Hastings & District Geological Society Journal

Hastings and District Geological Society
affiliated to the Geologists' Association

President
Professor G. David Price, UCL

Founded 1992

Rock fall east of Ecclesbourne Glen, Hastings - 11th December 2009

Picture by David Burr

Volume 16 December 2010

Cover picture: Rock fall east of Ecclesbourne Glen, Hastings - photo: David Burr (see page 46 for article)

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2010 Officials and Committee

Hastings & District Geological Society Website - http://www.hastingsgeology.btik.com (This web address may change within the next 6 months. If you have problems accessing the site google 'Hastings & District Geological Society')

Geologists' Association Website - http://www.geologistsassociation.org.uk

Contributions for next year's Journal would be appreciated and should be submitted by the October 2011 meeting.
Please contact Peter Austen on: tel: 01323 899237 or e-mail: p.austen26@btinternet.com

This Journal is issued free to members of the Hastings & District Geological Society (HDGS) and is also freely available on the HDGS website.

HASTINGS & DISTRICT GEOLOGICAL SOCIETY

Minutes of the A.G.M. - 13th December 2009

The Meeting was declared open at 2.40 p.m. by the Chairman, Ken Brooks. There were thirty-one members present.

1) **Apologies:** Were received from:
Colin Parsons, Trevor Devon, Pat Littleboy, Pauline Mackay-Danton, and Jim Priestley.
Welcome: Ken welcomed guest Ferdinand Keller.

2) **Minutes of the last A.G.M.:** These were printed in the *H.D.G.S. Journal* which had been handed out to members. Their acceptance was proposed by Tony Standen and seconded by Pat Dowling, and a show of hands indicated that they were unanimously accepted.

3) **Chairman's report:**

a) 2009 Programme: Ken said that it had been another busy year and he summarised the year's activities:

Lectures by visiting speakers:
'Black Smokers and the Origin of Life' by *Dr*. Richard Herrington
'Messel - a World Heritage Site in Germany' by David Bone
'Fossil Fakes' by *Dr*. Chris Duffin
'Six Characters in Search of the Geology of East Sussex' by Tony Brook
'Tectonic Effects on the Crust' by *Prof*. David Price

Members' Day talks:
'Snowball Earth' by Ron Elverson
'Making a Mineral Collection' by *Dr*. Trevor Devon

Field Trips:
New Year's Day Walk
Dryhill Quarry & Moorhouse Sand Pits Quarry
Fairlight Cove
Natural History Museum

b) Ken said that attendances for meetings had been up yet again, the average being 31, and the highest 39 (for David Price's *'Tectonic Effects on the Crust'*).
He said that the field trip to Dryhill Quarry had started off in torrential rain, but that it had stopped by the time everyone arrived at Moorhouse Sand Pits, and he thanked John Boryer for leading the trip. He also thanked Peter and Joyce Austen and Gordon Elder for leading the trip to Fairlight Cove in June.
He said that the behind-the-scenes visit to the Natural History Museum had been extremely successful, visiting the palæontology store rooms and the preparation laboratories. He was also very impressed with the quantity of their dinosaur bones found in the Hastings area in the nineteenth century.
Ken explained that this year's barbecue party at Gordon's had had to be cancelled because of the weather.

c) Ken thanked Peter and Joyce Austen for the superb job they had again made of the *H.D.G.S. Journal*. He said that they had saved the Society a lot of money by doing all the printing, collating and stapling themselves, which commercially done would have cost about twice as much as the amount they had produced it for.

d) Ken explained that the subscriptions for next year had had to be increased for the first time since the foundation of the Society in 1992. This was to cover the cost of the *Journal*, the increase in the cost of hiring the hall for meetings, and guest speakers' expenses and fees.

e) *Awards For All:* Ken said that the Committee had spent a lot of time working on the application for this grant to buy a laptop and digital projector for the Society, but that it had been turned down. Although they had accepted our initial request, they said that we had applied to the wrong funding body and should have gone to the Heritage Lottery Fund. The Committee had made enquiries into this, but it would appear that the reasons for which we were turned down by *Awards For All* would also apply to the Heritage Lottery Fund. Ken said that the Committee was now looking into the possibility of approaching local funding bodies.

f) Ken said that Dale Smith and Chris Woodcock had been doing research into local quarries marked on old maps and had brought some of the maps along for viewing.

g) He said that we would be having a Christmas Raffle to help raise funds for the Society and thanked all those who brought prizes along and Siân Elder for taking charge of the raffle. The previous Agate Raffle in September had made £24.

h) Finally he said that there were more *Down to Earth* and *New Scientist* magazines for sale and that last year's sale of books and magazines had raised £31.10p.

4) Treasurer's report:

Diana had typed up Norman Farmer's *Statement of Income & Expenditure for the Year Ending 31st December 2009* which was handed out to members. Norman briefly ran through the items, saying that although there had been a slight surplus this year, the subscriptions had been increased to keep our heads above water. The acceptance of the report was proposed by Anne Hancock and seconded by Tony Standen.

5) Election of the Committee:

It was suggested that the Committee be re-elected again en bloc and this was proposed by Diana Nichols, seconded by Dale Smith and unanimously carried.
Ken said that another member was required and proposed that Pat Dowling should be elected as she had had experience on the Open University Geological Society committee and had also worked for Hastings Museum. This was seconded by Geoff Bennett and unanimously agreed. The Committee was said to be as follows:

2009	**2010**
Chairman	
Ken Brooks	Ken Brooks
Treasurer	
Norman Farmer	Norman Farmer
Secretary	
Diana Williams	Diana Williams
Journal editors	
Peter & Joyce Austen	Peter & Joyce Austen

Librarian & Education Officer	
Gordon Elder	Gordon Elder
Website manager:	
Trevor Devon	Trevor Devon
Other Officers	
1. Colin Parsons	Colin Parsons
2. John Boryer	John Boryer
3.	Pat Dowling

6) 2010 Programme: Copies were handed out to all members present. Those unable to attend would be receiving their copies with the next letter to members. Ken thanked Diana for her work in preparing the Programme and gave a brief résumé of next year's lectures:

- *'Building Stones of Canterbury'* - by Geoff Downer
- *'The Wealden Iron Industry'* - by Jeremy Hodgkinson
- *'Scientists Through Coelacanth Eyes'* - by *Dr*. Peter Forey
- *'The Giant Gastropod Mystery'* - by *Dr*. Paul Taylor
- *'Fossil Plants of the Jurassic'* - by *Prof*. Paul Kenrick
- *Presidential Lecture* - by *Prof*. David Price

He said that there would be two Members' Day talks this year, one of which would be:

- *'The Nautilus and the Ammonite'* - by Ken Brooks
- Another to be arranged. One idea put forward was a hands-on identification day.

The 'outings' for 2010 would be:

- New Year's Day walk at Fairlight
- Field trip to Sheppey where there is a variety of fossils from the Eocene Period in the London Clay. Ken mentioned the publication of an excellent new book called *London Clay Fossils of Kent and Essex* published by members of the Medway Fossil and Mineral Society.
- Barbecue Party with Trevor Devon
- Another field trip to be arranged. John Boryer suggested Lambs Philpots Quarry in West Hoathly and said that he would make enquiries. Peter Austen said that this was where Perce Allen did most of his work.
- Peter Austen said that there would be field trips to Smokejacks in April & September.

7) Any Other Business

- Ken reminded everyone of the New Year's Day Walk which would begin with optional lunch at the Smuggler Pub, Pett, at 12 o'clock. The walk itself would start at 2 p.m. from the pub and he said that this year the tides would be right for a walk along the beach where there had been several spectacular cliff falls. He asked members to let us know if they would like to have lunch first as a table had to be booked beforehand.
- Ken reminded members that their annual subscriptions were now due.
- John Boryer gave a vote of thanks to the Committee and they were given a round of applause.

Ken declared the Meeting closed at 3.10 p.m.

HASTINGS & DISTRICT GEOLOGICAL SOCIETY

Statement of Income & Expenditure for the Year Ending 31st December 2009

INCOME	£	EXPENDITURE	£
Subscriptions		**G.A. Affiliation fees**	33.00
Single 38 @ £12.50	475.00	**Hire of hall**	126.00
2 (part year)	12.50	**Society *Journal* production**	175.43
Family 13 @ £15.00	195.00	**Insurance premium**	138.00
		Stationery, copying, postage	115.55
N.B. in addition		**Society visits**	350.00
2 No. Single		**Lecture fees and expenses**	186.50
2 No. Family		**High visibility vests**	29.25
paid and included in		**Refreshments**	20.00
2008 accounts		**Advance for summer barbecue**	130.00
		Materials for display screen	9.73
Receipts from Society visits	480.00	**Purchase of books**	5.00
Repayment of advance for summer barbecue	130.00		
Raffle receipts	24.00		
Sale of books and magazines	31.10		
	1,347.60		1,318.46
		Surplus being excess of income over expenditure	29.14
	1,347.60		1,347.60

Bank Account and Monies in Hand

Balances as at 31st December 2008	£	Balances as at 31st December 2009	£
NatWest Bank	377.22	NatWest Bank	417.73
Monies in hand	30.89	Monies in hand	19.52
	408.11		437.25
Increase in Balances	29.14		
	437.25		437.25

December 2009

The Nautilus and the Ammonite

by Ken Brooks

H.D.G.S. Members' Day talk - 18th July 2010

This lecture was inspired by a poem in which an ammonite and a nautilus travel the world's oceans for millions of years until they are finally separated by extinction.

Fig. 1. The Nautilus (left) and Ammonite (right)

The Ammonite

Ammonites belong to a group of sea animals known as cephalopods which today includes their relatives the octopus, squid, cuttlefish and nautilus.

It was nearly 500 million years ago that the first cephalopods appeared in the ancient seas. From primitive organisms they gradually evolved into highly successful species, with the ammonites becoming most prolific during the Mesozoic, 250 to 65 million years ago.

The ancient Greeks gave the name 'ammonite' to this fossil because its coiled shape resembled the horns of the ram-headed Egyptian god, Amun.

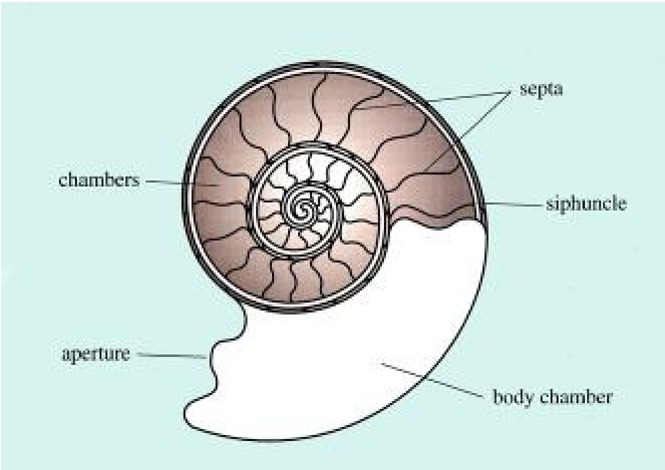

Fig. 2. Section through an ammonite.

An ammonite's shell has internal chambers (Fig. 2) which increase in size as they rotate around a central point. The largest chamber, with its open aperture, would have contained the ammonite's body. As the animal grew bigger, it secreted minerals to enlarge the aperture while at same time sealing off part of the shell behind its body, thereby creating a new chamber. The chambered interior of an ammonite is known as the phragmocone.

Most shells have about five or six whorls (rotations) and it has been estimated from fossil evidence that each whorl took from between four months to three years to grow.

A tube-like structure, called the siphuncle, linked the chambers by passing through the upper part (venter) of the coiled shell. A recently sealed chamber would contain sea-water but this was gradually replaced by gases (mainly nitrogen, oxygen and CO2) which diffused into the chamber through osmosis. Once filled with gas, a chamber generally stayed that way – though small amounts of water could re-enter through the siphuncle for fine tuning of buoyancy at various depths.

Some ammonites have been found with small calcite plates called aptychi. In the past it was assumed that each aptychi formed a cap which closed the opening of the shell to protect the animal from predators. However, more recent research seems to indicate that they were part of the jaw apparatus.
Although the fossilised shells of ammonites occur in huge numbers, almost nothing is known of their soft parts – apart from possible outlines of digestive organs and ink sacs which, in very rare cases, have been preserved. While no evidence of tentacles has been found, it can be assumed that ammonites were similar to modern cephalopods such as nautiloids and squids in this respect.

Much of what we know about ammonites has been worked out by studying their shells and by using models of them in water tanks. Occasional muscle scars preserved on the shell interior suggest that ammonites probably moved by forcing water through a funnel-like opening to propel themselves in the opposite direction (jet propulsion!).
Some ammonite fossils reveal intricate suture patterns which formed beneath the external shell wall and locked each chamber together like jigsaw puzzle pieces. Sutures are often visible where the shell has been worn away either by erosion or through artificial polishing. As well as serving to lock the chambers together, the construction of complex sutures probably provided extra strength to the shell when diving to deeper water. As every species of ammonite has its own unique suture pattern, this can provide a very useful means of identifying particular specimens.

Fig. 3. Spiral ammonite.

Those with thick-ribbed shells were likely to have been slow-moving bottom-dwellers. Fossil evidence indicates that their diet included molluscs and crustaceans which lived on the sea-floor. These ammonites were themselves preyed upon by larger predators and have been found showing teeth marks from such attacks. However, mollusc borings in ammonite shells are sometimes misidentified as teeth marks. Having strongly-ribbed and thick shells, sometimes with protective spines, would certainly have increased their chances of survival. They may also have escaped from an attack by squirting ink, much as modern cephalopods do.
Ammonites with flattened, discus-shaped, streamlined shells are thought to have been fast-moving hunters which fed on various marine creatures including fish and even their own kind. An attack probably involved stalking their prey, then rapidly extending tentacles to grasp the victim, which would be torn apart by strong, parrot-like jaws. These are believed to have been located between the eyes at the base of the tentacles.

The majority of ammonites have a shell that forms a flat coil, known as a planispiral (Figs 5 & 6). However, some have shells that are almost straight – such as *Hamites* from the Gault Clay. These partially uncoiled and totally uncoiled forms began to diversify during the early part of the Cretaceous. Other species, known as heteromorphs, evolved with shells coiled into a helix shape (Fig. 3), resembling a *Turritella* gastropod. Perhaps the most bizarre looking example of a heteromorph is *Nipponites* (Fig. 4), which is found in Japan and the USA. It appears to be a tangle of irregular whorls without any obvious symmetry. However, upon closer inspection, the shell is actually a three-dimensional network of connected 'U' shapes. Some theories suggest that ammonite shells

*Fig. 4. Knotted ammonite (*Nipponites*).*

evolved with various shapes and sizes because this played an important part in their social and mating behaviour.

During their evolution the ammonites faced no less than three catastrophic extinction events. The first occurred during the Permian (250 million years ago), when only 10% of species survived, but these managed to expand throughout the following Triassic. However, after another huge extinction event at the Triassic/Jurassic boundary (200 million years ago) only one species remained. Despite this, during the next 150 million years, their numbers increased and diversified once more. Finally, in a disastrous extinction event at the end of the Cretaceous period, 65 million years ago, all of the ammonites totally disappeared. The ash and dust from a meteor impact and volcanic eruptions would have blotted out sunlight around the earth for months or even years. It has been estimated that this would have killed off much of the planktonic plants and zooplankton in the sea – possibly the very food upon which the tiny ammonite offspring depended for their survival. Another factor may have been the huge increase in predatory fish during the Upper Cretaceous – a theory which is supported by teeth marks on ammonite shells. Fossil evidence also indicates that ammonite species had been in decline for around 30 million years before this extinction – an event which proved to be the last straw for them.

When ammonites died and sank to the sea-floor they were gradually buried in accumulating sediment. Bacterial decomposition of soft parts often resulted in the precipitation of minerals which formed a hard concretion around their shells.

Most fossils have been preserved as a result of mineralisation. Such minerals include quartz and iron pyrites (Fig. 5), but the most common is calcite, a mineral dissolved from limestone by groundwater and transported in solution. In a process known as diagenesis, original aragonite shell material is gradually replaced by recrystallised calcite to produce a detailed replica. Sometimes, when a shell disintegrates completely within a short time, the empty space is filled with sediment which eventually hardens to become a fossil cast with no internal structure.

Fig. 5. Pyritised ammonite from Lyme Regis.

Ammonites may be found in many sizes - ranging from millimetres to metres. The Portland stone near Swanage contains *Titanites*, which is often 60 cm (2 feet) in diameter. One of the largest recorded specimens, measuring up to 2 m (6.5 feet) across, was found near Münster in Germany.

There are species that display iridescence in their shells, although this would not have been visible during the ammonite's life. The colours are created by refraction of light and the microscopic structure of the fossil shell material. When such fossils are found in clays their original mother-of-pearl shell may be preserved as an iridescent coating. This effect is often found in specimens from the Gault Clay of Folkestone while other beautiful examples (*Psiloceras*) can be seen in the Jurassic shales at Watchet in Somerset.

Today ammonites are abundant in the Jurassic limestones of Dorset and Yorkshire, and the Cretaceous chalk of Kent and Sussex. They make ideal index fossils for dating rocks because certain species lived within well-defined time periods. It is often possible to link the rock layer in which they are found to specific geological periods and therefore geological maps can provide excellent guides to the best locations for collecting.

In medieval times fossilised ammonites were thought to be petrified snakes, and were called "snakestones" or "serpent stones". According to a famous legend dating from the 7th century, a local Saxon abbess named Hilda wanted to build an abbey on the cliffs overlooking the sea at Whitby. Unfortunately, the site was plagued by snakes, but on Hilda's command they hurled themselves over the cliffs. After writhing and curling up as they fell through the air, the snakes hit the beach and immediately turned into stone. Hilda was later canonised to become Saint Hilda.

In the 17th century three snakestones were incorporated into the Whitby coat of arms, and in 1808 the legend of St. Hilda was immortalised by Sir Walter Scott in his poem, Marmion.

> Thus Whitby's nuns exulting told -
> How that of thousand snakes, each one
> Was changed into a coil of stone,
> When holy Hilda prayed.

Since then many generations of local people have sold 'St. Hilda's serpents' to visitors. The absence of heads on the snakestones was difficult to explain, so the enterprising inhabitants simply 'restored' the heads by carving them on the ammonites.

To commemorate the legend of St. Hilda a particular species of ammonite, *Hildoceras* (Fig. 6), was named after her.

Fig. 6. The ammonite Hildoceras bifrons *from Whitby.*

The Nautilus

The name 'Nautilus' is derived from the ancient Greek word for 'sailor', perhaps because it reminded them of a ship bobbing in the sea. Today, the nautilus is often described as a "living fossil" because it has remained virtually unchanged for more than 400 million years.

Fig. 7. Section through a nautilus.

Its shell is formed from a nacreous aragonite with a white iridescent inner layer (mother-of-pearl). Like the ammonite, a nautilus retains its original shell throughout life and creates larger chambers as it grows. The rotating chambers increase in number from around four, when hatching, to thirty or more in adults. This produces a structure which is well known as one of the finest examples in nature of a logarithmic spiral (Fig. 7). However, unlike the ammonite, which has its siphuncle at the top edge of its shell, the siphuncle of the nautilus rotates through the middle of the shell.

The nautilus is a predator which feeds mainly on shrimp, small fish and crustaceans, but because very little energy is expended in swimming it only needs to eat about once a month. It usually has up to ninety short tentacles – more than any other cephalopod. These are arranged into two circles around the mouth and have a very strong grip. Instead of pads and suckers the tentacles have ridged surfaces which enable them to stick to their prey. It also has powerful parrot-like jaws that are capable of slicing through the hard exoskeletons of arthropods.

In order to swim, a nautilus uses jet propulsion by forcing water into and out of the living chamber with a funnel called the hyponome. Despite having a bulky shell, it is capable of making rapid darts and turns as well as being able to hang motionless in the water. It is able to achieve this because, like the ammonite, its shell has gas-filled chambers which can be adjusted to give neutral buoyancy. However, a nautilus shell cannot cope with extreme pressures. At depths greater than about 800 metres (2,600 ft) it would almost certainly implode.

The animal has excellent camouflage in the water. When seen from above, the shell is darker in colour and marked with irregular stripes, which help it to blend into the dark water underneath. The underside is almost completely white, making the animal almost invisible when viewed from below.
Unlike many other cephalopods, the nautilus does not have good vision. Its eye structure is highly developed but lacks a solid lens. It has a simple ‘pinhole’ eye which is constantly open to the environment. Instead of vision, it is thought to use smell as the primary sense for finding food and locating potential mates.

Despite their similarity in life style and design, the fact is that the nautilus survived while the ammonite disappeared in the last mass extinction, 65 million years ago. It appears that while the shallow-water ammonites were affected by catastrophic events which killed off the plankton, some of the nautilus species were able to survive by moving to deeper water to find food.
Today the nautilus belongs to a group which comprises seven living species and a single sub-species that is found only in the Indian and Pacific Oceans. Most of them never exceed about 20 cm (8 inches) in diameter, although one species from western Australia may reach nearly 27cm (1 ft).
They usually inhabit the deep slopes of coral reefs at about 300 metres (980 ft), and move towards the surface at night to feed, mate and to lay eggs. Females spawn once a year and attach the fertilised eggs to rocks in shallow waters, where the eggs take eight to twelve months to develop and hatch. A nautilus may live for over 20 years – an exceptionally long life-span for a cephalopod.

Unfortunately, the ‘great survivors’ are now facing their greatest challenge – humans. Thousands of nautiluses are caught for their shells, which are sold as souvenirs or carved into jewellery or buttons. Their numbers are declining and sadly one population in the Philippines has already been wiped out.
After the nautilus has survived all that Earth can throw at it over 400 million years, it is up to us to make sure it isn’t pushed into extinction by the most voracious predator of all!

THE NAUTILUS AND THE AMMONITE

The Nautilus and the Ammonite were launch’d in storm and strife;
Each sent to float, in its tiny boat on the wide, wide sea of life.

They roam’d all day, through creek and bay, and travers’d the ocean deep;
And at night they sank on a coral bank, in its fairy bowers to sleep.

And the monsters vast, of ages past, they beheld in their ocean caves;
And saw them ride, in their power and pride, and sink in their deep sea graves.

Thus hand in hand, from strand to strand, they sail’d in mirth and glee;
Those fairy shells, with their crystal cells, twin creatures of the sea.

But they came at last, to a sea long past, and as they reach’d its shore,
The Almighty’s breath spake out in death – and the Ammonite liv’d no more.

And the Nautilus now, in its shelly prow, as over the deep it strays,
Still seems to seek, in bay and creek, its companion of other days.

And thus do we, in life’s stormy sea, as we roam from shore to shore;
While tempest-tost, we seek the lost – but find them on earth no more!

G. F. Richardson 1851

Dinocochlea – 'The Giant Gastropod Mystery'

Report of a talk given by Paul Taylor (NHM) – 18th April 2010

by Peter Austen

Introduction

On our Society visit for a 'Behind the Scenes' look at the Natural History Museum in October 2009, Paul Taylor, a research scientist in the Palaeontology Department at the Museum, kindly brought out part of a large spiral rock structure for our party to inspect. The specimen was found in the Hastings area in 1921, and had been named *Dinocochlea*, although it is informally known as the Hastings 'giant gastropod'. Paul had been researching the origins of the structure, and was due to publish a paper giving the results of his research. He had already published the first part of the story in the magazine *Deposits* (Taylor and Sendino 2009), with the conclusion to follow after the formal publication of his work in the journal *Palaeontology*. Our Chairman, Ken Brooks, invited Paul to come and speak to our Society on his work, particularly as the specimen was found in the Hastings area, and Paul kindly agreed.

Paul came to address our Society on the 18th April 2010, and what followed was a fascinating talk covering the story of the discovery of *Dinocochlea*, its subsequent interpretation, the characters involved, and Paul's work on the specimen, explaining how he thought the structure had been formed. Although this is a report on Paul's talk, I have included in the appendix some relevant local newspaper articles from the time, and a later exchange of correspondence in the *Sussex County Magazine*.

Fig. 1. Photo of Dinocochlea *in the position that it was found. (from Woodward 1922)*
Photo: Mr. H. T. Pottinger, Stepney (1921).

Dinocochlea – discovery and description

In 1921 while workmen were constructing a new road connecting St. Helens Road and Sedlescombe Road North they uncovered some large spiral structures, lying horizontally in the rock (Fig. 1). The cutting was close to the Old Roar waterfall, not far from Hollington Quarry and passed through some sandy beds of the Wadhurst Clay, part of the Lower Wealden Hastings Beds (for location see figure 2). The engineer in charge of the roadworks, Mr. H. L. Tucker (Anon. 1922b), immediately informed Mr. W. R. Butterfield, the curator at Hastings Museum. Unfortunately, explosives had to be used to break up the large structure which meant that some parts of it were destroyed, but enough remained, including crucially the apex of the spire, for a reconstruction to be made, and Mr. Butterfield had been able to observe the structure before its removal by explosives.

Fig. 2. Location of Dinocochlea *find.*

The specimens were sent to Dr. Arthur Smith Woodward, the Keeper of Geology at the then Geological Department of the British Museum (Natural History), now the Natural History Museum. Dr. Smith Woodward passed the specimens on to a colleague, the recently retired BM(NH) head librarian Mr. Bernard Barham

Woodward (no relation) who was an expert on molluscs, for him to study and describe. B.B. Woodward was convinced that the structures were the "internal casts of a large univalve molluscan shell", basically a large gastropod, and in 1922 published a paper formally naming it as *Dinocochlea ingens* (Woodward 1922), the largest reconstruction being 7 ft 3 ins (221 cm) long (Fig. 3) – a true monster of a gastropod (Fig. 4).

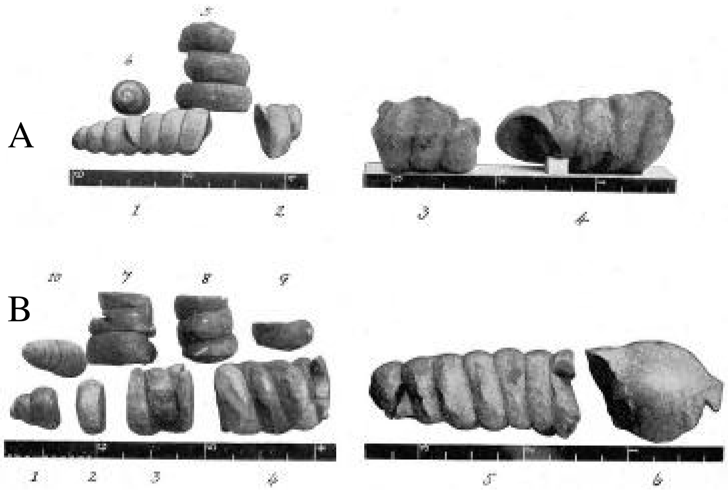

Fig. 3. Fragments of Dinocochlea *reconstructed to form two individuals – A. Sinistral form and B. Dextral form. (from Woodward 1922)*

Another character involved in the discovery of the giant gastropod was William J. Lewis Abbott, who had moved to Hastings in 1898 and opened a jewellers shop in St. Leonards. In an unpublished manuscript Lewis Abbot had noted the discovery of similar spirals in around 1900 at the nearby Hollington Quarry. In a newspaper article (Anon. 1922a) detailing an excursion that Mr. Lewis Abbott had led for the *Hastings and St Leonards Natural History Society* in May 1922, the author, who although not named is probably Lewis Abbott himself, clearly gives the impression that Lewis Abbott was responsible for the discovery of *Dinocochlea*. This claim was refuted by Kennard (1947), who also suggested that specimens that Lewis Abbott had given to the British Museum were taken from the excavations without permission. Lewis Abbott was also on a short-list of possible culprits who assisted Charles Dawson in the now infamous Piltdown Man fraud (Weiner 1955).

Not everybody agreed with B.B. Woodward's interpretation of the structure, and within days of Woodward's paper being published, Butterfield published an article in the *Hastings & St Leonards Observer* (Butterfield 1922) praising B.B. Woodward's reconstruction of the structure, but expressing grave doubts as to whether it was actually a gastropod. Butterfield had seen similar concretions at the excavations (Fig. 5) showing a spiral structure, but they were clearly not gastropod. Others were to follow – Leslie Reginald Cox published two papers showing that *Dinocochlea* was not a gastropod (Cox 1929, 1935), and publication of Cox's 1935 paper led to an exchange of correspondence in the *Sussex County Magazine* (Martin 1935; Belt 1936). H. Dighton Thomas (1935) also agreed with Cox that they were not gastropods. Within the scientific community Lewis Abbott and B.B. Woodward were the only two people who still believed it was a gastropod.

Fig. 4. Reconstuction of dextral form of Dinocochlea*. (Replica – Hastings Museum: original is in the Natural History Museum) Photo: Marjorie Hutchinson*

Fig. 5. Concretions found in association with Dinocochlea*. (from Cox 1935)*

Evidence against *Dinocochlea* as a gastropod

There are a number of reasons to suggest that *Dinocochlea* is not a gastropod.

Dinocochlea measures an incredible 7 ft 3 ins (221 cm) in length – the largest present day gastropod, the Australian Trumpet shell, *Syrinx aruanus* (Fig. 6), is only a third of that size at 73 cm.

When a mollusc dies and is fossilised, the hollow interior of the shell is normally filled with mud or sediment, and the shell itself is dissolved away leaving a hollow outline of the shell structure, known as a steinkern. We would therefore expect to see gaps in the spiral structure of *Dinocochlea* where the shell would have been, but there is no evidence of this. There is also no evidence at all of any shelly material remaining.

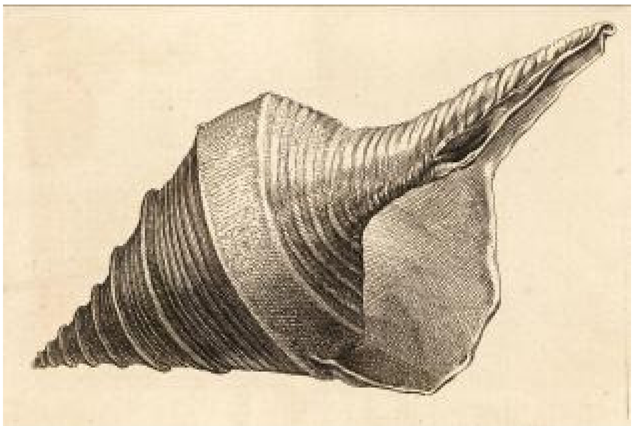

Fig. 6. The Australian Trumpet shell, Syrinx aruanus. *(drawing by 17th Century artist Wenceslaus Hollar)*

All gastropods start life as babies, with a tiny first spiral (a protoconch). As the gastropod grows it retains its tiny tip and becomes larger further down its length. No matter how large it grows it will always retain its tiny first spiral (see the tip of largest present day gastropod in figure 6). This is not the case in *Dinocochlea* – the first spiral is enormous and it is impossible to have a baby gastropod this big.

The spirals of gastropods are either right-handed (dextral) or left-handed (sinistral), but with the rare exception of aberrant forms, they are never both within the same species. With *Dinocochlea* we have a number of both dextral and sinistral forms (Fig. 7).

At the large end of a gastropod you would expect to see an aperture in the shell, within which the animal would have lived. This is not the case in *Dinocochlea* – despite some reconstructions showing an aperture, the large terminal end on all of the specimens found was rounded, with no evidence of an aperture.

Gastropods normally grow with mathematical regularity in a logarithmic spiral. Woodward (1922) claimed that *Dinocochlea* followed this mathematical regularity, but whilst the missing parts of *Dinocochlea* were filled in using this logarithmic approach, it was not really true for the actual parts of *Dinocochlea*.

Other alternatives for *Dinocochlea*

A number of other alternatives were considered for *Dinocochlea*.

Giant coprolite (fossil excrement):
– Spiral coprolites are quite common – they mainly come from sharks due to a spiral valve that forms their digestive tract and in fact many of the spiral coprolites found are actually casts of this spiral digestive tract.
– Hollington Quarry, where Lewis Abbot first reported finding *Dinocochlea*, had also yielded remains of the large herbivorous dinosaur *Iguanodon*, which could be a possible source of large coprolites.
Unfortunately neither of these explain *Dinocochlea*.

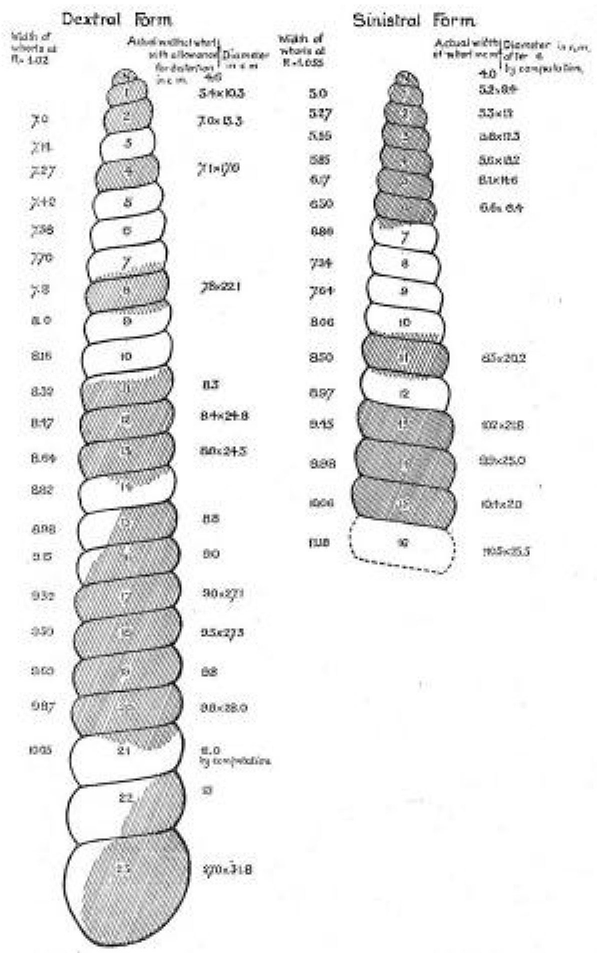

Fig. 7. Reconstruction of dextral and sinistral forms of Dinocochlea. *(from Woodward 1922)*

Neither sharks nor dinosaurs could have produced coprolites the size or even the shape of *Dinocochlea*. In fact *Iguanodon* coprolites are not known from the fossil record, mainly due to their food source being almost entirely vegetation. Most coprolites are from theropods – theropods eat meat and bone, so their coprolites contain more minerals and phosphates and are thus more likely to fossilise.

Burrows: Another option considered was that of burrows. Large spiral burrows have been found in Tertiary deposits, sometimes made by beavers, but of course there were no beavers in the Cretaceous and in any event their burrows form an open (corkscrew type) spiral, rather than a closed spiral. Other spiral burrows are common in the fossil record but they are normally quite small, being made by small invertebrates like shrimps or worms. Also *Dinocochlea* was found horizontally within the sediments, whereas most burrows are vertical, although some small invertebrates such as the worm *Helicodromite*s do make horizontal burrows.

Concretions: Concretions are inorganic pseudofossils. They are hard structures in sedimentary rocks formed by segregation of cements during diagenesis. They often grow by radial accretion of cement and some have an organic nucleus, such as a shell. They are usually spheroidal, but can be more complex in shape, taking on the rough shape of the animal that they are growing around, and their composition varies – they can be carbonate, siliceous or phosphatic.
As mentioned above Butterfield noted that ordinary concretions (Fig. 5), which were clearly not gastropod, were also found in association with *Dinocochlea*.

So, what is *Dinocochlea*?

Dinocochlea is actually a combination of two of the above. It's a spiral burrow that formed the nucleus around which a concretion grew.

Paul showed us examples of various stages of burrow-cast concretions, as well as burrows in flint from the chalk of Speeton in Yorkshire, and also structures called "Mummy envelopes" where concretions formed around burrows. He also showed examples of sandstone concretions from the Wadhurst Clay (known as the Tilgate Stone) found along the Hastings coastline today (Fig. 8).

Fig. 8. Sandstone concretions (Tilgate Stone) from the Wadhurst Clay along the Hastings coastline.
(from Brooks 2001)

The spiral burrow that formed *Dinocochlea* would have been made by a small worm, with a diameter possibly no wider than 1 mm and around 1 cm long. It would have fed by moving through the sediment and a slight asymmetry in its body layout would mean that it had a natural tendency to move in a spiral, as do some present day worms. As it fed and grew the radius of the spiral would have increased, and it is possible that the 7 ft length of *Dinocochlea* may have represented its complete life cycle.

In moving through the sediment it would have left small organic traces where it had been. The bacterial decay of the organic matter in the burrow would have increased the alkalinity, thus encouraging the precipitation of calcium carbonate forming the concretion. Paul estimated that the concretion would have taken around 10,000 years to grow. Over time this would have grown outwards from its initial nucleus and eventually coalesced, forming a closed (involute) coil.

Fig. 9 shows a cross section of one of the concretions that formed *Dinocochlea*, the centre being where the small worm would have been burrowing and feeding. Other sections through the concretion showed that this was consistent throughout the spiral stucture.

Finally, Paul found a computer programme on the web that simulated the growth of a corkscrew-like coil similar to a burrow. This showed that it was possible for a very small spiral burrow to grow into a structure very similar to *Dinocochlea*, with all of the spaces between being completely filled. This, together with all the other evidence was the final piece in the puzzle.

Fig. 9. Section of Dinocochlea *at the Natural History Museum showing the concentric growth of the structure from a central nucleus (arrowed). (£1 coin for scale)*

Photo: Diana Williams.

Paul's conclusion, supported by the evidence he presented, was that *Dinocochlea* was a concretion that had grown around a spiral burrow made by a small worm. His explanation was certainly the most convincing that I've heard as to the true nature of *Dinocochlea*, and hopefully will put to rest a puzzle that has endured since the structures were first discovered nearly 90 years ago. For those of us who wanted more, Paul and *Dinocochlea* appeared four days later (22nd April) on the last programme of the BBC's excellent series looking at the work of the Natural History Museum – "*Museum of Life*".

Acknowledgements

With thanks to Anthony Brook for bringing to my attention the *Sussex County Magazine* articles, and to Ken Brooks for the *Hastings and St Leonards Observer* articles.

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Appendix - Transcript of *Dinocochlea* articles

Hastings & St. Leonards Observer – 10th June 1922

MORE ABOUT THE GIANT FOSSIL SNAILS.

—— :o: ——

BY THE CURATOR OF HASTINGS MUSEUM.

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Mr. W. R. Butterfield, curator of the Hastings Museum, provides some further particulars of the large fossil snails recently discovered. He writes:—

"A few months ago I gave a very brief account of some fossils of large size, which had been found near Silverhill, in making the new arterial road, and which Mr. Philip H. Palmer, the Borough Engineer, courteously permitted to come to the Hastings Museum, as their rightful and appropriate home. At the time I wrote the specimens were at the Geological Department of the British Museum, where they were undergoing expert examination. While specimens are being examined by specialists, it is the custom amongst naturalists to be reticent about them, and especially is this the case if there are grounds for believing that the specimens represent species new to science and because of this I was precluded from making more than a bare announcement. The ban, however, is now lifted, as the results of the examination are published in the June number of the 'Geological Magazine.'

"At the desire of Dr. A. Smith Woodward, Keeper of the Department of Geology, Mr. B. B. Woodward undertook to examine and describe the fossils, and he has accomplished his task—a task of uncommon difficulty, owing to the fragmentary nature of the specimens—in a most able manner. He concludes that the fossils are the internal casts of a large univalve molluscan shell, of a genus and species hitherto unknown. The name he has invented for the creature is *Dinocochlea ingens*; that is the large fearsome shell. The creature must have been an inhabitant of freshwater lagoons, as one cannot imagine that a mollusc of such ponderous bulk could have been a land animal, or could have lived in the flowing waters of a river. It required to live in more or less tranquil water, where it would have support for its great weight, and where there was least risk of damage to its vulnerable shell. Mr. Woodward has restored the principal specimen found, and he gives a diagrammatic figure of it, from which we learn that the shell attained to a length of just over seven feet. This restoration seems to me to be a most interesting piece of work. I saw the specimen, now restored, whilst it was lying in the rock, and before it had been disturbed, by the workmen at the excavation. The explosion in blasting had wrecked portions of it, and some of the whorls had been shattered into such small fragments, which, moreover, were scattered in all directions, that it was quite impossible to put the pieces together again. Fortunately, however, the apex of the spire was untouched by the explosion, and lay in its original position, and thus it was easy to ascertain the total length. I am glad to be in a position to state that the actual length, as estimated at the time, agrees most closely with Mr. Woodward's restoration. It is also certain that the restoration is in all other essentials, a faithful representation of the original. The exact number of whorls may or may not be correct. The point is one which does not matter very much, and which cannot be settled at the present time. Nor does it matter greatly that the author has included in his restoration certain whorls which clearly belong to a different individual.

Whether these casts will be finally accepted as representing a gigantic Wealden Gastropod seems to me to be a little doubtful. A disturbing element in the find was the presence, along with the fossils (if fossils they be), of concretionary masses of sand-rock, some of very large size, and the difficulty was to distinguish between concretions and fossils. Mr. Woodward states that the twist of the fossils conforms to the law of the logarithmic spiral, and that no known concretion does so. But some of the bodies, which are admittedly concretions, exhibit spiral features. There is at the Hastings Museum a large concretionary mass in which a spiral twist is plainly traceable. I suspect there is a closer connection between the concretions and the so-called fossils than is supposed by the author, and that, if the true nature of the concretions could be demonstrated, much light might be thrown upon the fossils.

There is also another point which still remains obscure. The interior of a spiral molluscan shell is not like the interior of a bucket or of a drain-pipe; that is to say, it is not a cavity bounded by simple outer walls. The whorls of a spiral shell continue into the interior of the shell. I suppose everyone is familiar with the beautiful structures revealed when half a spiral shell is ground away lengthwise. In the fossils all traces of the internal structures of the shell are completely obliterated. It is, of course, easy enough to understand that, by a process of gradual solution, the shelly matter itself, both externallv and internally, might wholly disappear; but in such large casts as these are the probability is very slight indeed that every trace of internal structure would likewise disappear. Mr. Woodward explains the matter by supposing that on the dissolution of the shell, the ponderous cast, while yet in a plastic state, shrank upon itself, and obliterated all traces of the shell. But surely at the time the cast was in a plastic state the shell would be present; one cannot suppose it had been dissolved away at so early a stage.

These casts look exactly as if they were composed of hardened silt, which has filled spiral cavities bounded by nothing but outer walls. In some cases the casts do show internal markings at the fractures, but these markings seem to point to nothing more than that the cavities were not silted up all at once, but by successive stages—in other words, they are lines of accretionary growth. It was the presence of these well-pronounced markings, of purely inorganic character combined with the absence of even the faintest trace of internal organic structure, that first led me to feel a little doubtful that we are dealing here with fossils at all, and I cannot but feel a little doubtful still. Beyond their external form, which certainly simulates to an astounding degree a spiral molluscan shell, there is nothing much else that I know of to support the view that they are fossils.

Newspaper article - source unknown - 16th June 1922

7-FEET SNAILS.

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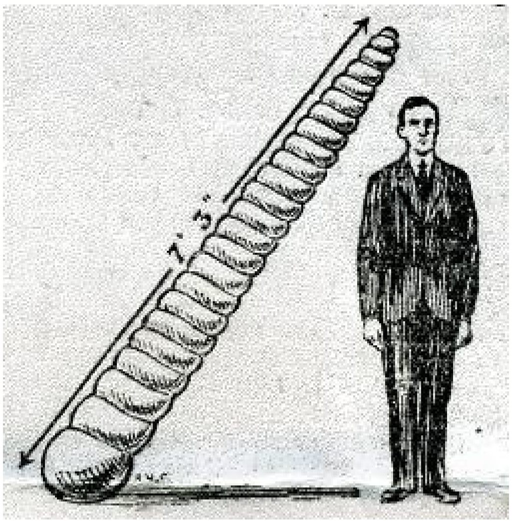
Giants of 80 Million Years Ago.

The casts of giant spiral snails, 80 millions of years old, over 7ft. in length and each with some 60ft. of winding passages, have been discovered during the



cutting of an arterial road by the Hastings Corporation. The spot was near Silver Hill, to the north of St. Leonards. The discovery has created quite a stir in geological circles, and geologists are asking:

> **How could this colossus of its class suddenly appear and again disappear leaving no descendants?**
>
> **What did the monster feed on, and what preyed upon it?**

It is thought that these snails were contemporary with the huge snake-necked monsters which roamed the earth in the early days of the world.

The discovery of the spiral bodies was made by Mr. H. L. Tucker, acting as engineer to the Hastings Corporation. The casts were in the cavities of the surrounding sandstone and were badly broken by blasting.

The fragments were sent to the Natural History Museum, South Kensington, where Mr. B. B. Woodward, the geologist, set to work on piecing them together. By an ingenious mathematical formula for a spiral he was able to plot out on paper the theoretical shape of the shell.

He found that Nature had constructed her spiral so accurately 80,000,000 years ago that it differed from an accurate mathematical spiral by less than 1 per cent.

The curious reader will find a technical description of the discovery, together with photographs, in the June number of the "Geological Magazine."

Sussex County Magazine, Vol.9 (1935), p. 719-720

The Hastings Giant Spirals

Lovers of Sussex and its geology cannot fail to be interested in the article by L. R. Cox on the "Hastings Giant Spirals," in *The Hastings Naturalist* for August, 1935. Herein is fairly weighed the evidence for and against *Dinocochlea ingens* being a giant mollusc, and the possibility of it being merely a concretion, but admittedly an extraordinary one. If it were a mollusc, it must have been a creature that had sported from the normal, and was but one of many others that were found at the same time in the ferruginous sandstone of the Wadhurst Clay at Silverhill. Mr Cox's conclusion is that all these spiral bodies, of which there are several measuring over six feet in length, must have been concretions, although, as he says, it is difficult to suggest any causes or conditions which would make a concretionary growth take the form of a spiral. Therein lies a great difficulty indeed.

Why I am writing this is to show to what end we are tending, if we begin to attribute to natural concretionary causes the formation of fossils which we do not wish to accept as organic remains. Dr Plot attempted to explain fossils for the most part as "formed stones," and to show that the stones we now find in the form of shell-fish were really "*lapides sui generis*, naturally produced by some extraordinary plastic virtue, latent in the earth or quarries where they are found." "How many hundred things are there in the world," he says, "that have some resemblance of one another which nobody will offer to think were ever the same. . . ."

Of course the idea that fossils were what were called "formed stones" was not new in Plot's time (1677). In the very early days of geology, the general idea was that there existed in the earth a "plastic force" which imitated natural objects, resulting in *lusus naturae*, "figured" or "formed" stones. Their formation was attributed to some occult influence from the stars. Da Vinci (1452-1519) ridiculed the idea and was convinced that fossils were really the remains of living creatures. But this did not prevent Mercati, in 1574, describing the fossils in the Vatican, denying that they were organic remains, but maintaining that the stones had been brought to that shape by starry influences. Even Martin Lister (1638-1712) wrote: "I am apt to think there is no such matter as petrifying of shells in the business; but that these cockle-like stones are everywhere as they are at present, *lapides sui generis*, and were never any part of an animal." Geikie's *Founders of Geology* gives many of these early interesting theories that were held concerning fossils.

Interesting concretions are to be found in the Magnesian Limestone, as everybody knows, and the late Dr Abbott wrote a good deal about them. But I know of no concretion that shows the spiral form of the gasteropods [*sic*] so clearly as does the Hastings giant. Before we abandon the clearly-designated solution that these forms are the remains of giant molluscs, it is manifestly for those who oppose this solution to show us more clearly where spiral concretions of the same size and length are to be seen.

In passing, it might be interesting if the many remains of this spiral that were formerly in the possession of the late Lewis Abbott could be traced. The whole assemblage should be re-examined carefully. The reconstructed remains set up vertically in the Hastings Museum can scarcely be called a successful reconstruction. As Mr Cox shows, they were found in a horizontal position in the strata, but have been set up vertically, and it may be questioned if the reconstructed parts are really accurate. In particular, the end where the aperture should be must be quite incorrect. If it were intended to show it as a mollusc surely something resembling the aperture of a mollusc should have been reconstructed, or failing that, it would have been wiser simply to show the whorls themselves as found in the strata, without any reconstruction whatever.

But the problem will still remain. It is no argument against its organic origin to say that because nothing of the sort has ever been found before, therefore its molluscan origin is improbable. We might just as well doubt the former existence of the six-foot lobster-like *pterygotus* of Devonian times if mere size is considered. We might as well doubt if the giant *ortloceras* of carboniferous times was a cephaloped [*sic*], and attribute it to a "plastic force" in nature. It is for those who say that *dinocochlea* is a concretion to prove it, or they may be placed in the same category as Plot or Martin Lister, with their *lusus naturae*.

EDWARD A. MARTIN.

<u>Sussex County Magazine, Vol.10 (1936), p. 66-67</u>

Hastings Giant Spirals

The question of the origin of these spirals, about which Mr E. A. Martin writes in the last number of the *S.C.M.*, is, as he says, a difficult one, and no complete explanation has yet been found. As far as I know, Mr Martin is the only geologist who now supports their molluscan origin; but these pages are hardly a suitable place for discussing such a problem, and I write merely to point out that in two particulars his article may prove misleading in the future. I am now the only survivor of those who had to deal at first hand with the discovery, when several erroneous ideas got abroad, so it seems desirable that I should put on record the facts of the case.

Mr Martin writes: "It might be interesting if the many remains of this spiral that were formerly in the possession of the late Lewis Abbott could be traced." When the foreman of the works realised there was something unusual about the rock his men were breaking up, he sent some specimens to the Hastings Museum and was at once requested to secure all the pieces he could. Mr Lewis Abbott got possession of some, and this dual possession led to difficulties which were solved by *all* the remains being sent to the British Museum for expert examination. So everything connected with the discovery that has been preserved is now at South Kensington.

Again, Mr Martin writes: "It may be questioned if the reconstructed parts are really accurate. In particular, the end where the aperture should be must be quite incorrect. If it were intended to show it as a mollusc, surely something resembling the aperture of a mollusc should have been reconstructed." This conveys a wrong idea of the intention of the reconstruction carried out at South Kensington under the direction of the late B. B. Woodward. The pieces were not put together to show them as portions of a molluscan shell, but as a reproduction of what had actually been found. One can imagine what an outcry would have been raised if features had been added or suppressed in support of any particular theory. A disconcerting circumstance from the molluscan theory point of view is that in no single instance is there any sign of a mouth. Instead, the ends, where a mouth should be, consist of a rounded nodule, usually of larger diameter than that of the whorls; and microscopical examination of the material has failed to show any trace of shell structure in it or in any other part of these remarkable finds.

I may add that the exhibit in the Hastings Museum is a replica of the original shown at South Kensington, and was presented to us by the British Museum in return for our having placed all the original material in our possession on permanent loan to the Natural History Museum.

ANTHONY BELT
(Vice-Chairman, Hastings Museum Committee)

Field trip to the Building Stones of Canterbury – 13th June 2010

by Trevor Devon

Eleven HDGS members assembled in front of the Canterbury Law Courts on a fine June Sunday morning to meet up with our guide for the day, Geoff Downer. Geoff had previously given a talk to HDGS in the Spring on the building stones of St. Augustine's Abbey and clearly had a great passion for this subject (he called it a "hobby").

The day was spent on a gentle walk around the eastern part of Canterbury, largely taking in St. Martin's Church, St. Augustine's Abbey and Canterbury Cathedral. Geoff provided a fascinating commentary on the geology, history, archaeology and architecture of the area, and stopped at appropriate sites to explore and identify the building stones more fully. Given that Canterbury had been an important major Roman town, and its subsequent ecclesiastical history from Saxon to Norman and medieval times, there was no shortage of material to see.

Fig. 1. Remains of St. Augustine's 13th Century Conduit House.

After a brief introduction to the geology of the Ouse valley, we took a short walk to look at the 13th century Conduit House (Fig. 1), a well-preserved example of medieval water technology that was used to collect groundwater from the natural springs of the surrounding hilly terrain and gravity feed it down to St. Augustine's Abbey using lead pipes. The reservoir and tunnels are constructed of all sorts of stone, using some reclaimed material from the nearby city, and the structure would originally have borne a circular roof. From this fascinating feature, we then joined a famous footpath that had once served as the main track from the port of Fordwich (on the Wantsum Channel) to Canterbury along which all the imported building stones were transported. Geoff explained that building stones had to be imported because Kent had so little good building rock (too much chalk!).

This track brought us down to St. Martin's Church (Fig. 2), the first of Canterbury's three World Heritage Sites (the Cathedral, and St. Augustine's Abbey being the other two). This church was built in the 6th century on the site of a Roman building that had been used as a chapel by King Ethelbert's Christian wife, Queen Bertha. It is the oldest Christian church in continuous use in the British Isles and was used to welcome St. Augustine to Canterbury in A.D. 597. The church has been enlarged several times, notably in the 7-8th century and in the 13th century and so it was interesting for us to examine the stones used in the walls. Notable of course was the reuse of Roman building materials, especially the long orange bricks: on one wall Geoff pointed out a massive Roman lintel composed of a single stone – a blue ragstone typical of Hythe. Apart from the wide use of flint, common to Kent, other local stones identified in the walls included brown, grey and yellowish Thanet sandstones and greenish Kent ragstone from the Maidstone area. The other main ingredients were pale yellowish Caen limestone blocks and pale greyish Marquise stones, both from France. A couple of rarer stones were pointed out: tufa, which is irregularly shaped vesicular limestone that has formed by crystallization out of ambient temperature saturated waters and Purbeck marble. The latter is a stone normally used for interior decoration, but as its high

Fig. 2. Geoff Downer explaining the stonework used in the construction of St. Martin's Church.

iron content gets oxidised by weathering, over time this leads to disintegration of the rock where it is used externally. The church wall was a really great introduction to early building stones and would prove to stand us in good stead when we continued our walk down to St. Augustine's Abbey.

Our route took us down on to the Richborough road, which due east leads to the Roman harbour of that name, close to present day Sandwich. Richborough featured a castle at the southernmost end of the Wantsum Channel and was almost certainly the primary landing point for the invading Roman forces. As we walked west along this road (called the Longport) towards Canterbury city centre we stopped (briefly!) outside Canterbury Prison, built as the city goal in 1808, and looked at the impressive gateway and very high brick walls. Next door was an impressive white building constructed in blocks of Portland stone which had been the Old Sessions House, but now belonged to Christ Church University: adjacent as an extension is a modern circular building that has been sympathetically built in Portland stone as well, except in this case the stone blocks have been made from quarry residues cemented together (much cheaper!). On the opposite side of the Longport was an attractive row of almshouses built of brick in 1597 in the Dutch style. This brought us to St. Augustine's Abbey, built towards the end of the Saxon dynasty in the 10th century. We did not actually need to enter the premises as its outer wall in Longport provided plenty of scope for looking at the building stones used. By now we were able to spot the "obvious candidates" – Caen stone, flint, ragstone, and sandstones, and found the rarer Marquise stone, tufa and Purbeck marble.

Fig. 3. Geoff Downer explaining the stonework on the Quenin Gate.

Our next stop on our itinerary was a modern (1960's) 5-story office block that had been dressed with some interesting ornamental stone claddings: panels identified included some metamorphic schist with a bright sheen from the mica; darker panels of gabbro, possibly Rustenburg granite (but actually a gabbro) and panels at street level of attractive brecciated serpentinite with veins of calcite. Next door the building featured a black plinth of orbicular granite with pinkish feldspar rosettes – the sort of stone used for kitchen tops; this one is known commercially as Rapakivi granite from Finland.

Fig. 4. Bronze statues of King Ethelbert and Queen Bertha in Lady Wootton's Green.

Along Lower Bridge Street we were now following the eastern city wall where we stopped at the Quenin Gate (Fig. 3) to inspect the stonework in the wall. Identified here were several original Roman stones and orange bricks that partly outlined the original gate, blocks of Caen limestone, pieces of Kentish ragstone and sandstone. The Quenin Gate, also known as the Queen's Gate, was on Bertha's route from the city to St. Martin's Church. On the other side of the road we could see the beautiful Renaissance brickwork of Fyndon's Gate, the main entrance to St. Augustine's Abbey. In front of the gate a pleasant little park has been created, Lady Wootton's Green, in which lifesize bronze memorial statues of King Ethelbert and Queen Bertha have been erected recently (Fig. 4). This was a nice spot for a rest and lunch!

After lunch we convened in the Cathedral precincts for an account of the construction of the Cathedral (Fig. 5), or should we say the five cathedrals! Geoff had to contend with the bells that pealed for some ten minutes, but on the plus side, being Sunday afternoon there was no admission fee to pay! The Cathedral as we know it today is over twice the length of the first Norman cathedral, and that was built on the site of a smaller Saxon cathedral. The design of two towers at the western end with a taller tower towards the eastern end extends throughout the five structures, although by the late 12th century the "eastern tower" had now become more central. During the 12th and 16th centuries various extensions were introduced, towers were taken down and reassembled, walls restructured with larger windows and reinforcing flying buttresses and additional chapels constructed at the eastern end. The major construction stone evident was the Caen limestone from Normandy quarries owned by Duke William, but as we walked around the cloisters and outbuildings Geoff showed us examples of tufa, sandstones, Purbeck marble, Marquise stone, onyx marble, and ferricrete that had been used in walls, columns, doorways and towers.

Fig. 5. Canterbury Cathedral.

It was also evident from our walkabout how much restoration has been done in more recent times (including the present): Caen stone remained the main restoration stone, although there has been some problems with the quality of some of the supplies. A west country shelly limestone from the Mendips, Doulting stone, has been used in restoration for the past 100 years where shaping and carving is significant (e.g. monuments, doorways and windows). In a trick question, Geoff asked us to identify the building stone of the high central tower called the Bell Harry Tower: it looked like Caen stone, but it was explained that the construction material was actually brick, clad with Caen stone! The brick was used because the stone would be too heavy for a tower of that height. Bringing the walk full circle, in one sense, to the north of the Cathedral buildings we saw the circular water tower (Fig. 6) that was at the monk's end of the water pipes from the Conduit House.

The group enjoyed this outing very much and was very grateful to Geoff for his guidance notes and providing such a well-paced and fascinating account of these remarkable buildings.

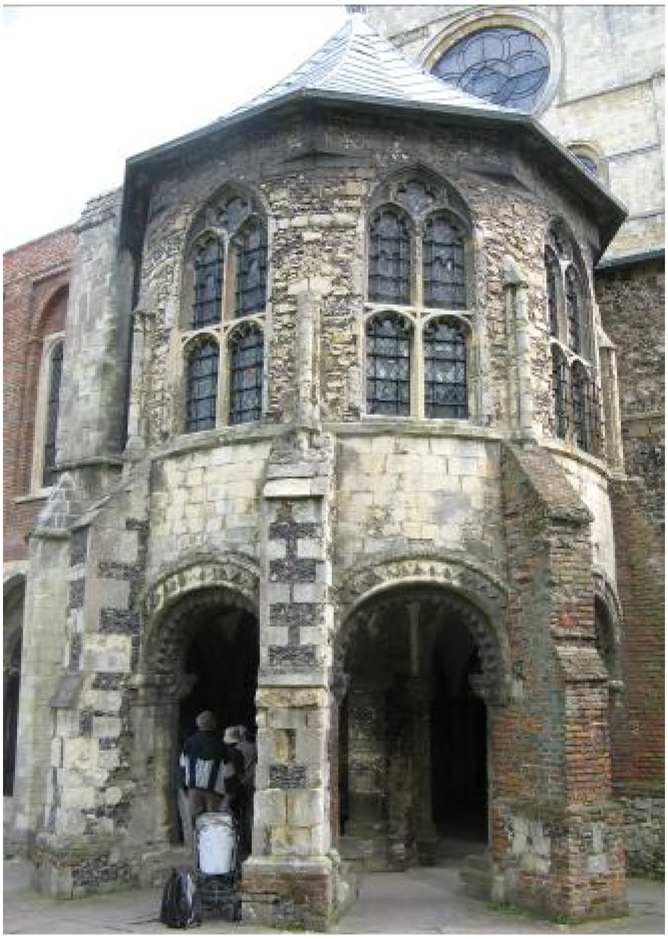


Fig. 6. The circular water tower used by the monks that was fed from St. Augustine's Conduit House shown in figure 1.

Coastal Erosion and Sea Defences in the Hastings area

by Siân Elder (Hillcrest School, Hastings)

Introduction

This article is based on a school project, carried out in September 2009, looking at coastal erosion and sea defences in the Hastings area, and covers the coast at Hastings, Fairlight Cove and Pett Level.

The beach at Hastings seafront shows lots of different types of sea defences (Fig. 1), for example the groynes, sea wall, harbour arm and the shingle.

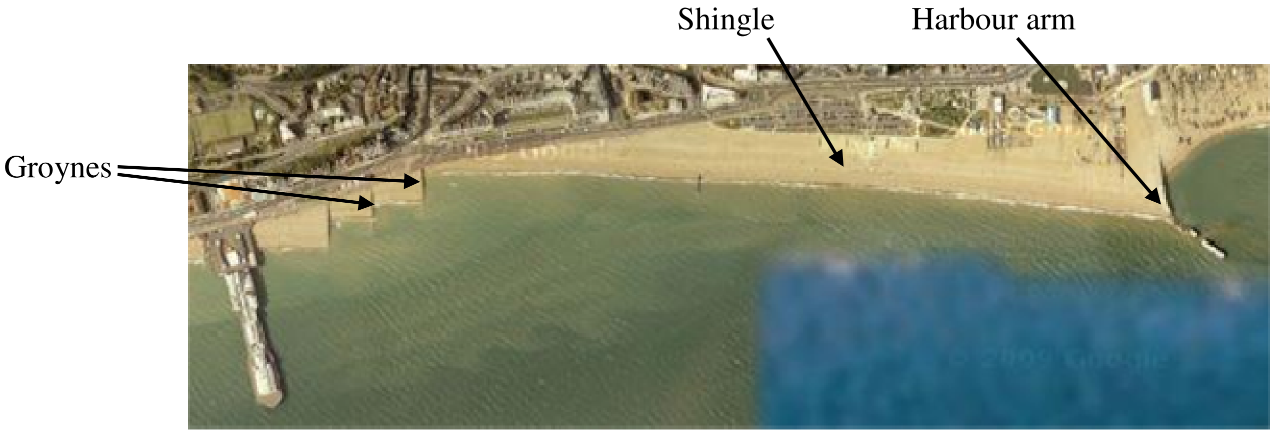


Fig. 1. Beach at Hastings seafront © Google Maps

There are groynes at Pett Level as well (Fig. 2), but not as much shingle as at Hastings.

Fig. 2. Pett Level © Google Maps

Fig. 3. Fairlight Cove
© Google Maps

At Fairlight Cove there is a reef which is a 0.5 km long line of rock armour which was imported from Norway (Fig. 3).

There are a lot of different types of sea defences. At Hastings and Pett Level there are groynes which prevent longshore drift from occurring along the beach. Longshore drift is where the prevailing wind carries the waves from the south-west along the shore and as it does so it moves the shingle along the beach. This can cause problems for places like Hastings because the town is so close to the shore-line that if all of the shingle was moved from the beach to Fairlight, there would be nothing stopping the sea at Hastings from flooding the town centre and the Old Town. That is why we have the sea defences like the groynes, sea wall, rock armour and harbour arm.

Questions

The project aimed to answer the following questions:

What physical processes are acting on our coastline?
What evidence is there to prove that these processes are occurring?
How are humans managing this coastline?
How should this area be managed in the future?

Work Undertaken

Slope profiles were taken of three beaches in the Hastings area, and sketches made at two locations. An environmental beach audit and a beach survey were also carried out.

Slope Profiles

The first slope profile was taken at West Hastings. Figure 4 shows the groynes and the pier. The red line shows where the slope profile was taken.

Fig. 4. Slope profile at West Hastings

© Google Maps

The second slope profile was taken near East Hastings. Figure 5 shows the storm drain that runs from the beach into the sea, and the shingle which is a very good sea defence. The red line shows where the slope profile was taken.

Fig. 5. Slope profile at East Hastings

© Google Maps

The final slope profile was taken at Fairlight Cove. Figure 6 shows the cliff which, in the past, has been eroded. However, now the artificial reef is in place (pictured) we can see by the vegetation growing on the slopes (also pictured) that the cliff is now quite stable. Figure 6 also shows where the slope profile was taken (red and blue line). (The Google Earth image shows the tide further in than when we measured the beach profile.)

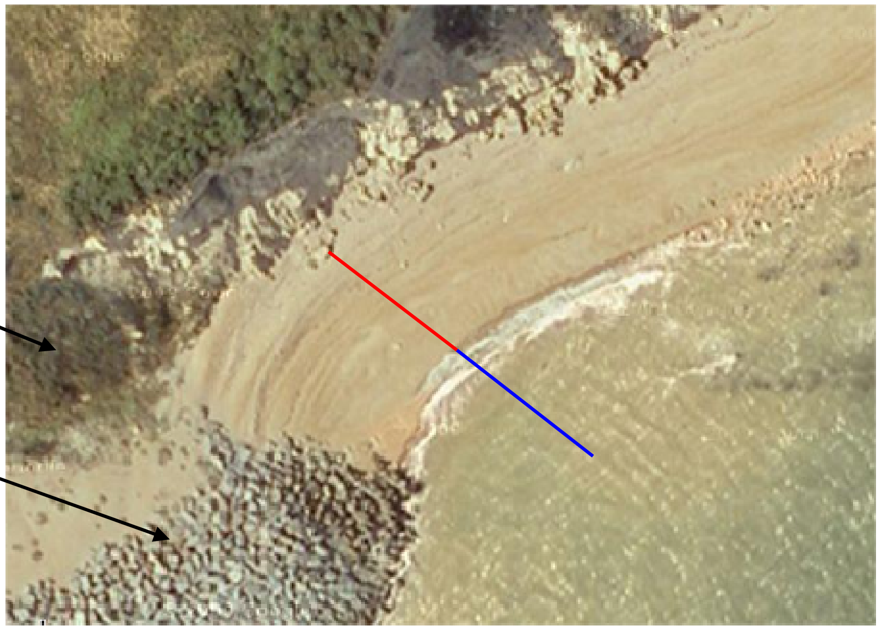


Fig. 6. Slope profile at Fairlight Cove

© Google Maps

The following graphs were produced of the beach profiles.

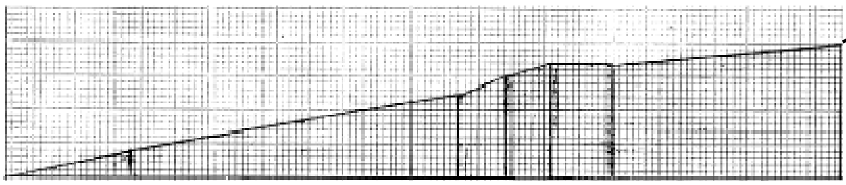


Fig. 7. Beach profile at Hastings west - Length of beach: 49.5 m - Height of beach 8 m

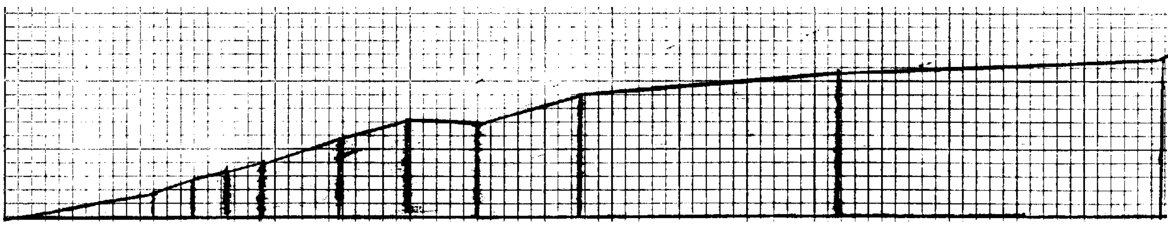


Fig. 8. Beach profile at Hastings east - Length of beach: 69.95 m - Height of beach 10 m

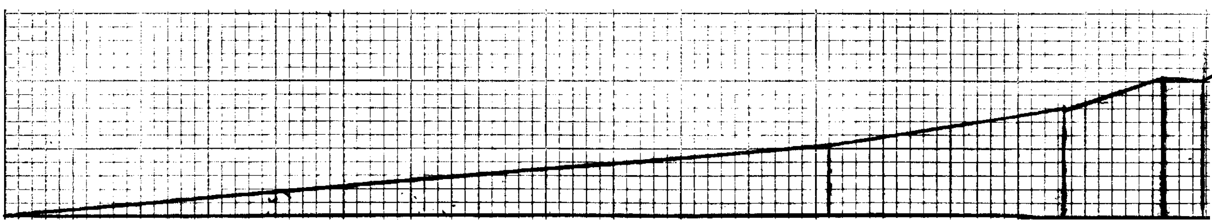


Fig. 9. Beach profile at Fairlight - Length of beach: 73.1 m - Height of beach 8 m

The results of these beach profiles are given overleaf in Table 1.

Table 1. Beach Profiles

Fairlight

Angle	Measurement
1st 5 Degrees	49.50m
2nd 10 Degrees	14.10m
3rd 18 Degrees	6.60m
4th -3 Degrees	2.90m
	Total: 73.10m

West Hastings

Angle	Measurement
1st 11 Degrees	7.70m
2nd 9 Degrees	19.50m
3rd 22 Degrees	3.10m
4th 16 Degrees	2.60m
5th -1 Degrees	3.70m
6th 5 Degrees	12.90m
	Total: 49.50m

East Hastings

Angle	Measurement
1st 10 Degrees	9.30m
2nd 18 Degrees	2.40m
3rd 12 Degrees	2.30m
4th 15 Degrees	2.10m
5th 18 Degrees	4.90m
6th 15 Degrees	4.20m
7th -3 Degrees	3.90m
8th 15 Degrees	6.10m
9th 5 Degrees	15.25m
10th 2 Degrees	19.50m
	Total: 69.95m

The beach profiles (Figs 7, 8, 9) showed the difference in the amount of shingle on each beach. Fairlight is the longest beach at 73.10m whereas Hastings west is the shortest beach at 49.50m. Hastings east is 10m high compared to Fairlight and Hastings west which are 8m high. The amount of shingle on East Hastings and West Hastings combined show that it is the best protected place on our coast. Most of the people that live there think that it is the most important part of the coast in this area. Hastings is famous for its fishing and tourism so it wouldn't be much good without the sea defences to stop any flooding from occurring.

Field Sketches

The field sketch of Pett Level looking at the cliff (Fig. 10) shows that there is erosion occurring. The wave cut platform and the broken down rocks from the cliff can be seen. Also, there is no vegetation growing up the side of this cliff – a sign of erosion. The sketch also shows a house which needs sea defences to save it from being destroyed. Without the sea wall (pictured) and the groynes (also pictured), the house would not be there. This shows just how important sea defences around our coast are.

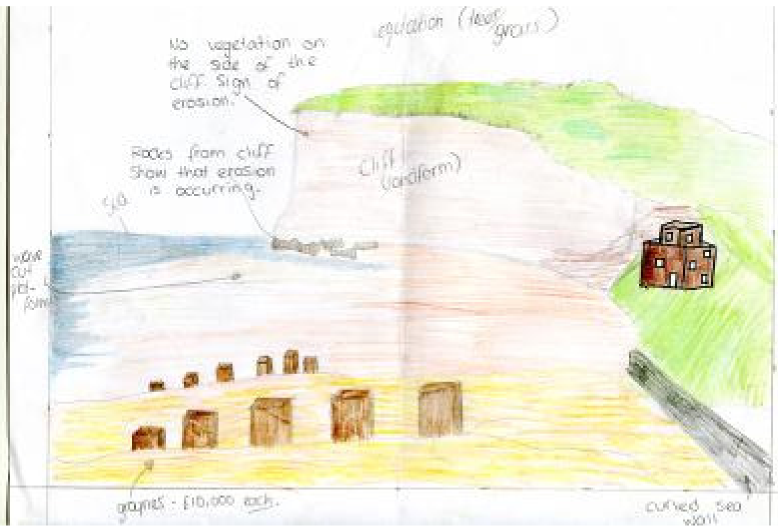


Fig. 10. Field sketch from Pett Level of Cliff End

The field sketch of Fairlight Cove (Fig. 11) shows the man-made (artificial) reef consisting of large pieces of granite imported from Norway. It also shows the house on the edge of the cliff and the vegetation, which indicates that there is no further erosion. Since the rock armour has been put here, it has prevented the waves from eroding the cliffs. Unfortunately it is too late for the owners of this house, however, when the house was built, it was not near the edge of the cliff, but was inland. Whoever moved here maybe didn't know how fast coastal erosion happens and what it can do to your property.

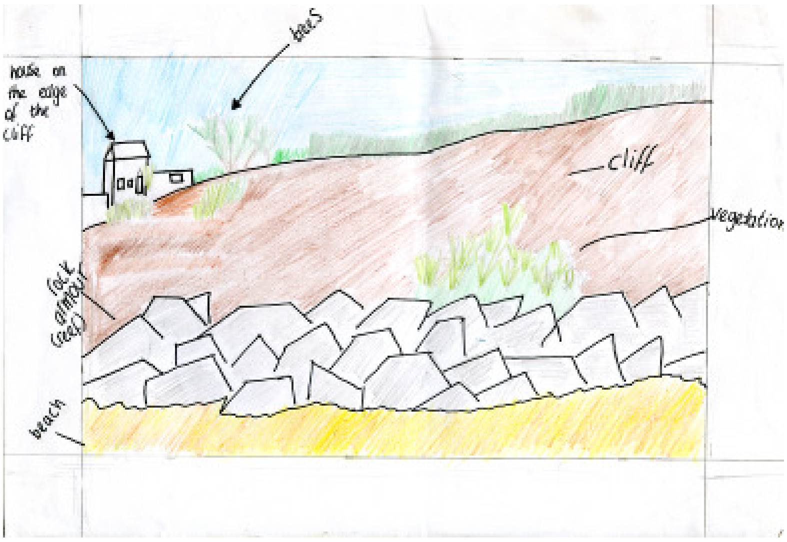


Fig. 11. Rock armour and vegetation on cliffs at Fairlight Cove

Environmental Beach Audit

I devised an environmental beach audit to assess the quality of the beaches and the area around them. Key elements of each location were scored out of 10 for 'Look', 'Use' and 'Effectiveness', giving a total out of 30 for each element. The audit is my assessment of the beaches at East Hastings, West Hastings and Fairlight. The overall total for west and east Hastings was out of 150 and for Fairlight Cove the overall total was out of 90. The results of the audit are given in Table 2 below.

Table 2. Environmental Beach Audit

Hastings West	Look	Use	Effective	Total
Beach	9/10	8/10	9/10	26/30
Sea Defences: -Groynes	4/10	6/10	9/10	19/30
-Sea Wall	7/10	7/10	8/10	22/30
Pier	3/10	2/10	3/10	8/30
Public Area	5/10	8/10	5/10	18/30
				Overall Total: 93/150

Hastings East	Look	Use	Effective	Total
Beach	8/10	8/10	9/10	25/30
Sea Defences: -Harbour Arm	6/10	5/10	9/10	20/30
-Sea Wall	2/10	6/10	7/10	15/30
-Groynes	2/10	7/10	6/10	15/30
Public Area	8/10	9/10	7/10	24/30
				Overall Total: 99/150

Fairlight Cove	Look	Use	Effective	Total
Beach	7/10	7/10	8/10	22/30
Sea Defences: -Artificial Reef	5/10	9/10	9/10	23/30
Cliff	6/10	7/10	9/10	22/30
				Overall Total: 67/90

East Hastings received the most points out of 150.
My table for West Hastings shows that I think the beach is useful, effective and looks nice, which is why I gave it 9s and 8 out of 10. It is effective in the way the shingle is a natural sea defence. This is the same for East Hastings too, however, Fairlight only received 7s and 8 out of 10 because there isn't much of a beach now that there are sea defences.
The groynes at East Hastings received a 6 and a 7 for how effective and useful they are because, even though they can't be seen, they have helped stop longshore drift from occurring. They can't be seen because they are buried by the shingle, and this is proof that they have helped because otherwise the shingle would not be there.
I gave the public area of East Hastings 7-9 out of 10 because of the rides on the seafront which a lot of families use, and the small train rides that go from one side of the beach to the other.

Beach Survey

I designed a survey to find out what people think of the beaches at Hastings, Fairlight Cove and Pett Level (see Appendix 1) and to find out how much the public know about the coast surrounding the area that they live in. A small sample of 10 friends and family filled out my questionnaire and below is a summary of the results.

Questions 1 and 3. Four people who completed the survey visited the beach more than 11 times a year. Everyone thought that spending money on the beach defences is important. I now know from these two questions that we have good reason to continue to spend money on our coast.
Question 2. Pett Level and Fairlight got the most marks for what the public thought was the nicest looking beach. This is probably because they are the two places that have the least amount of sea defences.
Questions 4 and 5. Only two people out of the ten didn't know what sea defences there are in Hastings, Pett and Fairlight. This shows me that most people in Hastings are informed about what sea defences there are around our coast.
Question 6. Everyone thought that it would be important to restore the Pier. I think that it's a very important attraction in Hastings both from how it looks to how much money Hastings receives from tourism. [Editors note: Survey undertaken before Hastings Pier was damaged by fire.]
Question 7. Seven people wouldn't want to spend more money on the sea defences. However, three people wouldn't mind. This shows me that the majority of people who live in Hastings wouldn't want more than £1 million spent on saving the coasts around them as this is the amount being spent every year.
Question 8. There was an equal amount of people who thought our coast would look better or worse in the next ten years. Also, two people didn't know what to think!

Examples of sea defences at West Hastings

Fig. 12. Groynes. Also showing Longshore Drift (red arrow) and prevailing wind (blue arrow) © Google Maps

Figure 12 show how longshore drift occurs at Hastings. We can see that the groynes are protecting Hastings because the shingle has built up on the west side of each groyne and there is less shingle on the east side. This is because longshore drift has tried to move the shingle from west to east, but the groynes have prevented it from happening. Therefore, some of the shingle has moved but has not been able to move far because the groynes are in the way. Consequently the shingle has been deposited on the west side of the groynes.

To stop the sea from flooding Hastings, we also have the sea wall (Fig. 13). As you can see from figure 13, it is curved at the bottom. This means that as the waves hit the wall, they don't splash up over the walkway, they flip back down on themselves. This gives them less energy and also doesn't cause any damage to Hastings or to the people walking on the path.

Fig. 13. Curved sea wall, stops waves flooding the pathway.

Conclusion

I am now able to answer the questions on the coastline that were in the introduction:

What physical processes are acting on our coastline?

1. Deposition and Longshore Drift

Longshore drift causes shingle to move along the coastline in a zig-zag pattern going east (Figure 14).

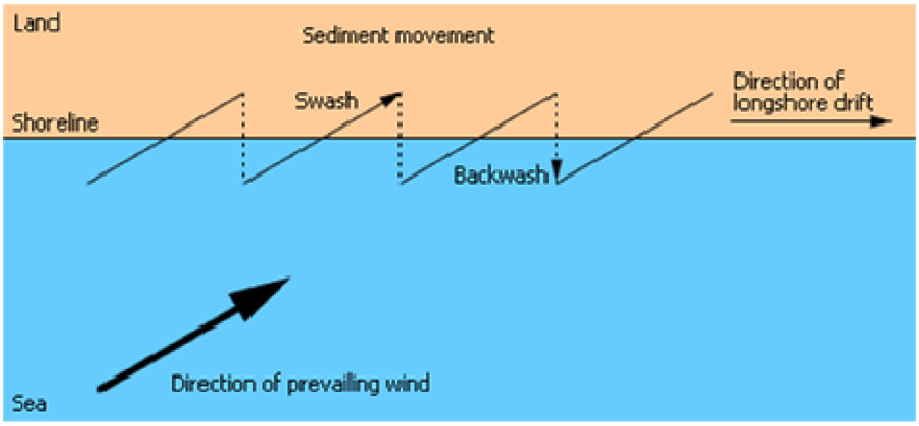


Fig. 14. Diagram of longshore drift

(Picture from www.google.co.uk/images and www.absoluteastronomy.com)

In Hastings there are groynes to stop this from happening (Fig. 12) because if longshore drift was allowed to happen, there would be no shingle to act as a sea defence. Consequently, the sea would be able to flow back to where it used to be (at the cliffs) before the sea defences were put there.

2. Erosion

There are lots of different types of erosion that occur on our coasts:

Abrasion or Corrasion is caused by waves that throw sand, pebbles and boulders against rocks. This works like sandpaper and wears the rocks away.

Hydraulic Action is where water is forced into cracks in the rock. Air parcels are compressed by the running water. However, as the waves retreat, the air expands explosively which weakens the joints and cracks in the rock, causing them to break and fall.

Corrosion or Solution is where the sea water dissolves soluble material from rocks. This occurs along coasts that have chalk or limestone where calcium carbonate (limestone) is dissolved.

Attrition is where rocks or boulders that have already been eroded from the cliff knock together and slowly wear into smaller rounder pieces.

Erosion depends on how much energy the waves have and how soft the rock is. The softer the rock and the more energy the waves have, the faster erosion will happen.

What evidence is there to prove that these processes are occurring and how are humans managing this coastline?

The groynes stop most of the shingle from moving away from Hastings beach. Unfortunately, this means that places like Fairlight Cove and Rock-a-Nore don't have much shingle for a defence.

Hastings Beach – look how much shingle is here…

Fig. 15. Hastings beach

© Google Maps

…and here at Rock-a-Nore… …and also here at Fairlight Cove.

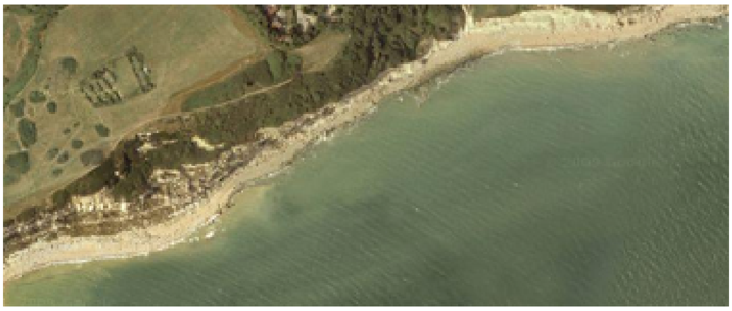


Fig. 16. Rock-a-Nore

© Google Maps

Fig. 17. Fairlight Cove © Google Maps

Fairlight Cove was vulnerable to erosion. Figure 18 shows a house at Fairlight Cove that has been destroyed by coastal erosion. Coastal hydraulic action caused the cliff to crumble under the house. To stop this coastal erosion from continuing, Rother District Council decided to put a reef of rock armour along the coast that was worst hit. This was put here in 1990 and consists of big granite boulders from Norway. This has helped considerably over the past 19 years that it has been here, but unfortunately, some of the granite boulders are already starting to erode.

Fig. 18. Abandoned house at Fairlight and reef of rock armour.

How should this area be managed in the future?

The sea defences are a very important part of our coastline and if we don't continue to spend the amount of money we are spending on them now, all the coastal processes discussed in this article will take over. More houses will be destroyed than now; villages and maybe even towns will be wiped out by flooding. If we don't take action now, then when? In the future when it's too late and we have to spend even more than we would have to now?

Some people think that Hastings would be a more important place to protect than Fairlight because of the amount of people that live in each place. Hastings has a population of 86,400 (2008) whereas Fairlight has a population of just 1,682 (2007).

Some people will argue that Fairlight is just as important as Hastings. One resident watched his 4-bedroom bungalow fall into the sea in 1999. He now has to live in a caravan with his two dogs as his insurance company refused to pay.

Doesn't this story prove that Hastings is not better than Fairlight and does not need more protection than anywhere else?

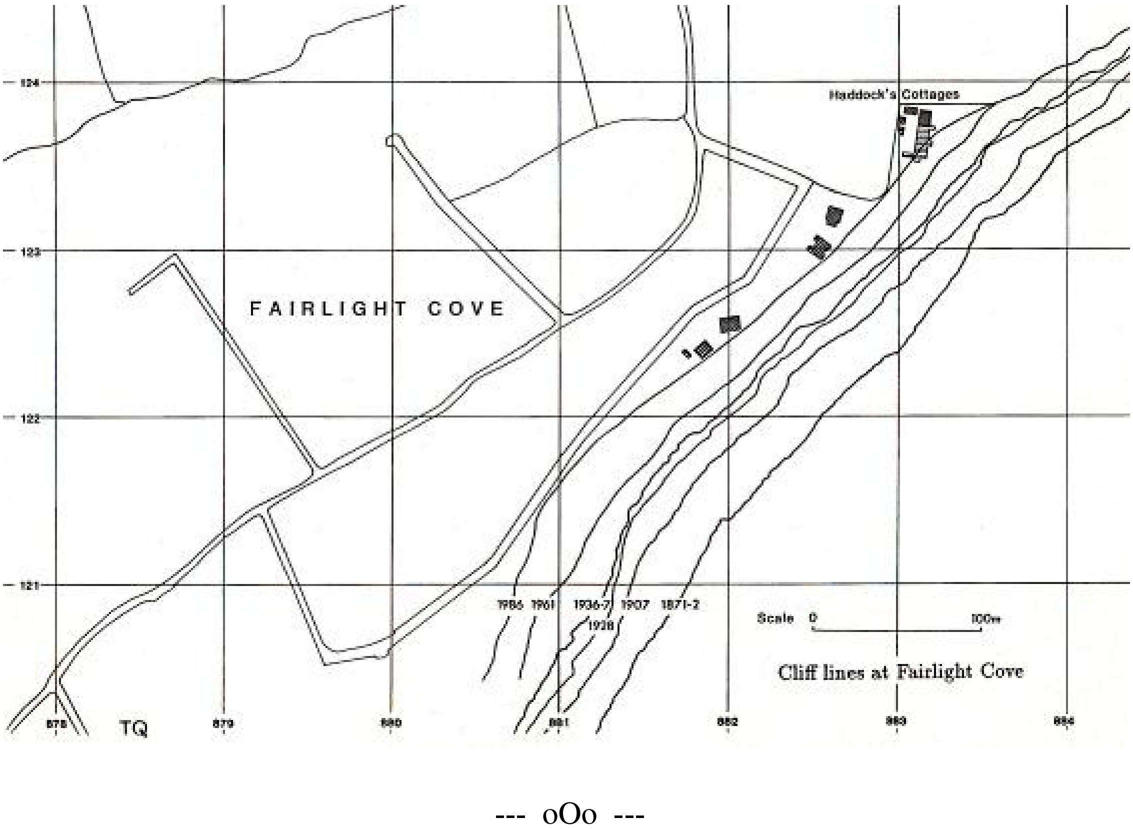
If you look at the table of the Government's shoreline management plan policy proposals (Appendix 2) you will see how the Government plans to protect different parts of our coast. It shows that Hastings is going to be protected for the next 100 years. However, Fairlight Cove to Hastings is not going to be protected, even though there are still houses on the cliff.

An option may be to move everyone out and then let nature take over.

The bird's eye view field sketch of Fairlight Cove (Fig. 19) shows how much of the cliff has been eroded since 1871. From this map we should be able to predict how much erosion would have taken place if we didn't have the reef. This would help the Council because if they allow the reef to erode, they will know from this map how much more erosion would occur without any sea defences.

We can prevent coastal processes from occurring, but only for so long.

Fig. 19. Map of Fairlight Cove, showing erosion since 1871.



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Appendix 1 - Beach Survey

1) How often do you visit Hastings/Pett Level/Fairlight Cove every year?
   ☐ 0-5 times a year ☐ 6-10 times a year ☐ 11+ times a year
2) Which part of our coast do you think looks the best?
   ☐ Hastings ☐ Fairlight ☐ Pett Level
3) Do you think that spending money on our beaches is important?
   ☐ Yes ☐ No
4) Do you know what sea defences we have at Hastings, Fairlight and at Pett Level?
   - I don't know what sea defences there are. ☐
   If you don't know what sea defences there are, move on to **Question 6**.
5) If so what are they?
   - At Hastings there are...................
   - At Pett Level there are....................
   - At Fairlight Cove there is..................
6) Do you think the pier should be restored?
   ☐ Yes ☐ No
7) Would you be happy to spend more money on sea defences?
   ☐ Yes ☐ No
8) Do you think that Hastings beach, Pett Level and Fairlight Cove would look better in 10 years time or worse?
   ☐ Better ☐ Worse

Thank you for completing my survey

Appendix 2 - SUMMARY OF SHORELINE MANAGEMENT PLAN POLICY PROPOSALS

SMP	SMP CELL	FRONTAGE	0 TO 20 YEARS	20 TO 50 YEARS	50 TO 100 YEARS
South Foreland to Beachy Head	15	Jury's Gap to Camber	HTL	HTL	HTL
	16	Camber Sands	HTL	HTL	HTL
	17	River Rother	HTL	HTL	HTL
	18	River Rother to Cliff End	HTL	HTL	MR
	19	Cliff End to Fairlight Cove	NAI	NAI	NAI
	20	Fairlight Cove East	MR	MR	MR
	21	Fairlight Cove Central	MR	NAI	NAI
	22	Fairlight Cove West	(NAI)	(NAI)	(NAI)
	23	Fairlight Cove to Hastings	(NAI)	(NAI)	(NAI)
	24	Hastings	HTL	HTL	HTL
	25	Bulverhythe & Glyne Gap	HTL	HTL	HTL
	26	Bexhill & Cooden	HTL	HTL	HTL
	27	Pevensey & Hooe Levels	HTL	HTL	HTL
	28	Sovreign Harbour	HTL	HTL	HTL
	29	Eastbourne	HTL	HTL	HTL
	30	Beachy Head	(NAI)	(NAI)	(NAI)

KEY
HTL = Hold the Line
MR = Managed Retreat
NAI = No Active Intervention

MR
= cell contains property or infrastructure. (Brackets indicates no property etc)

On Mantell, Buckland and Castle Hill, Newhaven

by Anthony Brook

Priority of discovery is the ultimate of scientific endeavour. Whoever makes the discovery first claims the glittering prize, and the rest immediately become also-rans, no matter how brilliant their research might be. Sometimes, though, for various reasons, History can make a mistake and priority should, in fact, be awarded elsewhere. This is a case in point, where the initial description of a unique geological feature should really go to William Buckland, of Oxford, rather than Gideon Mantell, of Lewes, as generally assumed.

During investigations into the strange history of the rare Sussex mineral, aluminite, formerly known as Websterite, I came across a sparse reference which read: Buckland, Geol. Trans., 4, p. 294, which was sufficiently intriguing to require checking. It turned out to be a long article in an early issue of the Transactions of The Geological Society, with considerable relevance to Sussex and its strata. The full reference, for the record and future use, is William Buckland 'Description of a series of Specimens from the Plastic Clay near Reading, Berkshire: with Observations on the Formation to which those Beds belong', Transactions of The Geological Society Vol. 4, Part 2 (1817) 277-304, which, from its customary wordy title, would seem to relate to specimens from the 'Plastic Clay', which was the contemporary term for those beds immediately above the Chalk — what we would nowadays call the Woolwich and Reading Beds.

The second part of the title and the paper is often overlooked but that is where Buckland is taking the larger view and considering the Plastic Clay in locations other than Reading in Berkshire, such as Sussex. Indeed, pages 294-97 are solely concerned with the Plastic Clay in Sussex:

a) 'Appearance of the Plastic Clay formation on the coast of Sussex.
b) Sections near Seaford and Newhaven.
c) Plastic Clay near Arundel',
followed by two further Sections of even larger scale and significance:
d) 'Connections of beds of Plastic Clay formation in England with the French beds of the same era' — the cross-Channel connection, and
e) 'General character of the Plastic Clay formation in England'.

This is a very important and very early consideration of a specific Sussex strata, bearing in mind that Buckland read his paper to a Meeting of the Geological Society on 6 January 1816. It certainly became public knowledge, and in the public domain, the following year when it was published in the Society's Transactions, which circulated to a small but well-connected coterie of geological enthusiasts, some of whom lived in Sussex.

When I read Buckland's 'Section of Strata at Castle Hill, Newhaven', it seemed horribly familiar. I was sure I had seen it, or something very much like it, somewhere before — and, indeed, I had, in Gideon Mantell's Fossils of the South Downs, published in May 1822, which is generally assumed to be the first descriptive Section of the Palaeocene strata at Castle Hill, Newhaven. It would appear that Buckland beat him to it, by 5 years at least, although whether Mantell was aware of, or had even read, Buckland's paper in the Transactions is another matter. Probably answered in the affirmative, although Mantell certainly does not acknowledge Buckland's priority in any way.

To prove my point — that it was William Buckland who published the first descriptive Section of the Strata at Castle Hill, Newhaven — I have listed, in the accompanying Table, Buckland's 1817 description on the left and Mantell's 1822 description on the right, for direct comparison; it thereby becomes clear and evident that Mantell's description is only a minor elaboration of Buckland's! The differences are really insignificant: it is verging on the identical, even the thickness of the various strata is exactly the same. It could be argued that that was bound to be the case, as the rocks had not altered in the interim, in which case the earlier version always takes precedence, as in the naming of fossils and minerals: Buckland thus prevails over Mantell.

I rest my case. Priority for the Section of Strata at Castle Hill, Newhaven should be awarded to William Buckland, as published in the Transactions of The Geological Society in 1817. Please note that Buckland has antecedence for the first descriptive Section of the Castle Hill Strata while Mantell retains credit for the first illustration of this special stratigraphical section, as portrayed in the Frontispiece of Fossils of the South Downs, a lithograph engraved by his wife, Mary Ann Mantell, in May 1818, which is curiously close to Buckland's published description.

William Buckland ‘Description of a series of Specimens from the Plastic Clay near Reading, Berks., etc’ Transactions of Geological Society Vol. 4, Part 2 (1817) 296-97			Gideon Mantell Fossils of the South Downs 1822, 257-258		
Section of the Strata at Castle Hill, near Newhaven, commencing with the lowermost deposit					
No.	BUCKLAND	Thickness (ft)	No.	MANTELL	Thickness (ft)
1.	Chalk, containing alumine in hollows on its surface	50	1.	Chalk with flints	50
			2.	Ochraceous clay, containing hydrate and subsulphate of alumine, and crystalized sulphate of lime	c. 1½
2.	Breccia of green sand and chalk flints, the latter covered with a ferruginous crust	1	3.	Breccia of greensand and chalk flints, the latter covered with a green and ferruginous crust	1
3.	Sand, varying from yellow to green and ash in colour	20	4.	Sand, of various shades of yellow, green and ash colour	20
4.	Series of clay beds containing coaly matter, selenites and fibrous gypsum; also leaves of plants and sulphur-coloured clay	20	5.	Blue clay with a marl of sulphur yellow colour; including large crystals of sulphate of lime, with fibrous and foliated gypsum	20
	[possibly above as ‘coaly matter’]		6.	Seam of surturbrand, or coal	c. ½
			7.	Indurated reddish-brown marl, the lower part slaty, containing impressions of leaves, and casts of cerithia, cyclades, etc.	A few inches
5.	Foliated blue clay containing cerithia and cyclades, and a few oysters. In this clay is a seam of iron pyrites, c. 1 inch thick, with pyritical casts of cyclades and cerithia	10	8.	Blue clay, containing immense number of shells, chiefly of genus Cerithium; teeth of a species of squalus, etc. This bed is traversed by a seam of pyrites, few inches thick, containing casts of cerithia	} 10
			9.	Blue clay with broken bivalve shells, apparently of genera cytheria and cyrene	
6.	Consolidated argillaceous rock, full of oysters, with a few cyclads and cerithia	5	10.	Bed composed almost entirely of oyster shells held together by an argillaceous cement	5
7.	Alluvium, full of broken chalk flints mixed with sand	10	11.	Diluvium, consisting of yellow and fawn-coloured sand, with pebbles: the latter evidently formed of broken flints rounded by attrition	10-15
	Total	116		Total	118-123

From my Bookshelf

by Trevor Devon

Last March I opened my copy of Scientific American and found a fascinating article by Robert Hazen on "Evolution of Minerals" in which he describes five distinct phases of mineralogical evolution of the Earth, where the number of minerals increased with each phase from a few hundred in basaltic "Black Earth" to the several thousand we now know in "Green Earth". This "timeline" approach to the creation of different minerals is quite novel and importantly includes the impact of life (Green Earth) on mineral evolution. This implies that when exploring the minerals in extraterrestrial rocks we might have some new mineral markers for life. I would readily commend this article to all mineral collectors (as an aside, there is even a phosphate mineral named hazenite after the author!).

I had not come across Robert Hazen before, but I noticed that he had written a book "Genesis" quite recently (well, 2005 in fact) and so bought a copy. This book provides a comprehensive up-to-date guided tour of the scientific search for the origin of life on earth. Robert Hazen is an astrobiologist and so this is an "insider's story" laced with personal insights and interesting accounts of the scientists involved. The book is written in a scholarly manner with lots of additional notes and references; it is not written in my view for the layman, although an acquired awareness of some geology, chemistry and biology would suffice to get the most out of this excellent book and reveal the progress that is being made in this fundamental science.

Inspired by reading this book, I turned to my bookshelf to retrieve a copy of John Gribbin's "Stardust". I bought this book back in 2001, having read a number of Gribbin's earlier books, including "Schrodinger's Cat" on the history of quantum mechanics and "The Case of the Missing Neutrino". Although an astrophysicist, John Gribbin's books are very readable and relatively accessible to readers not steeped in a scientific education. He brings the exotic collection of brilliant scientists of our time very much to life and traces the evolution of life from atomic stardust. Although there is some common ground, this account dwells more on the earlier phases of astrophysics than Robert Hazen's "Genesis", and so the two are actually complementary. I will state here that I am in no way influenced by the fact that I was a chemistry undergraduate at Sussex University at the same time as John Gribbin was studying astrophysics there!

I also remembered that I had in my book collection a Penguin paperback version of Paul Davies' "The Fifth Miracle" written back in 1998 on the search for the origin of life. As with the other two books, this author starts with attempts at defining what life actually is, but differs from the others in also seeking some rationale for life, which creationist speculation is surely beyond the realm of scientific examination! All three books convey the very real excitement of fundamental science, the progress being made and the yawning gaps still to be explained. Also I found the stories of the men and women of science really fascinating and couldn't help the feeling of being overawed by some of the intellectual giants who stride across this huge stage.

And talking of intellectual giants, I couldn't help reaching for the bookshelf and reading again "Fred Hoyle: A Life in Science" a biography of astrophysicist Hoyle written in 2005 by Simon Mitton, one of Hoyle's students. It was Hoyle's famous science fiction novel "The Black Cloud" that introduced the idea of life on Earth originating in other galaxies, an academic concept formally referred to as exogenesis and related to panspermia. Some older readers may remember Fred Hoyle from his popular radio and television commentaries on astrophysics, and especially his prominent disagreement with the Big Bang Theory (a name he actually coined as a joke!). Hoyle created the world famous Institute of Theoretical Astronomy at Cambridge and largely pioneered the science of cosmology; despite being the leading light of the team that explained the evolution of the elements from cosmic events, he was snubbed by the Nobel Prize committee for petty political reasons. I can heartily recommend this account of a true British genius and a fascinating larger-than-life eccentric Yorkshireman!

My final offering is not strictly from my bookshelf, but rather that of an hotel I was staying at in Madeira earlier this year. With the intriguing title "13 Things that do not make Sense" written by

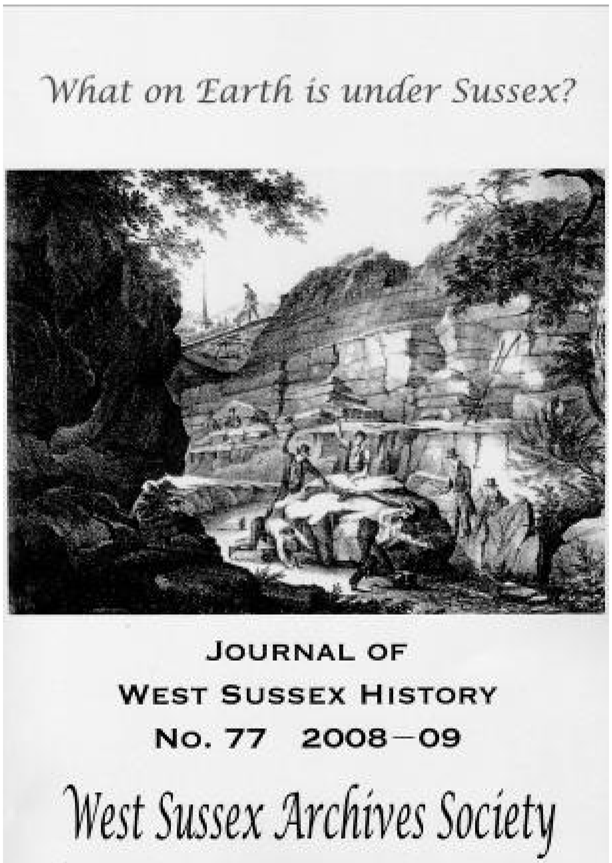
Michael Brooks in 2009, this is an entertaining romp through a variety of current scientific mysteries from anomalies in the cosmos, dark matter, dark energy, cold fusion, the chemical origins of life, E.T., and the giant virus through to death, sex, free will, the placebo effect and homeopathy. The topics are all easy to read and provide a great starting place for stimulating follow-up reading.

I hope this brief excursion through some of the books I have read and enjoyed personally this past year stimulates others to "dip in" and gain a better appreciation of the wonder of scientific achievement and the evolution of some of the "big ideas" of science. This is perhaps particularly pertinent at a time when Science does not always get a "good press"! Maybe some other members could share similar reading experiences in future issues of our Journal?

What on Earth is under Sussex?

A Series of Essays Exploring the History of Geology in Sussex

Review by Peter Austen



When reading about the history of geology we mostly hear of the more famous names from the early years – Charles Lyell, William Smith, William Buckland, to name but a few. It makes a welcome change to hear about some of our local, less familiar characters who have made particular contributions to the understanding of the geology of Sussex, both from when the science of geology was in its infancy and from more recent times, and although most were not as well known as their contemporaries their contributions should not be overlooked. Anthony Brook has pulled together a series of essays looking at various aspects of the development of geology in Sussex with contributions from seven authors, all of whom have obviously researched their subjects well. Anthony came to our Society in 2009 to give a fascinating talk on some of our early local geologists, and you should also recognise a further three of the seven authors as having given talks to our Society in recent years.

John Mather charts the rise of Brighton from its beginnings as the small fishing village of Brighthelmston through its heyday as a fashionable spa resort in the 18th and early 19th centuries. Whereas contemporary sources generally attributed this increased prosperity to the patronage of the Prince Regent (later to become George IV), John Mather points out that Brighton had already been popularised in the 1750s by local physicians such as Dr. Richard Russell and later Anthony Relhan who promoted the virtues of sea bathing and taking the waters in an attractive south coast location within easy reach of London. The short summer season for sea bathing was extended to an all year round pursuit in later years by the building of bath houses. John Mather also discusses the local natural Chalybeate Spring, near 'The Wick' in what is now Hove, and also the Royal German Spa where mineral waters were manufactured.

In the second essay Wolf Mayer discusses the contribution of the Reverend Charles Wilton to the geology of West Sussex, which although minor, was amongst the earliest to describe the County's geology. His field notes are "perhaps the earliest-surviving geology field notebook in Sussex". Wolf Mayer also points out that although Wilton was a "biblical literalist" and believed in the biblical account of Creation, he did not let this influence his geological studies. In his field work both in Sussex and later in Australia after his emigration there, his interpretations were always based on careful observations and the rational assessment of the evidence.

The volume contains two essays on Gideon Mantell, perhaps the best known of Sussex's geologists. The first by John Cooper is an interesting look at the relationship between Gideon Mantell and the local press during his time in Brighton between 1834 and 1838. At first when Mantell moved to Brighton in 1834 he was feted by the local press, and John illustrates this with extracts from the newspapers of the time, but eventually, for whatever reason, the *Brighton Guardian* turned against both him and the *Sussex Royal Institution*, of which he was a founder member. Mantell became increasingly disillusioned and this, together with financial difficulties led to his eventual move to London and the sale of his collections to the British Museum. The second essay by Melanie Keene discusses one of Mantell's most popular works, his book *Thoughts on a Pebble; or, A First Lesson in Geology*, which between 1836 and 1849 ran to eight editions. The book was inspired by a number of intelligent questions from Mantell's nine-year old son Reginald, to whom it was dedicated, and recounted the life history of a flint pebble picked up in a stream near Mantell's Brighton home. Mantell tried to show the reader that with a little curiosity and knowledge, the mind could be opened up to the wonders of the natural world, and Melanie Keene uses the story of the book to give an insight into Mantell himself.

Chris Duffin gives us an essay on Herbert Toms, who during the 1920s and '30s recorded and preserved the folklore of Sussex before it was lost with the advent of the modern age. Toms trained with the renowned 19th century pioneer archaeologist Lt-General Pitt Rivers for three years between 1893 and 1896, and on the strength of this he secured a post at Brighton Museum in 1896. Following the death of his wife in 1927 he spent his free time roaming the Sussex countryside talking to local residents and workmen about local folklore and meticulously recording his conversations. We learn that witchstones (holed flints) can be used to fend off witches, fairies and pixies, and that Shepherds' Crowns (flint echinoids) correctly placed on the windowsill can ward off lightning strikes and ensure that the household will "never want for bread".

Michael Bates writes about Edward Alfred Martin and his ideas on the glaciation of the South Downs. Martin worked as a Civil Servant in the General Post Office, but had a lifelong love of natural history and geology and wrote on both. He spent his life trying to understand the landforms of the South Downs and in 1920 put forward his ideas in a paper entitled *The Glaciation of the South Downs* where he argued that they had been shaped by glaciers, an idea that did not stand the test of time.

In the final essay David Bone discusses the work of Martin Venables. As an amateur natural historian, Venables contributed a wealth of information on the natural history of West Sussex throughout his life (more than 2,500 articles for the '*Selbourne Notes*' column in *The West Sussex Gazette* over 50 years). However, David Bone concentrates on Venables' geological reports in the Proceedings of the Natural Science and Archaeology Society, Littlehampton, between 1933 and 1938 covering Venables' work on the Eocene deposits of West Sussex. Venables made significant contributions to the understanding of the geology of West Sussex and his work on the London Clay of Bognor Regis helped establish the area as a nationally important geological site. This essay clearly illustrates the importance of the 'amateur' geologist in the advancement of geology.

This book gives a fascinating insight into the work and character of several Sussex geologists from the 18th through to the 20th century, each of whom contribute to our subject in different ways, and clearly some more successfully than others. The book is an excellent read, running to 96 pages, with many illustrations – it's good to see the history of the development of geology in our County recorded in this way and I look forward to the second volume in the series.

What on Earth is under Sussex? A Series of Essays Exploring the History of Geology in Sussex is available at the discounted price of £11.20 (£10 + p & p). To obtain a copy send a cheque (payable to **Guildbourne Publishing**) to Anthony Brook at Guildbourne Publishing, Worthing, West Sussex, BN11 4BQ. A limited number of copies will be available at our monthly meetings for £10 (no postage).

Geology and Palaeontology in the News

A review of recent research and discoveries

Edited by Peter Austen

Introduction

The following is a summary of recent research and discoveries in or associated with geology and palaeontology. Where possible I have included enough detail (i.e. species name, author, etc.) to allow for a search of the internet for further information. In most cases more information is available, including an abstract of the paper and press releases, and quite often if you go to the author's own website or the museum/university website to which the author is affiliated you may be able to obtain a copy of the original paper. If you do not have a computer at home, all libraries in the UK are now equipped with computers with internet access for use by the general public.

North American Clovis people not wiped out by comet?

A controversial theory that the North American Clovis people and much of North America's large mammals were wiped out when a comet exploded over North America 13,000 years ago has been challenged by a team of researchers from the University of Wyoming in Laramie, USA. The original theory was put forward by a team of researchers led by Richard Firestone, of Lawrence Berkeley National Laboratory in California, USA, in 2007 (*Proceedings of the National Academy of Sciences*, 2007, Vol. 104, No. 41, p.16016-16021) based on magnetic microspherules found at 25 Clovis sites, which they claimed to be an indication of cosmic debris from a comet explosion. The new team led by Todd Surovell, an archaeologist at the University of Wyoming in Laramie, USA, could not find any trace of the microspherules at any Clovis sites, including two that had been studied by the Californian team (*Proceedings of the National Academy of Sciences*, 2009, Vol. 106, No. 43, p.18155-18158). Firestone's team say that the new research did not employ the right techniques to recover the microspherules, however, another group led by Jennifer Marlon, a doctoral geography student at the University of Oregon in Eugene, USA, investigated a further 35 sites but could not find any evidence for burning of biomass, which would have occurred if there had been continent-wide fires following an impact (*Proceedings of the National Academy of Sciences*, 2009, Vol. 106, No. 8, p.2519-2524).

Transition from pterosaurs to pterodactyls

In the early Jurassic 200 million years ago the skies were dominated by primitive long-tailed pterosaurs, which over the next 100 million years evolved into the more advanced, short-tailed pterodactyls. However, with the absence of any transitional fossils palaeontologists have only been able to speculate how one form evolved into the other. Now the discovery of a fossil (Fig. 1) in China by Junchang Lü of the Chinese Academy of Geological Sciences in Beijing, China and his colleagues has thrown new light on how this transition occurred. The fossil, named *Darwinopterus modularis*, has the long skull and neck typical of the more advanced pterodactyls, but the rest of the body, including the long tail, is similar to the more primitive pterosaurs (*Proceedings of the Royal Society B: Biological Sciences*, 2010, Vol. 277, No. 1680, p.383-389). The fossil also demonstrates how natural selection acts on groups of characters, such as the head and neck, rather than on individual traits.

Fig. 1. Skull of Darwinopterus *(185 mm long).*

Photograph: Junchang Lü

Extinction of large mammals in North America

A study by Jacquelyn Gill of the University of Wisconsin–Madison, USA, and her colleagues has found that the collapse of large mammal populations in North America, including the mammoths, occurred before the major climatic changes that have been suggested as the cause of the extinctions (*Science*, 2009, Vol. 326, No. 5956, p.1100–1103). She has also suggested that the collapse of the megafauna and the loss of the large herbivores may have set off widespread changes to the ecosystem leading to a larger variety of plant species and a higher incidence of fires. The study carried out analysis of sediment cores, looking at levels of spores of the dung-borne fungus *Sporormiella* which began to reduce 14,800 years ago, until finally collapsing 13,700 years ago, indicating the extinction of the megafauna. They also concluded that the extinctions were not caused by either the cooling period known as the Younger Dryas or a purported comet impact (see "*North American Clovis people not wiped out by comet?*" on page 37).

Tetrapod footprints predate tetrapods

The earliest evidence of tetrapods (vertebrates with limbs rather than paired fins) is dated to the Fammenian stage (374-359 million years (Myr) ago) of the Devonian based on the remains of the early tetrapods *Ichthyostega* and *Acanthostega*, with the possibility of it being as far back as 385 Myr based on isolated traces of tetrapod bones. It had been thought that the tetrapods diverged from a group called the Elpistostegalians (a group of large lobe-finned fishes) represented by species such as *Tiktaalik* or *Panderichthys* sometime between 391 and 385 Myr ago. Now, a team led by Grzegorz Niedźwiedzki of Warsaw University in Poland have revealed well-dated fossil tracks (Fig. 2), clearly made by a four-limbed animal possessing digits (*Nature*, 2010, Vol. 463, No. 7277, p.43-48). The tracks, thought to have been made in marine tidal-flat sediments, were found in an old quarry in Zachemie, Poland, and have been accurately dated to 397 Myr, approximately 18 million years older than the earliest tetrapod body fossils and 10 million years earlier than the oldest elpistostegids. This has now forced a rethink of the fish-tetrapod transition, and is likely to lead to more field work looking for evidence of earlier tetrapods.

Fig. 2. 397 million year old tetrapod trackway found in Polish quarry.

Photo: Grzegorz Niedzwiedzki

Did dinosaurs originate in South America?

The discovery of a number of well-preserved theropod dinosaurs in New Mexico, USA, has led a team of palaeontologists led by Sterling Nesbitt, of the University of Texas at Austin, USA, to suggest that the dinosaurs originated in South America (*Science*, 2009, Vol. 326, No. 5959, p.1530-1533). Dinosaurs first appeared around 230 million years ago and the 215 million year old fossils of the new theropod, named *Tawa hallae*, together with other finds at Hayden Quarry, Ghost Ranch, Abiquiu, New Mexico, suggest that the early dinosaurs (theropods, sauropods and ornithischians) migrated from South America around 220 million years ago into the rest of Pangaea. Nesbitt's conclusions are supported by the presence in Hayden Quarry of multiple dinosaur species known to have originated much further south, however not all palaeontologists agree with this interpretation – Kevin Padian, a palaeontologist at the University of California, Berkeley, USA, acknowledges the importance of the discovery, but is still looking for more primitive dinosaurs to settle the question.

Rapid refilling of the Mediterranean

5.6 million years ago the waters of the Mediterranean were cut off from the world's oceans and were desiccated by evaporation (The Messinian Salinity Crisis). Then 5.33 million years ago the Straits of Gibraltar were breached and the sea began to flow back into the Mediterranean. A study of the channel cut by the waters, conducted by Daniel Garcia-Castellanos of the Institut de Ciències de la Terra Jaume Almera, Barcelona, Spain and colleagues, has shown that at the start of the breach the water flow was slow, continuing for several thousand years, but it also suggests that the last 90 per cent of the water was transferred in a very short period of time, possibly from a few months to two years. This could have led to a sea level rise in the Mediterranean of more than 10 metres per day (*Nature*, 2009, Vol. 462, No. 7274, p.778-781).

Earliest mammal-like reptiles (anomodonts)

The anomodonts were a group of mammal-like reptiles that were widespread from 270 to 200 million years ago. A recently discovered specimen from Gansu in China, has proved to be the oldest known anomodont (*Proceedings of the Royal Society B: Biological Sciences*, 2010, Vol. 277, No. 1679, p.285-292). Jun Liu of the Chinese Academy of Sciences in Beijing, China, and his colleagues have described the specimen, named *Biseridens qilianicus*, and believe that it is the most basal anomodont yet found, making it the oldest branch on the anomodont family tree. This lends support to the idea that anomodonts originated in the northern continent of Laurasia rather than on the southern continent of Gondwana, as previously thought.

The colour of dinosaur feathers

The feather colours of the earliest birds and theropods has, until recently, owed more to the artist than to science. Now a team of palaeontologists led by Michael Benton of the University of Bristol, UK, and Zhonghe Zhou of the Institute of Vertebrate Paleontology and Paleoanthropology in Beijing, has discovered 100 million year old colour-producing sacs in the fossilised feathers of small theropods from the early Cretaceous Jehol site in northeastern China. These structures have previously been found in fossilised bird feathers, but not in theropods. The team found two types of these sacs – sausage-shaped organelles called eumelanosomes which would have produced black feathers and spherical organelles called phaeomelanosomes, which would have produced reddish feathers. They didn't find any evidence of other colours, but then the proteins responsible for producing yellows, purples and blues degrade more rapidly than the organelles responsible for producing red and black. Previously some researchers have claimed that the filaments found in these theropods are partially decayed dermal collagen fibres, but this work shows that they were definitely feathers. We also now know that the dark-coloured stripes on the tail of the theropod dinosaur *Sinosauropteryx* were very likely chestnut to reddish-brown (Fig. 3) (*Nature*, 2010, Vol. 463, No. 7284, p.1075-1078).

Fig. 3. Reconstruction of a Sinosauropteryx.
Image by © Chuang Zhao and Lida Xing

Early reptiles ate insects

A remarkable discovery in Oklahoma, USA, has produced the first direct evidence that early reptiles ate insects as part of their diets. Two skulls of a 280-million-year-old reptile (yet to be described), were found in caves in the hills of Oklahoma, USA. On closer inspection Sean Modesto, a biologist at Cape Breton University in Nova Scotia, Canada, and his colleagues, discovered insect remains on the teeth inside the two skulls. Scientists had long thought that early reptiles were insectivorous – their teeth were sharp and curved inwards, making them ideal for piercing insect skeletons and holding struggling prey, however, this is the first direct evidence of this (*Biology Letters*, 2009, Vol. 5, p.838-840).

Madagascar's biodiversity

Madagascar has one of the world's most diverse faunas. Scientists have long thought that this came about by the animals being rafted there on logs or matted vegetation from Africa, and then once on the island, evolving to fill all the available niches, but one of the problems with this scenario is the distance from Africa, and the fact that the currents flow in the wrong direction, away from Madagascar. Now two scientists, Jason Ali, a geologist at the University of Hong Kong in China, and Matthew Huber, a palaeoclimatologist at Purdue University in Indiana, USA, have plotted the position of Africa and Madagascar 60 million years ago and found that their position, 1,650 km south of the present day position, would have meant that the current was then flowing from Africa to Madagascar, and would have been much stronger, making the rafting of animals to Madagascar much more likely (*Nature*, 2010, Vol. 463, No. 7281, p.653-656).

Burgess Shale type fossils found in the Ordovician of Morocco

Until now it had been thought that the sometimes bizarre soft-bodied creatures found in Canada's Burgess Shale and other deposits of similar age became extinct before the end of the Cambrian (488 Myr ago). Now a team led by Peter Van Roy and Derek Briggs of Yale University in Connecticut, USA, report the discovery of numerous diverse soft-bodied creatures (Fig. 4) in the Lower and Upper Fezouata Formations of the Lower Ordovician of Morocco (488 to 471 Myr ago) which shows that these unusual creatures did survive through to the Ordovician. The fauna, from around 40 sites in the Draa Valley in the desert region of southern Morocco, includes around 50 new species and provides a link between the Burgess Shale communities and creatures representative of the later period known as the Great Ordovician Biodiversification Event. The fossils also included horseshoe crabs, pushing back their fossil record by 30 million years (*Nature*, 2010, Vol. 465, No. 7295, p.215-218).

Fig. 4. Cheloniellid arthropod from Morocco, around 475 million years old.

Photo: Peter Van Roy / Yale University

Evidence of life at 3.2 billion years ago

Although life is thought to have begun early in the Earth's history, the evidence for this has always been ambiguous and open to interpretation as being of non-biological origin. Now a team led by Emmanuelle Javaux of the Department of Geology, University of Liège in Belgium, report the discovery of a large population of spheroidal microstructures from 3.2 billion year old shales and siltstones of the Moodies Group, Barberton Greenstone Belt, South Africa. A detailed study of the microstructures (up to about 300 µm in diameter) has identified them as being organic-walled microfossils that possibly cohabited with microbial mats in the photic zone of marginal marine environments (*Nature*, 2010, Vol. 463, No. 7283, p.934-938).

Was *Baryonyx* semi-aquatic?

The spinosaurs, the group which includes *Baryonyx*, were known to have a diet that included fish, but they have always been thought of as terrestrial dinosaurs. Now research by a team led by Romain Amiot at the University of Lyon in France, has produced evidence that the spinosaurs may have been semi-aquatic, spending a lot of time during the day in water. The researchers looked at the values of the oxygen-18 isotope in the enamel of the teeth of the spinosaurs and compared them with the values found in known terrestrial vertebrates (theropod dinosaurs) and known aquatic or semi-aquatic vertebrates (crocodiles and turtles) of the same period. Terrestrial animals have higher concentrations of this isotope than aquatic and semi-aquatic animals. Their research found that the spinosaurs had oxygen-18 values that were lower than those found in terrestrial theropods, but were closer to the values found in the aquatic and semi-aquatic crocodiles and turtles. This semi-aquatic habit would also have allowed the spinosaurs to coexist more easily with other large theropods by reducing competition for food and territory (*Geology*, 2010, Vol. 38, No. 2, p.139-142).

Snake snacks on small sauropods!

A recent study of a clutch of dinosaur eggs found 23 years ago in late Cretaceous (67.5 Myr) calcareous sandstones of the Lameta Formation near Dholi Dungri village in Gujarat, western India, has revealed the remains of a 3.5 metre-long predatory snake coiled around an egg and near the remains of a sauropod hatchling. The study was undertaken by Jeffrey Wilson, a palaeontologist at the University of Michigan, USA, and a team of colleagues including the original finder, Dhananjay Mohabey of the Geological Survey of India. They report that the snake, named *Sanajeh indicus*, did not have detachable jaws like modern boas and pythons so was unable to swallow the eggs whole – more likely it waited for its meal until one of the small sauropods hatched. The study is the first to report a snake in association with a dinosaur nesting site (*PLoS ONE* Biology 8(3): e1000322 (2010)).

Leaf mimicry in Jurassic lacewings

The discovery of two well-preserved fossil lacewings from the Middle Jurassic Jiulongshan Formation in northeastern China shows that insects had evolved leaf-mimicry 165 million years ago, well before the rise of the flowering plants. The study led by Yongjie Wang of the College of Life Sciences, Capital Normal University, Beijing, China, showed that the wings of the two lacewings, *Bellinympha filicifolia* and *Bellinympha dancei*, although not as advanced as present day leaf mimics, show a similarity to the leaves of the contemporaneous bennettitaleans and cycads, both members of the gymnosperms (Fig. 5). It's likely that the insects were extinct by the mid-Cretaceous, by which time the angiosperms (flowering plants) were becoming dominant and the gymnosperms were starting to decline (*Proceedings of the National Academy of Sciences*, 2010, Vol. 107, No. 37, p.16212-16215).

Fig. 5. Middle Jurassic lacewing from China (far left) and Cycadophyte leaf (near left).

Scale bars: 10mm (insect), 20mm (leaf)

Photo: National Academy of Sciences

Modern humans interbred with Neanderthals

A team, led by Svante Pääbo, a geneticist at the Max Planck Institute for Evolutionary Anthropology in Leipzig, Germany, has found that most modern humans outside of Africa have between 1% and 4% Neanderthal genomes as a result of interbreeding with Neanderthals. The team sequenced the DNA extracted from Neanderthal bones found in Vindija Cave in Croatia. The bones are dated at between 38,300 and 44,400 years old and the findings suggest that *Homo sapiens* bred with the Neanderthals after *Homo sapiens* had migrated out of Africa around 100,000 years ago. On the basis of past human migration patterns, they propose that this interaction took place within the eastern Mediterranean area (*Science*, 2010, Vol. 328, No. 5979, p.710-722).

Horned dinosaurs found in Europe

Until now remains of Ceratopsians (horned dinosaurs) have only been found in Asia and western North America. Now Attila Ősi of the Hungarian Academy of Sciences, Budapest, Hungary, and colleagues, report the discovery of cranial material of a small Ceratopsian from the Upper Cretaceous Csehbánya Formation, in the Bakony Mountains of western Hungary. This is the first definite record of Ceratopsians in Europe and the team believe that they migrated from Asia into Europe (*Nature*, 2010, Vol. 465, No. 7297, p.466-468).

Dinosaurs nested in geothermal fields

Dinosaur nesting sites are now regarded as quite common and can be found on several continents, but a recent discovery in Argentina has shown that some dinosaurs used geothermal vents to help incubate their eggs. Gerald Grellet-Tinner, an associate researcher at the Field Museum in Chicago, Illinois, USA reports the discovery of the nests at a Cretaceous hydrothermal site at Sanagasta, La Rioja Province, Argentina. This research shows that the sauropod dinosaurs regularly returned to the geothermal fields to lay their eggs. Today, a turkey called *Megapodius prichardii* nests in similar volcanically heated burrows on Niuafo'ou island, Tonga (*Nature Communications*, 2010, Vol. 1, No. 32).

Mammal-like crocodile from the Cretaceous

Recent discoveries of Cretaceous fossil crocodyliforms have shown that they differ considerably from today's crocodiles, particularly those found in the southern continent of Gondwana. Patrick O'Connor of Ohio University, USA and his colleagues, report a new crocodile named *Pakasuchus kapilimai* from the Cretaceous Galula Formation in the Rukwa Rift Basin of southwestern Tanzania. These crocodiles, part of a group called the notosuchians, were only 50 cm long from head to tail, and would have hunted insects and other small prey (Fig. 6). It's likely they lived mainly on land as their nasal openings are on the front of their skulls as opposed to today's aquatic crocodiles whose nasal openings are on the top of their skulls to allow breathing whilst partially submerged. Another unusual feature is their mammal-like teeth which had more in common with a cat than their present-day crocodile relatives, and it's likely that they filled the ecological niches taken by the mammals in the northern continent. One researcher commented that if some of the teeth had been found in isolation they could easily have been mistaken for mammal teeth (*Nature*, 2010, Vol. 466, No. 7307, p.748-751).

Fig. 6. Reconstruction of Pakasuchus kapilimai.

Reconstruction: Mark Witton, University of Portsmouth

Origin of dinosaur feathers older than previously thought

The Carcharodontosaurs were the largest of the predatory dinosaurs and until recently they had only been found in the southern Gondwana landmass. Now a team led by palaeontologist Francisco Ortega of the National University of Distance Learning in Madrid, Spain, have described an almost complete and exquisitely preserved skeleton of a 6 m long theropod from the Lower Cretaceous of Las Hoyas in Cuenca, Spain. The theropod, named *Concavenator corcovatus*, had some unusual features – it had a strange hump on its back, but more surprisingly it had a row of small bumps on its arm (the ulna), which researchers think were structures that anchored quills to the creature's bones. These would have anchored the roots of feathers to the arm as in modern birds, and it's the first time that evidence for feathers has been found in the Allosaurs, the group to which the Carcharodontosaurs belong. Feather anchoring structures had already been identified in the Coelurosaurs, the lineage which includes *Tyrannosaurus* and *Velociraptor* and also the ancestors of modern-day birds. If this interpretation is correct it means that feather-like structures appeared in the dinosaurs much earlier than previously thought, before the Carcharodontosaurs and Coelurosaurs diverged in the middle Jurassic (*Nature*, 2010, Vol. 467, No. 7312, p.203-206).

2.1 billion year old macrofossils

Reports of macroscopic fossils from the Palaeoproterozoic era (2.5 to 1.6 billion years (Gyr) ago) have always been controversial. The first undisputed eukaryotes (multi-cellular organisms) first appear in the fossil record around 1.6 Gyr ago. Now a team comprising Abderrazak El Albani of the University of Poitiers in France and Stefan Bengtson, a palaeozoologist at the Swedish Museum of Natural History in Stockholm, Sweden, and their colleagues, report the discovery of structures up to 12 cm in size from the 2.1 Gyr old black shales of the Palaeoproterozoic Francevillian B Formation in Gabon (Fig. 7). They interpret the structures as being discrete populations of colonial organisms deposited under an oxygenated water column. At 2.1 Gyr the Gabon fossils occur after the increase in atmospheric oxygen that occurred between 2.45 and 2.32 Gyr ago known as the Great Oxidation Event, and could be seen as the precursors of multicellular life, which expanded so rapidly in the Cambrian explosion 550 million years ago (*Nature*, 2010, Vol. 466, No. 7302, p.100-104).

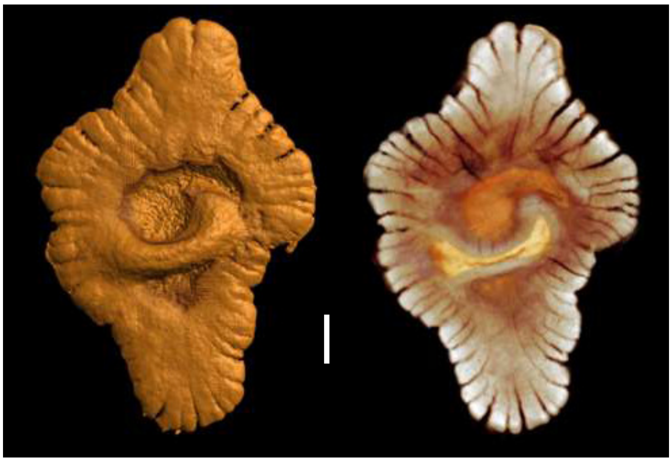


Fig. 7. Virtual reconstruction of 2.1 billion year old multi-cellular organism from Gabon, taken using X-ray tomography. (Scale bar 5mm)
External structure (left). Internal structure (right)

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Oldest member of the daisy family

The daisy family, which includes the sunflowers and dandelions, is the largest of all the flowering plants, but it has a poor fossil record. Now palaeobotanist Viviana Barreda, of the Argentine Museum of Natural Sciences in Buenos Aires, Argentina and colleagues, have described the oldest member of the family yet found. The specimen, complete with large flower heads, leaf-like structures and slender stems (Fig. 8), was found in rocks of Middle Eocene age (47.5 Myr) in Patagonia, Argentina. Genetic comparisons with living plants had placed the origin of the daisy family in southern South America at around 50 million years, but until now this has not been supported by the fossil record (*Science*, 2010, Vol. 329, No. 5999, p.1621).

Fig. 8. Fossil of the earliest member of the daisy family - 47.5 million years old.

Photo: Science /American Association for the Advancement of Science

Extracts from 'Wealden News'

by Peter Austen

Introduction

Wealden News is a newsletter produced by myself and Ed Jarzembowski, which covers items of interest relating to the Wealden deposits of southern England that may not necessarily be covered in the scientific or national press. These can be new fossil finds, reports on stratigraphy or new publications. Below are edited extracts from the February 2010 issue of *Wealden News* (No. 8) that have a local interest to *Hastings & District Geological Society* members. Any website references have been updated.

The full version of *Wealden News* No. 8 may be downloaded from the *Wealden News* website: http://www.kentrigs.org.uk/wealden.html. Previous copies of *Wealden News* (back to 1998) may also be downloaded from this site. If you do not have access to a computer at home, all libraries in the UK are now equipped with computers with internet access for use by the general public.

The article "**Vertebrate fauna from Ashdown Brickworks, Bexhill, East Sussex**" by Peter Austen, David Brockhurst and Kerri Honeysett has not been included as this runs to 11 pages. It is however freely available on the internet.

Bennettitalean trunks from Hastings

Next time you traverse the section from Rock-a-Nore to Ecclesbourne Glen keep a watchful eye at low water for trunks of the Wealden bennettitale *Monanthesia*. The bennettitales are an extinct group of gymnosperms (seed plants), superficially similar in appearance to the cycads. The two groups are only distantly related (see Austen, 2001 'What are Bennettitales?'), and although the bennettitales became extinct at the end of the Cretaceous, they formed an important component of the land vegetation during early Cretaceous times.

Fig. 1. Bed showing bennettitalean trunk exposed (top one of two long trunks - film pot for scale just right of centre) *Photo: Sue Bower*

Over the past few years two of these bennettitalean trunks have been recorded in shoreline exposures of the Ashdown Formation (Hastings Beds, late Berriasian to early Valanginian). The first was found in 2002 by Sue Bower embedded in the sediment at low water about 100 metres east of the end groyne at Rock-a-Nore (Figs 1 to 3), and in 2008 another was found by Wolfgang Pachner close to the waterfall at Ecclesbourne Glen, once again embedded in the sediment at low water (Fig. 4).

Fig. 2. Bennettitalean trunk from top of picture in fig. 1 (film pot for scale above trunk). *Photo: Sue Bower*

The coastal section at Hastings from Rock-a-Nore to Cliff End is famous for its early Cretaceous fossil plants, and of the 130 or so species recorded from the Weald, around 90% have only been found as macrofossils along this 8 kilometre section of coast. Although a large number of these were collected in the late 19th and early 20th century, and many are only known from a few specimens, interesting material can still be found.

Both the Wealden bennettitales and cycads have been comprehensively redescribed by Joan Watson and her colleagues (Watson & Sincock, 1991 and Watson & Cusack, 2005), updating the previous major work by Seward (1895).

It's important to record these exposures when they appear, as once exposed, unless they are quickly reburied by sediments, they are rapidly destroyed by erosion.

My thanks to Sue Bower and Wolfgang Pachner for photographing the specimens, and also to Ken Brooks and Alan Prowse for bringing them to my attention.

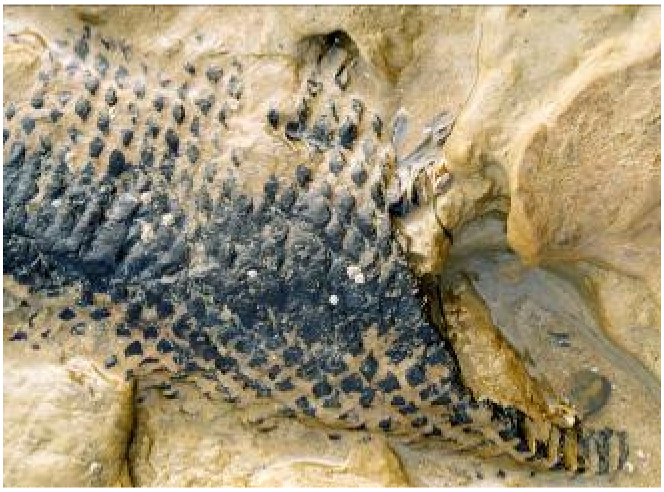


Fig. 3. Close-up of end of bennettitalean trunk shown in fig. 2. *Photo: Sue Bower*

Fig. 4. Bennettitalean trunk found in 2008 (similar scale to that in figs 1 to 3). *Photo: Wolfgang Pachner*

References

Austen, P.A. 2001. Recent fossil plant finds from the Hastings area (What are Bennettitales?). *Wealden News*, 5, p.3-5. (http://www.kentrigs.org.uk/wealden.html)

Seward, A.C. 1895. *The Wealden flora II. Gymnospermae*. Catalogue of the Mesozoic plants in the Department of Geology, British Museum (Natural History) **2**, xii + 259 pp., 20 pls (London).

Watson, J. & Cusack, H.A. 2005. Cycadales of the English Wealden. *Monograph of the Palaeontographical Society*, London, 622, part of volume **158** (for 2004), 189 pp., 10 pls.

Watson, J. & Sincock, C.A. 1992. Bennettitales of the English Wealden. *Monograph of the Palaeontographical Society*, London, 588, part of volume **145** (for 1991), 228 pp., 23 pls.

Peter Austen

Web in amber from Bexhill

What is thought to be the world's oldest spider web in amber has been found in Wealden deposits in East Sussex.

The amber was found by Jamie Hiscocks in layers of lignite within coastal exposures of the Ashdown Formation (Hastings Beds, earliest Valanginian) close to Bexhill, East Sussex.

The discovery was first reported to the annual meeting of the Palaeontological Association at Glasgow in December 2008 by Professor Martin Brasier, a palaeobiologist at Oxford University (Brasier *et al.*, 2008), and has now been published in the *Journal of the Geological Society* (Brasier *et al.*, 2009). At 140 million years old, it is 10 million years older than the previous oldest fossil spider web, which was found in Lebanese amber (Anon., 2008).

It is thought that the web was produced by an orb web spider. Charred bark and burnt sap inside the amber suggests that the tree, probably a conifer, had been damaged in a fire and produced resin (later to become amber) to protect itself from infection (Gray, 2008).

Further reports and photos can be found in *Geoscientist* (Day, 2010), *The Times* (Henderson, 2009) and *The Daily Telegraph* (Anon., 2009), all of which can be found online.

References

Anon. 2008. Earliest spider web. *New Scientist*, Vol. **200**, No. 2687/2688, p.7.

Anon. 2009. Fossil hunter finds 140-million-year-old spider's web. *The Daily Telegraph*, 30th October 2009.

Brasier, M., Cotton, L. & Hiscocks, J. 2008. Earliest Cretaceous ‘firestorm amber’ with spiders’ webs, from the ~140 Ma dinosaur trackway beds of Bexhill (Abstracts of oral presentations). *The Palaeontological Association Newsletter*, No.60, p.18.

Brasier, M., Cotton, L. & Yenney, I. 2009. First report of amber with spider webs and microbial inclusions from the earliest Cretaceous (c. 140 Ma) of Hastings, Sussex. *Journal of the Geological Society*, **166**, 989-997.

Day, S. 2010 (January). Bewitched by fossil web (Geonews). *Geoscientist*, **20**(1), 14.

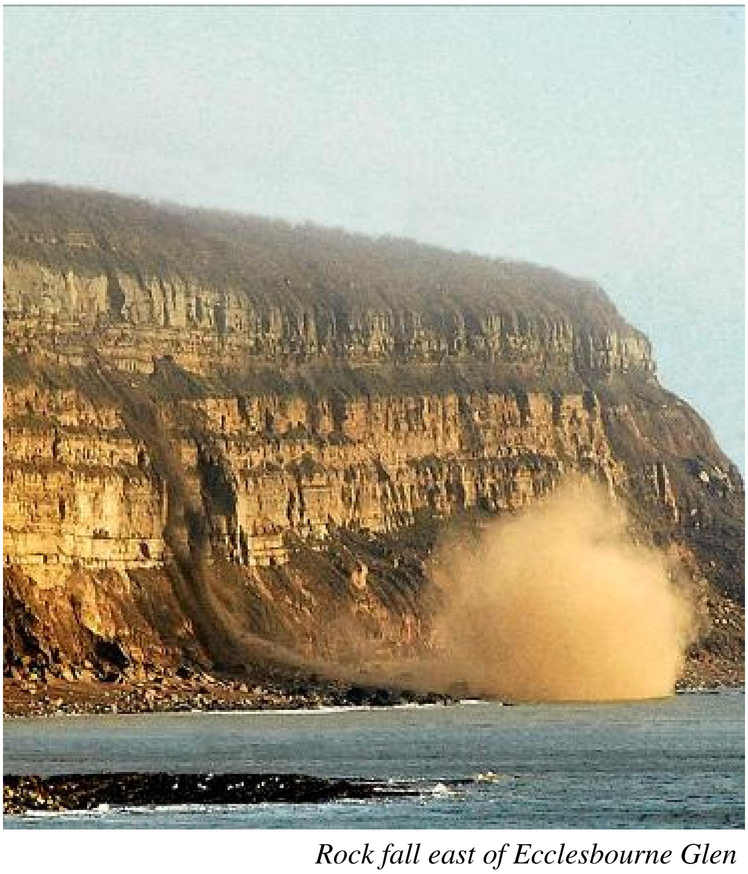
Gray, R. 2008. World’s oldest spider web found on English beach. *The Daily Telegraph*, 13th December 2008.

Henderson, M. 2009. 140-million-year-old spider’s web discovered frozen in time. *The Times*, 31st October 2009.

Cliff falls along the Hastings coastline

The 5-mile section of coast east of Hastings from Rock-a-Nore to Cliff End is frequently subject to cliff falls, particularly after periods of wet weather, but because of their sudden nature they are rarely caught on camera. In our 2008 Journal (see ‘Cliff fall at Cliff End, East Sussex – 30th January 2007’, *HDGS Journal*, Dec 2008, Vol. 14, p.28-29) we published an article by David Talbot of the Medway Lapidary and Mineral Society showing photographs of a cliff fall at Cliff End in January 2007. On the cover and right are two photographs of a spectacular fall from the cliffs just east of Ecclesbourne Glen taken by David Burr of Burwash. The photos were taken by Mr Burr from Rock-a-Nore car park on the morning of 11th December 2009. Mr Burr said that initially there was what looked like an explosion about two-thirds of the way up the cliff but there was no sound. The coastguard were called, but no-one was hurt in the fall.

Both sets of photos also serve as a warning to geologists traversing these coastal sections to be ever vigilant.



Rock fall east of Ecclesbourne Glen

Picture by David Burr

Bexhill borings

The coast at Bexhill-on-Sea, East Sussex, shows some cliff and foreshore sections of the Hastings Beds yielding dinosaur footcasts and fossil wood. The latter may be pyritised and liable to disintegrate. One such piece yielded pyritised tubes which appear to be infillings of borings across the grain in the carbonised wood (Figs 1 & 2). The tubes resemble the work of beetles, but other organisms (especially bivalves) will also attack driftwood. Please let us know if you have seen similar structures in the Wealden and help track down these traces.

Ed Jarzembowski

Fig. 1. Pyritised tube in carbonised wood (cm. rule for scale) *Photo: Ed Jarzembowski*

Fig. 2. Individual pyritised tubes (scale divisions 1mm.). *Photo: Ed Jarzembowski*

Geological Websites

Useful websites with a geological interest

Edited by Peter Austen

The internet is home to tens of thousands of websites with a geological interest, and it is often difficult to sort the wheat from the chaff. For every quality website there are many which leave a lot to be desired. As a general rule university and museum websites are fairly good, and given below are details of a few other sites worth a visit. If you do not have access to a computer at home, all libraries in the UK are now equipped with computers with internet access for use by the general public.

All sites were valid as at 1st November 2010.

If you know of any particularly good websites then please let me know and I will include them in the next issue of our Society Journal.

Google Books and the Internet Archive

In the last Hastings Journal I gave a list of Gideon Mantell's books and papers that were available on Google Books (see 'Gideon Mantell available on Google Books', *HDGS Journal*, Dec 2009, Vol. 15, p.36-37). The Internet Archive also has a wide range of old books on all subjects freely available online, and can be accessed on http://www.archive.org/

Topley (1875) available to read online

The classic 1875 memoir on the Weald by William Topley is available to read (but not download) online, supplied courtesy of American Libraries. You could also print all 541 pages, but only one page at a time! It's available on the Internet Archive at http://www.archive.org/ Type "Weald" into the search engine and it will appear as one of the titles.

Reference

Topley, William. 1875. The geology of the Weald (parts of the Counties of Kent, Surrey, Sussex, and Hants.). *Memoirs of the Geological Survey, England and Wales (Old Series)*, H.M.S.O., London, xiv, 503 pp.

Ordnance Survey – Get a Map
http://www.ordnancesurvey.co.uk/oswebsite/getamap/
Allows you to access and download sections of Ordnance Survey maps. In the words of the site "You can search for small-scale maps (up to 1:25 000 scale) anywhere in the UK simply by entering the place name, full postcode or National Grid reference – and copy them for use on your personal website."

British Geological Survey
http://www.bgs.ac.uk/OpenGeoscience/?Accordion1=1#maps
If you're unsure about the geology of an area this site allows you to study the geology in detail. It covers the whole of the UK and allows you to either look at the pure geology or the geology overlain with a map of the area. An extremely useful site.

NERC Open Research Archive
http://nora.nerc.ac.uk/
This is the site of the Natural Environment Research Council and it allows access to 8,900 research papers, 2,601 of them on the earth sciences.

Earth Heritage Magazine
http://www.earthheritage.org.uk/download.html
Earth Heritage is a twice-yearly magazine with articles on geological and landscape conservation. It is produced by the Joint Nature Conservation Committee, Natural England, Scottish Natural Heritage and the Countryside Council for Wales. Issues are available online from 2002 (Issue 18) to date.

AMNH Digital Library
http://digitallibrary.amnh.org
This is the Research Library of the American Museum of Natural History. It contains the results of research by museum scientists and their colleagues in the areas of zoological systematics, palaeontology, geology, evolution, and anthropology. A search using the term 'paleontology' (spelt the American way) brings up 1,331 publications.

GEOLOGISTS' ASSOCIATION FIELD MEETINGS – 2011

The Hastings and District Geological Society is affiliated to the Geologists' Association, and as such members are entitled to attend GA lectures, normally held at Burlington House, London, W1, or attend any of the GA field trips. Details of both are available at monthly meetings.

SUSSEX MINERAL SHOW

Saturday 12th November 2011

10.00 am to 4.30 pm

Clair Hall, Perrymount Road, Haywards Heath

(Close to Haywards Heath Station)

Minerals, gems, fossils, meteorites, flints, books and accessories on display and for sale

Illustrated Talks

Organised by the **Sussex Mineral & Lapidary Society**

Details and map available from Trevor Devon at HDGS meetings closer to the date of the Show

HDGS Field Trip to Sheppey

Sunday, 23rd May 2010

HDGS members on the beach at Sheppey.

Photo: Roger Blaker

HDGS members on the beach at Sheppey in front of a World War II pill box.

Photo: Laura Blaker

HDGS Barbecue

Sunday, 15th August 2010

HDGS Barbecue hosted by Trevor and Fiona Devon.

Photo: Peter Austen

HDGS Members' Day

Sunday, 10th October 2010

"Spot the quarry." Members were asked if they could find the location of four 19th century quarries on maps provided by Dale Smith:
Shorndean Quarry
Hollington Quarry
Little Ridge Quarry
Old Roar Quarry

Photo: Diana Williams

Display of photos and fossils from the Hastings area by Ken Brooks

Photo: Diana Williams

Members enjoying one of the many microscopes available.

Photo: Diana Williams

Iron Minerals display wins first in Show

Congratulations are once again due to Trevor Devon for securing first prize for his exhibit of iron minerals at this year's Sussex Mineral and Lapidary Society Annual Show.

The theme for the Society's annual show competition was "Iron Minerals" where the specimens were all required to feature iron in the chemical formula. Trevor's winning entry was a selection of nearly 50 specimens that traced the chemical diversity of iron as found in natural minerals. These included such familiar sulphide and oxide minerals as iron pyrite, marcasite, haematite and goethite to the more exotic salts such as scorodite (arsenate), vivianite (phosphate), wolframite (tungstate) and jarosite (sulphate). Trevor also showed that iron featured very widely in silicate minerals with fine examples of aegirine, epidote, ilvaite, actinolite and mica, as well as a very rare specimen of balangeroite (a "fluffy" ferromagnesian mineral from Italy). This combination of well-chosen specimens, their presentation and the "story" was remarked upon by the judge, Mike Rumsey (Natural History Museum), in placing the display first out of six high quality entries. Trevor, needless to say, is "over the moon" as this is the second time he has been selected to put in an entry to the Sussex Show and has won both times!

Trevor's winning "Iron Minerals" display

Photo courtesy of Sussex Mineral & Lapidary Society

Mike Rumsey presenting first prize to Trevor

Photo courtesy of Sussex Mineral & Lapidary Society

Details of next year's Sussex Mineral and Lapidary Society Show are on page 48.