac.uk/about/news/manchester-scientist-helps-uncover-lifes-biggest-secrets-in-asteroid-bennu/

Cover Photograph

The foreground shows one of a number of plateau top spring fed ponds which form upon a perched water table, most likely underlain by a Cornstone layer within the Devonian- Freshwater West Formation. These would have provided potable water for Hill Fort communities, and subsequent smallholdings and hamlets, in this case at Wall Hill Thornbury ; https://www.themodernantiquarian.com/site/11677/wall-hills-thornbury . The background shows the Herefordshire Plateau to the west.