Buckinghamshire Geology Group

Newsletter No 38   January 2022

Ice Age features at College Lake

Rock 'dumplings' near Twyford

Giant ammonite spotted in Paris

Crystal found near Calvert

From the Editor

As we move into 2022, and whatever level of normality that will bring, we look forward to a new year of geological walks, talks and field meetings. One good thing to have come from the recent challenging years is the widescale use of video conferencing technology allowing speakers and audiences from near and far to tune in to all manner of talks in the comfort of our living rooms. As we increasingly and happily move back towards in-person events a number of members have asked if we are going to still continue with our programme of Zoom talks to which the answer at our last committee meeting was a resounding yes.

Following requests in previous editorials I am pleased to say that the number of notes and articles being sent in is increasing. Apologies if yours is not included in this newsletter but it will certainly turn up in future editions. Please do continue to send them in, whether it's a piece on some aspect of geology that particularly interests you or possibly a reaction or follow-up to something you have read in this or previous issues. And, as always, questions and photos of mystery objects are always welcome.

While we endeavour to produce newsletters as often as we can, sometimes gaps in publication will occur due to external pressures. However, our programme of events will roll on. And so, if you don't already, please do keep an eye on our website and Facebook page for updates.

I look forward to hearing about rocks, minerals and fossils you may have found, any geological trips (from field, town and museum) you have been on and, of course, any personal slants you may have on our local (and not so local) earth heritage.

Mike Palmer

Sea Dragons in the News - Sea Dragons in the Library

Type 'sea dragon' into any internet search engine and you will be presented with a plethora of articles about the recent and impressive fossil finds at Rutland Water nature reserve, east of Leicester. Although originally spotted in late 2020, news of the discovery has been held back to allow the removal of all fossils from the site.

The reference to sea dragons is a hangover from pre-19th Century interpretations of fossil ichthyosaur finds, the jaws of which must have surely come from dragons that inhabited the sea during a time before the biblical flood. Today, we recognise ichthyosaurs as a group of large, prehistoric, marine, fish-like, air-breathing, reptiles dating from the Triassic, Jurassic and Cretaceous periods.

The recent Rutland find is impressive, not least because of its length, confirmed at 10.5m (over 34 feet) long, making it the largest ichthyosaur to have been found in Britain so far. But the real reason for my mention of this current news story is to fly the flag for our very own ichthyosaur find – the 'Caldecotte Monster', albeit dating back to 1982. It was also nicknamed 'Big Eye' on account of its football-sized eyes, thought to be an adaptation to either swimming in deeper, darker waters or a possible nocturnal lifestyle. Its scientific name, *Ophthalmosaurus* sp., translates simply as 'eye lizard'.

While only half the size of its Rutland relative, 5 metres (16 feet) is still an impressive length (imagine going for a swim with it!). Having been excavated, conserved and mounted in a case it now looks down on the studious visitors to Milton Keynes reference library. And so, if you haven't already seen it, now is surely the time.

An Ophthalmosaurus species of ichthyosaur known to have lived in Bucks 160 million years ago

The Caldecotte Monster, Milton Keynes reference library

Longer serving members may recall my mentioning the 'Caldecotte Monster' in previous newsletters and so, I thought this time I would draw upon a submission by BGG committee member, Mick Oates, to the *Bucks in 100 objects* project, run by Buckinghamshire Culture (see https://buckinghamshireculture.wordpress.com/bucks-in-100-objects) to provide some further information.

Mike Palmer

'This fossil; a skeleton of an extinct marine reptile, swam through the Jurassic seas some 160 million years ago, until its demise, whereupon it sank to the soft, dark sea floor to be covered by mud that became the Oxford Clay Formation. It was found in 1982 by a workman during excavations for Caldecotte Lake, Milton Keynes.

Excavating Caldecotte Lake, Milton Keynes

Excavating the Caldecotte Ichthyosaur

Close up of 160-million-year-old Ichthyosaur ribs

Luckily, experts from Leicester University were involved, and the skeleton, of which some 75% is preserved, was lifted, conserved, recorded, reconstructed and eventually found its permanent place, back in Buckinghamshire, on the wall of Milton Keynes Central Library where it can be seen by any member of the public.

As an object of Bucks interest, it carries great palaeontological value. Prof. Dave Martill studied the skeleton and published his research on the ichthyosaur which included an interpretation that it hit the sea floor snout-first, preserving soft jaw tissues and almost unprecedented probable skin pigment cells where it penetrated the anoxic sediment. The upper parts show evidence of predation and the growth of oysters on the decomposing carcass). It is an icon of Jurassic marine life and fossilisation. It reminds viewers that during geological time, much has changed and the fauna of the Earth was very different in the past. It is a signal that almost anywhere, interesting discoveries can be made by anyone in commonplace excavations. It provides an inspiration for young people (and the older generation too) to become interested in geology and palaeontology in particular.

Mick Oates

News from Discover Bucks Museum

Work continues to progress on the five new permanent display galleries at the newly renamed *Discover Bucks Museum*. It was hoped to open the geology, archaeology, Bucks people and art galleries towards the end of last autumn with wildlife to follow this year. However, such work (as we gleaned from other museums) is always more involved that you would imagine and some elements are yet to be completed, notably a major display case exploring the 2014 discovery of the Lenborough Hoard (*Discover Bucks Archaeology* Gallery). As a result, the Museum has pushed the opening date back to April 2022.

A key element of the *Discover Bucks Geology* gallery still requiring work is a large-screened, introductory Bucks geology audio-visual interactive. In addition to providing an important geological overview it also aims allow visitors to explore links between the physical objects on display in the gallery and the geology to be experienced outside the museum in the shape of Buckinghamshire's varied landscapes, our built environment and the many ways in which rocks and minerals have been utilised, past and present.

Current ambitions are for an opening around Easter.

Mike Palmer

Recent finds

Rushmore Country Park Mystery Find

The following images were sent to me by a colleague's neighbour whose granddaughter had found an unusual object during a visit to Rushmore Country Park on the Greensand Ridge near the Bucks/Beds border. The object was described as hard, hollow and about 3 inches in length.

Mystery object from Rushmore Country Park

Mike Palmer

Response
I have come across objects like this in Lower Greensand deposits such as those exposed in the sand quarries of Bedfordshire. Such objects are formed of iron-cemented sand.

In some cases, iron cemented nodules are found to encase balls of clay or fossilised wood. These objects attract iron oxide that cements the sand grains together producing a hard outer coat. Occasionally these have a mould of a bivalve inside. Such objects are always oval or slightly elongated in shape with no tube-like extensions. Occasionally, they may be almost spherical. Sometimes they may still have the fossil wood or clay ball inside although this may have been lost leaving a hollow cavity.

The same object from a different angle

But this one is different. The 'ball' shape has tube like ends to it, which have been broken off which changes things. This is a trace fossil – a fossil not of the organism itself but something it has left behind and, in this case, almost certainly part of a shrimp burrow. The tube-like processes are the burrows the shrimp moved along, and the bulbous part is the dwelling or resting place i.e., its home.

These burrows attract the iron that cements the sand around it (as hematite and limonite mostly) due to the effects of shrimp faeces in the burrow. As they live in loose sand, some shrimps are known to reinforce their burrows with faeces deliberately to stop the sides collapsing.

And so, originally formed in a prehistoric seabed some 115 million years ago, this shrimp dwelling has finally seen the light of day.

Jill Eyers

Recent finds

Rock 'dumplings' from Twyford

Here are some photos of what look like 'rock dumplings' made of stone, mineral and fossilised wood. They were found at Portway Farm close to Twyford. When I saw them, I thought of you.

Septarian concretions, Portway Farm near Twycross

Tom Clarke

Response
These large stones always attract a lot of attention, and no wonder, because they do look unusual at first...

They are called septarian concretions or nodules and are formed when a patch of lime concentrates around something in a mudstone sediment (often a shell) a short distance below the seafloor, during the time of deposition. These concretions shrank as they hardened and small cracks formed in their interior. These filled with mineral, which in this case will be calcite (calcium carbonate). The initial thin band of brown calcite and a second infilling of white calcite indicates two phases of mineral growth.

Internal structure of the septarian concretion showing the bands of brown and white calcite within a cement stone matrix

Carbon isotope data tells us that most of the initial carbonate had an organic origin, and oxygen isotopes reveal that the initial concretion formed at a temperature between 13-16 degrees ^{O}C, which would have been the same as the contemporary Jurassic sea-floor temperature. The concretion started forming concurrent with pyrite precipitation, resulting from sulphur-fixing bacteria converting iron sulphate to iron sulphide. Internal shrinkage and cracking started at this time with a lining of the brown calcite. Much later, probably after uplift of the seafloor, meteoric water gained access to the clay sediment from permeable formations below and displaced the marine water, depositing a white calcite layer onto the brown lining.

Because of the way these concretions formed, it is not unusual for a decent, uncompressed fossil to be found inside them, though it may have a "crazy paving" appearance due to the shrinkage that occurred in the concretion as it became more indurated. If concretions are eroded somewhat, and the regular pattern of shrinkage cracks appears on the surface, they have been called turtle stones.

Twyford village is on the outcrop of the Oxford Clay. A prominent layer of these concretions occurs in the Lower Oxford Clay in association with the hardened clay bed labelled the “Acutistriatum Band’’. They were a prominent feature in the face of the “knott hole’’ (clay pit) at the nearby Calvert Brickworks. The quarrymen called them “pebbles’’ as opposed to the hard Acutistriatum Band, which they referred to as “rock’’. Both were troublesome to the brick making process so were removed before conveying clay to the works and could be seen, discarded in heaps, in the pit.

I wonder if these Twyford examples came originally from the brickworks.

Kosmoceras sp ammonite on the concretion surface

One of the concretions shows an imprint of an ammonite, *Kosmoceras*, which is compatible with an Oxford Clay origin, although similar concretions occur in most of the Jurassic clay formations of the Midlands.

Other images show compressed fossil wood, probably from a gymnosperm (conifers and their relatives). This is quite a common occurrence in Jurassic clay formations in the UK.

Compressed fossil wood within one of the concretions

Mick Oates

Recent finds

Ammonite from Padbury footpath

I found this marvellous ammonite lying on lop of a ploughed field while following a footpath near Padbury (SP718302). Its longest dimension is 15.5cm and thickness, 7.5cm. Any thoughts on its identity and origin would be most interesting.

Val Atkins

Side view showing calcite crystals within one of the exposed chambers

Response

This is certainly a decent ammonite, broken out of a septarian concretion (see previous article). Padbury is on the Oxford Clay, but this ammonite resembles far more a perisphinctid form from the Kimmeridge Clay, possibly *Pectinatites*, so my conclusion is that it must have travelled south with the ice sheet from maybe Lincolnshire (which is not at all unlikely as I have found a big boulder of the Whin Sill, from Northumberland, in a field behind Manor Farm, Padbury).

The crystals present in the side view will be calcite.

Mick Oates

More From Val

Bucks may not be home to the most impressive fossil deposits but we have our stars. The finds of large *Titanites* ammonites and the Pliosaur bones as noted in Newsletter 37 are but two [don't forget the Ichthyosaur – MP]. There are well-known fossil bearing rocks; bivalves from limestone and chalk, belemnites from the clays of Aylesbury Vale, etc, and so no shortage of find spots (well done Aria and Luna for your Haddenham finds). As mentioned in the last newsletter, many fossils weather out to the surface and are quickly spotted. Even the glacial till which covers much of North Bucks has good finds. Here, *Gryphaea* sp. left after the retreat of the Anglian ice sheet, 420,000 years ago are scattered on the surface.

If you walk over the glacial till, as I do around Padbury and Adstock, you will find other treasures in the many rock types present having been brought south by vast ice sheets from Scandinavia. Echoing Graham's talk on Burnham Beeches (see Newsletter 37), here too are the ubiquitous and far-travelled Bunter pebbles. There are many flints, both fractured lumps and pebbles, some of which contain fossils. There are chunks of limestone and some rocks which look like quartz to my ignorant eye. So, plenty of rock and fossil hunting to do around here.

My really amazing find in this area was the ammonite featured in this article, found simply lying on the surface of a ploughed field. I have seen and handled many different fossils over the years but the moment I picked up this fossil, I became acutely aware of its tremendous age. It had lived and died in a prehistoric sub-topical sea and become buried in the accumulating sediments and eventually fossilised. It had then been lifted up to the surface of its rocky bed, picked up by a glacier and dumped on a Buckinghamshire field. It had been vigorously ploughed up and down for fifty years and yet, survived for me to find it.

This is one of many wonders of Bucks fossil heritage.

Val Atkins

Recent finds

Crystal find in near Calvert

The crystal shown below was found by metal detectorist, Tom Clarke in a field near Calvert.

Selenite crystal

It is an excellent example of a selenite crystal, a form of gypsum (Calcium sulphate). Such crystals may be encountered in a number of marine clays in Bucks – we have specimens in the Museum's collection from the London Clay, Kimmeridge Clay and, as in your case, the Oxford Clay.

Although these clays formed millions of years ago at the bottom of seas similar to the North Sea today, the crystals themselves formed much later after movements in the Earth's crust and changes in sea levels lifted the clays above the waves to dry land, as we find in Bucks today. Under these conditions the upper surfaces of the clay, although still buried, became exposed to ground water percolating down through the subsoil. Here, the water reacts with pyrite/marcasite crystals dispersed through parts of the clay to form sulphuric acid. This then reacts with calcium carbonate in the clay (derived from prehistoric seashells) to form crystals of calcium sulphate in the form of selenite crystals.

Mike Palmer

News

Ground-breaking Ice Age features at College Lake Nature Reserve

The tranquil landscapes of today's College Lake Nature Reserve were once an active quarry supplying chalk for the former Pitstone cement works. In 1969, preparations for the extraction of chalk for cement making saw the clearance of overlying sediments. Taking advantage of these freshly exposed surfaces, Bucks County Museum's field archaeologist, Dr John Evans explored the site. John was a pioneer of using snail shells to date archaeological deposits. In his notebook he described a number of Ice Age features in the form of involutions and ice wedges and suggested the possible presence of ancient water channels.

Pitstone Quarry No 3 with the cement works in the background before its transformation into College Lake Nature Reserve. Photo: Rodney Sims

In 1976 a buried water channel was exposed revealing fossils mammal bones, including those of straight-tusked elephant, narrow-nosed rhino, giant deer and hippopotamus. The finds were attributed to the warm Ipswichian interglacial, dating to around 120,000 years ago and are now in the collections of the Natural History Museum, London.

In the early 1980s, another, lower channel was exposed and dated to the end of an earlier interglacial period around 220,000 years ago. Fossils, here, included woolly mammoth, steppe mammoth, horse, brown bear and steppe lion indicating a climate slightly cooler than that of today. These fossils are in the collection of Bucks County Museum.

Exposures created by the active quarrying of the site showed that these two channels were separated by sediments (flinty coombe rock) showing evidence of cold, periglacial conditions, similar to Siberia today. This evidence included involutions, caused by intensive freeze-thaw cycles, and ice wedges. These features were observed along a line stretching for just under a mile and have, along with the fossil finds, led to this part of the site being designated as a Site of Special Scientific Interest (SSSI).

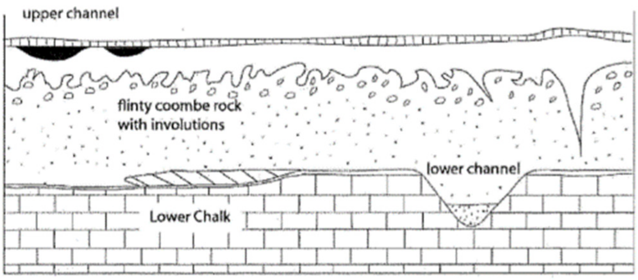


Diagram adapted from Murton *et al* (2001)

Unfortunately, the original exposures have degraded over time and become obscured. The loss of these features has been commented on over the years, however, because of their SSSI status, any work on these areas, including conservation work, requires the approval of Natural England, the national body tasked with preserving these important sites. And so, while we were conscious of the potential of these features, we were also reticent to take any action. A visit by Dr Eleanor Brown (a Quaternary geo-diversity and geo-conservation specialist for Natural England) provided us with an opportunity to ask the question: would we be allowed to open up these features again?

The answer was positive and so, with encouragement from Natural England and support from the Geologists' Association (in the person of Nick Pierpoint), we examined possible sites to re-expose a section and reveal these long-hidden features. Unfortunately, the line also runs close to a major track, in places only a metre away. However, a forty-metre length was identified where the track was seven metres away. This degree of separation is important as it would seem likely that any new vertical exposure would need to be cleaned from time to time by cutting further back into the bank.

Before such an approach could be approved, however, some measure of how well such an exposure would hold up over time was needed. And so, in 2018 a one-metre wide trial exposure was opened. During the first winter the new face held up better than was expected and estimates of the rate of loss of features based on monitoring over nine months suggested that we could expect that new and larger exposure to be visible for in excess of 5 years.


Trial exposure. Photo: Rodney Sims

Working with Natural England, a forty-metre length was identified as being suitable for possible exposure. It was quickly realised that a full-length exposure would have required a tremendous amount of work to both create and maintain. Instead, the decision was made to divide the length into five, eight-metre portions. In addition to providing easier maintenance, this approach also massively extends the longevity of the overall resource allowing new exposures to be revealed serially over time.

In August 2019, work began on an 8-metre exposure and was completed in January 2020 along with a new access path.

8 metre exposure, January 2020 . Photo: Rodney Sims

New access path: Photo Rodney Sims

With the onset of the Covid pandemic access to the site was limited but a site visit in July 2021 showed that the face had held up very well with features remaining clear and distinctive.

July 2021 with new interpretation board in position. Photo: Mike Palmer

On 10th August 2021 the site was officially opened and it is hoped the exposure will be a useful teaching resource as well as a fascinating spectacle for visitors. College Lake would like to thank BBOWT members (and in particular the local Chilterns Group) along with the Geologists' Association's Curry Fund and the Quaternary Research Association's Geo-conservation and Outreach Fund for their financial support.

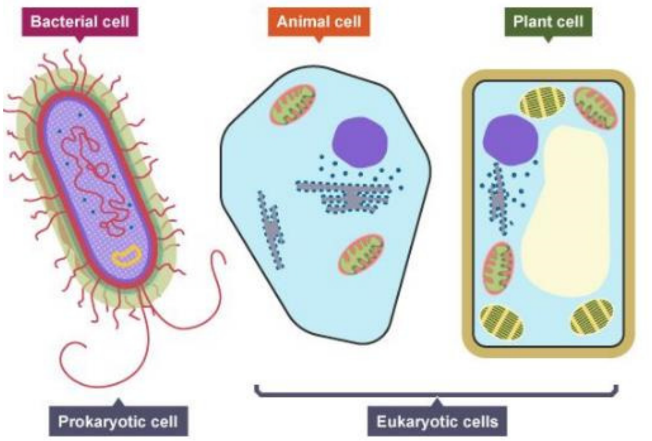
Rodney Sims

Zoom talks

It's life Jim, but not as we know it

Saturday 6th March

This was the intriguing Star Trek influenced title of a talk given in March by Jill Eyers. The life in question was the very first life on Earth. The talk literally started at the beginning – with how complex organic chemicals can link together in the first place. It then considered how the huge leap might be made from making biological chemicals to actually forming those chemicals into living things. Truly mind-boggling. The timescales are difficult to comprehend. From the Earth forming around 4.6 billion years ago, the first biological chemicals are found in 4-billion-year-old rocks in Greenland. So, with 600 million years to make some chemicals, it was going to take a while to make life on Earth.



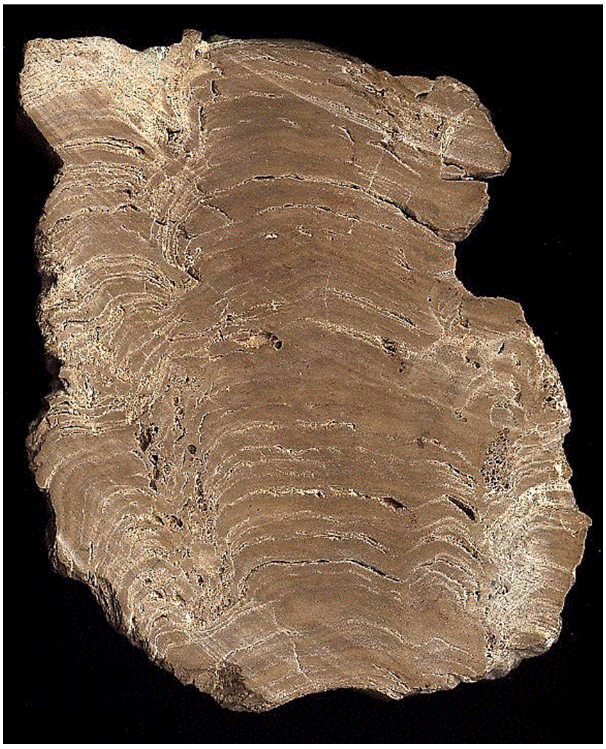
Bacteria – simple cells known as prokaryotes – where the contents and life-processes are distributed throughout the cell compared with those of animals and plants.

The first evidence we have is for bacteria from around 3.8 billion – all extremophiles (what a word!) that could cope with a world devoid of oxygen, very hot and chemical-rich. In fact, the organisms used chemicals as their food source. It was an event from 3.5 billion years ago that we have the evidence for the first mass extinction of this extremophile life. The cause of this event was a new bacterium (cyanobacteria) which had chloroplasts in its cell and could produce oxygen. By making use of the sun's energy these bacteria photosynthesised, producing oxygen as a waste product.

Oxygen extinguished the first life-forms – literally oxidised their bodies! Oxygen was the first toxic poison on Earth, a strange concept when we consider how essential it is today for modern life.

Banded ironstone. The layers were originally horizontal sediments which have been folded. The colours are due to iron minerals. Black layers are iron in a reduced state (no oxygen). The gold patches are pyrite associated with the black layers and confirming no oxygen. The red is where oxygen was present. Diurnal layers? Maybe. Certainly, representing the dawn of photosynthetic life.

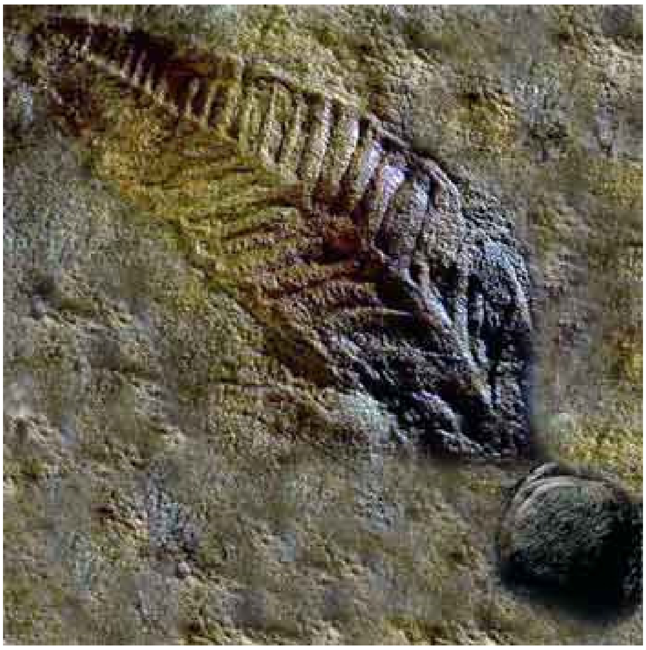
Cyanobacteria grow in layers, a little like algal growths with these layers interspersed with sediment to form mounds called stromatolites.



Stromatolite.

At this time, all life at this point is single-celled and there is a long wait until the first multi-cellular organisms arrive but it was worth waiting for. Rocks aged 610 million years old have produced an amazing range of 227 genera of multicellular animals. This is known as the Ediacaran fauna.

The name comes from the Ediacaran Hills in Australia, where they were first found. They have since been found in 11 countries including Britain (*see Newsletter 29, August 2017 – Charnwood Forest field trip*).



Charnia. An animal once grouped with 'sea pens', but research has now shown has a body plan that is not like anything living on Earth today, or ever has been. Like many of the Ediacaran animals, it has no known grouping.

A reconstruction of the Ediacaran sea floor. All these organisms are soft bodied. Soft bodies rarely preserve and this is why this fauna is so rare.

Placing some of these 'weird and wonderfuls' into a known biological classification is really problematic. It is mainly done on body plan – something schools teach early on in biology classes. Sometimes organisms superficially look like a known animal. In the past they have been wrongly classified because of this.

The same misclassification is true of organisms in the next momentous leap for life on Earth – an event often called the 'Cambrian explosion'. This occurred 545 million years ago with the Burgess

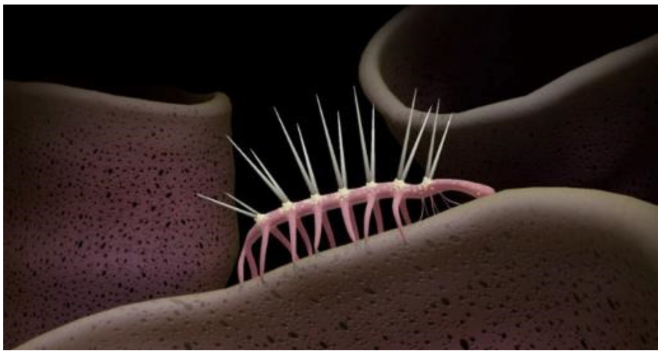
Shales of Canada being a prime find location. However, it is often argued that, although it seems as though there is a profusion of life suddenly appearing in the Cambrian, it is probably explained by the fact that we see them better as a result of their hard shells - hard parts preserve much more easily in the fossil record and so are more likely to be found.

These organisms are also difficult to assign to biological groups. However, many intense studies on body plans have now revealed some of the secrets of these animals. A range of animals, from worm-like creatures to sponges, predators to scavengers and much more, were illustrated – many with reconstruction videos (videos are a lovely way to bring these enigmatic creatures to life. But it is all interpretation, based on body plans from fossils).

Halkiera – now interpreted to be an ancestor of bivalves, but it is very different and placed in a new group of its own – the Diplacophora.

Wiwaxia – looking like an armoured slug, but with no living relatives.

In conclusion, the overriding theme of the talk was to look at how ancient and seemingly alien-like, fossils presented in 2-D. could be interpreted into 3-D living organisms. What did they look like, how did it move, what did it eat? A classic example, *Hallucigenia* , was shown – famous for the first interpretation being upside down!



Hallucigenia – thought to be a lobopodan, here shown the correct way up (we think!).

Hard but enormously interesting to imagine

Jill Eyers

Zoom talks

Ammonites: from myth and folklore to geological relevance

Saturday 10th April

As the title suggests, Mick Oates' talk provided a comprehensive overview of ammonites covering their folklore, evolution, biology, appearance and extinction along with a look at how ammonites are used by geologist today. It was clear that Mick has a passion for these *"delightful planispiral fossils that have been sought after throughout history and prehistory"*, having collected them from his childhood to the present day.

Unfortunately I was unable to attend the Zoom talk presented to the Bucks Geology Group in April but was able to catch up by watching a recording of the same talk delivered to the Herts Geological Society in September 2021 (see www.youtube.com/watch?v=3WFFbOBQKjk&list=PLJRv32mNThx4lloR6Dn_lUo0HI03dSCWV&index) which had the added bonus of including some recent news on the possible discovery of a fossil said to preserve the soft-body parts of an ammonite – read on.

Mick began by looking at how ammonites have featured in folklore and mythology. The very word, ammonite is derived from the ram's-horned god Amun (Egyptian) or Zeus Ammon (Greek) and they have long been prized by people from across the world. Said to have been useful for buffalo hunting in North America while an ammonite tossed in a milk pail in Germany would prevent cows going dry. In Scotland washing a cow in water that had ammonites steeping in it was said to cure cramps and in some parts of the country ammonites were known as cramp stones. In certain parts of India, fossil ammonites were prized as incarnations of the god, Vishnu and if you bathed an ammonite it would endow you with 10,000 blessings. In Rome they were related to prophetic dreams while in Greece they cured insomnia.

Snakestone: ammonite with carved head

In Britain they are sometimes known as snakestones due to the story of St Hilda, a 7th Century abbess of Whitby, who is said to have turned a plague of snakes into stone, as evidenced by the abundance of coiled stone snakes (or ammonites) along the coast. The story encouraged pilgrims to visit the abbey while local artisans carved heads onto ammonite fossils to re-enforce the legend. Such is the strength of the story that Whitby is one of only three towns to have fossils incorporated into its coat of arms, the other two being Scunthorpe, with *Gryphaea*, and Dudley, with a Trilobite.

In Victorian times fossil collecting really took off with ammonites being particularly prized. However, with only shells to go on (no soft-tissue parts preserved) it was uncertain what these animals would have looked like. Mick showed an early imagining of a Jurassic seascape, *Duria Antiquior, a more ancient Dorset,* Henry De la Beche (1830), in which an ammonite can be seen sailing along the surface of the sea in a similar fashion to how the modern Portuguese-Man-o'-War or the By-the-Wind-Sailor (both colonial hydroids) use the wind to cross the oceans today.

Duria Antiquior, a more ancient Dorset, Henry De la Beche (1830). Not the sailing ammonite on the right

Ammonites are cephalopods, which today include the octopuses, squid, and cuttlefish, all of which use jet propulsion to get around by means of squirting water through a syphon (or hyponome). Perhaps the closest living animal to an ammonite in terms of appearance is a Pearly Nautilus. It must be emphasised, however, nautiloids (including Nautilus) and ammonoids (including ammonites) diverged as separate evolutionary groups hundreds of millions of years ago. They do still share some basic common features with both having planispiral (flat-spiral) shells divided into a series of internal chambers, something that separates them from superficially similar gastropods such as garden and pond snails.

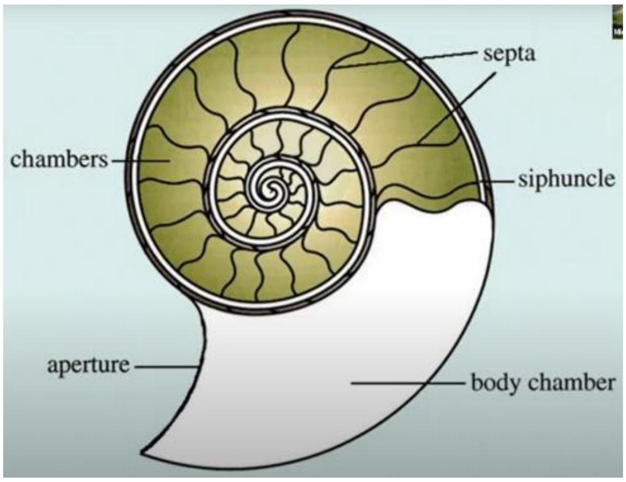
Cross-section through a nautilus shell showing internal chambers connected by a tube – t he siphuncle

A cross section of a nautilus shell shows another important feature shared with ammonites, a tube or siphuncle connecting each chamber to the next. This allows the animal to adjust the levels of gas and water in the chambers and so change buoyancy thus allowing the animal to move up or down in the water like a submarine.

So, what did ammonites look like? Mick showed an artist's impression of a late Cretaceous ammonite, *Placenticeras*, pointing out that the fossil record doesn't provide much evidence for soft body parts or colouration. However, we can make some assumptions. We know that they lived in fairly shallow water and so it would have been very useful for them to have some sort of camouflaged shell. It is also assumed that they have protrusive eyes to provide all round vision above and below to keep an eye out for predators.

Artist's impression of an ammonite (Planticeras sp)

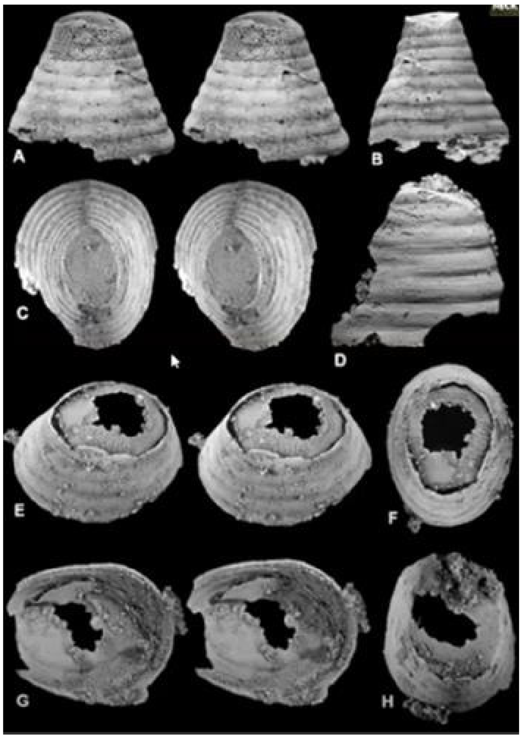
Fossil ammonite hooks have been found, albeit not very common, which were presumably deployed on tentacles and used for catching slippery prey, such as jellyfish. Finally, most modern cephalopods (octopuses, squid, cuttlefish, nautiluses) use the ability to change the colour of their skin as a form of communication and so it can be assumed that ammonites possessed this ability too.



Ammonite anatomy

Mick ran through the basic ammonite anatomy pointing out that the creature lived in part or most of the outermost chamber, hence the name body chamber. It is thought that the animal would have been able to retract itself into this chamber when threatened. It was also noted that while ammonites and nautiloids both have a siphuncles connecting that interconnected the chambers, these are positioned differently in the two groups.

Moving on to ammonite evolution Mick traced their origins back to the early Cambrian, 540 million years ago in the form, of small, conical shells belonging to the genus *Tannuella.* These provide the earliest known evidence for shelled creatures with several internal chambers.



Early Cambrian Tannuella fossils

By the Ordovician period just after 480 million years ago, a number of different nautiloid species, notably orthocones, had appeared with clearly identifiable chambers connected by siphuncles. However, unlike the later nautiloids these species had straight shells.

Section of an orthocone (nautiloid) fossil with siphuncle visible running through the middle

Artist's impression of an orthocone (Orthoceras) By Nobu Tamura (http://spinops.blogspot.com)

By the Devonian (420 million years ago), the straight-shelled orthocones were still present, some with shells up to one metre in length. But interestingly we see the first appearance of Goniatites with planispiral shells. These represent the first ammonoids, the group that will go on to include the ammonites. But why go spiral? Mick identified several advantages. The spiral form requires less shell and so requires less energy to build. It also provides greater stability in the water with the centre of mass nearer the centre of buoyancy.

A Goniatite showing the planispiral form

As we go through the Devonian, ammonoids become more common and diverse. Mick drew our attention to how the chamber walls were expressed on the outside of the shell as suture lines, noting how they were not just straight or slightly curved lines that you would expect from nautiloids but rather they have saddles and lobes. This is a feature of the ammonoids and as they evolved further during the Carboniferous and Permian these suture lines develop an increasing range of complex forms, each characteristic for their particular species.

Devonian ammonoid. NB suture lines with saddles and lobes

Devonian – Carboniferous Ammonoid (a Goniatite). NB increasing complexity of the suture lines

Permian ammonoid (Metalegoceras sp). NB further increasing complexity of the suture lines

Triassic ammonoid (Ceratites). Note the further increasing complexity of the suture lines

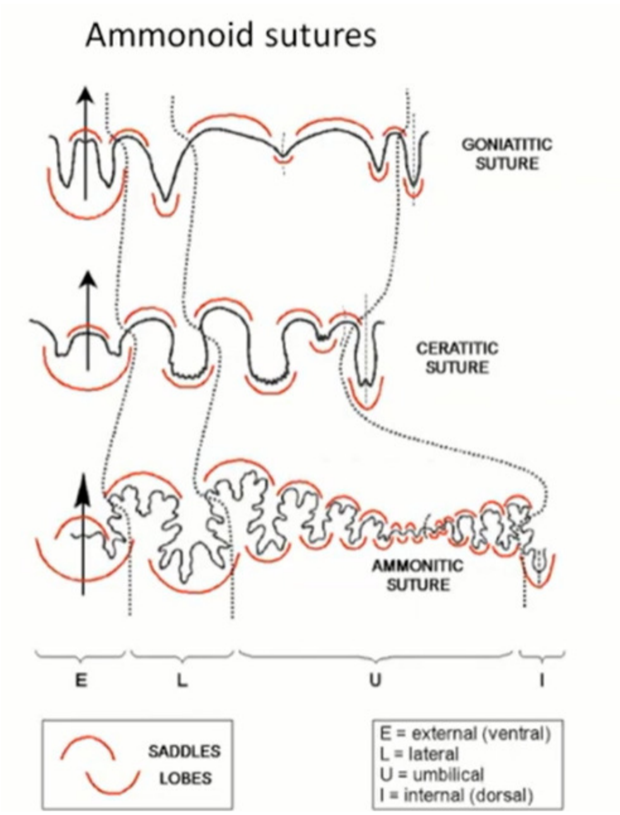


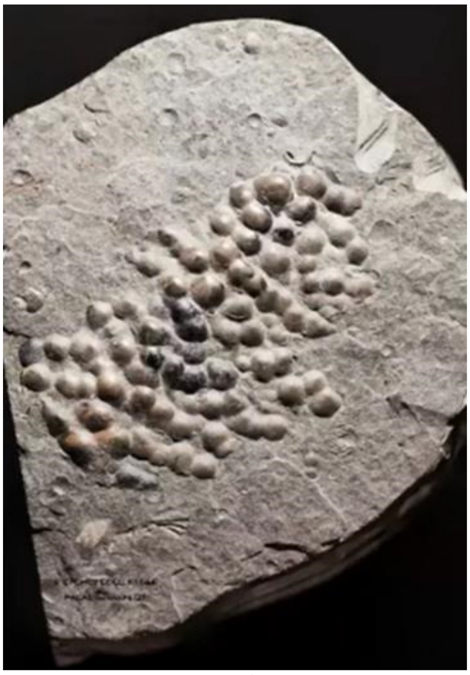
Diagram showing the increasing complexity of suture lines from Goniatites through Ceratites to Ammonites

By the end of the Permian an enormous diversity of ammonoid forms had developed, however, many of these were lost during the Permian–Triassic extinction event 250 million years ago. Interestingly, Mick pointed out that many of these forms would reappear, albeit as new, more evolved species, in the Jurassic and Cretaceous – a nice example of parallel evolution whereby animals separated by enormous lengths of time re-evolve similar forms due to the living in similar environmental niches.

At the end of the Triassic, 200 million years ago there was another extinction event which knocked the ammonoids right back, however, two groups survived into the Jurassic, *Phylloceras* and *Lytoceras* stocks and were the forerunners for all true ammonites. While ammonites are noted for their rapid evolution and turn-over of new species, Mick pointed out that surprisingly *Phylloceras* and *Lytoceras* stayed almost unchanged to the end of the Cretaceous. Some designs seem to stand the test of time.

Two survivors into the Jurassic - Phylloceras (left) and Lytoceras (right)

Moving onto life-cycles, Mick highlighted a recent discovery from the Dorset coast of fossilised ammonite eggs found in intimate association with the ammonite that was trying to lay them. From such eggs free-swimming tiny larvae, comprising one or two chambers, would hatch out. These were so small and numerous that they would have been swept far and wide on the oceans' currents, helping explain the world-wide distribution of some ammonites. Over time some of these would develop into adults and breed to start the whole cycle again.



Fossil ammonite eggs from the Dorset coast

In recent decades it has been realised that male and female ammonites had quite distinct appearances. Many fossils that were once described as different species are now known to be the male and female forms of the same species. This has partly been recognised through the fact that the inner most whorls of both types are identical and also by the fact that the two forms always seem to share the same geographical range and appear and disappear in the geological record together. Male ammonites are smaller and known as microconchs while female shells are larger and hence are referred to as macroconchs. This difference in male / female size is also evident in modern cephalopods. Female, are generally thought to be bigger due to the need to carry large pouches of eggs.

Male microconch (left) and female macroconch (right). Note extension – lappet – on male

Mick also pointed out the strange aperture modification of the male called a lappet. It is currently unknown why this modification occurred as it seems to serve no known purpose.

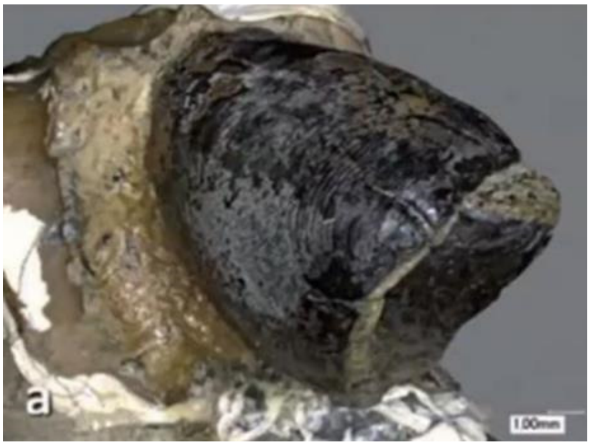
Parapuzosia seppenradensis cast,
Museum of Natural History, Paris

Ammonite species can be seen to vary tremendously in size, from tiny adult microconchs only 3mm across to the massive *Parapuzia seppenradensis*, from the late Cretaceous, reaching sizes of over two metres across.

Moving on to feeding, ammonites, depending on their size, would have fed on a range of marine creatures from plankton up to bivalves, gastropods, crustaceans and fish.

Other than their shells, one of the few parts of an ammonite that are commonly found as fossils are aptychi (or singular, aptychus). These may be found independently of their accompanying shell and sometimes as a pair, leading early geologists to interpret them as bivalve fossils. Once their association with ammonites was acknowledged it was assumed that they formed an operculum – a protective covering over the aperture of the shell to protect the animal within in times of danger. An increasing number of fossils have now been found showing the aptychi located within the body chamber leading to the realisation that these, in fact, form part of the animal's feeding apparatus. Fossil evidence also shows that ammonites had a beak, similar to those of modern squid, however, being made from chitin, they are less commonly fossilised.

Ammonite fossil with aptychi

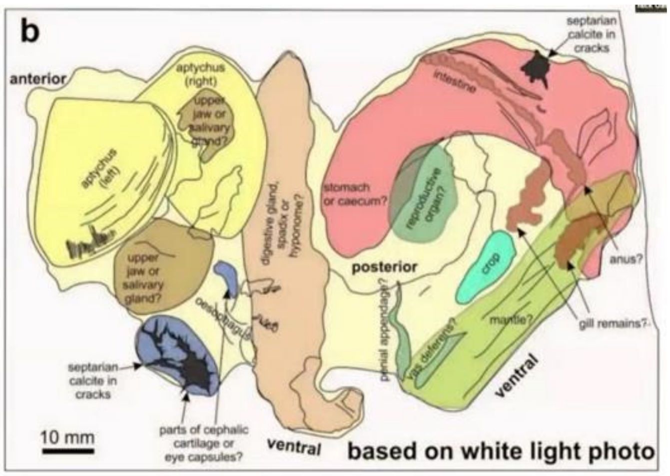


Ammonite beak

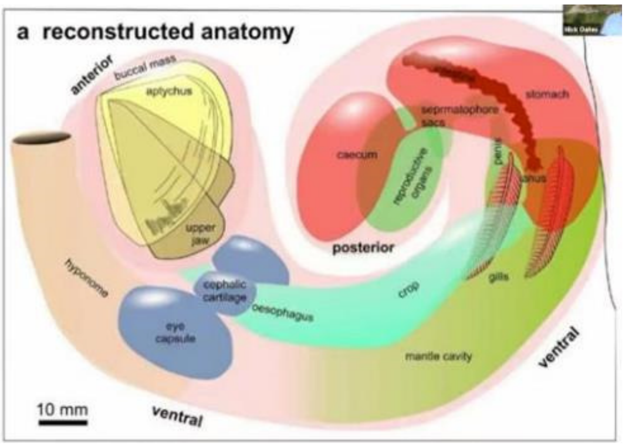
It has been said that there are no fossils showing the soft-tissue structures of ammonites but a recent paper by some Swiss geologists may possibly change that. The paper describes a very interesting discovery from the Solnhofen limestones of Bavaria. These strata are noted for the fine preservation of a range of fossils including *Archaeopteryx* and the soft tissue structures of belemnites. This recent find is of an ammonite aptychus with a blobby mess next to it but no sign of the ammonite shell. Close analysis of the fossil has led the authors to believe that they have found the soft-body parts of an ammonite.

It has only just been described and so the interpretation is open to question but current evidence suggests that the structures are similar to other cephalopods such as the modern nautilus. Unfortunately, no tentacles are represented in this fossil.

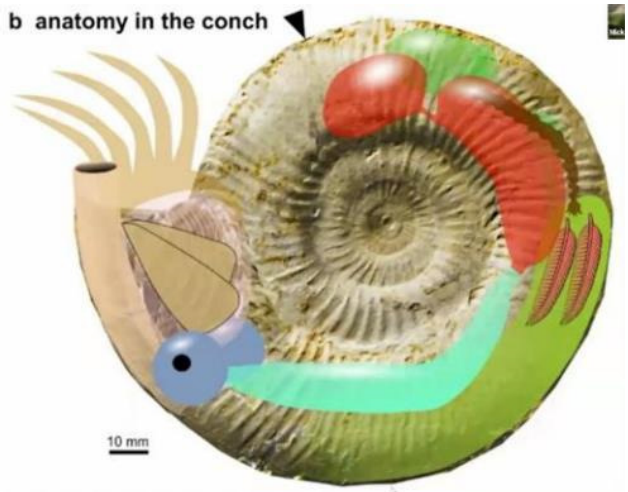
Fossil aptychus (top left) with ammonite internal organs?



Annotated diagram of fossil



A reconstructed anatomy (nb: the hyponome on the left is the siphon that ammonites use for jet-propulsion)



Anatomy superimposed over a Perisphinctid ammonite

Why the soft-body parts are found away from the shell is unknown but one possible explanation is that a belemnite (known to prey on ammonites) bit into the shell at the back of the body chamber and pulled out the body but then, for reasons unknown, dropped it and didn't retrieve it.

Moving on unusual fossils of another sort, Mick described how during the Cretaceous, certain ammonites began developing some very unusual evolutionary forms. After millions of years of sticking to a successful planispiral shape some species began to deviate, developing uncoiled forms, shells with extended hooks, shells with cones spiralling up and even simple straight cones similar to the distant, ancestral orthocones mentioned earlier in this report.

Two examples of heteromorph ammonites

These are the heteromorph ammonites, the name simply meaning *'different shape'.* As the Cretaceous progressed the forms became more elaborate. Why this occurred is not known but it is assumed it was a response to whatever environmental niche they were occupying.

Whatever shape ammonites were, the end of the Cretaceous, 66 million years ago, saw the extinction of the ammonites along with belemnites, plesiosaurs and dinosaurs. Or did it? Mick showed a slide of some poorly preserved ammonites fossils from Denmark found from just above the Cretaceous – Palaeogene divide. Such fossils are very rare and so, if they did survive the end of the Cretaceous, they didn't last very long.

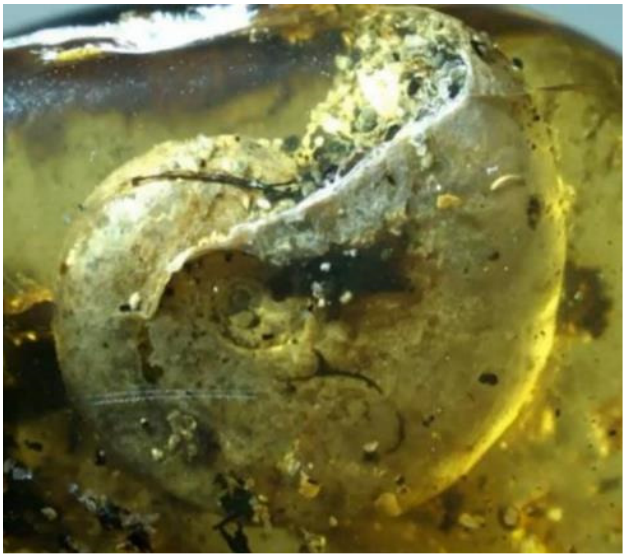
With living ammonites extinct, today, we are left with the opportunity to discover their fossils. Ammonite preservation within the fossil record varies tremendously from faint imprints to three-dimensional fossils replete with their original nacreous shell. One slide showed a nice three-dimensional fossil of *Kosmoceras* preserved in pyrite, the pyrite having originated from sulphur-fixing bacteria in anoxic (oxygen-free) environments feeding on organic sulphates within the rotting carcass of the animal. Other slides showed how ammonites found in clay have suffered from the crushing pressure of overlying sediments while others have gained protection from forming within concretions and nodules, waiting to be picked up on a North Yorkshire coast and revealed with the crack of a hammer.

Crushed ammonite in clay

Preservation quality can vary within a single fossil. In some Jurassic clay fossils, sediments have got into the larger outer chambers and protected them from crushing while the sediment-free inner whorls haven't been so lucky and have not survived. In other environments, chambers that have not been filled with sediments from outside have instead, become filled with minerals such as calcite precipitating out of water.

Ammonite with inner chambers filled with crystals of calcite

A major surprise of the talk was an image of an ammonite, a small, juvenile *Puzosia* sp), encased in 99 million-year-old amber. How it got there no one knows - presumably picked up by a bird and dropped onto a tree actively exuding resin?



Ammonite in amber

Mick then asked the question, where can you find ammonites? To which the answer was *'anywhere where Jurassic and Cretaceous rocks are exposed'*. In Britain this means anywhere broadly in a line stretching from Lyme Regis in Dorset up to the Whitby on the North Yorkshire coast and all counties in between including Buckinghamshire. Mick also identified some surprising outliers including locations on Skye and Mull, Carlisle and County Antrim.

Moving further afield Mick picked out Morocco as a particularly rich source for ammonites as several slides testified. Mick described how the rocks are *"so rich in beautifully formed ammonites that the locals have taken up ammonite mining",* with some tunnels stretching 40 metres into the hillsides to retrieve fossils sell to visitors.

Inside an ammonite mine, Morocco

As already mentioned, Mick has been collecting ammonites since childhood and gained enormous experience in working on his finds to bring out their best appearance. *'Hitting with a hammer can be a risky business'* was one clear message, with great potential to break the fossil you are trying to preserve. His tool of choice is an air pen (and air-abrasive) although this is not going to be available to everyone. The advice would be to scrape away slowly.


Ammonite before and after cleaning with an air pen

Fossils from clay can be tricky, e.g., the *Ringsteadia pseudoyo* ammonite (below), due to the risk of cracking after drying out if left exposed to the air for more than an hour or two. Keeping it damp (wrapping plastic bags) until you are able to process it is vital. Careful use of a scalpel and damp cotton buds can then reveal the delicate shell.


Revealing an ammonite by careful use of a scalpel

While the search for ammonites can provide much pleasure to the collector, ammonites in the fossil record are of immense importance for the study of geology. Mick described the wide geographical range achieved by some ammonites and their value therein for geologists. One slide showed a photo of *Reinekia anceps* found by Mick in India, along with a photo of the same species found in France. Another, *Mamites nodosoides*, found on the banks of the Humber has also turned up in Peru and Morocco. This world-wide distribution of ammonite species makes them very useful for correlating dates for geological strata across the world.

Mick moved on to describe how Frederich Quenstedt (1809-1889) and Alfred Oppel (1831-1865) developed the zonal scheme in Jurassic and Cretaceous stratigraphy based on which ammonites were found in each strata. As you move through the stratigraphic sequence the ammonites change, sometimes showing an evolutionary progression of species or sometimes a completely different species. Mick cited several reasons why ammonites are particularly suited to this purpose.

- They are found in many types of marine sediments
- They are relatively common
- They evolved rapidly, with many species present only for a short duration (geologically speaking)
- They are relatively diverse and easy to identify
- They have a world-wide distribution

Mick ended by showing how today, ammonites continue to be embraced in many walks of life, from jewellery, tattoos and even wine labels. Mick cited the particularly interesting example of Stuart Baldwin, stockist of scientific books and dealer in fossil reproductions, who wore a ring with a microconch shell of an ammonite on it while his wife sported one with the macroconch equivalent for the same species.

Sixty six million years after their extinction ammonites, it would seem, live on in many interesting and surprising ways.

Mike Palmer

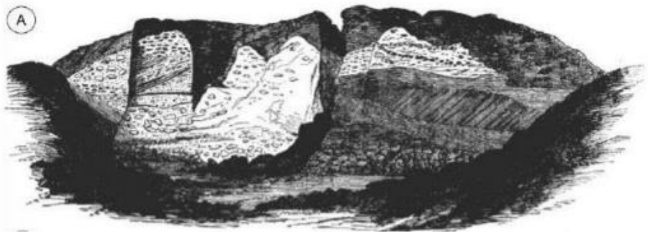
Zoom talks

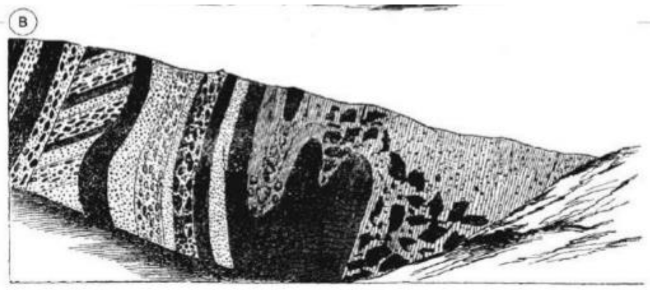
The glacial and periglacial history of the Middle Pleistocene Ice Margin of the British Ice Sheet in north Buckinghamshire. *Saturday 12th June*

Simon Price delivered a fascinating and detailed talk about the Buckinghamshire-based elements of his Cambridge University PhD thesis. His research covered the Quaternary of Bucks as very little attention had been paid to interpreting this part of the County's geological history. The field area covered not only Bucks, but also sections into Oxfordshire. His big question for the research was to discover if this part of England during the Middle Pleistocene was more similar to that of the West Midlands or East Anglia – both of these areas had already been very well investigated at the time he started the project. He also wanted to pinpoint the dating of events seen in Bucks. The timing of the Anglian ice advance was well recorded in the literature, but were the periglacial features and geomorphology seen in Bucks of Wolstonian or Devensian age? In this respect he pointed out how important the periglacial environment was – and that it was not 'all about the ice'. It was an interesting point made that all the multitude of maps that firmly show the maximum extent of ice at each glacial advance are actually based on very little evidence! For this kind of map it is the mapping of sedimentary deposits such as till, moraine and outwash deposits that is crucial. However, coming through Buckinghamshire this evidence is poorly exposed.

The research work was based on recognising Quaternary Domains which categorise geomorphology and sediment type. This is a good way of grouping geomorphology and hence deducing palaeoenvironments.

As exposures were patchy in distribution the archive material proved very useful. Old accounts of the early pits in Tingewick and Foscott showed diagrams of highly deformed and faulted sediment. These kinds of glaciotectonics in soft sediment are linked to periglacial activity.





Historic sketches of A) a former pit in Tingewick and B) Foscott (from Green, 1864)

The east-west railway line workings also proved very useful as the sediment records from Tingewick-Stowe-Buckingham-Bletchley showed a gradual change of domain from no glaciation to proglacial.

The series of logs drawn during the study provided the evidence required to prove the general domains across the region.

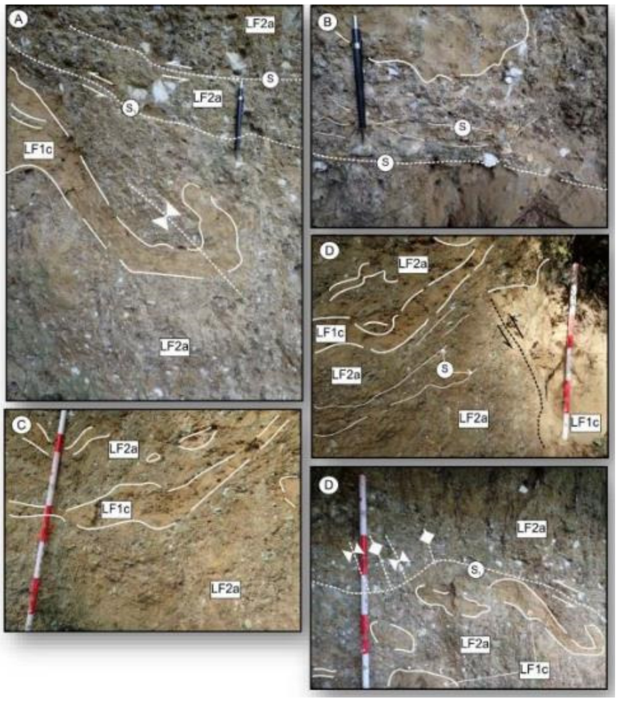
At **Bletchley (Newton Longville)** the bedrock is Oxford Clay overlain by a series of till, sands and gravels. A lot of the gravel is composed of flint and chalk clasts. The till is a blue-grey diamicton also with chalk clasts.

Moving westwards clay and silt dominate, and micro-faulting indicate brittle deformation. The succession includes subaquatic till with outwash sediment and the deposits of a pro-glacial lake. Deposition in shallow water is indicated by fine ripples.

In **Buckingham Sand Pit** there are three main facies:

1. Blue-grey till with chalk cobbles (and a second till seen in the east of the pit at the base)
2. Interbedded sands, silt and clay
3. Gravels and cobbles

The main till can be best seen in the boardwalk section nearest the rear gate. Here very distinct shear planes can be seen, along with overturned folds and sub-horizontal shears. There is some alignment of the chalk clasts. The lowest level in the quarry is where the lower till can be exposed by digging. This is very distinct to the till making up most of the main face. It is full of Triassic-derived clasts. It indicates a transport direction from the northwest. In contrast the upper chalky till indicated a transport direction from the northwest.



Buckingham Sandpit showing:

- *Deformed sequence of chalk-rich diamicton (till) and interbedded, laminated silty sand*
- *Overturned folds and sub-horizontal shear zones*

The Home Farm Pit section at Stowe shows two sand and gravel facies. The main unit is a reddish-brown series of sands and gravels, dipping and showing a range of sedimentary structures. The gravels have chalk clasts, lots of reworked Gryphaea from the Jurassic and, importantly, till cobbles. These reworked till cobbles are chalk-rich.

Home Farm Pit, Stowe

At the top is an irregular unit of dark reddish-brown sands. Past workers have interpreted this horizon as due to involution in response to periglaciation. Simon interprets this layer as being the result of dissolution of the paler chalk clasts, thus leaving the residue of darker sand. Looking at the evidence at Stowe with that of nearby localities led Simon to interpret this area as the result of a terminal glacial fan. It fits the bill in being a gravel rhythmite and has channels cutting down in many places. Notably, the till has not come very far, as it would have been destroyed by long transport.

Part of the research involved optically stimulated luminescence dating which resolved the following dates for these locations:

Home Farm, Stowe, till cobbles:	168 +/- 17
Buckingham Sand Pit, Upper till:	178 +/-17
Buckingham Sand Pit, Lower till:	205 +/- 13
Bletchley, till	145 +/- 10

These are minimum dates and this means that they may in actual fact be Anglian (as has been recorded previously), especially if light had not been kept out from the time of deposition (which results in a younger age).

The concluding interpretations from the field evidence observed were:

1. A pre-glacial environment was not seen.
2. The first till seen in Bucks is that in the lower part of Buckingham Sand Pit with Triassic-derived clasts.
3. Ice retreats (evidence in the coarse gravels and cobbles of Buckingham Sand Pit).
4. Glacial event 2 seen at Bletchley showing oscillation at the edge of a lake.
5. The main glacial event seen in the chalky tills of Bletchley and Buckingham Sand Pit with the latter affected by deformation.
6. De-glaciation and ice retreat.
7. As ice retreats Stowe gravels represent deposits at the ice margin and where the ice stood still for a while.
8. Periglacial involution superimposed on glacial sediments. Seen at many locations e.g. College Lake, Stowe.

The final conclusion was that North Buckinghamshire is much more similar to the West Midlands than to East Anglia.

Jill Eyers

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. Zoom talks are free.*

Booking: *Booking is usually required for all field meetings and indoor events to avoid meetings becoming oversubscribed and to allow organisers to communicate any last minute changes.*

Clothing: *Some trips, especially quarry visits, may require protective clothing such as helmets and high-vis jackets. These will be stated on the event flier nearer the time.*

Saturday 29th January, 4 – 5pm **Exploring Morocco's Palaeontological Riches.** A Zoom talk by Dr Mick Oates. Members will be emailed a link to our Zoom talks. Simply click on the link shortly before the talk and follow the instructions. If you are not a member, please contact bucksgeologygroup@gmail.com to request a link several days prior to the talk.

Saturday 19th February, 4 – 5pm **Rivers in time**. A Zoom talk by Dr Jill Eyers telling the story of rivers from the very first drop of water on Earth and taking you on a journey through time. How do rivers record ancient environments and what does this tell us of our geological past. The story goes on to the rivers we know and love today. Members will be emailed a link to our Zoom talks. Simply click on the link shortly before the talk and follow the instructions. If you are not a member, please contact bucksgeologygroup@gmail.com to request a link several days prior to the talk.

Saturday 27th March, 12.30 – noon **Hidden Aylesbury.** A walk with Dr Jill Eyers exploring the geology hidden in plain site of the town centre's buildings and streets. BOOKING ESSENTIAL. Please contact Jill at bucksgeologygroup@gmail.com for further details and to reserve your place

Sunday 24th April, 10am – 3pm **Coombs Quarry.** A beautiful walk with Dr Jill Eyers taking in the medieval Thornborough Bridge and Roman barrows before exploring the Jurassic rocks and fossils of the quarry. BOOKING ESSENTIAL. Please contact Jill at bucksgeologygroup@gmail.com for further details and to reserve your place.

Sunday 8th May, 11 – 11.30am **AGM** via Zoom followed by ***1.30 – 3pm*** **Field Trip to Northmoor Hill Nature Reserve** (near Denham) with Dr Jill Eyers to explore the geology and landscape dating from the Cretaceous to the Ice Age. BOOKING ESSENTIAL. Please contact Jill at bucksgeologygroup@gmail.com for further details and to reserve your place

Monday 30th May, **An MK Parks Trust event: Great Linford Rocks & Fossils.** Jill Eyers will be on hand to identify fossils and lead short tours of the old quarry. Please visit the Milton Keynes Park Trust website and click on 'event' for further information.

Saturday 4th June (times to be confirmed) **Local Stones and Rocks from afar in Buckingham.** A walk with Dr Tom Argles looking at the building stones of Buckingham. BOOKING ESSENTIAL. Please contact Jill at bucksgeologygroup@gmail.com for further details and to reserve your place

Saturday 25th June, 10am – 2pm **The Geologists of Hartwell House – his museum and garden** with Mike Howgate. Meet for tea, coffee and biscuits (cost £6) in the library of Hartwell House (a requirement for entry into the grounds) before an introduction by Mike to Dr John Lee and his mid-19th Century museum followed by a guided tour of the grounds to discover a range of geological features. There will then be an opportunity to visit the Discover Bucks Museum Resource Centre at Halton to see a selection of geological specimens collected by Dr Jon Lee. Places limited – BOOKING ESSENTIAL. Contact Mike Palmer at mpalmer@discoverbucksmuseum.org for further information and to book your place.

Membership Details

Membership is open to beginners and experts alike.

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.

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: julia.carey@buckinghamshire.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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