THE WEST SUSSEX GEOLOGICAL SOCIETY

OUTCROP

Number 60 Winter 2019

Unveiling of
40th Anniversary plaque
on Worthing Pier

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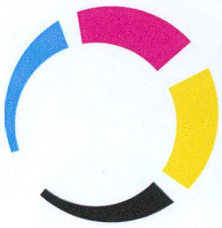
Established in Worthing, 1982



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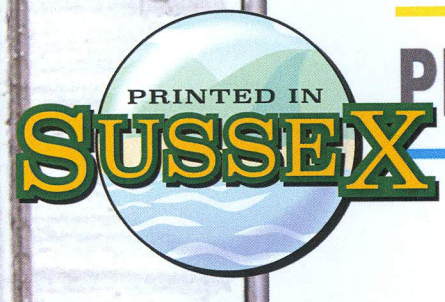

OUTCROP 60

Winter 2019

Contents

From the Editorial team

Thank you to all who have submitted articles for this issue.

Contributions for Outcrop 61 are very welcome and should be sent by email or on disc to Jo Paxton by **1st March 2020** but earlier would be appreciated.

Contributions to Outcrop are very welcome and should be in a Word document, using font Times New Roman, size 11 with headings in bold, main heading font size 16, sub heading font size 12.

***All** images **Must** be the original size (not processed!) and enclosed as **Separate Files**, any included within Word documents will **Not** be used.*

Each contributor is responsible for ensuring that all necessary permissions and licenses are obtained, as required, particularly for the reproduction of illustrations.

All views and opinions are solely those of the individual authors.

The West Sussex Geological Society does not accept responsibility for views and opinions of individual authors in this publication.

The G.A. Magazine, Circulars and Magazines from other Societies, books, newsletters and other items of interest are on the table in the hall at each meeting for your perusal.

IMPORTANT NOTE

You are now able to pay your subscription by standing order or one off electronic payment. Bank details are as follows;

using your name as the reference. Subscriptions are due annually on 1st January.

The Society would appreciate your using this method, but cash or cheque will still be accepted.

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From The Chairman

Welcome to the Winter 2019 edition of Outcrop, our sixtieth! We have now started our autumn talk programme, and though it seems a while ago, over the summer we unveiled our stained-glass panel on the pier at Worthing – though it felt like November.

Thanks to Alan Bell who initiated and led this, and we also produced a Pebbles on the Beach leaflet. David Bone assisted with this and has used it for our initial launch and then as part of the recent Beach Clean weekend. Both the panel and the leaflet were generously funded by the Curry Fund of the Geologists' Association, who we thank for this.

Otherwise we have had a number of field trips, including Bob Chandler's one to Dorset and assisted at the Portsmouth Museum natural history day. Thanks to our committee who have planned most of the 2020 talks and field trips.

And we have a new logo – inspired by Alan's ideas for the stained glass – you will see our new logo on the cover. This highlight's David Bones artistic talents.

Best wishes

John Lonergan – Chairman

W.S.G.S Lecture Programme

W.S.G.S. meetings are held of the third Friday of each month at 7.30pm (no meetings in July and August) at St Stephen's Church, Angola Road, Worthing.
Although every effort is made to notify of any changes, we advise members to confirm field trips and lectures at least one week in advance.
All changes are updated on our website.
Details and further information from:-

FIELD TRIPS - John Lonergan

LECTURE PROGRAMME - Betty Steel

2020

17 January	Lecture	**Brighton ChaMP got Water Project.** Simon Deacon, Environment Agency
21 February	Meeting	**AGM** followed by a short talk by Andy Cosham and cheese & wine
20 March	Lecture	**Piltdown.** Colin Prosser, Head of Natural England
17 April	Lecture	**TBA**
17 May	Lecture	**TBA**
19 June	Lecture	**Darwin's fossil mammals.** Dr Pip Brewer. NHM
18 September	Lecture	**Scotland's Lost Meteorite.** Ken Amor, University of Oxford
16 October	Lecture	**The Boxgrove Wider Area Project;** Mapping early Pleistocene deposits across the coastal plain of West Sussex. Dr Matt Pope, University College London
15 November	Lecture	**The rising of Continents and sinking of Oceans.** Professor Craig Storey University of Portsmouth
11 December	Meeting	**Members Xmas Meeting.** David will give a short "Polar bears and coal mines; an excursion to Svalbard". Followed by Raffle, festive food

NOTE THAT THIS IS THE 2nd FRIDAY IN THE MONTH

We are insured through The Geologists' Association
On any field trip you are required to wear helmets and high visibility jackets in quarries.
This is always advised. Goggles must be worn when hammering
and suitable footwear be worn at all times.

West Sussex Geological Society
2020 Fieldtrips

Saturday, 21 March 2020 - Nymans Landscape Gardens

Led by David Bone with Greg Thomas, meet at 10.30 in the Nymans' National Trust car park (free, but pay to enter property). Then a walk to explore the geology, history and landscape of the estate are surrounding views.

Sunday, 26 April 2020. Pulborough Ridge

Led by John Lonergan, meet at 10.30 at Pulborough Railway station for a six mile walk around the Hythe Beds, Lower Greensand, ridge on which Pulbourgh was built. Views of the Downs, Arun gap and into the Weald, looking at the geology, history and archaeology

Annual Long Weekend Field Trip, Friday 29th to Sunday 31st May 2020, on the Isle of Wight

More details to follow, a leader for Saturday and another for Sunday.

Wednesday, 10 June 2020 - St Mary de Haura Church, Shoreham

Led by David Bone, meet at 19.00 (to be confirmed) at the church, New Rd, Shoreham-by-Sea, BN43 6RA. This twelfth century church is an ideal place to study the building stones, and where they come from. It also has an impressive history and architecture. We might even go to a hostelry afterwards to continue the discussions.

Sunday, 21 June 2020 – Downe House, Kent

Meet at Downe House at Luxted Road, Downe, Kent, BR6 7JT at 11.00.This is the home of Charles Darwin, and where Origin of Species was written. It includes museum, the restored house, rooms and garden This includes his sand (thinking) walk – his going twice round for difficult problems. Owned by English Heritage, with free entry to their members. We will aim to car share – and it has a café.

Sunday 26 July 2020 - Seaford

Led by Andy Cosham. Times to follow. A three-mile walk examining the landscape and geology of Seaford Head and Hope Gap, including the wave cut platform, and discussing the Cuckmere and Seven Sisters.

Sunday 16 August Pebbles on the Beach

Led by David Bone, meet at Worthing Pier at 14.30. To explain the geology and landscape – but also the pebbles on the beach. How flint formed, its different types and fossils – and not just looking at flint pebbles!

September and October still being planned.

Two visits are planned to Smokejacks in Surrey. The trips are being run as part of the Kent Geologists' Group field programme for 2019. This Weald Clay brick pit has yielded many important finds over the past three decades. Dates to be advised.

Please note that on all field trips we will collect one pound from WSGS members and two pounds from visitors to cover costs (and Day Membership for our insurance)

John Lonergan

Field Trip Secretary
West Sussex Geological Society

Website; www.wsgs.org.uk

Please check the website for any changes

Woolly Crete

Anthony Brook

I thought I had told you all about the Crete family, but, perhaps, I was mistaken.....

On 8 August 2018 Roger Cordiner and I were doing some fieldwork inspecting the foreshore at low tide in front of the Chalk cliffs at Peacehaven, in East Sussex, and had stopped for a mid-afternoon break and cup of tea at the mobile teavan on the Undercliff roadway, when I looked up and saw 'Woollycrete' rumbling past (see attached photograph).

'Good Lord! Another member of the Crete family!' I remember remarking,' Perhaps this one keeps water out by using wool as an insulating membrane!'

No such fanciful strata, I'm afraid. The answer is far more mundane: Woollycrete deliver concrete, which, at least, is a 'crete'. Woollycrete (Southeast) Ltd provide 'expert concrete supplies across East Sussex and the Southeast, with modern volumetric mixers, and flexible service and delivery', from an industrial estate in Hailsham, East Sussex.

Pity, as I rather liked the idea of Woollycrete as an obscure member of the Crete family.

Meeting Reports

May 2019 - By Jo Paxton

Cope and Marsh: The Bone Wars

Othniel Charles Marsh (1831-1899) & Edward Drinker Cope (1840-1897)

Dr Chris Duffin, Natural History Museum

The Chairman welcomed Dr Duffin back who has spoken to us several times before. Chris started his lively, well illustrated presentation by giving us background on the two palaeontologists, Othniel Charles Marsh and Edward Drinker Cope who in the latter half of the 19th century after an initially amicable relationship, became increasingly competitive, spiteful and hostile as their respective careers became more successful.

Cope came from a farming background with fluctuating fortunes, eventually inheriting the family farm thus bestowing financial freedom; whilst Marsh although coming from a humbler background was fortunate to enjoy the patronage of his uncle George Peabody, the philanthropist. Both wrote numerous papers over their lifetimes, Cope publishing his first, aged 19 in which he completely reclassified salamanders coincidently both embarked on the grand tour of European museums leading to their first meeting in Berlin during 1863, after which they corresponded amicably for the next five years, keeping one another abreast of research and developments, but increasingly Marsh sensed the presence of competition. Then followed years of trading insults and subsequent bitter hatred.

It was fieldwork and discoveries in the New Jersey Marls during 1866 that led to their falling out, after Marsh bribed pit operators to divert future fossil finds to him instead of Cope. By 1873 open hostility ensued. Cope collected all Marsh's errors and threatened to publish them all.

Both men were able to self-fund expeditions each summer through Colorado, Nebraska and Wyoming and spend winter publishing their discoveries, a number of which were significant. Each year increasing their competitiveness accompanied by accusations and counter accusations of spying, stealing workers and fossils and bribery. These digs lasted from 1877 to 1892 each man using small armies of fossil hunters in mule drawn wagons or on trains and sending tons of fossils back east.

Colourful happenings include Marsh conducting field work with "Buffalo Bill" Cody in the Badlands and Marsh associating with Red Cloud and General Custer.

The public animosity between the two lasted until Copes death in 1897, by which time both men were financially ruined, and the reputation of American palaeontology harmed in Europe for decades.

Both men made significant finds with Cope discovering 56 new dinosaur species and Marsh 80 their discoveries include *Triceratops, Diplodocus and Stegosaurus*. Some of their ideas such as Marsh's that birds are descended from dinosaurs have been upheld.

September 2019

The Great Southwell Landslip of 1734 - a major toppling failure

Dr Eddie Bromhead

Report by Jenny Clark

Dr Bromhead has visited Portland many times with students. Portland is an island connected to the mainland by a shingle beach, Chesil beach. Unusually, as the onshore drift is west to east, the Chesil shingle sorting is finer at the Bridport end and larger at Portland. In a map dated 1710 shows a tombolo connecting the island to Verne, now a prison. The connection has since been eroded away.

Toppling is rare compared with landslip, falls and slides. The event at Southwell, situated just east of the Bill, was a toppling of large blocks of stone, the analogy being to a row of unsupported books which will topple rotationally clockwise. This was the second largest recorded historical landslide at 1.5 miles long (2.4 km). Toppling at West Weare shows a mechanism involving crushing in th Portland sandstones. Just east of Southwell is Church Ope Cove (possibly Hope) with a history of smuggling in olden times.

Quarrying has taken place over many years, it was used in the building of St Paul's, but there is a decline in production now. A railway, disused since 1920, leads to the cliff edge where waste was tipped in between the blocks before falling to the beach. Using the word "rabbit" is actively discouraged on Portland as superstition has it that these animals were instrumental in undermining the Portland stone, instead, refer to them as "The Long-Eared Ones".

22,000 years ago sea level was 140 metres below today. The graph which Dr Bromhead showed a steady rise covering these thousands of years, due to the interglacial periods but the recent years are hardly noticeable on the graph.

The stratigraphy of Portland is quite complicate, apart from Portland Limestone, there are narrow beds of Dirt Bed, Top Cap, Whit Bed and Base Bed. Also there is a wider band of Cherty series, followed by a series of narrow strata of basal shell bed, Portland Clay, and sandstones with Kimmeridge Clay at the base.

In the toppling scene, the tensile toppling fracture zone is above the toppling zone and crushing zone. So why does toppling occur here? Meet DORIS (Dorset Integrated Seabed Survey). The sea bed around Weymouth and Portland shows a series of parallel transform faults which also continue through the Island of Portland. The strata of the island doesn't just dip North/South; there is a fold axis almost N/S because there is a dome to the West and another to the East. At Southwell, the coast is sub parallel to the faults thus already dividing the Portland Limestone into strips. Weymouth Bay and Portland evolved through several glacial cycles – evidenced by raised beaches. The Southwell toppling in 1734 occurred during the Little Ice Age, but there had been other topplings prior to that.

Dr Bromhead made a plea for geological maps to continue past coastlines and show the geology of the sea floors.

Meet a Member

John Lonergan

1 What fired your interest in Geology?

I've been interested in walking and landscapes since I was a child, my father is also a Civil Engineer and interested in geology, though principally in minerals (from the shape and mathematical point of view – I remember his interest when we were in Kenya for his work when I was a child). I'm more interested in how thigs came to be as they are now – so structural, processes and systems and geomorphology. Hence being interested in archaeology as well

2 How long have you had that interest?

As long as I can remember! – I remember reading Professor Dudley Stamp's New Naturalist book on Geology more than once as a child. And the Pebbles on the Beach book. We did collect fossils at Bracklesham – but they were damp and less than fragrant – my mother was not impressed.

3 Did/does your career involve any geology?

Yes, it was taught as part of my Civil Engineering degree at the University of Leeds, and I took the geotechnical options. My design experience for my professional qualification was in Balfour Beatty's Temporary Works Design department – so including excavations and foundations. Then onsite I worked in earthworks and structures on highway projects, then in managing temporary works (a good excuse to enter holes in the ground) and design management. This included leading the redesign proposal for the cut and cover tunnels under the M1/M62 interchange in Leeds.

4 What has been your involvement with the WSGS?

I've been a member since 1988, I remember Bob Robelou writing to me when I joined as we lived in Borers Arms Road in Copthorne and asking about wells – as you'd expect. Then after moving nearer going on a lot of field trips I rashly volunteered to help in 2010 so became Field Trip Secretary, and the Chairman in 2010 after Ken Steel. I was voted in at the AGM while on a walking holiday – but had agreed!

5 What do your friends and family think of your involvement in geology?

My young nephews are impressed – they like fossils and dinosaurs. The rest of my family views it as harmless. Even my sister in Aberystwyth to whom I recommended the turbidites at the back of the beach – we went on a field trip there in the last century.

6 How important do you think geology will be in the future?

As we try to find scarcer and more specialised resources, to reuse areas and structures and also to mitigate the effects of past land and resource use I can only see more need for both pure and applied geology. In parallel there is still plenty we do not understand and still to be investigated. And then there are nearby planets...Plenty of interesting work and study!

7 What's your favourite rock/fossil and why is that?

Rubies in Zoisite – my father bought piece in Kenya the second time we were there and it always sat in the dining room, it is green and red – very similar to garnets in eclogite

A picture of me channeling Fred Dibnah on our Fernhurst / Older Hill field trip in 2015. (Mick Penn.)

8 What is your favourite rock?

My favourite rock is rubies in zoisite, as I remember my father buying, rather than collecting, a sample of this striking green rock with red crystals. He worked in East Africa for a year in the late 60s and again in the mid-70s, and our family lived there then, in Kenya. The photo is from the web, www.mineralminers.com/html/ruby-zoisite.stm, as my father's specimen is buried somewhere in their attic!

It is actually called Anyolite, but mainly composed of zoisite. It is also known as "ruby in zoisite" because it is composed of green zoisite with bright red ruby crystals, sometimes accompanied by black crystals of the hornblende tschermakite. It is found mainly from Tanzania and Kenya. As a generic petrographic description of this rock would be like corundum-pargasite zoisiteite. But it has been given a more euphonious name, Anyolite, from the word for green in the native language (anyoli) of the Masai tribe. (sample, inside back cover)

I now know more about it than I did before - it does look like garnets in eclogite, though.

Dorset field trip, 18-19 May 2019

Leader: Dr Robert (Bob) Chandler

Report: David and Anne Bone

We had high expectations of this weekend field trip as our leader is a well-known expert on the Jurassic of Dorset especially its ammonite faunas which he has studied for many years. The focus of this trip was the Inferior Oolite succession of south-west Dorset. This spans the lower part of the Middle Jurassic, comprising 14 ammonite zones and 58 ammonite faunal horizons within a maximum thickness of 20 m. In this area, the Inferior Oolite is a variably condensed sequence resulting from reduced sediment input or gaps in the succession that mark periods of non-deposition. Occasionally, thin conglomerates are all that survive of a sediment sequence that was eroded before deposition recommenced. This was the result of tectonic movements in the Middle Jurassic that reactivated faults in the underlying Palaeozoic basement rocks to cause uplift in the seabed topography. During that time, Dorset was at a latitude around 25°N, covered by warm shallow seas dominated by the deposition of sandy, fine-grained and iron-rich limestones with an abundance of marine fossils.

The party of 13 members and guests of the WSGS convened at the National Trust car park at Hive Beach (SY 490888), Burton Bradstock on a cool but dry Saturday morning. Those who arrived early partook of breakfast and refreshment at the excellent (and recommended) Hive Café. Descending to the beach west of the car park, we were introduced to the Bridport Sand Formation that underlies the Inferior Oolite and is exposed in the cliffs. Cross-bedded, yellowish, alternately friable (non-cemented) and harder (calcite-cemented) sandstones, are interpreted as a broad, offshore sandbar that migrated southwards through time. Hive Beach lies on top of the Bride Fault, which downthrows to the south-east and is clearly visible in offshore charts. Both offshore and onshore it is marked by a linear array of large, pale grey Inferior Oolite limestone boulders, which were seen to contain superb specimens of large fossil nautiloids. Our next stop was an addition to the itinerary but enabled our leader to continue his introduction to the geology of the area, illustrated by the dramatic cliffs at West Bay, Bridport (SY464902). Here, a recent cliff fall had brought down boulders of yellow Inferior Oolite sandy limestones to beach level where we were soon busy with hammers and chisels (Figure 1). A small number of ammonites were collected, some of which ended up being given to interested members of the public, who were also searching for fossils.

Leaving an increasingly busy beach scene behind us, we drove inland through narrow country lanes to see a small 4-metre section in the Inferior Oolite at Upton Manor Farm, Uploders (SY 513 935). The exposed beds had been usefully numbered, which helped Bob to explain the considerable variations in thickness between beds and also those missing at different localities in south-west Dorset. We also saw how the cowshed, constructed on a former quarry floor, used the white-washed, former quarry face as the rear wall of the building. A short walk took us to the remains of an excavation and a pile of rock removed during field clearance from which some ammonites, bivalves, gastropods and belemnites were collected. Returning to the rural roads, we then headed to Horn Park and a picnic lunch.

Horn Park Quarry (ST 458022) is allegedly the smallest National Nature Reserve in England. Formerly three consecutively worked quarries, two are now occupied by an industrial estate whilst the northerly and most recent quarry is securely fenced off and entered via a locked gate (for which our leader had the key). Surrounded by a 4 m high face, the quarry floor is perfectly flat and clearly an erosion surface as it revealed numerous planed-off sections through ammonites, large and small. At the east ed of the quarry, we were shown a shallow excavation into the quarry floor which contained numerous beautifully preserved ammonites (Figure 2). These had been covered by a metal wire cage to protect the specimens from enthusiastic collectors (Figure 3), although a rock pile at the other end of the quarry provided a limited collecting opportunity. On a personal note, we can recall visiting Horn Park during the peak of its operation when ammonites and other fossils could be found in huge numbers, some of which still decorate our house and garden. Our final stop on Saturday was a farmyard at Mapperton (SY 496998). Here we spent some considerable time searching piles of locally excavated loose stone and gathering a good collection of ammonites and other fossils before driving cross-country to our overnight stop at a hotel just outside Yeovil, with dinner, bed and breakfast.

Our second day started fine and sunny but with the prospect of rain moving in later. Our first site was an active working estate quarry at Frogden (ST 648183). Approached via a network of farm tracks, we parked up near a pile of quarry waste. As Bob explained the geology, we couldn't help noticing the moulds and fragments of large ammonites in rocks awaiting our further attention. Bob also pointed out numerous large nautiloids (of the type we saw at Hive Beach), but far too heavy to extract or collect. Unfortunately, we did not have permission to enter the working quarry (and this had been made very clear to our leader) but we were able to look at some cut stone blocks alongside the working sheds at the edge of the quarry floor. The flat surfaces revealed an intricate and complex series of burrows made by marine organisms when this had been the sea floor many millions of years ago. Leaving the quarry, some of us remained to hammer the stone piles for more fossils whilst Bob led the rest of the group across an adjoining field to see a SSSI ection of the lower beds – now getting rather overgrown and weathered but still discernible. Without a doubt, our cars were far more heavily laden on departure from Frogden then they were on arrival.

More driving took us to our final site for the weekend. Here, at Louse Hill (ST 610161), Bob opened the gate off a country lane which took us into a field with grazing sheep. No need to park here, he says, so we continue across the

field and uphill to park on the grass within the confines of a former shallow quarry on the hilltop. We first had our picnic lunch under an increasingly grey sky, before our attention was diverted to a few remaining scree slopes of Inferior Oolite whilst Bob elaborated again on the variation in beds over a short distance and the rich ammonite faunas that result. We were all impressed with the level of knowledge being shared with us and the use of the ammonite faunas (which looked much the same to the uninitiated) to identify the complex sequences of variable thickness depending on where you are in the area. As this is designated as a Site of Special Scientific Interest, we were not allowed to hammer the rock face but there were enough fossils in the fallen material to keep members happy (Figure 4).

However, the time soon came to give our thanks to Bob Chandler for an interesting and productive weekend which, it soon became apparent, was just in time before the skies opened for a very damp journey home. Our thanks also to John Lonergan for organising the weekend and the overnight accommodation.

See Rear Cover for figures

Supergiant Pterosaurs: a world tour

Prof. David Martill, Portsmouth University

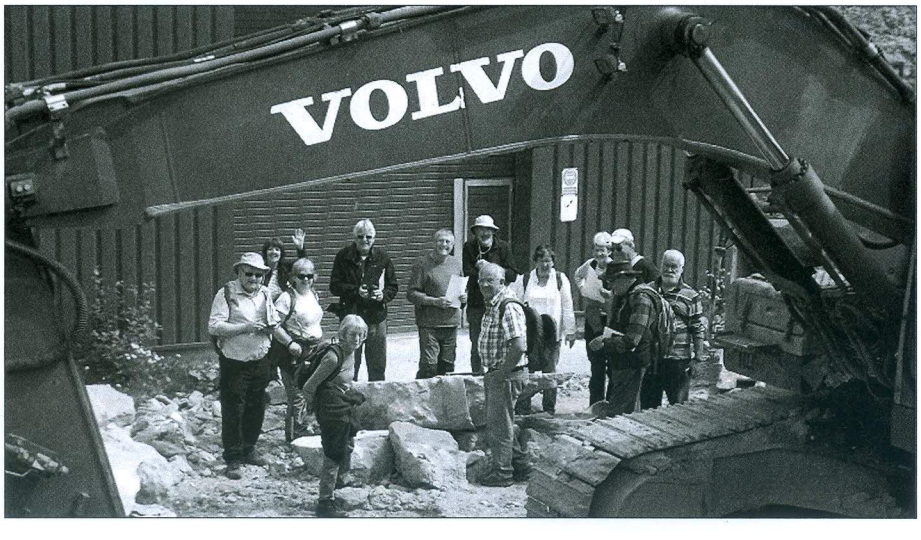
The first known specimen came from Bavaria in 1784 and was described by Collini who didn't name it. In 1809 Couvier recognised it as a flying reptile and called it *Petrodactyl* - note the spelling- meaning "stone wing". This was possibly a typing error as it is later referred to as *Pterodactyl*, meaning "winged lizard". A number of other specimens turned up in the 1800's including Mary Anning's *Dimorphodon,* and Marsh's *Pteranodon.* They have been found all over the world, with several species in one habitat at the same time. A few Deposits are fossil lagerstätte with an exceptional concentration of fossils and some are conservation deposits, with fewer but very well preserved fossils, with stomach contents, eggs containing possible embryo remains and even skin. The first found fossils tended to be of the smaller species, with wingspans of less than 1m. Many were thought to be bird bones and were left languishing in drawers. Mantell had some bones bigger than any to that date with an estimated wingspan of 4-5m. Through the years, specimens got bigger and bigger till the 1970's supergiants with estimated 12m wingspans.

Pterosaurs are recognised as the first flying vertebrates and date from the Triassic, 115-120 million years ago. They are not ancestors of birds, although Seeley classed them as ornithosaurs, but they are more closely related to them than they are to living reptiles. Primitive ones, such as *Ramphorhyncus,* retained a long tail of vertebrae and toothed jaws and it is thought they evolved from a tree dwelling insectivore. Their wing design is similar to bats, having a membrane, but with one extra-long finger (our ring finger) forming the leading edge and three fingers outside the membrane at the wrist. They had five toes.

Since flight design cannot be easily changed, they started to adorn their heads with crests and adapt the beak to their diet. The skull is lightweight with a large orbit and two fenestrae behind the eye – a typically reptilian feature- and antorbital fenestrae, as do archosaurs, indicating they are a sister group. They had some sort of pelt, or fuzz-covered body and became extinct at the end of the Cretaceous.

Prof. Mantill then described numerous species from various world locations with entertaining stories of their discovery, survival and recognition, with the biggest ones often misidentified at first due to their enormous size. One of these was *Quetzelcoatlus,* from Big Bend in Texas, discovered by a sedimentologist who was afraid to make a fool of himself when he judged the wingspan to be 18m or so. Also the Romanian *Hatzegopteryx* which has a spherical occipital chondyl typical of a reptile and so big it was thought to be a theropod dinosaur. Britain's biggest pterosaur to date is a poor specimen from the Greensand, a *Coloborynchus,* comprising solely of a jaw tip with tooth sockets.

Prof. Mantill recommended we check out several books, particularly by the artist Mark Whittton with depictions in life-like settings. With a final flourish he started to unroll a life-sized diagram of a pterosaur managing to reveal one wing and part of the body before hitting the wall at the far side of the room! This gave us a clearer idea of their incredible size.



Visit to Chichester Stoneworks

Blue Plaque to Martin Venables, Bognor Regis geologist

David Bone

Low tide on the shore at Bognor Regis, west of the pier, will reveal a conspicuous reef of rocks running out to sea (Figure 2). These are the Bognor Rocks, large calcareous sandstone concretions within one of the beds of the London Clay Formation that outcrops along the foreshore from near Butlins in the east to Pagham Harbour in the west. The London Clay, of course, underlies the city from which it takes its name. At Bognor Regis, most of the London Clay succession lies buried beneath beach sand, with just occasional exposures that reveal the underlying geology. It is only as a resident that it is possible to watch the changing conditions and be ready to spot the opportunities when they happen.

Edmond Martin Venables (1901 – 1990), Martin to his friends, was such a person (Figure 1). Interested in natural history from an early age, he was soon attracted to the geology intermittently exposed on a stretch of foreshore between the pier and the Bognor Rocks within easy reach of the family home. Fossils had been known and collected from the Bognor Rocks for many years and Venables was familiar with examples illustrated in Dixon's Geology of Sussex (1850). These particularly include some very nice molluscs that can be extracted from the softer pieces of the Bognor Rock (most can only be cracked open with a sledgehammer). But, with his regular visits to the beach, Venables realised that there were fossiliferous clay beds that lay east of the Bognor Rocks and slightly older in age.

The London Clay Formation is Eocene in age (50 million years in round numbers) and comprises a sequence of marine clays, silts and sands that were deposited in a warm temperate to subtropical seat. Some layers are fossiliferous whilst others can be quite barren. The occasional presence of plant debris suggests the presence of large rivers that could sweep terrestrial material out to sea, perhaps during storm conditions.

Venables published his findings in 1927, describing beds that he called the *Astarte* and Starfish Beds after the representative fossils. *Astarte* is a bivalve seashell and the starfish are actually brittle stars most usually found as pockets of fragmentary debris. In fact, only one complete specimen has ever been found and this was by Venables in 1924, when he retrieved his hammer from the beach and the brittle star was on the underside of the clay block in which it had been stuck.

Over the following years, Venables searched the foreshore to understand more of the geology. He took on the job of Curator of the town's first museum, which gave him time to follow his interests, also writing a weekly natural history column in the local newspaper and subsequently the *West Sussex Gazette*. Venables' next academic publication on the Bognor foreshore geology was many years later in 1963 but he added an amazing amount of new detail on the London Clay all the way to Pagham. Importantly, he had identified a series of beds just west of the Bognor Rocks that yielded a vertebrate fauna of sharks' teeth, turtle and crocodile as well as crabs, nautilus and a rich fossil flora

Figure 1. Martin Venables c. 1935 (from an original in the Sussex Record Office, Chichester, donated by David Bone)

of seeds and fruits. There were even small bird bones and a fragment of fossil mammal bone.

Informally named the Aldwick Beds after the nearby village, Venables searched the exposed clay surface of this area for fossils. For the small seeds, he started to collect the detritus of pyrite that was being eroded out of the clay beds by the sea. Pyrite (or iron pyrites; Fool's Gold) is an iron sulphide mineral that forms naturally in organic-rich clay sediments, often preserving fossils or infilling burrow systems. By collecting the pyrite debris, Venables was able to search for the smaller and intricately preserved fossils back at home. It was amongst this material that he was astonished to find tiny fossil beetles. Only a few millimetres in length (typically around 3.5 mm), several genera and species are represented. The clay layer yielding these fossils, named the Beetle Bed by Venables, is still one of the most important fossil insect sites in Britain and has resulted in much of the foreshore at Bognor Regis being designated as a geological Site of Special Scientific Interest. A poem by his sister, Florence Venables (1950) nicely records his geological finds (see inset).

I grew up in Bognor Regis and, as a teenager, often joined Venables on beach trips or sat in the old museum talking to him about the geology (often with a half-dissected bird awaiting taxidermy in front of him alongside a mug of tea and a jam doughnut). Ultimately, I became executor of his estate on his death and inherited the residue of his collection and library, although much of it had already been dispersed or given to the Natural History Museum in London. In accordance with his wishes, his ashes were scattered across the Aldwick Beds on a cold and windy winter's evening.

It was therefore with great pleasure that I was invited to unveil a Blue Plaque to Martin Venables on behalf of the Bognor Regis Local History Society (Figure 3). On 26 July 2019, a group of society members and interested public gathered on the promenade near the Rock Gardens

Figure 2. The Bognor Rocks (London Clay Formation) at low tide (David Bone)

building, where the plaque has been mounted on the wall facing out to sea across the London Clay that Venables first studied. It was bright, sunny day and I said a few appropriate words before we adjourned to the nearby beach café for tea and cake. Representatives of the local press were in attendance and the unveiling was recorded in the following edition of the Bognor Regis Post, although the photograph mis-identified me as the person standing on the opposite side of the plaque! (Figure 4). It is, however, a fitting public memorial to a person who dedicated so much of his life to discovering the geology of s stretch of foreshore that can be so unrewarding to the casual visitor.

See inside rear cover for Figures 3 & 4.

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"Sussex Primeval"

Where our green pastures lie to-day,
Before the earliest race of man,
Ere time laid down the London Clay
There once a mighty river ran.
A nameless river of the past,
Long-lost in the abyss of time,
'Twixt giant conifers and vast
Green palm-trees in their ancient prime.
The mammoth and the mastodon
Once roamed upon the daedal earth;
In immemorial aeons gone,
Strange monsters had their teeming birth.
What cataclysms long ago
Convulsed our Sussex of to-day;
The travail of the seismic throes,
And glacial ages' long delay.
What comets flamed across the sky,
That yet have to return again?
What mountains raised their crests on high
Where now the Sussex Downs remain?
And here beneath our Sussex land,
Primordial forests sank becalmed;
Below the stratum of the sand,
Tree, bird and beetle lie embalmed.
A tiny shard, a broken wing,
A fruit, a fern-frond petrified;
The foot-print of some unknown thing;
They lived so long ago, - and died.
Ere a new being had his birth,
That with another age began;
And Man appeared upon the earth,
And Mind made manifest in man.

F. M. Venables 1946

Weather Eye from **The Times** by Paul Simons

Anthony Brook

As some of you may know, I am a regular reader of The Times, the newspaper of record since 1785. Every weekday, towards the back of the main section of the paper, will be found a whole page devoted to Weather Forecasts, both in the U.K. and worldwide. Accompanying this welter of weather data there is always a column headed Weather Eye, in which Paul Simons comments briefly upon some weather phenomenon, past and present. Over the last 5 years or so I have made a point of collecting those weather-related articles by Paul Simons, which relate, in any way, to geological or Earth-science phenomena. I now have a list of 43 such pieces, from 'Lake Geneva Tsunami' (7 November 2013) to 'Woolly Mammoth and Rhino' (5 December 2018). I am sure there are more, which I have missed when I have been away from home and unable to access newspapers. (See appended list, to 31 December 2018)

No.	Date	Topic
1.	7 November 2013	Lake Geneva Tsunami
2.	14 January 2014	Earthquake Lights
3.	23 January 2014	Glacier in the Cairngorms
4.	18 February 2014	Floods lead to Sinkholes
5.	16 July 2014	Llyn Earthquake of 1984
6.	20 August 2014	Rumblings of Icelandic Volcano
7.	29 September 2014	Tsunami of 1014
8.	8 October 2014	Snow Patches in Scotland
9.	20 October 2014	Bardarbunga Volcano in Iceland
10.	23 December 2014	White Christmas
11.	17 July 2015	Strange Lights around Barmouth
12.	1 December 2015	Snow Patches in Scotland's Mountains
13.	15 January 2016	The Eemian Period
14.	26 February 2016	Ravenser and Coastal Erosion
15.	29 February 2016	Slowing of the Earth's Rotation
16.	7 April 2016	Icebergs of Iceberg Alley
17.	13 June 2016	'Penitentes' of the Dry Andes
18.	30 June 2016	The Art of Volcanic Sunsets
19.	3 August 2016	Giant Holes in Siberia
20.	16 December 2016	Fossil Lightning and Fulgurites
21.	27 December 2016	Deadly Avalanche in Lewes, Sussex
22.	9 January 2017	Seasonal Movement of Australia
23.	1 February 2017	Air Pollution and Crumbling Stonework
24.	28 February 2017	Heavy Rainstorms and Earthquakes
25.	5 April 2017	How Cold was the Little Ice Age?
26.	12 June 2017	Mount Tambora and the Velocipede
27.	21 July 2017	Corpses, etc from Melting Alpine Glaciers
28.	11 August 2017	Tsunamis and Landslides
29.	18 August 2017	The Moon, Solar Eclipses and Ice Ages
30.	5 September 2017	Construction on Floodplains
31.	30 October 2017	Sandstorms and Buried Villages in Scotland
32.	28 November 2017	Eruption of Mt. Agung, Indonesia
33.	28 March 2018	Rapid Coastal Erosion
34.	4 April 2018	East Africa is coming apart
35.	23 April 2018	Tsunami or Meteotsunami?
36.	4 May 2018	English Channel Megaflood
37.	25 September 2018	Tsunamis striking Scotland
38.	26 September 2018	Earth's Shifting Axis
39.	17 October 2018	Biological Relics of the Ice Age
40.	20 November 2018	The Worst Year in History---AD536
41.	27 November 2018	The Obliteration of Sodom and Gomorrah
42.	4 December 2018	The Strangeness of Deception Island, Antarctica
43.	5 December 2018	Woolly Mammoth and Woolly Rhino

Wild about Portsmouth

David Bone

Maybe not your first thought from the title but this was a family event held by Portsmouth Museum on Saturday 10 August 2019 to showcase the activities and organisations in their area associated with the natural environment (and especially for children in the summer holidays). The WSGS had an invitation to attend and also give a 20-minute talk as part of the programme for the day. I picked up the lead on this, ably helped by Alan Winter and Micky MacKinnon.

A prompt start was made to arrive at the museum in Portsmouth to start setting up soon after 8.00, to be ready in time for the public arriving from 10.00 onwards. We set up on two trestle tables with materials which I had loaded into the car the night before. One table was laid out with some large, impressive specimens, fossil and mineral, from my collection at home. The fossils included a large Portland ammonite, a good-sized shark's tooth from Morocco, a piece of dinosaur bone and a slab of Carboniferous ferns, whilst the minerals include a block of calcite crystals and some nice quartz crystals.

The second table was laid out with second-hand books and minerals to sell for fund-raising, whilst a third, small table held give-away leaflets and magazines, and information on the society. The Rockwatch publicity (national geology club for young people, hosted by the Geologists' Association) was extremely popular but I doubt if the WSGS picked up any new members in Portsmouth. Indeed, the event was principally attended by families with young children, many of the latter proving to be very switched-on (unlike the child (maybe 8 or 9 years old) who identified the Portland ammonite as a dinosaur). Alan Winter proved to be a master performer with the youngsters and full marks for his efforts in educating and entertaining (see figure).

I gave the short talk, unfortunately constrained by a late start and the next speaker wanting to start on time. The subject was fossil collecting at Bracklesham, although if I had been forewarned of the very young age of many of the children, I would have pitched it differently. Still, it seemed to go down ok, especially the free gift to every child of a fossils shark's tooth.

Alan, Micky and myself were kept busy throughout the day, with only the occasional lull, until shut down at 4.00pm. Micky tried very hard at the sales but we soon realised that most visitors had no or very little cash either on them (preferring to use plastic) or money free to spend. Perhaps something to consider for future sale tables. Of course, there was also some competition from the other exhibitors which included the team from Dinosaur Ilse, the geology museum at Sandown on the Isle of Wight. They also had fossils as well as a complete, although small, dinosaur reconstruction. If all goes to plan, the society will be visiting the museum on the long weekend field trip in 2020.

An exhausting day but we received a nice email thanking us for all our efforts. Apparently, the day was great success for the museum's first endeavour for this type of event with nearly 700 visitors instead of the usual 200 for a Saturday. Maybe the same again next year?

Alan Winter explains fossils to the young people at the 'Wild about Portsmouth' event.
Micky MacKinnon the foreground (David Bone)

Harrison Hagan "Jack Schmitt"

Alan Bell

The recent 50th anniversary of the first Moon landing prompted me to take a look at the lives of some of the astronauts that have been to the Moon (only 12 currently).

For this article to maintain a geological focus I have concentrated on the most recent living person to have walked on the Moon. He is an American geologist, retired NASA astronaut, university professor and former U.S. senator from New Mexico. His name is Harrison Hagan "Jack" Schmitt (born July 3, 1935)

In December 1972, as one of the crew on board Apollo 17, Schmitt became the first member of NASA's first scientist-astronaut group to fly in space. As Apollo 17 was the last of the Apollo missions, he also became the twelfth and second-youngest person to set foot on the Moon, and the second-to-last person to step off of the Moon (he boarded the Lunar Module shortly before commander Eugene Cernan). Schmitt also remains the first and only professional scientist to have flown beyond low Earth orbit and to have visited the Moon. He was influential within the community of geologists supporting the Apollo program and, before starting his own preparations for an Apollo mission, had been one of the scientists training those Apollo astronauts chosen to visit the lunar surface.

Schmitt resigned from NASA in August 1975 in order to run for election to the United States Senate as a member from New Mexico. As the Republican candidate in the 1976 election, he defeated the two-term Democratic incumbent Joseph Montoya. In 1982, Schmitt was defeated by Democrat Jeff Bingaman.

Before joining NASA as a member of the first group of scientist-astronauts in June 1965, he worked at the U.S. Geological Survey's Astrogeology Centre at Flagstaff, Arizona, developing geological field techniques that would be used by the Apollo crews. Following his selection, Schmitt spent his first year at Air Force UPT learning to become a jet pilot. Upon his return to the astronaut corps in Houston, he played a key role in training Apollo crews to be geologic observers when they were in lunar orbit and competent geologic field workers when they were on the lunar surface. After each of the landing missions, he participated in the examination and evaluation of the returned lunar samples and helped the crews with the scientific aspects of their mission reports.

Schmitt spent considerable time becoming proficient in the CSM and LM systems. In March 1970 he became the first of the scientist-astronauts to be assigned to space flight, joining Richard F. Gordon Jr. (Commander) and Vance Brand (Command Module Pilot) on the Apollo 15 backup crew. The flight rotation put these three in line to fly as prime crew on the third following mission, Apollo 18. When Apollo 18 and Apollo 19 were cancelled in September 1970, the community of lunar geologists supporting Apollo felt so strongly about the need to land a professional geologist on the Moon, that they pressured NASA to reassign Schmitt to a remaining flight. As a result,

Schmitt was assigned in August 1971 to fly on the last mission, Apollo 17, replacing Joe Engle as Lunar Module Pilot. Schmitt landed on the Moon with commander Gene Cernan in December 1972.

Schmitt claims to have taken the photograph of the Earth known as The Blue Marble, possibly one of the most widely distributed photographic images in existence. NASA officially credits the image to the entire Apollo 17 crew.

While on the Moon's surface, Schmitt — the only geologist in the astronaut corps — collected the rock sample designated Troctolite 76535, which has been called "without doubt the most interesting sample returned from the Moon". Among other distinctions, it is the central piece of evidence suggesting that the Moon once possessed an active magnetic field.

As he returned to the Lunar Module before Cernan, Schmitt is the next-to-last person to have walked on the Moon's surface. Since the death of Cernan in 2017, Schmitt is the most recent person to have walked on the Moon who is still alive.

After the completion of Apollo 17, Schmitt played an active role in documenting the Apollo geologic results and also took on the task of organizing NASA's Energy Program Office.

Schmitt has some controversial views on global warming linking it to the fall of communism which I won't go into here but more can be found on Wikipedia.

He was made an honorary fellow of the Geological Society of America for his efforts in geoscience in 1984 [41]

American Association of Petroleum Geologists (AAPG's) Special Award has been changed to the Harrison Schmitt Award in 2011. It recognizes individuals or organizations that, for a variety of reasons, do not qualify for other Association honours or awards. Schmitt received the award in 1973 for his contribution as the first geologist to land on the Moon and study its geology [44]

2015 Recipient of the Leif Erikson Exploration Award, awarded by The Exploration Museum, for his scientific work on the surface of the Moon in 1972, and for his part in the geology training of all the astronauts that walked on the Moon before him.

Source. Mainly Wikipedia

Down in the Dolines
Lidar Mapping of Doline Distribution
on the West Sussex Coastal Plain – Chichester to Arundel

R. J. Cordiner

LIDAR is lovely! Now that LIDAR imagery is freely available on the internet covering large areas of England and Wales (https:/houseprices), we can all become landscape sleuths and discover hidden archaeology, history and geology.

The web site 'houseprices.com' includes a mosaic of 1 metre resolution mapping of data from the Environment Agency and Natural Resources Wales, under Open Government Licence, surveyed over the past 18 years. The composite LIDAR map is composed of a mosaic of monochrome pre-rendered imagery. Coverage is however patchy with about 70% of the country covered, but enough is revealed in West Sussex to make it a very useful tool for geologists. The 1 metre resolution of the imagery is sufficient to show small changes in the height of the land surface.

LIDAR is an acronym for Light Detection and Ranging. This is carried out from an aircraft with equipment which transmits and receives laser pulses reflected from the ground surface. The data is recorded and later analysed to build up a detailed image of the land below. To present a realistic image of the landscape LIDAR imagery is generally presented with illumination from the northwest so that the topography stands out in 3D. Unlike aerial photography, LIDAR is not affected by cloud and is able to a certain extent to penetrate vegetation cover and shallow water to map the ground surface.

The imagery produced by LIDAR surveys of the opens up new areas of interpretation for geologists, revealing the intimate shape of landforms and details of geological structures, which often are not easily visible in the field. When viewed on a small scale LIDAR imagery of West Sussex clearly shows the different surface morphology of the 5 main geological / geomorphological units:

1.Coastal Plain
2.Chalk Downs
3.Greensand
4.Low Weald (Weald Clay)
5.High Weald (Hastings Sandstone)

Doline Survey of the West Sussex Coastal Plain; Chichester to Arundel

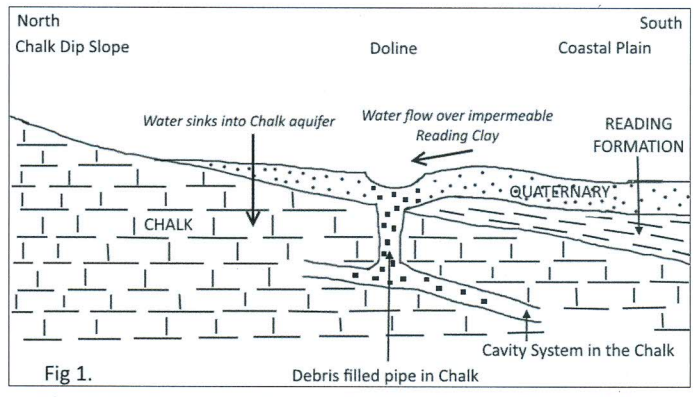

Fig. 1. Doline formation on the West Sussex Coastal Plain.

Dolines show-up on LIDAR as shallow circular-plan depressions in the land surface from c. 10 to 50m in diameter and up to 5m in depth. They are a common feature on the West Sussex Coastal Plain, particularly along the northern margin close to the Quaternary – Chalk junction. Dolines are one of a number of Karst features caused by limestone dissolution leading to collapse of surface rock and soil into underground voids (McDowell and Poulsom 1996). Unlike Sink Holes, Dolines have developed slowly with progressive downward movement of superficial deposits and soil into cavities in the Chalk. This process creates a saucer-shaped depression in the ground surface (Fig 1). They probably developed towards the end of the last Glacial Stage (Devensian) *c.* 10ka when permafrost had melted but cold conditions led to greater dissolution of the Chalk.

Cordiner (2003) mapped numerous dolines across the West Sussex Coastal Plain from a ground survey and analysis of large-scale OS. Maps. LIDAR imagery now makes the task of mapping dolines much easier as they readily stand out in the imagery (Fig 2). Some of the isolated dolines may however be former sand, clay or chalk pits.

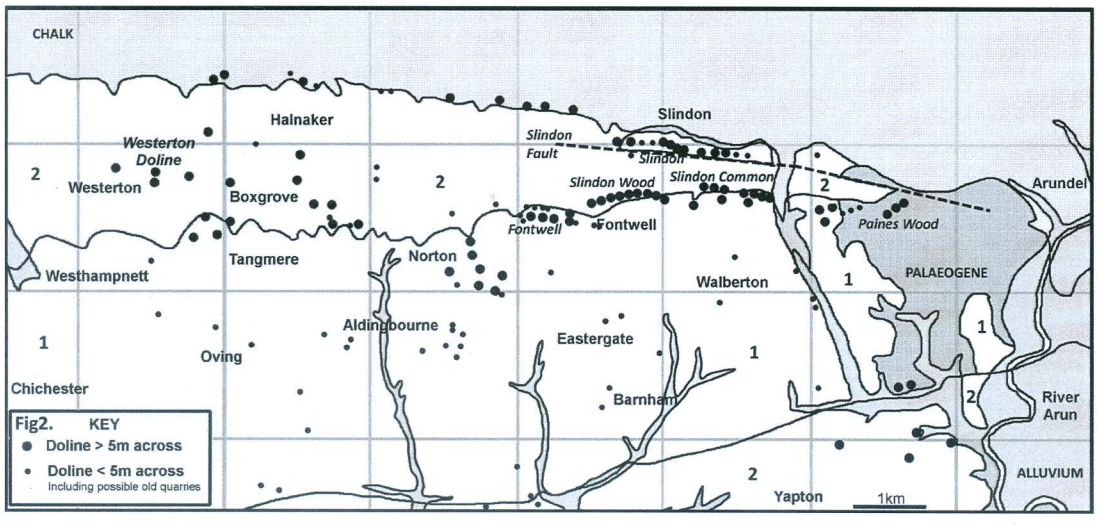

Fig. 2. Dolines on the West Sussex Coastal Plain between Chichester and Arundel.

Geology Key

1.Quaternary above Palaeogene
2.Quaternary above Chalk.

Doline Lines

The LIDAR imagery shows the previously mapped isolated dolines and doline groups (Cordiner 2003), and also reveals that there are lines of dolines which lie along or close to the northern boundary of the West Sussex Coastal Plain where it abuts against the Chalk dip slope. Doline lines are particularly well developed in the Fontwell to Binstead Wood area where they generally follow the northern boundary of the Reading Formation where it lies below a thin cover of Quaternary deposits (Fig 3, 4 and 5). They are therefore a proxy for the mapping of this boundary. A line of dolines follows the Slindon Fault where it runs in a roughly east-west line south of Slindon Village (Fig 6).

The development of lines of dolines probably means that the vertical sink holes beneath the doline depressions are connected by chalk cavity systems. Ground water flows into the dolines and then passes underground into the chalk fissure which links them. Sand and silt entrained into the doline tend to block the plumbing system over time so that the ground depression develops very slowly after the initial collapse. Mcdowell and Poulsom (1996) showed that dolines were more likely to be formed when the Quaternary Deposits overlying the Chalk were sand rich. They are therefore a good indicator on the West Sussex Coastal Plain of the presence of underlying Slindon Sand (Formation).

The reason for the development of Doline Lines above the Reading Formation – Chalk junction is not readily apparent. Groundwater within the Chalk, surface water runoff and a thin cover of sand-rich superficial deposits is

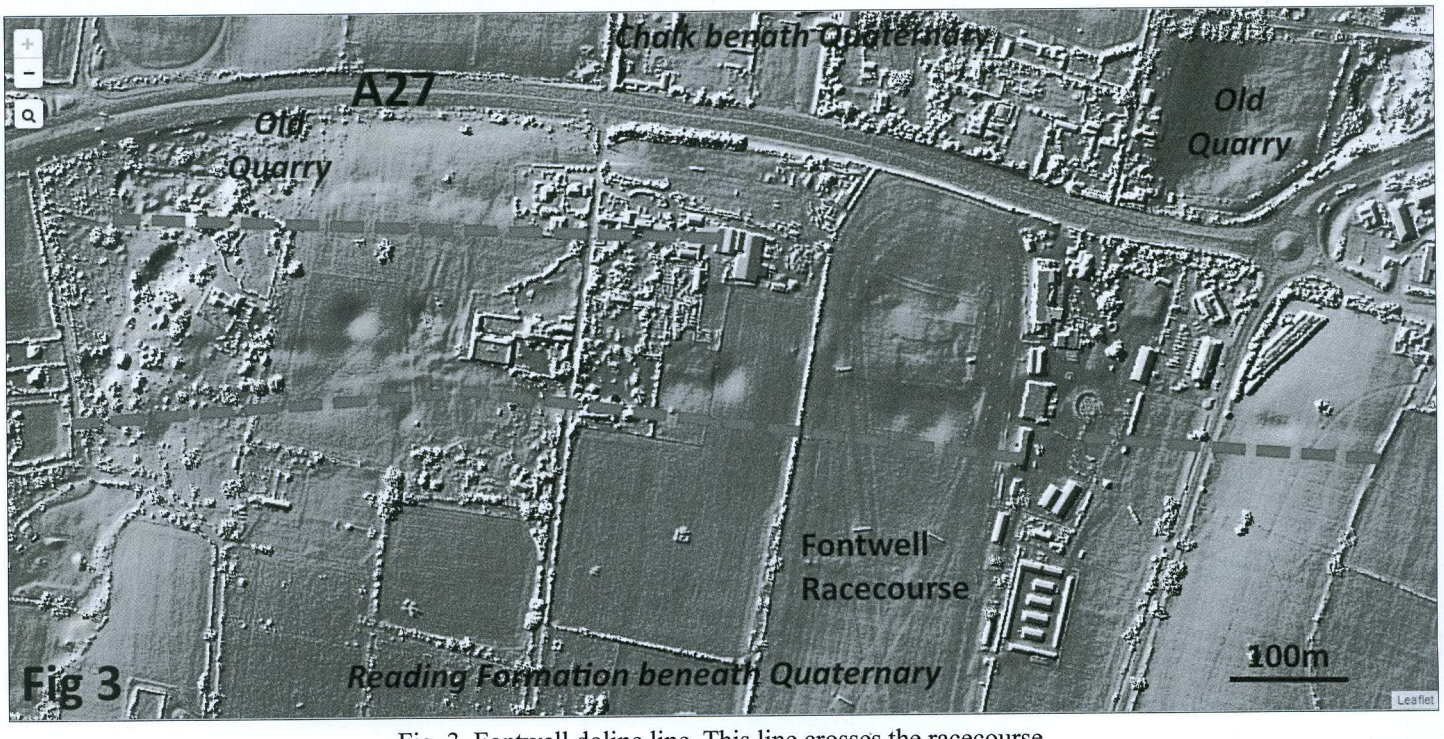

Fig. 3. Fontwell doline line. This line crosses the racecourse.

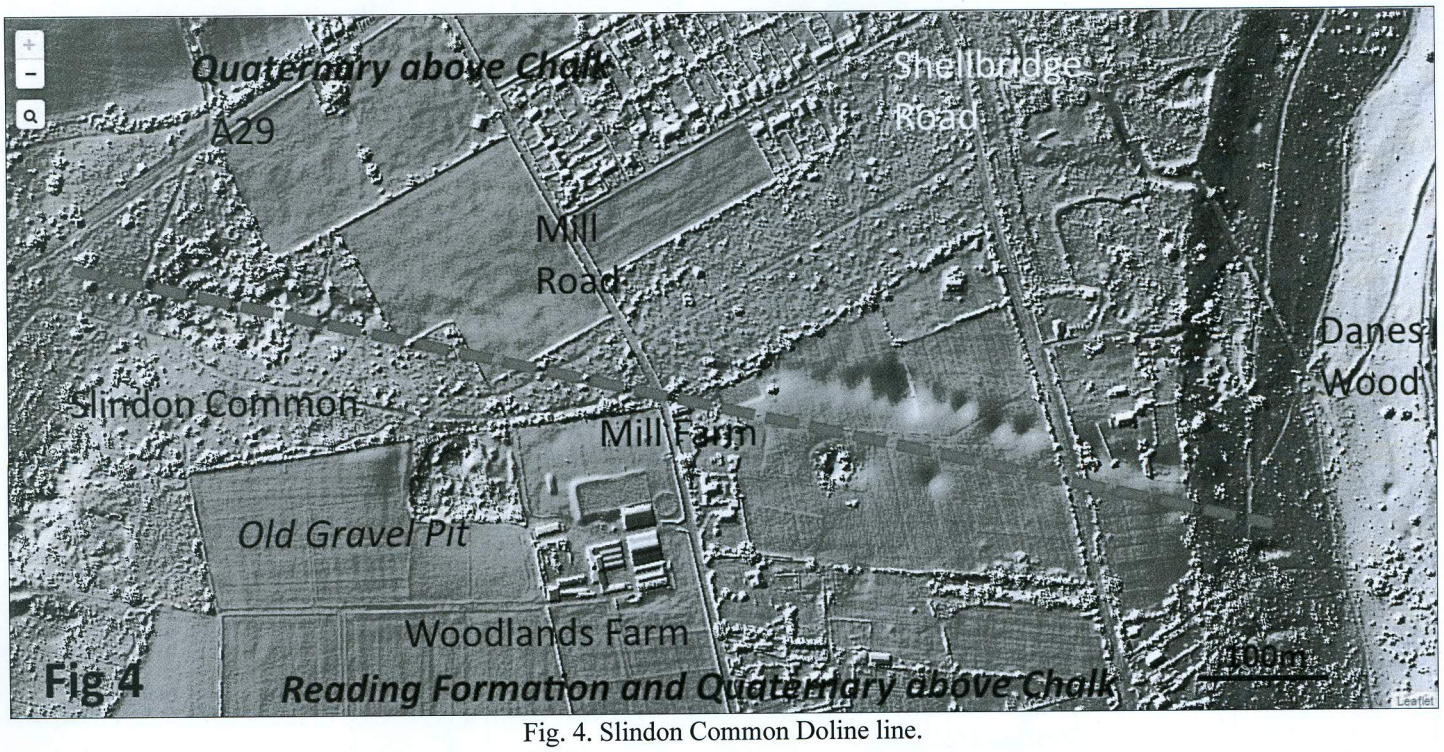

Fig. 4. Slindon Common Doline line.

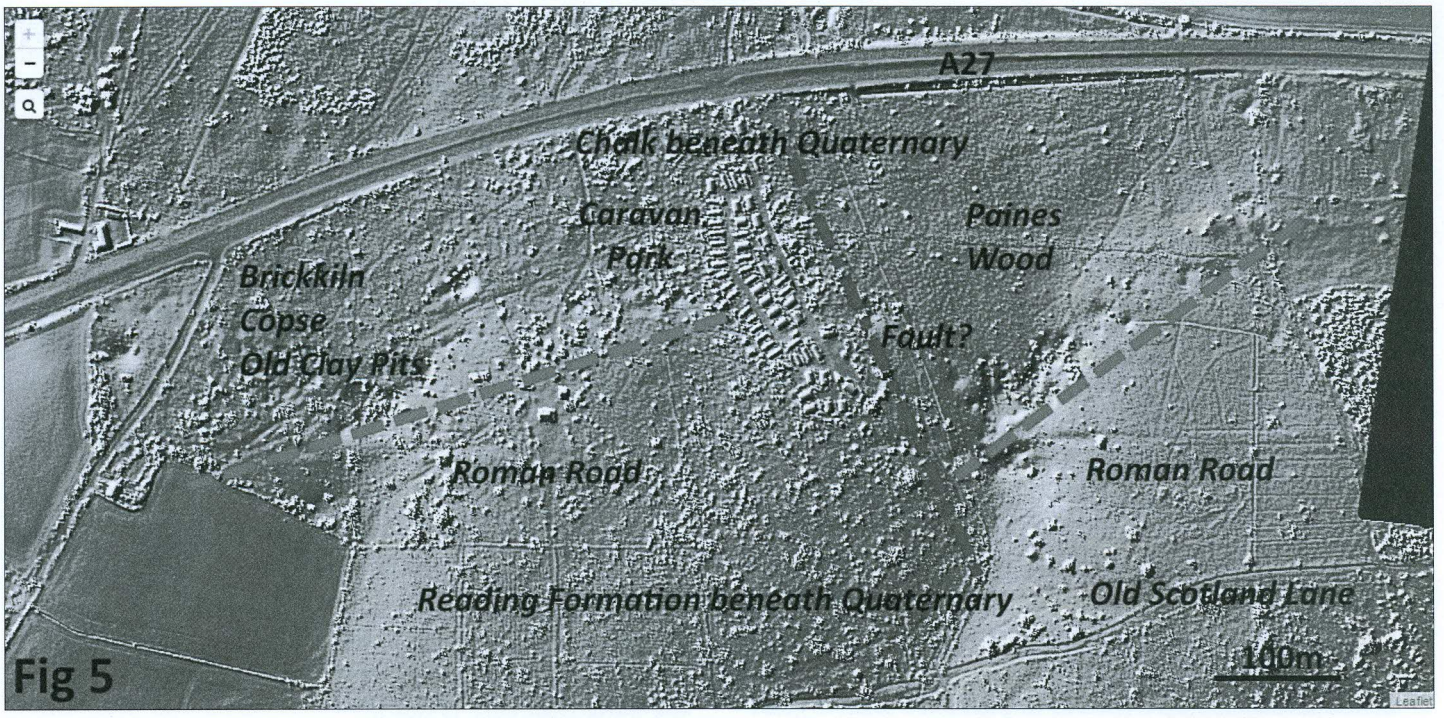

Fig. 5. Paines Wood Doline lines are offset probably by a fault. Note the line of the Chichester-Arundel Roman Road is easily visible.

required. A possible reason for the development of Doline Lines is that they lie along very shallow valleys which reflect the subsurface mini-scarp formed by the Reading Formation at its junction overlying the Chalk (Fig 1). Surface water could then flow into this valley for a short distance from the south bringing soil acids which promote the dissolution of Chalk cavities.

The 4 Doline lines:

1. Fontwell,
2. Slindon Common and
3. Paines Wood Margin of the Reading Formation against the Chalk and overlain by Quaternary deposits.
4. Slindon Along the line of the Slindon Fault.

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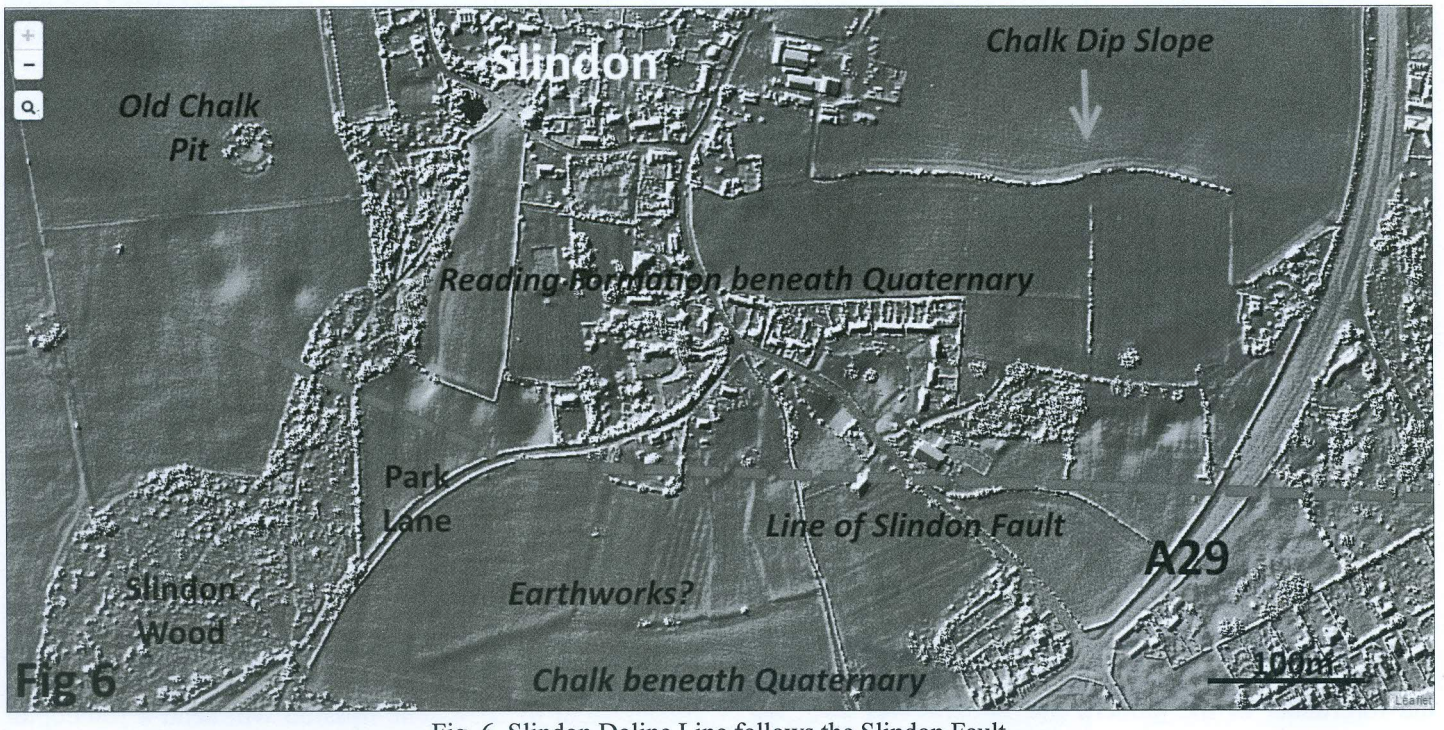


Fig. 6. Slindon Doline Line follows the Slindon Fault.

Paper, Scissors, Stone

Snippets of geological interest as reported in BBC Sky at Night Magazine (March 2019 to August 2019)

Mercury's dense iron rich core has always been a puzzle to researchers. Proportionally it is over twice as big as the cores of the other rocky, terrestrial planets, Earth, Venus and Mars. Now Maximillian Kruss and Gerhard Wurm have come up with an hypothesis that suggests that the interplay between magnetism and iron rich particles may be the key. During planetary formation the magnetic field from the sun would help iron rich particles to stick together in a protoplanetary disc and so the innermost region would tend to become more iron rich and build Mercury like planets. From Seeding the formation of Mercury's: An iron sensitive bouncing barrier in disk magnetic fields Read it online at arxiv.org/abs/1812.05338.

The earth's oldest rock has been found not on our planet but on the Moon. Recent analysis of lunar rocks brought back by Apollo 14 in 1971 found a small sample of material which originated on the Earth. It's thought the rock was launched into space by a meteor impact four billion years ago before coming to rest on the Moon.

NASA made its last attempt to contact it's veteran Mars explorer, Opportunity on 13th February 2019, marking the end of the rovers 15 year mission. Last contact was on 10th June 2018 when a global dust storm prevented the rover from charging its solar panels. Opportunity landed on Mars on 24th January 2004 along with its twin, Spirit. The pair were initially meant to last just 90 days.

Japanese asteroid investigator, Hatabusa 2, touched down onto Ryugu on the 21st February 2019. The spacecraft collected a sample of the asteroid by firing a projectile into the surface and retrieving the particles kicked up. The spacecraft will attempt another two touchdowns before returning to Earth with sample material in late 2019.

The Curiosity rover has measured the gravity of Mount Sharp on Mars by accident. The Curiosity team recently discovered that the rover's accelerometer readings can be used to measure fluctuations in the planet's gravity caused by changes in the rock density under the surface. Using data from October 2012 to June 2017, the team found that the rock under Mount Sharp is less dense than expected. Previously it was thought that Mount Sharp was buried under sediment which then eroded away but in this scenario the rock would have been denser because of the weight of the sediment.

NASA's first rover mission to Mars, Pathfinder, landed on the edge of an ancient sea. It's rover, Sojourner arrived in 1997 and imaged features that suggest flooding 3.4 billion years ago. The landing site marked a spillway between a northern ocean and an inland sea, writes Planetary Science Institute head scientist Alexis Rodriguez.

An astrolabe excavated from a Portuguese shipwreck has been certified as the earliest known by Guinness World Records. The thin, 175 mm diameter device is the forerunner of the modern planisphere, was used for navigation on Vasco da Gama's second voyage to India in 1502-03.

The Insight lander detected the first ever Martian seismic event (to humans) known as a marsquake on 6th April 2019. Over the next Martian year, Insight will use seismometers, heat sensors and other instruments to examine the planet's internal structure to help understand Mar's history and evolution. https://mars.nasa.gov/insight

After two years of processing the **Event Horizon Telescope** has released the first ever image of a black hole on 10th April 2019. The image was taken in April 2017, when eight radio telescopes across the globe joined together, effectively creating an instrument with a dish the size of the planet. This gave it enough resolution to pick out the shadow of a supermassive black hole at the heart of galaxy M87. Eventhorizontelescope.org.

Mercury's inner most core is solid, a new study has determined using data from NASA's Messenger mission. The core makes up 85 per cent of the planet's volume and the outermost core is liquid.

Recent results from **NASA's Mars Reconnaissance Orbiter** show that an ancient water ice cap could be lying a mile below Mar's northern pole. Geologist hope to use the ice to study how the planet's climate has changed over billions of years.

Water could have been brought to the **Earth by the collision which created the Moon.** A study has found that Theia- the Mars sized planetoid which collided with the proto Earth to create the Moon probably came from the outer solar system. Unlike objects which formed in the hot region near the Sun, like Earth, the planetary bodies created further out tended to be rich in water.

China's lunar probe Chang'e 4 landed in the South Pole-Aitken (SPA) basin, a crater spanning 2500km on the far side of the Moon on the 3rd January 2019. It's thought that the basin was a magma ocean during the Moon's infancy. As the molten rock cooled, the heavier elements sank so that when the basin solidified it formed a volcanic crust over a mantle of denser minerals such as olivine. Subsequent meteorite impacts have exposed the mantle so the Chang'e 4's Yutu2 rover can investigate the material So far though only traces of olivine have been found. "The absence of abundant olivine in the SPA interior remains a conundrum," say Li Chunlai from the National Astronomical Observatories of Chinese Academy of Sciences who led the study. http://english.cas.cn

The Hubble Space Telescope has revealed that yellow patches on Jupiter's Moon Europa are sodium chloride. This could mean that the ocean believed to lie under Europa's icy crust is salty, like Earth's. The compound may be a sign that the ocean floor has hydrothermal vents, which are havens for life on Earth.

NASA's latest planetary mission, Dragonfly will return to Saturn's icy moon, Titan. It is due to launch in 2026 and reach Titan in 2034. The mission will send a rotocopter to fly through Titan's thick atmosphere. Dragonfly will be

able to leapfrog up to 8km between the various landscapes on Titan. The initial mission will be two and a half years, aiming to cover 175km of terrain.

Evidence of a 1.2 billion year old meteor strike has been unearthed off the coast of Scotland. The meteor is thought to be 1km wide making it the largest meteor impact known in the UK.

Moon rocks collected by the Apollo missions have been used to study the Sun. A record of solar radiation is locked up inside the Moon rocks, giving scientists a glimpse into how the Sun has changed over time and it effect on the habitability of the inner planets. Prabal Saxena from NASA's Goddard Space Flight Centre led the study which measured levels of sodium and potassium in the Moon rocks. Theories suggest that the Earth and Moon should be made of the same stuff but these two elements are much rarer on the Moon. On the Moon the solar radiation has stripped them away as there is no atmosphere to offer protection.

www.nasa.gov/goddard

Dinosaurs and Diamonds

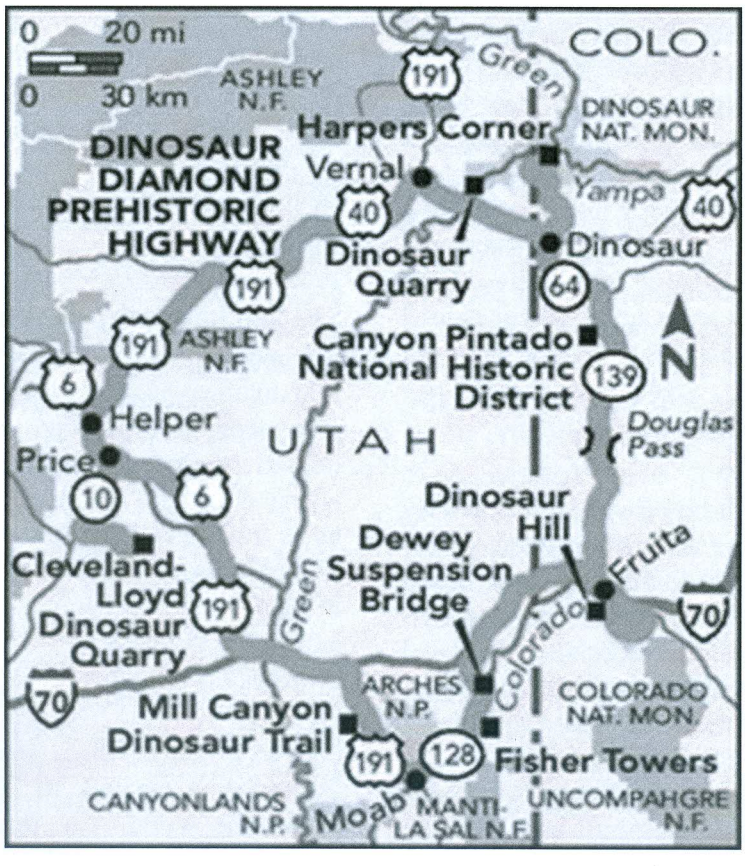
By Micky MacKinnon

As this is our diamond issue, I thought I would have a Google to see if there are any fossils out there with "diamond" or "adamant" in their name. I found three quite quickly - two sauropods, *Diamantinasaurus* from Australia (named after a nearby river) and *Adamantisaurus* from Brazil, (again named after its locality, and not from some brilliant adornation) and a rather beautiful millipede preserved in Miocene Mexican amber, *Anbarrhacus adamantis,* which possesses a nice diamond pattern on its head area.

The first item to come up however, is the Dinosaur Diamond. Although I had visions of a T.Rex shaped gemstone, or some irridescent sparkly dino egg, it refers to an area in Utah and Colorado, USA, unsurprisingly diamond shaped , and full of dinosaurs.

An area of scientific interest it includes Dinosaur National Monument, Canyonlands, Arches and Natural Bridges Parks, Colorado National Monument and several national forests. The easternmost point is in Grand Junction, CO, with geologic features of Book Cliffs and Grand Mesa, and unique rock formations. Next west, the Painted Canyon with petroglyphs, then on to the town of Dinosaur. This small town claims to be the most productive Jurassic period quarry in the world. Visitors can view wall studded with over 2000 bones and watch the palaeontologists at work. Crossing into Utah, the Old Spanish Trail passes through many interesting places - mountain passes, indian reservations, Nine Mile Canyon, and Cleveland-Lloyd dino quarry, a prehistoric mud trap claiming the densest concentration of fossils in the world. 60-odd miles southeast you come to Green River and Crystal Geyser, with scenic erosional and badland features. At the Utah Field House Museum are 18 life sized models including *Utahraptor,* discovered in 1991, and in Fruita, CO., with gorges and monoliths aplenty, a museum with robotic dinos, and interactive displays.

To qualify for the title "Scenic Byway" the road must meet at least one of six criteria – scenic, natural, historic, cultural, archaeological and recreational. The Dinosaur Diamond has all of these qualities and is a "must see" if you're ever in that area.



Geological Odds & Ends

Submitted by Betty Steel

Evidence for further Shetland tsunamis

Scientists have discovered that Shetland has been hit by at least two more tsunamis in the past 10,000 years than previous thought and are now working to identify the causes.

We already knew that a 20 metre high tsunamis swept across Shetland around 8,200 years ago, caused by the Storegga submarine landslide off the coast off the coast of Norway. However, there was no evidence to show that any more tsunamis had hit the area. Using new imaging and sound-wave technology, NERC-funded scientists have identified sands on Shetland that could prove additional tsunamis hit the region 5,000 and 1,500 years ago. This could mean that tsunamis are more common occurrence than previously thought in the UK.

Although more research is needed to find the exact cause of the tsunamis, the scientists agree that they could have been generated by an underwater landslide, which moves vast amounts of sediment across the seabed.

Planet Earth. Autumn/Winter 2018. Read more:- http://bit.ly/Shetlandtsunami

Greenland's ice at "tipping point"

Greenland's ice is melting faster than expected – and is doing so in regions where ice was presumed "safe", a new study has found. A team at The Ohio State University used satellite images and ground-based instruments to monitor the island's ice, and found that 400 billion tonnes were shed in 2012, four times more than in 2003. Greenland has long been monitored by scientists concerned about rising sea levels, but previously, research has focused on the southeast and northwest of the island, where there are many large glaciers which calve in warm weather, creating icebergs that melt in the Atlantic. For this study, however, researchers examined data from a broader area, and found that an alarming amount of meltwater was now being dumped in the southwest, where there are few glaciers. According to the study's lead author, Professor Michael Bevis, this indicates that Greenland's ice sheet is now melting rapidly, sending water coursing down rivers and into the oceans. "This is going to cause additional sea level rise. We are watching the ice sheet hit a tipping point." Greenland's ice sheets contain enough water to raise sea levels 23 feet.

From The Week. 2 February 2019

Threat to Himalayan ice caps

At least a third of the Himalayas' ice cap will melt by 2100, even if aggressive steps are taken to curb global warming, scientists have warned. The landmark report into the impact of climate change on the Hindu Kush-Himalayan (HKH) region predicts that between 36% and 66% of the region's ice will disappear, with the lower level of melting reliant of global temperature rises being within 1.5°C, which is considered optimistic. About 250 million people live in the HKH region – which harbours more ice than anywhere outside the Arctic and Antarctic – and a further 1.65 billion are reliant on the great rivers that flow from its peaks into China, India, Pakistan and other countries. The report predicts that river flows will first increase – potentially causing widespread flooding – and then start declining from about 2060. As well as affecting supplies of drinking water and hydroelectricity, this is likely to have a very serious impact on the region's agriculture. "This is the climate crisis you haven't heard of," said Dr Philippus Weser of the International Centre for Mountain Development, which complied the report." The consequences are pretty extreme."

From The Week. 16 February 2019.

Earth struck by huge solar storm

Evidence that the earth was struck by a monstrous solar storm more than 2,500years ago has been found in the Greenland ice core. The storm appears to have been ten times more powerful than any recorded in modern times, and while its impact onthe pre-industrial world would have been fairly minimal, scientists have warned that a storm of that magnitude now would be a "threat to modern society". Solar storms occur when charged protons emitted by the Sun career into the Earth's atmosphere and alter its electromagnetic field. Over the past century, a few have been recorded, but none have been serious enough to cause more than localised disruptions. The last major solar storm, the Carrington Event of 1859, predated the electronic age.

Recently, however, a new method for detecting solar storms in the past – by analysing the radioactive isotopes they leave behind in tree rings and ice cores – has revealed them to be more common than previously supposed. In 2012, a study of Japanese cedar trees indicated that a massive cosmic blast struck the Earth in AD774; the new study, by a team from Lund University in Sweden, has revealed a similarly, major even in about 660BC. Were it to hit today, a solar storm of that strength could knock out global "communication and navigation systems, space technologies and commercial aircraft operations", says the study.

From The Week. 21 March 2019.

The first image of a black hole

Astronomers have captured the first picture of a black hole – in a galaxy 55 million light years away. First theorised more than a century ago by Einstein, black holes are regions of densely packed matter from which nothing – including light – can escape. While this makes black holes themselves invisible, they are surrounded by rings of dust and gas, which are superheated as they are sucked in by the immense gravitational pull. These "halos" are among the brightest objects in the universe, making them theoretically possible to see with sufficiently powerful telescopes.

And now one has been captured by the Event Horizon Telescope, a network of eight radio telescopes spread across the world. The image traces the outline of a

supermassive black hole – believed to be 40 billion km across, or three million times the size of Earth, and to have a mass equivalent to 6.5 billion Suns – located in the M87 galaxy. "What we see is larger than the size of our entire solar system," said Professor Heino Falcke of Radboud University in the Netherlands, one of the project's astronomers. "It is an absolute monster."

From The Week. 20 April 2019.

New "hobbit" found in Philippines

The remains of a previously unknown and very tiny human species have been found in caves in the Philippines. These fossilised bones and teeth, thought to have belonged to two adults and a juvenile, suggested that the newly named *Homo luzonensis* lived about 50,000 years ago, on the island of Luzon. That would mean it was alive at the same time as the diminutive "hobbit" species *Homo floresiensis* was roaming the Indonesian island of Flores. The "hobbits" were no more than about a metre tall; the new species, which probably still swung from trees, could have been even smaller. And though distinct, it's possible that they're both descendants of *Homo erectus* that ended up on their islands, and experienced a shrinking process known as "island dwarfing" as a result.

The earliest fossil evidence for *Homo erectus* dates back about 1.8 million years; *Homo sapiens* emerged about 1.5 million years after that, joining the Neanderthals and the Denisovans. By 60,000 years ago, it's now clear that there were a number of different human species inhabiting various parts of Africa and Eurasia.

From The Week. 18 May 2019.

Reconstructing Doggerland

For 8,000 years, "Doggerland" – a vast strip of land that once connected Britain to continental Europe – has lain submerged beneath the North Sea. Now scientists have embarked on an ambitious project to chart the Mesolithic landscape, in the hopes of revealing traces of the thousands of prehistoric people who lived there until sub-Artic ice began to melt, and it was engulfed by rising sea levels. "We can't walk those fields looking for pottery or stone fragments, we can't dig", said Professor Vincent Gaffeny from the University of Bradford. Instead, he and his British and Belgian team will use seabed mapping data to produce a 3D chart revealing Doggerland's rivers, lakes, hills and coastline, reports The Guardian. They will also take core sediment samples to extract fragments of DNA from buried plants and animals, to reveal the secrets of a "lost continent".

From The Week. 18 May 2019.

How to prevent a "gold rush" in space

As we fret about the damage we have done to this planet, a study has suggested that it's not too soon to start trying to reach agreement on how to protect other, as yet untouched worlds from the ravages of industrialisation. Although space mining hasn't begun yet, millions are already being poured into companies seeking to exploit the water, metals and minerals locked up in asteroids, the Moon and rocky planets, with a view to the first missions beginning in as soon as a decade from now. "If we don't think about this now, we will go ahead as we always have, and in a few hundred years we will face an extreme crisis, much worse than we have on Earth now," said Dr Martin Elvis, of the Smithsonian Astrophysical Observatory in Massachusetts, and one of the authors of the new study.

Working with Tony Milligan, a philosopher at King's College London, Elvis has calculated that if space mining grows 3.5% annually, the solar system will be depleted of its key resources within 500 years. To avoid such a catastrophe, they argue that 85% of the solar system should be designated a protected "space wilderness".

From The Week. 25 May 2019.

The cosmic origins of bipedalism

Did our ancestors leave the trees and get up on two feet because the stars exploding in the Milky Way led to Africa's forests being replaced by savannah? It may sound far-fetched, but this is the thrust of a new academic paper that posits that an upsurge in cosmic ray-induced lightning strikes was crucial to the emergence of bipedalism roughly seven million year ago. The researchers in America drew on previous studies that concluded that from about eight million years ago, a series of supernovae occurred in our cosmic neighbourhood. The dying stars would have sent cosmic rays streaming towards Earth, massively increasing the ionisation of its lower atmospheres. This would have led to an increase in cloud to earth lightning bolts that could have sparked wildfires. Although there is no evidence for that, carbon deposits in soil from the period suggest that raging fires did become more common in that era. These, the paper contends, would have contributed to Africa's deforestation. With fewer trees to swing through, early humans would have adapted over time to walk upright.

From The Week. 8 June 2019.

Scotland's asteroid crater

A huge crater, created when a meteor struck Earth 1.2 billion year ago, may be hidden beneath the sea off the west coast of Scotland. Evidence for the strike was unearthed in 2008, when scientists on a field trip stopped to look at the Stac Fada Member, and unusual rock formation near Ullapool. Spotting green fragments in it that indicate an asteroid strike, they took samples for analysis and found quartz crystals, deformed by an impact.

Now, they have used "directional" measures within the rock – such as the orientation of magnetic particles – to work out where the strike took place. The spot is believed to be about ten miles off the coast near Lochinver – although at the time of the strike, what is now Scotland was close to the equator.

Crashing into Earth at 40,000mph the asteroid would have left a crater around 12 miles wide, which would have been filled in with sediment.

From The Week. 22 June 2019.

West Sussex Geological Society

The **West Sussex Geological Society** was formed in 1977 to promote the knowledge and interest in geology and to provide a forum for discussion, demonstration and exchange of views amongst its members.

The **WSGS** is a Local Group within the **Geologists' Association.** Amongst other benefits this entitles any **WSGS** member to attend any **GA** lecture or field trip for a nominal fee.

Details of Field Trips and lectures appear in the **GA** magazine available at every meeting.

Annual membership fees are payable from 1st January each year, as follows:-

Joint £19.00 **Single £12.00** **Student £4.00** **Junior £3.00**

Further details of membership and meetings may be obtained from any committee member.

The committee for 2018/19 is:-

CHAIRMAN	John Lonergan
HON. SECRETARY	Betty Steel
HON. TREASURER	Micky MacKinnon
FIELD TRIP SECRETARY	John Lonergan
MEMBERSHIP SECRETARY	Alan Bell
WEBMASTER	Alan Bell
EDITORS OF OUTCROP	The committee.
COMMITTEE MEMBERS	Jo Paxton
	Andy Cosham
	David Bone
	Alan Winter - Facebook page (contributions welcome)
Outcrop Design :	Martin Snow,

Dorset Trip
Figure 1.
The cliff and fallen Inferior
Oolite at West Bay, Bridport.

Dorset Trip
Figure 2.
Ammonites exposed at
Horn Park Quarry SSSI.

Dorset Trip.
Figure 3.
The group viewing ammonites
protected by a metal cage
at Horn Park Quarry

Dorset Trip
Figure 4.
Collecting from Inferior Oolite
scree at Louse Hill SSSI.

See report on page 6