Buckinghamshire Geology Group

Newsletter No 37 July 2021

Fossils finds in Haddenham

Mystery shell from shingle

Clay from volcanoes

Dinosaurs in Aylesbury

Membership renewals now due

With April 1st now passed, payments for membership to 31st March 2022 are now due with the exception of new members who joined after 1st November 2020 whose membership automatically rolls over (see page 20 for details).

From the Editor

Every time I sit down to compile another edition of the newsletter, I am conscious of the line from our membership page that says '*membership is open to beginners and experts alike'.* As a group we aim to be all things to all geologists, from the time-served specialists to those first experiencing the excitement and awe of discovering an object that is simply mind-bendingly old. This is, however, far more easily said than done.

We endeavour to provide a range of events and talks that meet the varied experience levels of our membership. Likewise, I hope that the newsletter provides some articles of interest to beginners and others that lean towards the more experienced geologist (and not forgetting everyone in between). However, to achieve this we need your feedback. Let us know how we are doing. Are there any types of articles not currently provided that you would like to see? Suggestions for newsletter content are always welcome.

In addition to varying levels of geological experience I am also aware that members are interested in our geology for different reasons. Some are interested in the identification of fossils. Other want to know more about how our landscapes have formed. Some may come from a local history perspective, intrigued by the geology underlying local industries, past and present, or the different building stones used in Bucks. Local geology may also provide artistic inspiration for some members while many public artworks with a geological influence can be found across the county. It would be helpful to hear what excites you about geology with a view to reflecting these interests in future newsletter content.

And finally, while I am always looking for articles from members I am just as keen to receive questions. Let us know what is puzzling you about our local geology and we will try to find someone with the answers.

Mike Palmer

Dinosaurs come to Aylesbury

As this newsletter is going to 'press' a new exhibition has opened at the Discover Bucks Museum (the new name for Bucks County Museum). *Dinosaurs Uncovered* is a travelling exhibition featuring a large collection of dinosaur skeleton casts and other fossils. It runs from 26th June to 18th September. Work on the museum's new permanent galleries (see below) has meant that I have not been involved with this exhibition but I did manage to call in and take a few photographs.

Perhaps one of our members may be able to provide a review for the next newsletter. More information on opening times and admission charges are available on at website at www.buckscountymuseum.org

Mike Palmer

New Geology gallery coming to Bucks County Museum

For the last two years plans for the County Museum's new permanent displays have been progressing. The previous *Touch of Bucks* galleries has been welcoming visitors for over a quarter of a century and so it is certainly time for a change. The new approach involves creating five linked but self-contained galleries comprising *Discover Bucks Geology, Discover Bucks Archaeology, Discover Bucks People, Discover Bucks Art* and *Discover Bucks Wildlife*. The first four are scheduled to open in early September while the wildlife gallery will open later towards the end of October.

Discover Bucks Geology will be the first of the new galleries to be encountered by visitors. The *Rocks and Minerals* case will feature a 1.9m tall simplified stratigraphic column made up of specially collected blocks of local rock from around the county. This will be complemented by examples of local minerals and artefacts related to these strata. A nearby, interactive wall projection will allow visitors to further explore our underlying geology.

The next three cases focus on our Jurassic and Cretaceous fossil fauna. The question of why so few dinosaur fossils have been found in Bucks is addressed in a small case featuring the enigmatic fossil claw found in in Aylesbury by a local resident in 1996.

The fossil sauropod claw from Aylesbury's mystery dinosaur

We know that the claw comes from a sauropod dinosaur (four legs, long neck, long tail, eats plants) courtesy of a visiting American dinosaur expert, Jack Horner. But as to which type it is difficult to say. We know that Cetiosaurs have been found in north Bucks (Clifton Reynes) and neighbouring Oxfordshire but the find location for this claw post-dates their presence. I provided images and details of the claw and its find location to the Natural History Museum's Professor Paul Barrett in the hope of linking it to other finds of similar age at the end of the Kimmeridgian but unfortunately no corroborating specimens are currently known and so, for the time being, the claw will remain the sole find of Aylesbury's mystery dinosaur.

The large *Prehistoric Seas* case aims to introduce visitors to the range of Buckinghamshire's Jurassic and Cretaceous marine fossils. Specimens will be arranged by broad groupings - ammonites, belemnites, sea urchins, etc., enabling visitors explore both the commonality and variation within each group. Evidence for some of Buckinghamshire's marine reptiles - ichthyosaurs and plesiosaurs and marine crocodiles - is also included here.

Mick Oates and son at Watermead Pliosaur, 1987

Pliosaurs, and in particular, the Watermead Pliosaur (excavated in 1987 under the Mick Oates' supervision) features in a neighbouring case. We had hoped to partially recreate the excavation in floor-embedded cases but unfortunately the underlying supporting steel structure didn't provide sufficient subfloor depth for this. A selection of fossils from the 1987 excavation along with pliosaur material from elsewhere in the county are displayed in the case set against a backdrop of a large drawing of a pliosaur swimming across the floor and up into the case.

Installing case backings and floor for the new Discover Bucks Geology gallery

Crossing over to the other side of the gallery visitors will be able to discover more about the assorted Ice Age mammals that lived in Bucks over the last 200,000 years through the numerous fossils that have been discovered in the county.

The *Ice Age Giants* case features evidence for three prehistoric 'elephants' excavated from a former chalk quarry near Tring (Pitstone Quarry No 3) and now better known as College Lake nature reserve. Fossil evidence shows that 200,000 years ago both Woolly Mammoths and Steppe Mammoths lived in Bucks while a rather unassuming fossil (a magnum bone) indicates the additional presence of the Straight-tusked Elephant. I had hoped to use one of the three molars in the collections listed, according to their labels, as belonging to this species but consultation with mammoth expert, Prof. Adrian Lister of the Natural History Museum led to these being redetermined as far more recent Asian elephant molars, presumably from ex-circus animals.

The accompanying *Ice Age Mammals* case will display the fossil evidence that provides clues to what other species inhabited our Ice Age environments including Woolly Rhino, Giant Deer and Brown Bear along with the possibly more surprising Hippo, Steppe Lion and Spotted Hyena. This varied range of animals really serves to underline how much the climate varied over the course of the Ice Age.

An early graphic showing the life-size drawing of a Steppe Lion with the lion jaw fossil from College Lake superimposed over it. Other fossil arrangements have changed

Three of the cases will include screens (as shown above) with rolling images to relate the often fragmentary fossil remains to how the animals would have appeared when alive. The *Ice Age Giants* screen will also hopefully feature images of College Lake from the current nature reserve through its Pitstone Cement Works incarnation 40 plus years ago and back into its two mammal-rich ice age episodes 120,000 and 200,000 years ago.

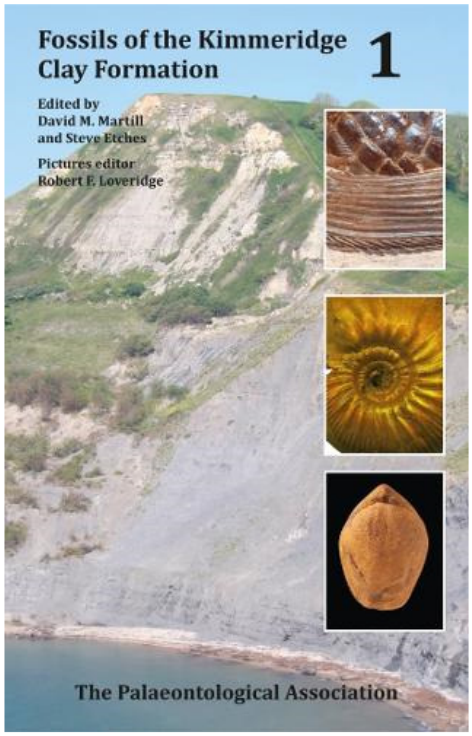
A final Ice Age mammal, our evolutionary cousin, the Neanderthal, will feature as a life-size, wall-mounted drawing holding a real Palaeolithic hand axe in one hand and a cast of a 90cm long mammoth limb bone in the other (the real bone being displayed in the *Ice Age Giants* case). Alongside is another life-size drawing of an aurochs, the 1.8m tall ancestor of our modern cattle, complete with a cast of a pair of horns

found at Colnbrook. A measuring scale will enable visitors to see how they measure up to our Ice Age past.

All being well we should be able to include photos of the finished gallery in the next newsletter.

Mike Palmer

Kimmeridge Clay books published



Kimmeridge is a small village on the Dorset coast, however, the eponymous clay found there also extends far to the north-east through Bucks and represents one of the major strata underlying Aylesbury Vale. Fossils found in the Kimmeridge Clay are also much in evidence in the Bucks County Museum's geology store. Here, small to medium-sized fossil specimens are stored in 200 drawers. Of these, 50 are occupied by Kimmeridge Clay fossils, representing by far the largest proportion for any locally occurring stratum. And so, a new publication providing up-to-date names, images and information for this important geological formation is to be welcomed.

Fossils of the Kimmeridge Clay Formation is the latest title to be published by the Palaeontological Association. A quick look at their website's publications page (see www.palass.org/publications/field-guides-fossils) lists it as number 16 in a series of fossil field guides. Other titles of interest to Buckinghamshire fossil hunters include

- No. 2 - *Fossils of the Chalk*
- No. 4 - *Fossils of the Oxford Clay*
- No. 12 - *Fossils of the Gault Clay*

Unlike earlier titles, *Fossils of the Kimmeridge Clay Formation* is divided into two volumes. The larger Volume 1 includes the introduction, a geological overview and accounts of the invertebrate fossils while the slimmer volume 2 covers vertebrate fossil, primarily fish and marine reptiles along with a few dinosaurs and pterosaurs.

While these books are not necessarily for the beginner, they do represent the next step for the confirmed amateur enthusiast providing both an overview of the Kimmeridge Clay and the only readily available account of its fossils.

I'm now hoping for a future volume covering the fossils of the Portland and Purbeck formations. One day perhaps.

Mike Palmer

Recent finds

Mystery shell in the shingle

The following photographs were recently sent in by an enquirer showing an internal and external view of a shell-like object found in shingle and described as being around the size of a penny. The enquirer was particularly intrigued by the elaborate pattern of the internal structure that didn't seem to match any of the more common seashells. So, what exactly is it?

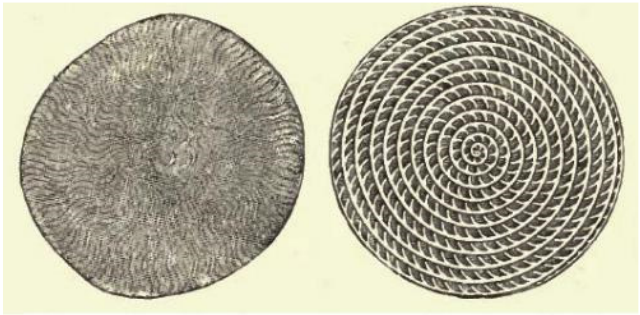
Committee member Mick Oates identified it as belonging to the Nummulites, a large group of marine shells.

The vast majority of seashells we encounter on the beach such as mussels, cockles and winkles are molluscs (related to the snails found in gardens). Nummulites, however, are not molluscs, instead belonging to an often overlooked group of organisms, the foraminifera.

Foraminifera are single-celled sea creatures that have been around since the beginning of the Cambrian period 570 million years ago. They are characterised by their shells which become fossilised. As single-celled organisms their shells are usually very small.

Nummulites, on the other hand, are known to get larger with *Nummulites laevigatus* reaching diameters of 1.8cm. They first appeared in the Cretaceous 145 million years ago with species still present today albeit not very common. It is interesting that the enquirer described the shell as being around the size of a penny as the name, Nummulites is derived from the Latin, *nummulus*, meaning 'little coin'.

Foraminifera are able to increase their size by adding extra chambers to their shells. Nummuilites do this in a flat spiral (planispiral) arrangement as shown below.



A Nummulite viewed from above and horizontally sectioned showing the planispiral arrangement

Most foraminifera have a single nucleus, however, Nummulites have many nuclei with cytoplasm spreading through the tiny chambers. They also share their shell with photosynthesising algae which aid the production of calcium carbonate, essential for making and extending the shell.

Unfortunately, no further information has been forthcoming from the enquirer and so we don't know exactly where this find came from beyond the fact they were found in shingle. Mick Oates spotted a page in David Bone's 2016 guide to *The Geology and Fossils of Bracklesham and Selsey* that described them as *'probably the commonest fossil on the beach at Bracklesham'* (on the south coast to the west of Selsey Bill) where they *'wash up, having been eroded from offshore fossil beds.'* Bracklesham's notoriety as a place for finding Nummulites is also mentioned on a page of the UK Fossils website (see www.ukfossils.co.uk/2012/01/24/bracklesham-bay).

As for the fossils age, Mick notes *'the sheer size of it suggests a Middle Eocene age'* circa 40 million years ago.

Mike Palmer

Recent finds

Fossil haul in Haddenham

While out on a recent litter pick in Haddenham (by the track between the train line and the new Cala homes development), budding geologist, 7 year old Aria, came across something far more interesting than the expected empty cans and crisp packets – an imprint of a sea creature that lived here millions of years ago. Mum, Lynsey, took to the internet and found a match with a fossil seashell called *Laevitrigonia gibbosa*.

Aria and Luna with the unexpected litter pick find

On seeing a photograph of the fossil, Bucks Geology Group committee member, Mick Oates, agreed that this could well be *Laevitrigonia gibbosa* but noted that there is another, more elongated relative called *Myophorella,* which is a little larger, more elongate and with slightly stronger ornamentation but *'without seeing the outline of the complete shell, I'd not be confident enough to suggest which one it is'*. Mick also suggested that to get a better idea of what the actual shell that made this prehistoric imprint looked like try *'impressing a piece of plasticine into your fossil'* (a useful suggestion for our next Rock & Fossil Day at the Museum).

As for its age, Mick was able to place it in the Portland Limestone. *'This underlies a lot of Haddenham and also parts of Aylesbury. I used to dig up a lot of fossils of exactly the same age in my old school garden in Walton Street, Aylesbury, nearly 60 years ago. This means that your bivalve was alive some 149 million years ago, when what is now Britain enjoyed a much warmer climate than today'*.

Mick also produced a helpful photo-compilation of some of the more common Portland Limestone fossils likely to be found in the Haddenham / Aylesbury area based on his own collection adding *'you are lucky to be living in quite a good place for finding these Portland Limestone shells, where they weather up into the soil*.

'That tiny Pleurotomaria (lower left) was my best fossil when I was 11 years old! You will notice that most of them are now the casts of the inside of the shell, because the 'Mother of Pearl' has dissolved. Shells made of the more robust Calcite (such as the oysters and clams) tend to retain the original shell material.

Taking up the challenge Lynsey, Aria & Luna returned to the site and found several more fossil bivalves including three *Protocardia dissimilis,* a *Camptonectes lamellosus* and another *Laevitrigonia* cast along with some ammonites as shown below.

Luna with ammonite find from second visit

Commenting on the ammonite fossil above Mick said that '*it might be Crendonites sp but is more likely to be an immature Titanites* or *Galbanites. A fossil in such complete condition is really quite rare. If you are really lucky, you might manage to acquire a fully grown Titanites. The fossil below was found in the grounds of Stone House (just down the Bishopstone Road). It is 65cm wide and took three adults to lift into a wheelbarrow only for the wheelbarrow to then break under the weight'.*

Massive Titanites (65cm wide) from the grounds of Stone House, mid 1960s

'If Aria is really interested in geology, then you could do no better than enrol her in Rockwatch, the nationwide club for keen young potential geologists. It is run by the Geologists' Association (of which I am currently a vice president). I have helped to organise Rockwatch activities since its inception in 1992 and I think you would find it just right for your daughter. The website is: https://www.rockwatch.org.uk/'

Sound advice. I wonder what fossils will turn up next.

Mike Palmer
with thanks to Mick Oates

Where can I find fossils in Bucks?

One of the commonest enquires sent into the Bucks Geology Group usually starts along the lines of *'My son / daughter / grandson / granddaughter is really interested in fossils. Where can we find fossils in Buckinghamshire?'*

In some parts of Britain such as the Dorset or North Yorkshire coast, the answer to this question would be easy. There, the fossil-rich coastal rocks are repeatedly battered by the sea, releasing a steady supply of fossils on to the shore. Unfortunately, Buckinghamshire is over 70 miles away from the sea. There are plenty of fossils beneath our feet, they just don't come to the surface that often.

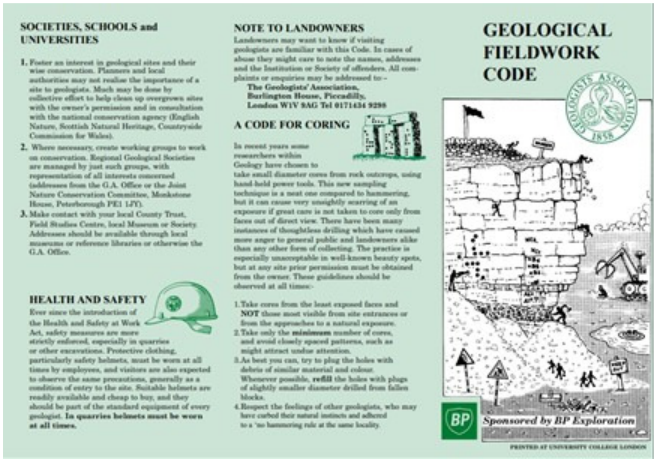
Away from the coast, some of the best fossil collecting areas are working and abandoned quarries. These days, however, it is far harder to gain permission to access working quarries while many abandoned quarries have either been all-collected-out, or worse, used for landfill.

But fossils are found in Buckinghamshire, as this newsletter can attest. In recent issues I have included images of the fossils that have been sent in for identification. One lucky person even found a marine crocodile vertebra recently (see Newsletter Nº 34, March 2020 (www.bucksgeology.org.uk/newsletter.html). It has to be said, however, that these finds are usually found by people just out for a walk, metal detecting or digging a pond, rather than a dedicated fossil hunt. But, with a bit of knowledge, you can increase your chances of finding fossils.

First, however, it is important to be aware of some '*dos and don'ts'*. Ensure that you take all necessary health and safety precautions. Quarries, holes in the ground and other rock exposures can be dangerous places. Make sure that you have permission to be there and always wear a helmet when working close to tall rock faces.

Collecting fossils from loose rocks on the ground is fine, as is collecting from temporary rock faces such as in working quarries (with permission). However, please **do not attempt to chisel fossils out of permanent rock faces**, such as those found in Local Geological Sites (LGSs) and other designated sites. These represent a geological learning resource for everyone to share and so, should be left *in situ*. Fossils may be found in the walls of buildings. Again, **no attempt should be made to remove fossils from the walls of buildings** as this represents criminal damage as well as the loss of further geological learning resources.

Further information and advice can be found in the Geologists' Association's *A Code for Geological Fieldwork* available on our website at www.bucksgeology.org.uk/pdf_files/GA_geological_field_work_code.pdf. With this understood, here are some tips to increase your chance of finding fossils in and around Bucks.


SOCIETIES, SCHOOLS and UNIVERSITIES

1. Foster an interest in geological sites and their wise conservation. Planners and local authorities may not realise the importance of a site to geologists. Much may be done by collective effort to help clean up overgrown sites with the owner's permission and in consultation with the national conservation agency (English Nature, Scottish Natural Heritage, Countryside Commission for Wales).
2. Where necessary, create working groups to work on conservation. Regional Geological Societies are managed by just such groups, with representation of all interests concerned (addresses from the G.A. Office or the Joint Nature Conservation Committee, Monkstone House, Peterborough PE1 1JY).
3. Make contact with your local County Trust, Field Studies Centre, local Museum or Society. Addresses should be available through local museums or reference libraries or otherwise the G.A. Office.

HEALTH AND SAFETY

Ever since the introduction of the Health and Safety at Work Act, safety measures are more strictly enforced, especially in quarries or other excavations. Protective clothing, particularly safety helmets, must be worn at all times by employees, and visitors are also expected to observe the same precautions, generally as a condition of entry to the site. Suitable helmets are readily available and cheap to buy, and they should be part of the standard equipment of every geologist. **In quarries helmets must be worn at all times.**

NOTE TO LANDOWNERS

Landowners may want to know if visiting geologists are familiar with this Code. In cases of abuse they might care to note the names, addresses and the Institution or Society of offenders. All complaints or enquiries may be addressed to:-

The Geologists' Association, Burlington House, Piccadilly, London W1V 9AG Tel 0171434 9298

A CODE FOR CORING

In recent years some researchers within Geology have chosen to take small diameter cores from rock outcrops, using hand-held power tools. This new sampling technique is a neat one compared to hammering, but it can cause very unsightly scarring of an exposure if great care is not taken to core only from faces out of direct view. There have been many instances of thoughtless drilling which have caused more anger to general public and landowners alike than any other form of collecting. The practice is especially unacceptable in well-known beauty spots, but at any site prior permission must be obtained from the owner. These guidelines should be observed at all times:-

1. Take cores from the least exposed faces and **NOT** those most visible from site entrances or from the approaches to a natural exposure.
2. Take only the **minimum** number of cores, and avoid closely spaced patterns, such as might attract undue attention.
3. As best you can, try to plug the holes with debris of similar material and colour. Whenever possible, **refill** the holes with plugs of slightly smaller diameter drilled from fallen blocks.
4. Respect the feelings of other geologists, who may have curbed their natural instincts and adhered to a 'no hammering rule at the same locality.

GEOLOGICAL FIELDWORK CODE

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Join a group

Local groups, such as ours, have local knowledge which they can share with members on field meetings. Not all meetings are based on fossil collecting but those involving access to quarries are certainly likely to increase your chance of finding fossils. And you are far more likely to gain access to a quarry as the member of a geological group. Look at Newsletter Nº 34, March 2020 (www.bucksgeology.org.uk/newsletter.html) to see the range of fossils collected during last year's quarry visits.

Join Rockwatch

If you have a child or grandchild who is interested in fossils and geology, Rockwatch is a nationwide geology club for children. Visit www.rockwatch.org.uk for more information.

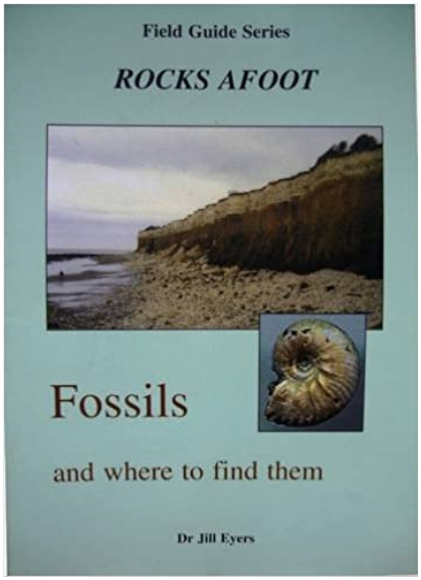
Understand your local geology

Some rocks are more likely to release fossils than others. For example, the Portland Limestone can be particularly rich in fossils, including ammonites, gastropods and bivalves, especially on the mid vale hilltops. Chalk may reveal sponges and fossil sea urchins. With this in mind, look for footpaths that cross ploughed fields, where you might strike lucky. Areas of glacial till in the norther half of the county may also reveal a range of fossils brought from afar by prehistoric ice sheets. For more information of the rock types found in Buckinghamshire and the fossils that can be found in them, click on the *'Bucks Geology'* tab on our website (http://www.bucksgeology.org.uk).

To view what rocks occur where in Bucks (and Britain), try the British Geological Survey's *Geology of Britain Viewer* (https://mapapps.bgs.ac.uk/geologyofbritain/home.html) that allows you to select and zoom in on any location in Britain to see what the underlying geology is.

Similarly, where large scale groundworks have taken place in the last few years, such as housing developments or other building works, fossils may have been disturbed and lurk on or in the soil for several years after. Please do not explore active building sites as these can be extremely dangerous. Spoil heaps, from drainage works and other excavations may be a source of fossils

Go further afield



If collecting fossils is your main aim you may need to expand your search beyond the county borders. *Fossils and where to find them* in Jill Eyers' *Rocks Afoot* series is a small booklet packed full of fossil collecting localities in England arranged by counties. Copies are available from Jill at £4.50 (including postage and packing) Contact Jill at bucksgeologygroup@gmail.com for more details.

Moving on-line, www.ukfossils.co.uk provides further information of UK fossil collecting sites.

Also, keep an eye on our events programme as we try to include one or two out-of-county trips each year. Recent field meetings have included trips to the Dorset coast, Bath and North Lincolnshire.

Think outside the box
Fossils can turn up in places you don't expect them. Gravel found on drives often comes from natural accumulations deposited by ice age rivers collected from further afield. Small fossils such as devil's toenails, *Gryphaea* sp. may sometimes be found here. Please take care if the gravel drive you are exploring is used by cars.

Other unexpected places include charity shops where fossils may occasionally turn up. One lucky customer came across part of a mammoth's tusk in an Aylesbury charity shop a few years ago (see Newsletter Nº 24, April 2014). Antiques shops may also have fossils for sale. Similarly, Museum gift shops often sell fossils.

What about looking for minerals in Bucks?
Buckinghamshire's rocks are all sedimentary, having formed from mud, sand and limestone laid down in prehistoric seas and ancient rivers. As a result, Buckinghamshire is not as rich in minerals compared to other parts of the UK with a more igneous or metamorphic past, e.g. Cornwall, the Lake District and parts of Wales and Scotland. But that does not mean that there are none to be found. Quartz and chalcedony may turn up inside flint nodules that can be found in chalky areas. Round balls of Marcasite may also occur in the chalk while crystals of selenite may be found in the clays of Aylesbury Vale.

As for actually finding them, all the previously mentioned advice for finding fossils applies for minerals as well. Happy hunting and let us know if you find anything.

Mike Palmer

The Volcanic origins of Fullers Earth

Reading the write-up of Jill Eyers' Zoom talk on volcanoes in the last edition of the newsletter reminded me of a local link with volcanoes from the Buckinghamshire / Bedfordshire border.

As the Cretaceous sea advanced across Britain it reunited the north European sea with the now flooded Wealden basin to the south (centred around the area occupied by the southern home counties today). The erosive force of this event led to the laying down of the Lower Greensand Group strata across Buckinghamshire and Bedfordshire. The quarries where the Lower Greensand is dug around Linslade and Leighton Buzzard, south to Woburn, are well documented as tidal sands of the Aptian Stage (125–113 million years ago), particularly the Woburn Sand Formation.

There is one aspect of them which is less well-known. This is the presence of volcanic deposits in the form of Bentonite, a natural clay made up mainly by Smectite clay (or "Fullers Earth").

Fullers Earth, Aspley Heath, Bedfordshire from the Bucks County Museum geology collection

This clay, which is often referred to as “swelling clay” as it expands in water, occurs in thin seams and lenses within the Woburn Sands. Thin beds probably resulted from single ash falls, while thicker seams were deposited when ash was washed down and concentrated into shallow lagoons. The mineralogy of the clay, actually predominantly Calcium Smectite, suggests that it formed from the conversion of volcanic ash to clay under the prevailing warm climatic conditions just over 100 million years ago, aided by post-burial changes beneath the sea floor. Further proof of this origin can be found in the presence of tiny fragments of fresh minerals such as zircon, sphene, biotite, feldspar, tridymite (a polymorph of quartz which forms under high temperatures) and zeolite (a family of aluminosilicate minerals that are characteristic of extrusive volcanic rocks). The mineral ash forming these clays was blown into the area on the wind, and its origin has been much debated. Initially, it was assumed that it was from the early stages of the Atlantic Ocean starting to open up which was to become responsible for the north-south oriented volcanic province in the West of Scotland immediately after the Cretaceous. This is now known to be probably true for the Albian, when the Gault Clay was being laid down 113 – 100 million years ago, and the later Cretaceous. But more recent discoveries, mainly as a result of petroleum exploration offshore Netherlands, have revealed evidence of Early Cretaceous volcanic pipes which fit better with the incidence of Lower Cretaceous bentonites in Southern England.

Fullers Earth was traditionally used since Roman times to de-grease sheep fleece – hence its name (a fuller being someone who cleans wool). Nowadays, bentonite is produced and sold for its water-absorbing properties, in products such as cat litter and industrial chemical spill mitigation; to bond silica sand in high temperature bricks, in drilling muds and even face packs. However, that dug along the Buckinghamshire/Bedfordshire border (since 1952) now finds almost all its use as a paper-filler (one of the reasons newspapers do not burn as well as in my youth). The quarrying of this unusual natural resource has caused much local opposition as it results in noise, dust and felling of trees on the popular wooded Brickhill ridge, although eventual overburden replacement should restore the land almost to its original levels.

As an additional related geological point, the name “Greensand” was coined for sediments rich in grains of the green mineral, glauconite. There is a preponderance of glauconite in Upper Cretaceous sediments in NW Europe and much of this is thought to have been derived by the glauconitisation of contemporary basaltic volcanic ash associated with the igneous activity that accompanied the break-up of Europe and North America to form the Atlantic Ocean.

Mick Oates

Zoom talks

The Ice Age

Saturday 12th December

44 people joined Jill via Zoom for her Ice Age talk. Jill began by asking what exactly is an ice age? As the name suggests, it is a prolonged period of global cooling allowing the build-up of vast ice sheets. When talking about the ice age we generally mean the events that took place over the last 2.6 million years, however, Jill flagged up the geological record contains evidence for several other ice ages hundreds of millions of years ago. These ancient episodes seem to have lasted for tens of millions of years and so, is it still early days for our recent ice age.

But is it always cold during an ice age? Fossil evidence and changes in oxygen isotope levels over the last 2.6 million years shows that long cold glacial periods of the ice age were punctuated by warmer interglacial episodes. And so, a picture emerges of great ice sheets repeatedly advancing and retreating over Britain, shaping the land as they go.

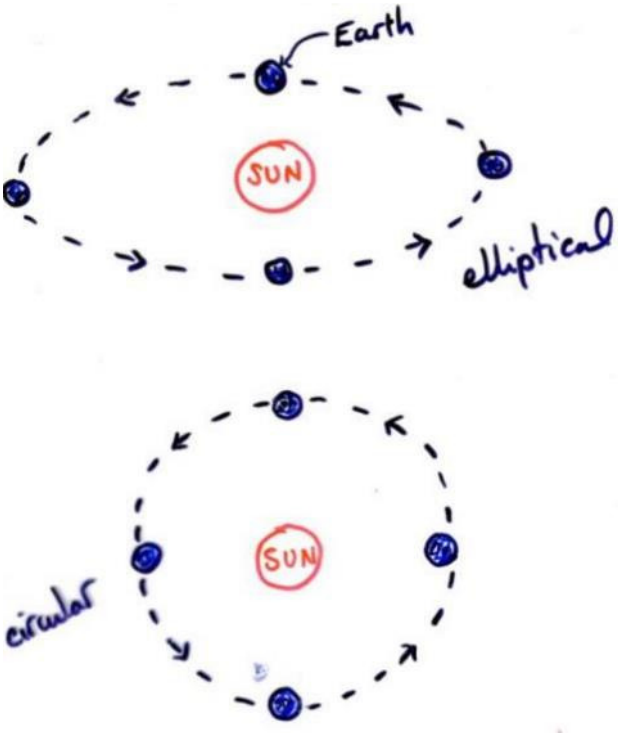
Greenland Ice Sheet

Jill then moved on to look as what causes an ice age. These are many and complex but in simple terms, changes in the positions of the Earth’s continents, along with variations in ocean currents and atmospheric composition are known to have

an impact on the Earth's climate. 300 million years ago the Earth's continents were all joined to form the super continent of Pangea leading to major global warming. Today, the flow of warm oceanic water to the Earth's poles is restricted by the current position of Antarctica at the South Pole and shielding effect of Asia and North America around the North Pole. This has led to the build-up of massive ice caps in northern and southern latitudes. These changes, however, do not explain the repeated climatic changes as evidenced by the fossil and oxygen isotope records.

Other forces, therefore, must also be at work. In the 1920s, Serbian mathematician, Milutin Milankovic, calculated cyclical changes in the Earth's movement through space, largely resulting from the gravitational forces exerted by other planets, notably Jupiter and Saturn. These cycles, both individually and collectively, can affect the amount of heat received from the sun. The three key cycles are: -

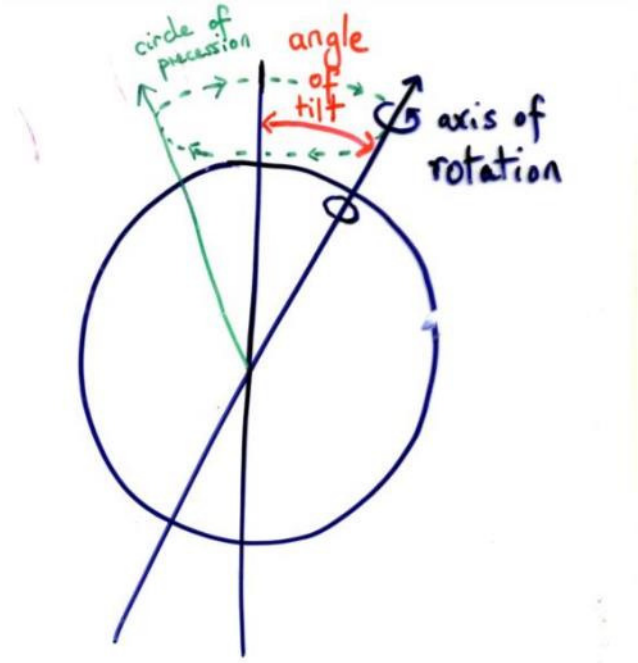
Eccentricity – variation in the Earth's orbit from near circular to mildly elliptical. A number of variants have been calculated which are thought to combine into 100,000 year cycle.



Eccentricity

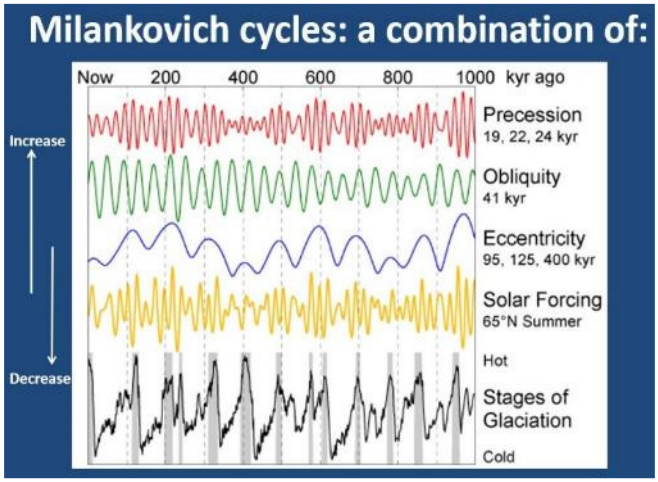
Obliquity – variation in the angle of tilt of the Earth's axis between over a period of 41,000 years

Precession - rotational variation within the Earth's axis with cycles of 19,22 and 24,000 years



Obliquity and Precession

These cycles combine to create periods of lower or higher global temperatures. Their level of impact, however, depends on the other factors back on Earth - continental positions, oceanic currents and composition of atmospheric gases. In the days of Pangea, when warm ocean currents were able to reach both poles, the Milankovitch cycles would have had little impact on the prevailing warm climate, however, with today's continental positions restricting such currents the impact is potentially more severe.



Jill went on to review the evidence for the ice age. Today, far away from the polar ice caps, it is difficult to image vast ice sheets reaching down to the Chilterns. So, what evidence can we find locally?

Although the ice has gone the ice sheets and melt waters have left sediments behind and sculpted the landscape in ways that reveal a colder past.

Moving ice sheets ripped up rock and soil from beneath them as they travelled. When the ice sheets melted, the mixed-up debris was left behind. These deposits, known as glacial till (formerly boulder clay) can be found in various locations in Buckinghamshire, north of the Chilterns. They were carried by the Anglian ice sheets just under 500,000 years ago, the most expansive of the glacial advances. The absence of glacial till on or south of the Chilterns in Bucks shows that the Anglian ice sheet, while eroding and pushing back the Chilterns escarpment, didn't actually cross it.

Glacial Till, Buckingham Sandpit

Another clue comes from the Soulbury erratic, a large lump of 300 million year old Carboniferous limestone picked up by an ice sheet, possibly in the Peak District, and dumped in what is now the middle of the road in Soulbury just under half a million years ago.

Buckinghamshire's commercially excavated sand and gravel resources are also of ice age origin. They were deposited by braided rivers, which today, are found in more northerly climes such as Alaska and Siberia. Jill described how today's slow, meandering Thames was, at times during the Ice Age, a wide braided river fed by meltwater from warming ice sheets. In winter, with much of the water locked up as ice the flow would be very small, however, in summer melting ice turned it into a torrential fast flowing river carrying and depositing vast quantities of sand, gravel and boulders. The width of the Thames during the ice age can be measured from the sand and gravel deposits that extend far beyond its current banks today. These would have been laid down intermittently with the oldest one being cut through by the next and so on, so that they form a series of steps or river terraces with the oldest one at the top and the most recent at the bottom.

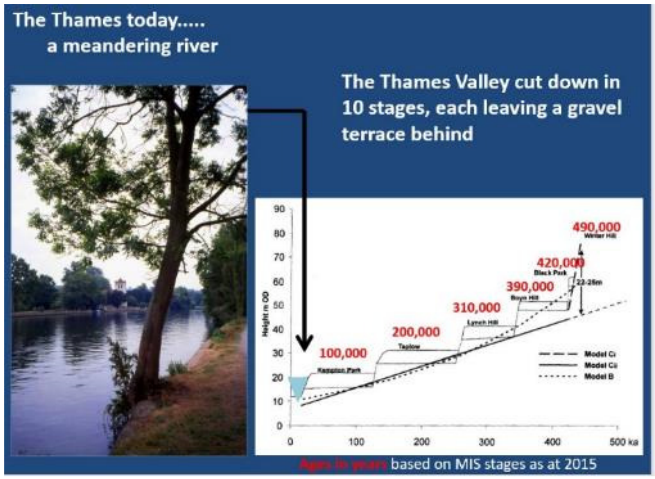


Diagram showing the modern Thames on the left and the progressively older river terraces on the right

Jill explained how the dry valleys of todays' Chilterns provided more evidence of the ice age. Today, any rainwater falling on the Chilterns is simply soaked up by the porous chalk, however, during the colder periods of the ice age, frozen ground water would prevent surface water from percolating downwards and so, would have flowed across the surface, rapidly eroding the valley as it went.

Fossils found in ice age deposits tell us something of the prevailing climates. Bones from woolly mammoths, woolly rhinos and reindeers may suggest a climate cooler than today while those of hippos and hyenas show that Britain was, 120,000 years ago, much warmer than today. It is not just the larger fossils that have a story to tell. Beetle wing cases, snail shells and pollen have all helped us paint a better picture of the changing environments of the ice age.

Jill closed with an invitation for members to join us at future field meetings to further explore the impact of the ice age on some of our Buckinghamshire locations.

Mike Palmer

Zoom talks

The geology and hydrology of Burnham Beeches *13th January 2021*

Those of you who have explored our website may have discovered Graham's self-guided Burnham Beeches Geology Trail. As a former resident and regular visitor Graham's talk provided an opportunity to build upon this leaflet and further explore this famous location.

After a brief introduction to the recent history of the site and its amazing trees Graham pointed out that it hadn't always looked like this. A borehole to the south provides evidence for three contrasting environments from its 80 million year old geological past.

This reveals Ice Age gravels overlying clays, silts and sands from the Lambeth Group before hitting chalk. Due to millions of years of erosion it is possible to encounter all three strata as you walk across the woodland.

Much of the terrain underfoot is formed from deposits of sand and gravel deposited by a large braided river that swept through this area during the last 450,000 years – the Ice Age Thames.

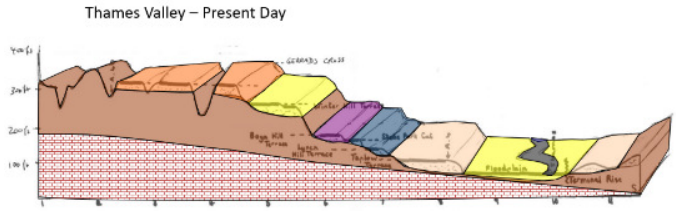
Ice Age gravels (Winter Hill terrace) Burnham Beeches gravel pit.

Braided rivers are very different from rivers in Britain today, however, they can still be found in more northerly locations such as Alaska and Siberia. In these colder regions summer warmth releases meltwater from ice sheets and snow producing vast torrents of water that forge wide river channels across the landscape. By contrast, the colder temperatures of winter limit water flow to comparative trickles through numerous braided channels. Through this fluctuating flow braided rivers carry and deposit large amounts of gravel.

Modern braided river showing the numerous small channels at a time of low water flow. The width of the overall channel indicates how great the peak meltwater flow would be in summer

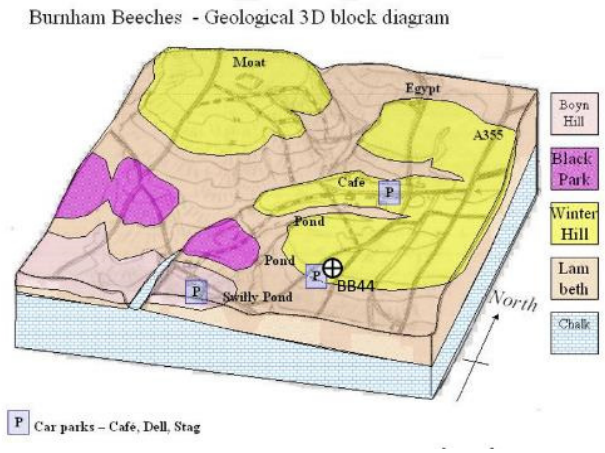
The Thames alternated between a meandering river and a braided river throughout the Ice Age depending on the prevailing climate. This has resulted in a series of different gravel accumulations over time known as terraces. The diagrams below show how new terraces were formed by cutting into the earlier ones thus creating a situation whereby the more recent terraces are within and below older terraces.

Diagram showing the River Thames 450,000 years ago cutting down through the Winter Hill Gravels (yellow) formed by an earlier braided Thames. These in turn, can be seen to have been cut through earlier Thames terraces (orange and red)



Diagram, showing how a series of river terraces (gravel beds) have been built up over time with each one cutting through earlier terraces. The modern Thames can be seen at the lower most level

Gravel from three Thames terraces can be found at Burnham Beeches. The oldest, the Winter Hill Gravels, cap the flat hill-top areas while the Black Park Gravels are found part way up the southern slopes. The youngest, the Boyne Hill Gravels, are only found in the south west.

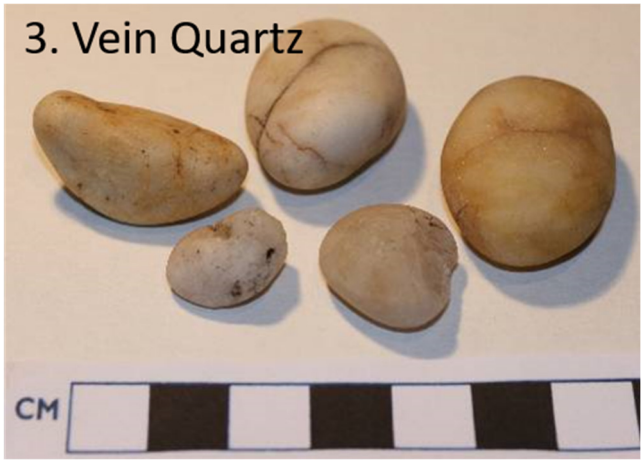


Linking past to the present, Graham pointed out how these prehistoric features have been utilised in modern-day traffic control through the careful placing of speed cameras as the A355 ascends the terraces.

Looking more closely at the gravels, Graham identified different types of pebbles found in them. By far the most common are flint pebbles. These come in different colours including black, grey, yellow, white and brown and are often broken revealing a sharp edge with rippling ‘shell-like’ fractures. This property was utilised by prehistoric humans in the making of stone age tools. Some of Buckinghamshire’s oldest Palaeolithic flint hand-axes, dating back 400,000 years, have been found in gravels from the Burnham area.

A second type are quartzite pebbles, hard, dense and smooth and usually a uniform reddish-brown in colour. They were originally formed as sandstone but have become hardened through mild metamorphism due to exposure to heat and pressure. They are sometimes called Bunter pebbles, a reference to the Bunter Sandstone Formation in the Midlands from which they were derived. When broken, individual sand grains can be made out on the fractured surface. Dating back nearly 250 million years in age these rocks predate the oldest outcrops of native Buckinghamshire rocks and were brought south by a combination of ice sheets and braided rivers.

A third group of pebble are those derived from vein quartz. These are milky white or cream in colour and originated as crystalline sheet-like intrusions into older rocks associated with hydrothermal or intrusive igneous activity. Dating back to the Devonian some 400 million years ago, they are probably one of the oldest rocks you can find within the gravels.



Moving further back in time, Graham looked next at the Lambeth Group sediments, formerly known as the Reading Beds and laid down 58 to 56

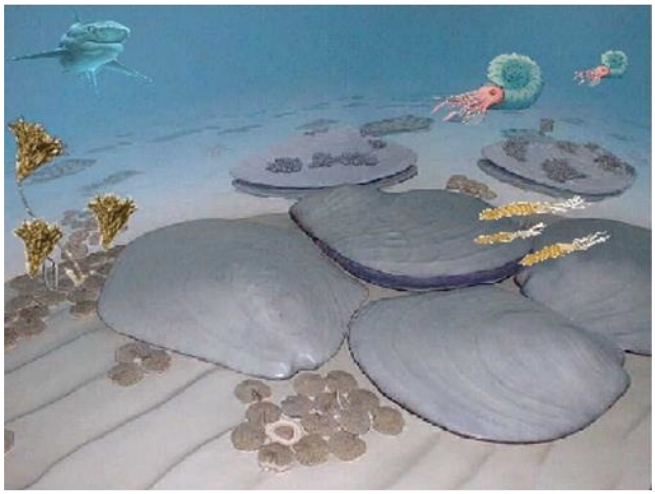
million years ago. At this time, Burnham Beeches found itself to the west of an open ocean and part of a large delta - estuarine region with muddy rivers laying down clays, silts and sands.

Muddy delta-estuarine environment

The inter-bedded nature of the sands, silts and clays within the Lambeth Group can result in multilayered aquifers with perched water tables. While the Reading Beds underly much of Burnham Beeches they are not commonly visible at the surface. Clays may be seen along the channels of streams such as the Nile while the exposed roots of fallen trees and dug earth of burrowing mammals may also reveal its presence. Underlying impermeable clays are also responsible for the area's boggy mires. Local clay has been extracted for brick and tile making in the past - an old clay pit and evidence for a kiln are known from the south of the area.

Lambeth Group clays exposed in the banks of the Nile stream

Graham them moved on to the oldest strata found at the surface at Burnham Beeches – the chalk. This was formed around 80 million years ago at a time when most of Britain was covered by warm, tropical seas far from land. In this environment sediments formed from microscopic life that thrived in the seas. Of these the most common were the planktonic, single-celled algae known as coccolithophores. Although rates of sedimentation were slow, for millions of years their microscopic shells rained down on the seabed to form the thick chalk beds we find today.



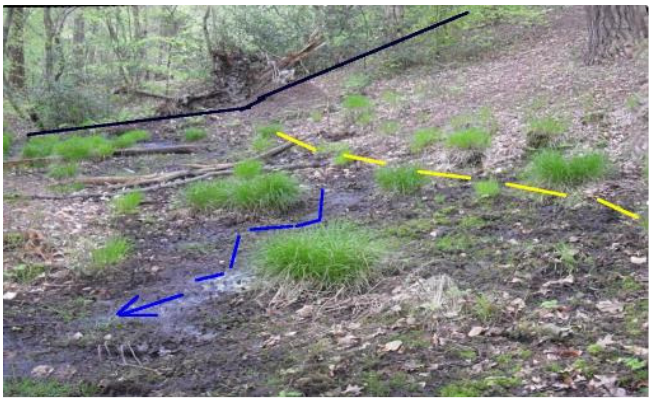
Having said this, Graham pointed out that chalk is rarely seen at the surface in Burnham Beeches with the floor of the old clay pit the best location to find it. Evidence for its presence, however, is provided by the occurrence of sinkholes as Graham went on to explore strong interplay between the area's geology and its hydrology.

The water table at Burnham Beeches has been (and still is) much studied as a result of concerns over the effects of largescale gravel extraction from the 1980s onwards. This led to a public enquiry in 1991 and the drilling of 199 water observation boreholes, some of which are still regularly monitored.

Water observation borehole near Sir Henry Peak's Drive

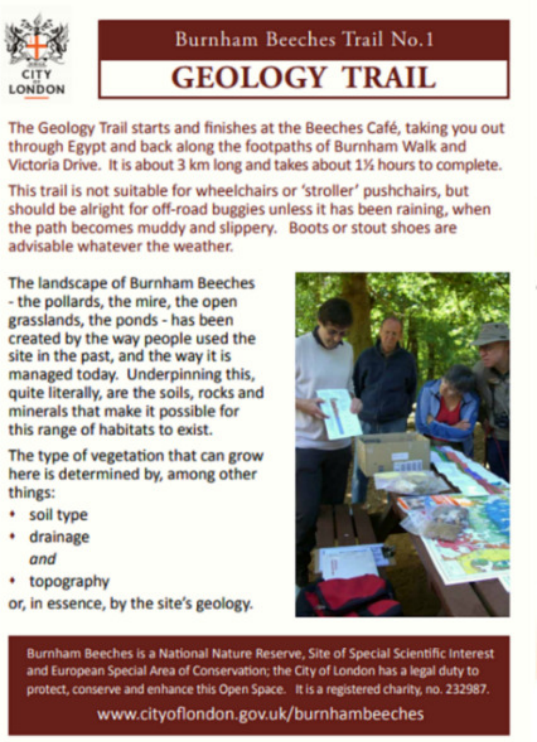
Burnham Beeches' most obvious hydrological features are its streams. The Withy and the Nile (the latter's name being linked to Egypt, a small hamlet to the east of Burnham Beeches) are the main two but a number of other intermittent and ephemeral streams may be found depending on

the season and rainfall patterns. All of these streams begin at springs which arise on slopes where the permeable Ice Age gravels meet the impermeable Lambeth Group clays.



Yellow line shows the junction between the Ice Age gravels above and the Lambeth Group clay below. The blue line shows the beginnings of a spring.

The most interesting manifestation of the local hydrology are to be found where the streams simply disappear into the ground. This is the result of sinkholes, where the chalk is close to the surface and water has dissolved a hole downwards taking the chalk. Graham pointed out that such features can be dangerous and should be avoided.



Burnham Beeches Trail No.1

GEOLOGY TRAIL

The Geology Trail starts and finishes at the Beeches Café, taking you out through Egypt and back along the footpaths of Burnham Walk and Victoria Drive. It is about 3 km long and takes about 1¼ hours to complete.

This trail is not suitable for wheelchairs or 'stroller' pushchairs, but should be alright for off-road buggies unless it has been raining, when the path becomes muddy and slippery. Boots or stout shoes are advisable whatever the weather.

The landscape of Burnham Beeches - the pollards, the mire, the open grasslands, the ponds - has been created by the way people used the site in the past, and the way it is managed today. Underpinning this, quite literally, are the soils, rocks and minerals that make it possible for this range of habitats to exist.

The type of vegetation that can grow here is determined by, among other things:

- soil type
- drainage

and

- topography

or, in essence, by the site's geology.

Burnham Beeches is a National Nature Reserve, Site of Special Scientific Interest and European Special Area of Conservation; the City of London has a legal duty to protect, conserve and enhance this Open Space. It is a registered charity, no. 232987.

www.cityoflondon.gov.uk/burnhambeeches

If you are planning a visit to Burnham Beeches, why not download Grahams self-led Geology Trail from our website at www.bucksgeology.org.uk/books_and_leaflets.html

Mike Palmer

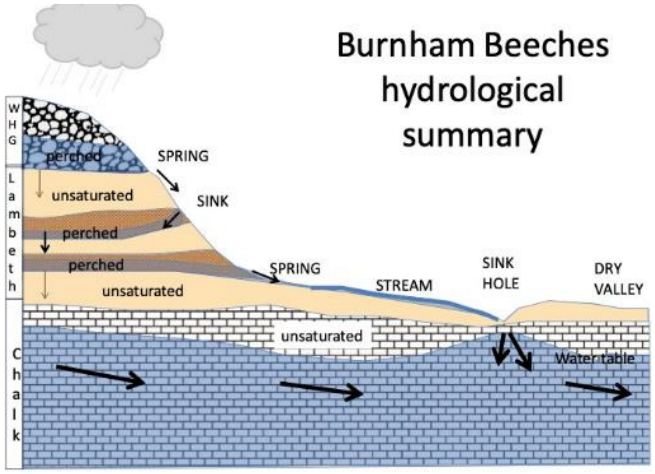
Zoom talks

The Chilterns and the London Aquifer

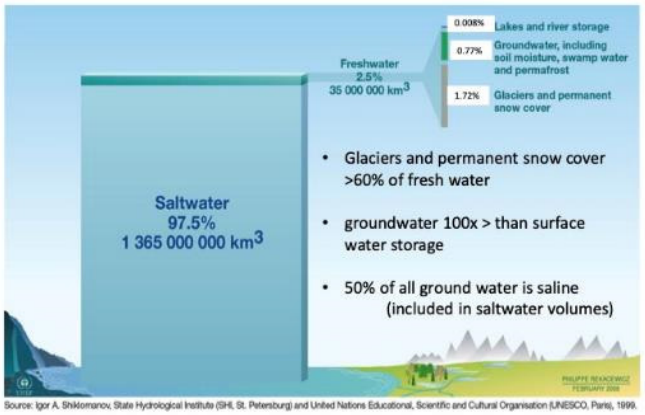
6th February 2021

The third socially distanced talk from the BGG was presented via the Zoom platform by Graham Hickman on the 6th February. The presentation had thirty-six attendees and included a Q & A session at its conclusion.

The talk started with a recap of the January talk on the Burnham Beeches and how the hydrology of the area fed into the London Aquifer.



The importance of groundwater in the global setting was outlined to give the big picture. Of all the water on the Earth only 2.5% is fresh and of that 2.5% only 1% is accessible.



"Water, water every where but not a drop to drink"

The Rhyme of the Ancient Mariner
Samuel Taylor Coleridge (1772 - 1834)

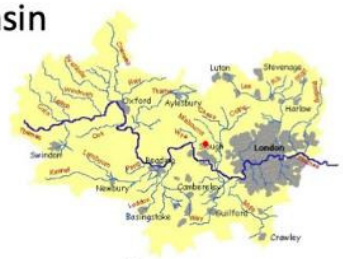
The Thames drainage basin was then described, in all approximately 13,000 km^2.

Thames drainage Basin

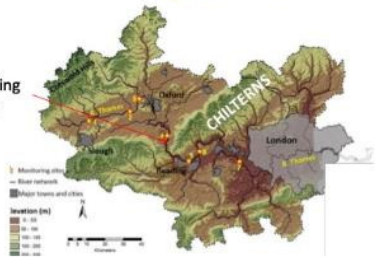
12,935 km² (4,994 square miles).

Average annual rainfall = 690mm
Average evapotranspiration = 410mm
>50% of rainfall is lost to evaporation
annual effective precipitation =280mm

Thames river:
length 344km (215miles)
fall ~108m,

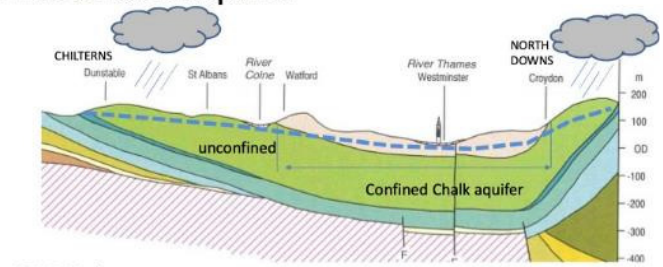


Goring gap



The large number of people living within the area together with the industrial usage have placed a high demand on the aquifer for the last 200 years. Water catchment is dependent on the underlying geology allowing an artesian basin to be formed. The steep sides of the North Downs to the south and the shallower Chilterns to the north form the sides of the basin with no natural outlets through them.

The London Aquifer



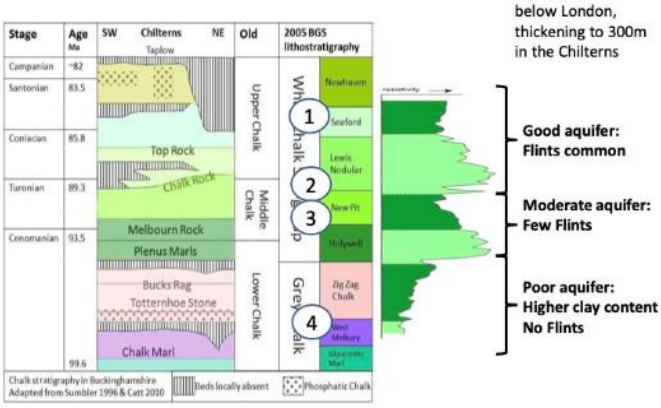
1820 Original Piezometric head

- The Chalk forms a **synclinal** fold below London
- Clays below and above the Chalk **confine** the aquifer so there are no natural outlets
- Pressure in the aquifer is created by the **hydraulic head** - saturated areas of the **Chilterns** and **North Downs**
- Water in a well drilled in the confined aquifer will rise to a height of the piezometric head and reach hydrostatic equilibrium – **Artesian Well**

The talk then covered the properties of the chalk aquifer. The chalk was formed at the bottom of the shallow warm sea that covered Southern England during the Upper Cretaceous. It is 98% calcium carbonate with flints. To make an effective aquifer the chalk should allow water to pass through. The different chalk stratigraphic units within the basin were then described and their effectiveness as an aquifer highlighted.

Chalk - detailed stratigraphic

Chalk thickness 170m to 210m below London, thickening to 300m in the Chilterns

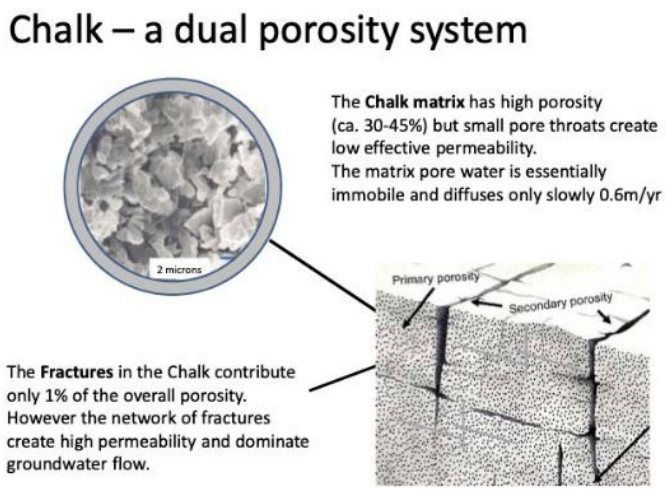


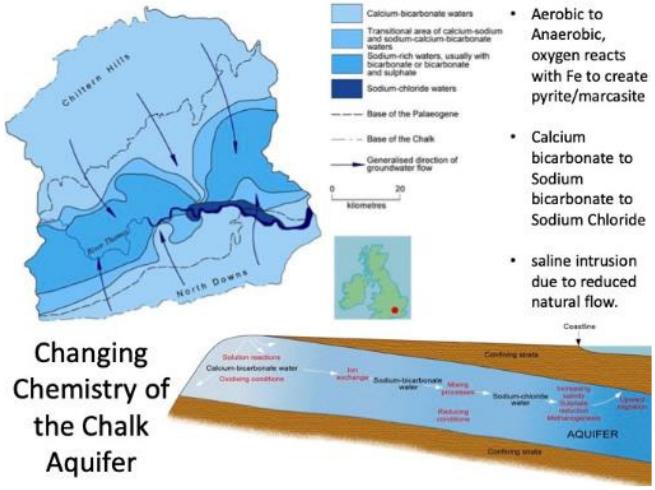
Chalk stratigraphy detail

Examples of the location of the various strata were then given.

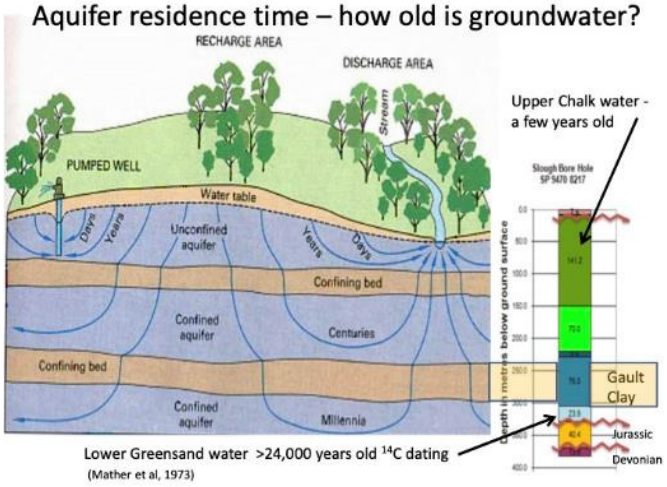
Chalk contains many joints and fractures which allow the groundwater to travel through and some formations contain difficult to detect faults as a result of orogenic action.

In addition, dissolution features, such as caves and sink holes, are common and these also permit groundwater to flow through the chalk.



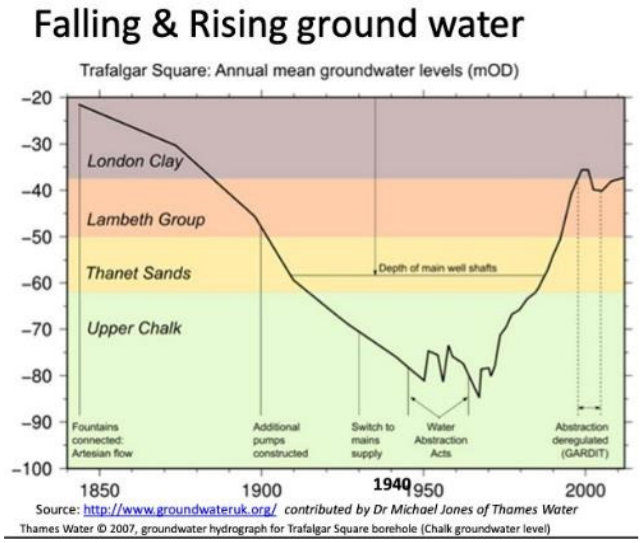


The age of the groundwater contained within the aquifer was then discussed and the methods used to determine this outlined. These include testing for radioactive minerals such as Argon^{39} and carbon^{14} as well as contaminants such as chlorofluorocarbons (CFCs). The age of the groundwater held within the aquifer and thus the length of time it resides varies from days, to years, to centuries and millennia.



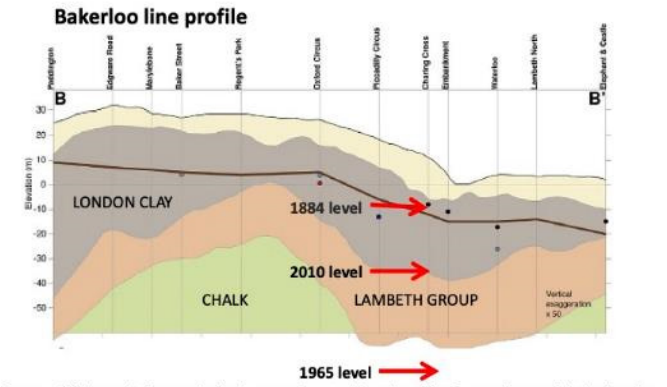
To protect the quality of any abstracted water source protection zones are placed around the abstraction point (well) based on the time taken for the groundwater to travel to the well. In zone 1, around the well, any biological contaminants cannot last more than 50 days. Zone 2, further out contaminants must be broken down after 400 days. During the time spent in the aquifer the chemistry of the groundwater changes as it flows through the aquifer. Typically, from calcium bicarbonate to sodium bicarbonate to sodium chloride waters.

Issues with the London Aquifer were then covered including changes in the abstraction rate leading to changing groundwater levels within the aquifer.



Management of the groundwater levels to safeguard the aquifer as a sustainable, secure and high-quality water resource together with protecting the areas infrastructure from flooding and damage. Underground lines and deep basements within the aquifer are vulnerable to subsidence or flooding and corrosion with changing groundwater levels.

Tube lines



Source: High-resolution geological maps of central London, UK: Comparisons with the London Underground, Jonathan D. Paul

Another issue is the ambient temperature of the groundwater, which has risen 1-2ºC over the last two decades to reach 14.9ºC in Central London, possibly caused by increased residence time in the aquifer. For the future, the Environment Agency manages the London catchment area to balance groundwater levels against abstraction in order to secure a sustainable source of water.

Adapted from Graham's talk by Ian Hudson.

Membership Details

Membership year runs from 1st April 2021 to 31st March 2022.

New members joining after 1st November 2021 will receive membership through to 31st March 2023.

Individual membership is £7.50 and Family membership is £12 per annum.

Membership is open to beginners and experts alike.

A copy of the membership form is available on our website under the 'Contact Us' tab. Please complete and return payment to

Membership Secretary, Julia Carey, c/o BMERC, Place Service, 6th Floor, County Hall, Aylesbury, Bucks HP20 1UY (Email: jcarey@buckscc.gov.uk)

Alternatively, you can pay your subscription direct to the Buckinghamshire Geology Group account at: Lloyds TSB (White Hart Street, High Wycombe) Sort code: 30-94-28, Account no 00744003

Further Information

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Email: mpalmer@discoverbucksmuseum.org

Website - www.bucksgeology.org.uk

Buckinghamshire Geology Group – *forthcoming events*

Cost: *Unless otherwise stated, all events are FREE to members. Non-members will be asked to pay a charge of £3.00 for attending field meetings and indoor events.*

Booking: *Booking is usually required for all field meetings and indoor events. This avoids meetings from becoming oversubscribed and allows the organiser to contact attendees with any last minute changes.*

Clothing: *Some trips, especially quarry visits, may require protective clothing such as helmets and high-vis jackets. Please enquire with the event leader or see event flier nearer the time for details.*

Attending Zoom talks: *Members will be emailed links to Zoom talks one week prior to the event. Simply click on the link and follow the instructions. If you are not a member please request the link via bucksgeologygroup@gmail.com. To avoid talks becoming oversubscribed please do not share the link.*

Saturday 19th June, 10.30am to 2.30pm **Field visit to Coombs Quarry** with Jill Eyers. A beautiful walk to the quarry from the Thornborough Bridge picnic area car park. The quarry has well displayed Jurassic rocks and fossils. We can enjoy a picnic lunch in the quarry before strolling back through the meadows. Contact Jill at bucksgeologygroup@gmail.com for further details.

Saturday 10th July, 10.30am to 4.30pm **Field visit to the Vale of the White Horse** with Jill Eyers. This beautiful walk will take in both geology and archaeology, including the Ridgeway, Wayland Smithy Neolithic burial chamber, Uffington Castle hill fort, Dragon Hill, the famous White Horse along with the all-encompassing geomorphology. A five mile slow paced walk on the flat in the morning but a steep climb in the afternoon to the hillfort. Picnic lunch. Parking in National Trust car park (free to NT members). Full handout provided. Contact Jill at bucksgeologygroup@gmail.com to be added to the list and receive further details nearer the date.

Wednesday 21st July, 3.30 to 5pm **Great Linford Rocks and Fossils** with Jill Eyers. As part of the MK Parks Trust's **Festival of Archaeology** Jill will be on hand at Great Linford Manor with tabletop display of local fossils and guidance for a DIY geological tour of the nearby stone circle and quarry (see www.bucksgeology.org.uk/great_linford.html for more information on these sites). The event is free but booking is required – see the MK Parks Trust website at www.theparkstrust.com/events/festival-of-archaeology-2021-family-archaeology-afternoon-2021-07-21 for further details.

Saturday 21st August, 10am to 2pm **Fossil Hunting – a MK Parks Trust event.** Did you know there are fossils at Great Linford Manor Park? Come along and hunt for them under the expert guidance of Dr Jill Eyers, our resident geologist or rock expert. Dr Eyers has identified that rocks at the Manor Park are over 170 million years old, that's older than some dinosaurs! At this outdoor event, learn how rocks form, what a fossil is and how to identify them in the local park. Suitable for all ages. 'Rock' up from 10am - 2pm. See www.theparkstrust.com/events/fossil-hunting-21-aug for more information

Saturday 18th September, 10.30am to 12.30pm **Visit to Northmoor Hill**, near Denham. Followed by picnic lunch. Geological walk around the nature reserve to see geology and landscape stretching from the Cretaceous period to the Anglian glaciation. Nature included where it turns up! Bring picnic lunch. No loos on site. Please note that heavy rain near the time of this visit may lead to this event needing to be rescheduled. To put your name down & get final confirmation of the event please contact Jill at bucksgeologygroup@gmail.com

Sunday 10th October, 10.30am to 12 noon **Hidden Aylesbury**. A town centre walk to discover the geology of Aylesbury hidden beneath the surface and the source of its very varied building stones. A view of Aylesbury that is a bit different! Led by Jill Eyers with guide notes to follow. It will take us to c. 12 noon and then can have lunch in town if wanted. For details and to be put on the list contact Jill at bucksgeologygroup@gmail.com
Thursday 14th October, 7.30 to 8.30pm **Hertfordshire Puddingstone - Formation, Occurrence, Quarrying and Use**. A Zoom talk by Chris Green of the Hertfordshire Geological Society. Details for joining the talk will be sent to members nearer the time. If you are not a member and would like to attend the talk please contact Mike Palmer at mpalmer@discoverbucksmuseum.org
Saturday / Sunday 6th / 7th November, **Geologists' Association Virtual Festival of Geology**. Further details in the next newsletter or visit www.festivalofgeology.org.uk