OUTCROP

West Sussex Geological Society

Number 61 Summer 2020

Moai partially buried at Ranu Raraku, Easter Island. Photo David Bone

www.wsgs.org.uk

ISSN 1463-6735


Grab yourself a set of our GREAT VALUE
A6 flyers
FLYERS ARE IDEAL FOR:
• Promoting Community Events
• Advertising Your Business
• Door 2 Door Mailings
• Low Cost Promotions
All our A6 flyers are printed both sides on a quality 300gsm gloss board from your supplied artwork and include FREE delivery. No artwork! Not a problem our design team can create your flyer for only £40.00
KENADS printers
For all your printing needs
2,500 ONLY £90.00
5,000 ONLY £95.00
10,000 ONLY £158.00
20,000 ONLY £310.00
Telephone: 01903 506444 www.kenadsprinters.co.uk

BPiF member

OUTCROP 61

Summer 2020

Contents

From the Editorial team

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

Contributions for Outcrop 62 are very welcome and should be sent by email or on disc to Jo Paxton - by **1st September 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 images included within Word documents will **Not** be used.*

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.

Change of Bank - IMPORTANT NOTE

Please note and amend accordingly the change of bank details for paying your subscription by direct debit / standing order or one off electronic payment

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.

www.wsgs.org.uk

From The Chairman

Welcome to the June issue of Outcrop. I hope everyone is well, even if things are a bit limited at the moment.

All WSGS physical events are currently postponed until at least September, please keep an eye on our website, www.wsgs.org.uk We have postponed our weekend in the Isle of Wight to 10/11th April 2021, please contact me for more information.

It does feel as though planning 2021 is too easy, just move over all of the events planned for 2020, unfortunately. With social distancing indoor meetings (and outdoor group events) aren't really practical, and public transport is not inviting at the present. At the moment I anticipate that we won't restart talks and events until the New Year, but if we can do so earlier, in a way that is safe and practical, we will. Social distancing would reduce the hall capacity from over forty to about a dozen. And outdoor meetings with social distancing would make it impractical or everyone to see and hear the leader.

The Geologists' Association are already planning for their Festival of Geology on 7th November 2020 to be moved online, and Tony Brook's Southeast England Regional Conference planned for Saturday 14 November is cancelled.

So, to keep things going we have had virtual committee meetings and Alan Winter has been sending around online geology articles and links, and we are aiming for these twice a month. Contributions welcome for this – including geological holiday photographs, with a little explanation, to remind us of the outdoors. Once we can restart we will start cautiously, then I'd look to plan a temporary increase in events to regain momentum. I'm keen to hear of any particular fieldtrips you'd like us to organise, and talks too. We can revisit od favourites!

The main thing is to stay healthy and safe - the rocks will still be there (if slightly more eroded) when this is over!

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

** All Lectures and Field Trips are on hold due to Government Restrictions*

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	**TBA**
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

Sunday 06 September **** See note***
Cissbury Geology and Archaeology Walk
Led by Alex Vincent, meet at 10.30 at the Coombe Rise car park, in Findon. We will look at how the geology influenced the archaeology of Cissbury and its surrounds. A half day walk.

Sunday 27 September **** See note***
Offington Cemetery
Led by Alan Bell and John Lonergan Meet at 2pm. To examine the wide range of rocks used in the memorials.

October and November still being planned.

Sunday 6th September 2020 **** See note***

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. Contact Peter Austen

**** All Field Trips are on hold due to Government Restrictions***

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

Meet a Member
Pat Waterston

1. What fired your interest in Geology

I've always been interested in anything that looks different, pebbles, shells on the beach, anything sparkly. I heard from a good friend through the children at school, there was going to be a geology class, "Splendid", I thought and went along to John Alchin's class. He was the head of the geology department at the boy's school and that's where we had our meetings

2. How long have you had that interest?

Forever! Certainly since the 1950s, I'm not really a scientist.

3. Did/does your career involve any geology?

No, not really. I trained in textile design and did a teacher training course at Hornsey College of Art and eventually became a teacher, printing, litho and bookbinding. In school it was lino cuts and potato cuts that's all we could get at the time; I was always curious and this came through.

4. What has been your involvement with the WSGS?

I was involved at the very beginning along with Bob Robelou, David Bone, Mike Goodchild and so on. I coined the title for the journal "Outcrop" and I was very proud of that. I can remember there in the early days stapling sheets together and so on, before it became a proper book. Over the years I had various roles on the committee, I was treasurer. I went on a lot of field trips and kept all the field notebooks. *(Note: Pat fully illustrated all her field notebooks with the most exquisite drawings. Her field notebooks are archived in Worthing Library)*

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

They thought at least it is sane(ish), something worth being interested in. Geology affects everything, the whole earth, space, growing things, food, soil. My husband was a horticulturist with Carters tested seeds and of course soil was affected by the geology, he was in bulb growing and seeds. I was interested in the magic of it all. Now of course you can see it on the television, which you couldn't before.

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

It's more important than you can ever realise, because it really affects everything, not only growing things, finding minerals, fossil fuels will run out and we must find an alternative, Flint isn't much good these days!

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

Anything colourful and/or with a good shape or form, anything interesting.

A brief geology of Easter Island (Rapa Nui)

Lecture report by David Bone

Thank you for the Christmas 2019 talk, David – would you mind writing it up for Outcrop, please? How could I refuse! At least any errors would be of my own making. Why a 'brief geology'? The answer is simply that Anne and I were on a guided archaeology tour – you will recall that the island is famous for its ancient stone statues, the moai – so the geology was gleaned as an aside during the trip and from internet sources on return.

Easter Island is about as remote as an island can possibly get. Located in the tropics 27° south of the equator in the Pacific Ocean, the nearest landfalls are

- Juan Fernandez Islands – 1,150 miles
- Chile – 2,180 miles
- Galapagos Islands – 2,230 miles
- Samoa – 4,120 miles
- Hawaii – 4,650 miles

By plane from the UK, it is about 14 hours to Santiago in Chile then another 5 hours across open ocean to Easter Island. The landing is good as the runway was extended to receive the space shuttle in case of emergency.

The island is small, hilly and roughly triangular. It stands alone in deep oceanic waters, with just two offshore rocky islets (little more than crags). The size of Easter Island can be best compared with the five times larger Isle of Wight with which we are more familiar:

	Easter Island	Isle of Wight
Length	14 miles	22.5 miles
Width	7 miles	13.5 miles
Area	64 sq. miles	380 sq. miles
Population	5,760	36,500

Formed over a 'hotspot', an upwelling of magma within an oceanic plate, the island comprises three major volcanic eruptive centres and lava flows with the oldest dating back around 770,000 years. Other dates are given on various internet pages, but these seem to be the most reliable. The island is dominated by the central cone of Terevaka rising to 507 metres whilst the undulating landscape is characterised by numerous weathered and degraded subsidiary and parasitic volcanic cones. There are few trees, with most of the land under grass or subsistence agriculture. The rugged coastline of sheers cliffs and rocky inlets drops into the surging ocean with little protection offered for harbouring boats. There is only one sandy beach.

It is now fairly well established that the island was originally settled by Polynesians in the 11-12th century. Due to population pressures back home, large canoes bearing families, livestock and provisions for long voyages would set off into the unknown in search of more land to settle. There is no evidence to suggest that the island was ever reached on more than one single occasion, although several canoes may have been travelling together.

Archaeological investigations reveal that, at the time, the island was covered by dense tropical rain forest, dominated by giant palm trees now only occasionally found in South America. Over time, the native population slowly grew to an estimated 15,000 with the consequent decline in natural resources due to over-exploitation. Deforestation progressed rapidly due to human activity and consumption of seeds by rats unwittingly introduced with the original settlers. This caused the loss of the indigenous wildlife and, eventually, no timber for boats which had enabled offshore fishing.

Easter Island was discovered by a Dutch fleet on Easter Day, 5th April 1722. The population had already dramatically reduced to just 3,000 to 4,000 but this was not the end of the story. Fighting between clans, depopulation by force, emigration and disease reduced the population to just 111 by 1877. Renamed Rapa Nui (Great Rapa) in the 1860s, the island was annexed to Chile in 1888 and turned over to Scottish sheep farming from 1903 to 1953. The few remaining people were forcibly relocated to the one population centre, now the town of Hanga Roa. Slowly, Rapa Nui is regaining its independence and the population is increasing again. It was granted special status from Chile in 1977 and tourism is its main industry. You certainly won't find any sheep there today or on any menu.

The moai statues are, of course, the iconic images of Easter Island, perhaps the most famous group being the line of 15 statues at Tongariki (Figure 1). As elsewhere, the statues stand upright on a low platform facing inland with their heads inclined slightly upwards – presumed to be spiritually watching over the indigenous population. This particular group was restored in the 1990s following a tsunami in 1960 that carried the statues 90 metres inland. At least 800 moai were carved, ranging in height from 2 to 10 metres and weighing up to 83 tonnes. Nearly all were carved from volcanic tuff outcropping at the Rano Raraku volcanic cone at the eastern end of the island.

Rano Raraku developed as a parasitic cone on the slope of the large Poike volcano. Here, initially from a submarine eruption, thick layers of homogenous grey unoxidized pyroclastic tuff rapidly accumulated around 400,000 years ago. The tall cliff now visible, and forming the quarry for the moai, was formed as a result of collapse into a submarine landslide prior to the extrusion of the surrounding lava flows (Figure 2). The Rano Raraku quarry still contains almost 400 statues, the relatively soft, poorly cemented homogenous tuff being ideal for carving. Many moai have barely been moved from point of quarrying and some are still waiting complete extraction, including El Gigante – over 20 metres long and weighing an estimated 274 tonnes.

Many of the Rano Raraku moai appear to be head and shoulders only (Figure 3), but this is simply due to burial of the bodies in talus weathering from the slopes above. How they were moved is the big question. Tradition says that the moai were placed on timber rollers and dragged to their place of erection (hence cutting down so many trees), others that they were dragged across beds of slippery seaweed. However, there are stories of the statues walking, which is not as improbable as it might seem. The statue bases are slightly rounded, and it might be possible that the statues could be slowly moved by rotating them on their bases.

Figure 1. Moai at Tongariki, Easter Island, restored in the 1990s. Photo David Bone

The only sandy beach of the island, on the eastern north coast at Ahu Nau Nau, is an idyllic spot with palm trees and picnic benches. However, carbon dating of deposits suggests that this is not the original landing spot of the Polynesian settlers. Behind the beach is another platform of moai, but these have all been reconstructed with their red top knots or pukao (hats). These were made from red volcanic scoria that was quarried at one locality only, Puna Pao. Here, ancient spatter cones blasted molten lava into the air, fusing into rock on cooling. The outline of the quarry can still be seen and a line of abandoned pukao line the track to the site. From here, the pukao were distributed around the island.

A few examples of fully reconstructed moai can be seen at various sites. The tall body and integral head of grey pyroclastic tuff, coral insets for the eyes, and surmounted by a red scoria topknot makes an impressive sight.

For the next step in our story, we move to the south-west corner of Easter Island and the 1.6 km diameter crater of Rano Kau (Figure 4). Formed by the subsidence of a magma crater, the 300 metre high coastal cliffs reveal around 50 separate lava flows interbedded with pyroclastic flows. Three offshore islets (the only other islands around Easter Island) preserve the remnants of rhyolitic intrusions. The crater now holds a crater lake, although the water level can vary significantly. On our visit, the water was very low (giving some local concern) and exposing reed-covered mud mounds. The sediment sequence here has been used for pollen analysis and dating of vegetational changes across the island.

On the rim of Rano Kau crater is the Orongo, the 'Birdman Village'. Sometime prior to European discovery the moai worship was slowly replaced by the Birdman culture. Birdman competitions started circa 1760 and toppling of the moai by competing groups began in 1770. By the 1860s, no statues were left standing. All those seen today in an upright position have since been re-erected.

The view from the crater rim at Orongo towards the islet of Moto Nui is impressive (Figure 5), especially when one learns about the details of the Birdman competition to decide the ruling clan on the island for each year. Springtime would see the arrival of the sooty tern, a migrating seabird, to nesting spots on Moto Nui. To the islanders, who had lost all memory of any other land, this was a magical event. Each clan chief would select a champion whose role was to descend the near vertical 300 m cliff, swim over a kilometre in shark-infested waters, collect an egg and return it intact via the same route to the cliff-top village. The chief of the winning champion became the ruler for the year. This dangerous activity ended with the arrival of the missionaries in the 1860s.

To complete this account, mention should be made of the numerous lava tunnels that cross the island. Increasingly identified and mapped in recent years, these tunnels can be kilometres in length and many metres in diameter. They form when fluid lava drains out from under a cooling crust and can be reused by lava rivers during subsequent events. They have now been recognised as important to the island population in the past, providing for shelter and storage as well as small havens for agriculture where the tunnel roofs have collapsed.

In conclusion, sunrise (very early) over the moai at Tongariki is an event not to be missed, although any photograph fails to capture the expanse and remoteness of the setting. Easter Island is certainly unique, and its history is a direct result of its geology and isolation. I would certainly go back and explore further if it wasn't so far and expensive to reach.

Fig 3 - Front Cover, Figs 2, 4 & 5 - Rear Cover

Meeting Reports

October 2019 : The Psychology of Volcanoes

Dr Chiara Maria Petrone

Micky MacKinnon

The big challenges concerning us are WHEN an eruption will occur, HOW BIG it will be and WHAT TYPE (blow or flow) ? There are already many monitoring activities going on continually, although not enough, recording seismic activity, gases, thermal waters and land movements. Some of these are on site, some via satellite observation.

There are lots of different types and shapes of volcano, many are colonised by humans and, being somewhat unpredictable, have a large impact on communities. An example is Stromboli, Italy, considered to be a gentle volcano with regular lava activity every twenty minutes, sometimes from several vents, but in the summer of 2019 it suffered a sudden large explosion with an enormous pyroclastic flow (she showed us a dramatic clip of a speedboat trying to outrun it).

Several large cities are very close to active volcanoes and most are strato types on subduction zones which tend to explode heavily. She reminded us of the Icelandic one in 2010 which produced a smallish but very harmful ash cloud affecting aviation all over Europe.

Mt.Tambora, Indonesia, 10th April 1815 was one of the largest recorded and climate was severely affected the world for about a year. 1816 became the "year of no summer" all over the northern hemisphere, although it spawned some historic treasures such as Turner's red sky paintings and the poem "Darkness" by Byron. It may even have had an effect on the Battle of Waterloo as it caused unexpected, prolonged rain and muddy conditions.

Merapi, Indonesia 2010 – a very active and one of the most dangerous volcanoes showed signs of unrest. Although the population was alerted, many refused to evacuate so there were many casualties.

Chaitén, Chile 2008 – earth tremors began in April, thought to be coming from a nearby active volcano. A 17km ash column erupted from a different, unknown, "extinct" neighbour. Most of the town had been evacuated but the ash remobilised a week later after heavy rainfall destroying 80% of it.

Four of the biggest eruptions last century were all supposedly dormant and somewhat unknown at the time. These days, as many volcanoes as possible are monitored, including active, dormant, and even extinct ones. It is considered active if it has erupted within the last 10,000 years, although that might mean "resting" if not actively erupting.

To better help with volcano psychology there is a new branch known as forensic volcanology, or, the personal history of a volcano. The traditional view is that there is a large pool of liquid magma under the volcano. This is now considered to be incorrect, and that it is more like a plumbing system of interconnected pockets filled with crystal mush, 60-80% solid, becoming more liquid nearer the surface. Since eruptions are mostly liquid, something must mobilise the mush. Does it then "shoot up" from the depths, or in stages through the pockets? A test pit was dug down through a volcanic deposit in Popocatepetl, Mexico, to analyse crystals in the layers. The crystals (plagioclase +/or pyroxene) start to grow from a nucleus and continue in increments, the concentric layers telling us something of the growth history. This is known as compositional zoning.

Each layer represents an injection of fresh magma which has a different physio-chemical content to another. In this study, they looked at the magnesium content of pyroxenes. In one rock sample, there were more mafic crystals which had started to grow in magnesium rich magma from deeper down, and others less mafic, which had started in less magnesium rich magma higher up. Some appear to have moved up and stopped in a higher pocket growing new layers of lower magnesium content, and then all erupted together. The question is, how long does it take for the magma to rise up sufficiently to erupt ?

Compositional zoning, as demonstrated, shows different compositions within one crystal, and the crystal tries to remineralise and equalise the layers by diffusing. Eruption "freezes" this process so you find clearly zoned (young) crystals and fuzzy, poorly zoned older crystals, perhaps 500 years old. In the Popocatepetl samples, some of the zoning was only about a week old… Monitors had indicated magma movement seven days prior to the destructive, Plinian type eruption, which shows the magma can mobilise very quickly.

The timescale of magma formation, storage and ascent beneath an active volcano and the processes that trigger an eruption are the keys to hazard assessment. It is clear we need to understand past eruptive behaviours to be able to better predict future events.

November 2019 : The Rise of Continents, The Sinking of Oceans

Prof. Craig Storey, University of Portsmouth

Micky MacKinnon

When did plate tectonics start?

The solar system formed around 4.56 billion years ago and planet Earth began to differentiate into layers (core, mantle, crust) within the first 30 million years. A recognisable planet with plates, volcanic arcs etc. had formed by 2½ billion years ago.

What are continents?

The crust is 30-40 km thick, comprising 0.8% of the Earth's volume. It is 61% silica, 4.7% magnesium oxide and similar to andesite. At the Moho (boundary) is a dense mafic layer of granulite through to schists and sediment.

How did they form?

Melting of the mantle adds new material to the crust. It may be an episodic plume, or via subduction (continuous). Melted mantle is basaltic, (55% silica). Differentiation occurs with heavier denser materials lower down, maybe sinking back into the mantle. Recycling of the crust occurs at almost the same speed as its destruction, so it is not increasing.

How old are they?

It is thought that about 70% of the crust had already formed by the end of the Archaean period, 2 ½ billion years ago. Archaean cratons now only compose about 1% of the crust. There are tiny amounts of accessory minerals in a sediment (titanite, zircon, apatite, rutile), and zircon, for example, can be used in uranium-lead dating. Tiny 200µ long crystals can show whether they formed by metamorphic processes or impact, or had been magmatically resorbed. A concentrically zoned crystal shows growth in magma and can be dated. The oldest so far come from the Yilgarn Craton in Australia and is around 4 billion, with Ur-Pb ranges from 4.4 to 3.8 billion. By using a range of minerals you start to get an idea of source and history.

At around 2 billion years ago there seems to have been a change, with reworking of new crust i.e. zircons show evidence they are coming from a reworked crust, not from mantle melt. These are detrital zircons.

Between 4 and 3 billion years ago there was rapid growth of continents with new zircons. After 3 bya this started to slow down…does this suggest tectonics had begun?

It is proposed that tectonics originated from an original "drip" of thin bits of crustal proto-continents melting into the mantle in Archaean times which progressed into proper subduction zones. 2.1bya seems to be the crucial period when the mantle started cooling rapidly and modern style tectonics began.

It has been suggested that subduction could have been triggered by an impact or series of impacts, or from the formation of the moon which destroyed much of Earth's crust. There is continental type stuff on the moon actually…

January 2020 : The Iron Industry in the Weald

Jeremy Hodgkinson

The Wealden Iron Research Group

Jo Paxton

For unforeseen reasons we were without a speaker for our January meeting and Jeremy very kindly agreed to step in at a week's notice to speak to our group.

Jeremy opened by saying he had spoken to WSGS before but it was some time ago so nobody would remember. He started by asking why was there a Wealden Iron Industry at all? One that continued off and on for two thousand years from 5th century BC to 19th Century AD at over 600 sites across the Weald. It was because all the requirements were there namely trees for fuel, water to provide power, stone and clay for bricks to build furnaces and most importantly iron ore.

The Saxons named the area we know as the Weald. The word Weald comes from the German word "walt" meaning wood.

The Wealden geology is sedimentary laid down in bands during the Cretaceous period, but over the last 140 million years or so severe faulting and folding occurred complicating the geology making prospecting for iron ore difficult. Iron ore occurred in the sands and clays of both the High and Low Weald. It's a carbonate called siderite, which weathers to an oxide called limonite and found in the ferruginous limestone bands within the Wadhurst clay. The main source is at the interface between this and the Ashdown Beds. The ore was often exposed in nodules along the sides of steep ghylls or stream valleys, more was found in the High Weald and found in the clay bands of the Tunbridge Wells Sands. In the Western Weald in the Vale of Fernhurst there were two main areas. Firstly, close to the interface with the Lower Greensand and Weald Clay and secondly close to the Hastings Beds.

Before and during Roman times, extraction was from open cast workings. When Julius Caesar arrived in 55BC in Sussex he observed that "iron in a small way was in the tidal regions". The industry flourished during Roman times with the "Classis Britannica" or British Transport Fleet taking a key role. It's estimated that as much as 30,000 tonnes of iron was produced in 30 years.

There was scant production during Saxon times this is evidenced by the discovery of just one site, near East Grinstead being attributed to the period. In medieval times production took off once more over the Weald, with important sites of this period being discovered in Crawley/ Horsham area.

Early iron production was initially carried out in small clay and charcoal "bloomeries" where after heating ore with charcoal a mass of iron would form at the base of the bloomery. This method of smelting ore was superceded by the blast furnace method which originated in northern France though requiring more ore and charcoal, output increased from a few kilos each day to nearer a tonne. Bellows were water operated requiring streams to be dammed forming ponds for storing water and higher temperatures obtained in this type of smelting process meant a different type of iron (cast iron) was produced. It was brittle and needed further working to reduce the carbon content to strengthen and make it easier to work. This work was called forging and it required even more water and charcoal therefore massive amounts of young sapling wood was used for all processes. It's estimated by 16th century there were 50 furnaces and 80 forges using 2.5 thousand acres of woodland each coppicing cycle of 15 years.

The navy had a tradition of using bronze cannon. It wasn't until 17th century and a shortage of bronze meant they went over to iron cannon and by 1756 and the seven years' war, 80% of guns were forged in the Weald.

This manufacturing stopped when it became cheaper to produce iron using coke in Scotland.

Although little now remains of the Wealden Iron Industry, some buildings do remain, these include furnace cottages for fillers, finers and founders and grand houses owned by iron masters. Hammer ponds and furnace ponds. Place names give clues too e.g. Abinger Hammer, Hammer, near Haslemere, Furnace Green.

Down In The Dolines - Lidar Mapping Of Doline Distribution
On The West Sussex Coastal Plain – Chichester To Westbourne

'Anyone relying on LIDAR is doomed'. Elon Musk 2019

R. J. Cordiner

The Environment Agency has made 1m-resolution LIDAR imagery coverage for large areas of England and Wales freely available on the internet under Open Government Licence (www. lidarfinder.com). Using this website it is easy to pinpoint the location of the LIDAR image on your screen using the pull-down Google Earth overlay.

'Lidarfinder' offers two different LIDAR views of the landscape depending on how the original data has been processed. After opening 'Lidarfinder' press the cog symbol to chose the type of imagery you would like to view. 25cm and 50cm imagery is only available for very small areas of England and Wales – particularly those liable to flooding. Chose the 1m imagery for the more complete coverage of the country.

DSM - Digital Surface Mapping is the easiest to find your way around by, as this is most similar to an aerial photograph, or Google Earth view. It shows the land surface with man-made structures and vegetation such as trees, which rise above it.

DTM – Digital Terrain Mapping has been processed to show the ground surface. Buildings and trees have been removed from the imagery as far as possible. However this is not completely possible, so that features which project above the land surface tend to show a mottled texture. This is the best imagery to use for studying the form of the land surface as it strips away the trees and houses to give a relatively smooth view of the landscape.

The map (Fig. 1) shows the solid and superficial geology together with the rivers and dry valleys of the area between Emsworth and Chichester. The geology is based on BGS mapping with further interpretation by the author using the LIDAR imagery. For instance the chalk outcrop along the Portsdown Anticline in the southern part of the map is readily identified even though it is covered with a mantle of raised beach and brickearth deposits, as it shows a mottled surface on the LIDAR imagery. Dolines have been identified as shallow depressions from 5 to 15m across in the ground surface.

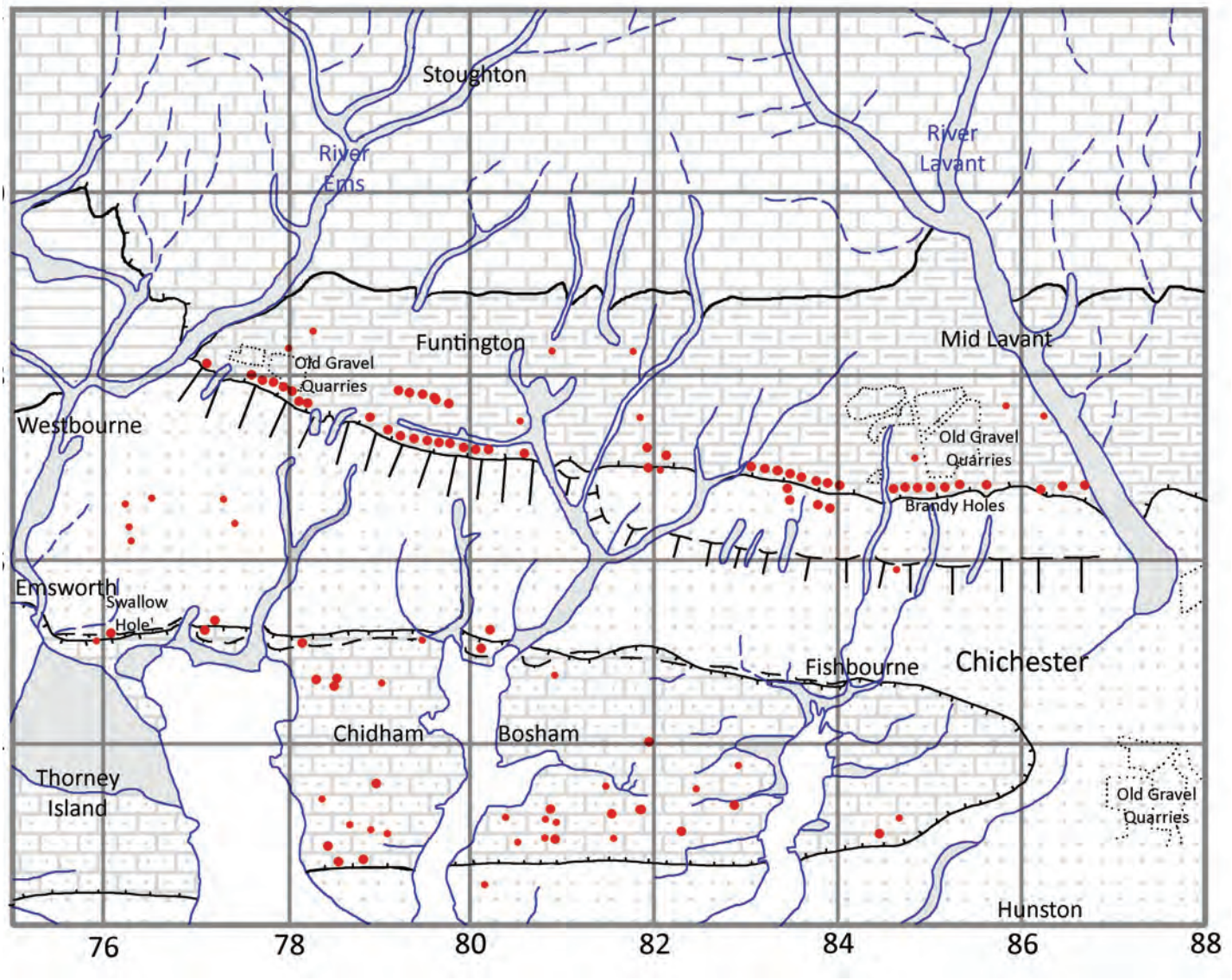


Fig.1 Geological Map of the area between Emsworth and Chichester showing location of dolines interpreted from a LIDAR image.

Dolines on the West Sussex Coastal Plain have formed where a relatively thin blanket of non-cohesive and permeable superficial deposits overlies chalk. In this area raised beach gravel, solifluction deposits and brickearth have slowly collapsed into shallow crater-like depressions, as they have slowly been washed down into fissures in the underlying chalk. Doline formation was probably initiated at the end of successive Cold Stages during the Pleistocene when solution of the underlying chalk would have been more active than today.

Across the area of the chalk inlier along the line of the Portsdown Anticline in the south of the map, which includes Thorney Island, The Chiddam Peninsula and the Bosham area, dolines occur sparsely, mainly in a random pattern. However across the northern part of the map a well-defined line of dolines runs slightly north of west, from the northern suburbs of Chichester to the River Ems near Aldsworth. As shown in the previous article (Cordiner 2019) the Sussex Coastal Plain doline lines mainly follow the Chalk – Reading Formation boundary along the southern margin of the chalk dip slope. Doline lines have formed in the overlying layer of superficial deposits consisting mainly of solifluction gravel.

It is not certain why doline lines have formed along the Chalk – Reading Formation boundary. A possible reason is that the movement of groundwater passing southwards from the chalk has been impeded by clay at the base of the Reading Formation. This bed of clay possibly forms a slight scarp buried beneath the overlying superficial deposits (Cordiner 2019, Fig. 1), which allows groundwater to infiltrate the underlying chalk along pre-existing fractures. Over time downward movement of groundwater has been concentrated at specific sites where chalk fractures have been preferentially enlarged. With enlargement of the fractures in the underlying chalk, superficial deposits have been washed down into them, leaving a crater in the land surface.

Sink Holes, Swallow Holes and Brandy Holes

The LIDAR image (Fig. 2) shows the Brandy Hole Lane, East Broyle Copse area in the northwest part of Chichester. A well-developed doline line extends east-west across the area to the north of Brandy Hole Lane, along the underlying Chalk-Reading Beds boundary.

The bank and ditch of the Iron Age 'Chichester Intrenchment' is visible running along the south side of Brandy Hole Lane. The 1898, 1:2500 scale O.S. map shows a 'Brandy Hole' at Grid Reference SU 856067, a Smugglers' Cave – G.R. 853067, entrances at 852067 and two further 'Entrances' in East Broyle Copse to the west. The area is marked as 'Roman Caves'. It is known that smugglers in the 18th century used these caves to hide brandy, a barrel of this spirit being discovered when building the foundations for the Chichester-Midhurst line, near where it crossed Brandy Hole Lane. It is known that gravel was formerly dug in this area; the pond in East Broyle Wood Nature Reserve being located in an old quarry. These workings may even go back to Roman times, as indicated on the 1898 O.S. map, as the nearby 'Intrenchment' bank would have been a ready source of flint gravel. It is possible that the Chichester Brandy Holes and caves started out as sink holes, which were later further excavated for flint gravel, and later further excavated by smugglers.

Fig.3
Photograph (2006) showing a sink hole in a field south of Brandy Hole Lane. A second sink hole can be seen in the left background.

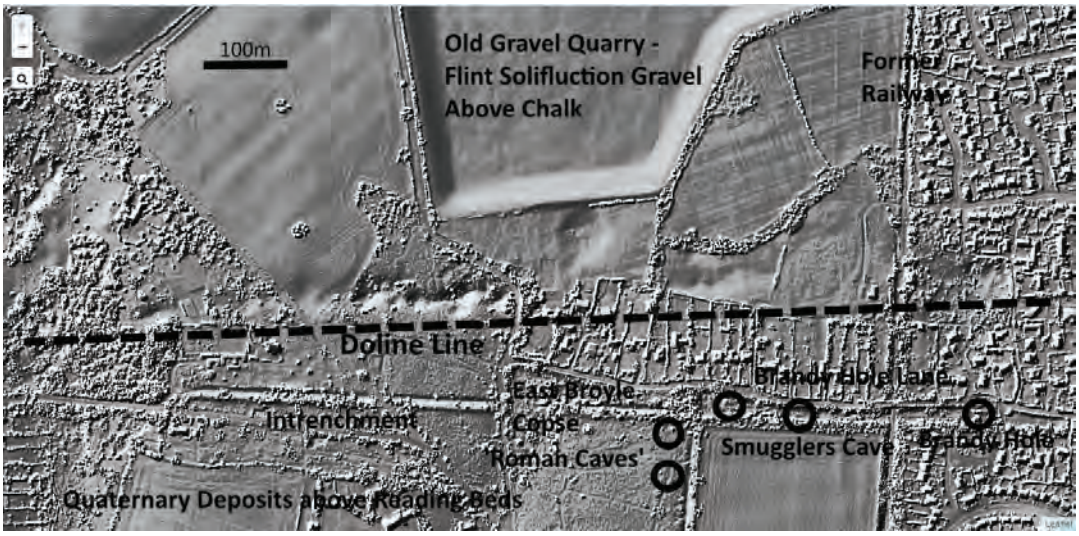


Fig.2
LIDAR image of the Brandy Hole Lane area on the north west side of Chichester, showing the doline line and Brandy Holes.

Sink holes are roughly circular pits caused by rapid collapse of poorly consolidated superficial deposits, soil and made-ground into underlying voids. These cavities are often initiated by removal of underlying material by excess water flow, caused by heavy rain or fracturing of water mains. Two sink holes each about 2m across were present in the field east of East Broyle Copse when I photographed them in 2006 (Fig.3). Such sink holes could be readily enlarged to extract gravel, and later caves could be excavated into their sides in which to hide illicit liquor.

The former one-inch to the mile Geological Survey sheet 331, Portsmouth and the Isle of Wight (part), shows a 'Swallow Hole' near Thornham Farm, Prinstead (G.R. SU 761052). The LIDAR imagery shows that this is one of a number of dolines located over the chalk where it outcrops along the axis of the Portsdown Anticline in the south of the map (Fig.1). This doline is one of a number in this area located close to the Chalk-Reading Beds junction. A swallow hole normally refers to the surface opening of a cave system in limestone country, and as such this surface depression has been miss-named. A doline line extending across the golf course to the west of Rolands Castle is also wrongly named as 'Swallow Holes' on the present 1:25,000 scale O.S. map. It would be interesting to visit these features to see if any of them are active sink holes.

Perhaps Elon Musk was right we should not just rely on LIDAR but get out to check what it shows!

Credit

Fig. 1 includes some BGS mapping information.

Fig. 2 LIDAR image from lidarfinder.com

References

Cordiner, R. J. 2019. Down in the dolines. LIDAR mapping of doline distribution on the West Sussex Coastal Plain – Chichester to Arundel. Outcrop 60. 13-15.

www.lidarfinder.com

Earthcache in Libya

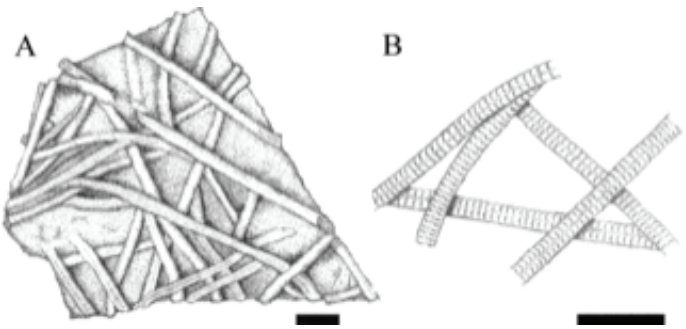
Micky MacKinnon

Following on from the introduction to geocaching, one of my earthcache finds was this one in Libya. We were in the Akakus area of high sandstone cliffs and weathered towers looking at prehistoric art, but knowing of my interest in rocks etc our desert guide proudly showed us evidence that the Sahara was once wetter. He stood on a boulder and then grandly moved his foot . "Ta Daa"... Fossil fish!!

We all surged forward to see, everyone clicking away, only...errr..what sort of fish is that? Well, not fish at all, but a very interesting assemblage of burrows caused by an unknown creature. The fan shapes and linear burrows were generated by the organism tunneling in clean sand and deeper into underlying mud so that only the lower part of the burrow system is preserved. In places, the burrows cross-cut preexisting cruziana structures (traces left by trilobites) . The burrows are blind ended, like a letter J, which suggests the organism was a filter feeder. Some claim these ICHNOFOSSILS were made by an invertebrate arthropod, such as a trilobite, sea scorpion or shrimpy thing, and others think it was a polycheate worm. As yet, no bodily remains have been found within a burrow to prove it one way or another, although there has been the organic compression of a long bodied arthropod discovered in association with arthropyhycus in a US deposit.

This TRACE FOSSIL is Silurian in age and indeed marks a time when the Sahara was not only wetter but actually a shallow marine environment.

The particular example we saw is *Arthrophycus,* meaning "jointed seaweed" as they were first thought to be of vegetable origin. Species is probably *alleghaniensis,* having a diagnostic form of transverse corrugation with a median furrow, and fanning out from both sides of the original burrow



Book Reviews

John Lonergan

Military Aspects of Geology: Fortification, Excavation and Terrain Evaluation

Rose, E.P.F, Ehlen, J, Lawrence, U.L;2019; Geological Society of London Special Publication 473; 314pp, hardback £110; ISBN 978-1-78620-394-6

This book is wide ranging and eclectic, and after an introductory paper, is split into three sections. The earliest is the Roman fort in Lympne in Kent, with most of the papers covering aspects of both World Wars, in all theatres, and ending with Islamic State military tunnels in northern Iraq. The introductory chapter sets out the overall history of military geology. Napoleon was the first to include geologists in a military operation. In Britain and Ireland, geological mapping started under the auspices of the army, becoming a civilian government agency only in 1845 as the Geological Survey of Great Britain. They then briefly outline the careers of notable military geologists.

The book is divided into three sections: Coastal Fortification, Excavation and Terrain Evaluation. The Coastal Fortification covers the late third century Roman Fort at Lympne, its principal interest being the accurate dating and magnitude of the movements. Next is groundwater supplies to Victorian forts, American coastal defence forts in the Civil War and finally the German WWII defence engineering geology in Norway.

The second section, on Excavation, is the longest. This commences with a comprehensive paper on WWI trench construction, then German military geology and mining on the Eastern Front in WWI, then three papers by Rose on the Royal Engineers quarrying and tunnelling in both world wars. Interestingly in WWI, there was a big emphasis on locating quarries for stone to supply the trenches and front-line areas, whereas in WWII the British moved from defensive construction after Dunkirk to planning for D Day and the construction of military infrastructure in all theatres of WWII. The final two papers are on British tunnels in Hong Kong and Islamic State in Northern Iraq. This included significant underground infrastructure, and they fabricated tunnelling machines for this.

The final section is on Terrain Evaluation and includes the Red River Campaign in the American Civil War, Ariel photographic intelligence in WWII and significant British Geologists and finally a review of a century of German cross-country mobility prediction. The British Geologists analysing the aerial photography included: D.L Linton (for attacks on the Tirpitz and V-weapon storage sites – later a geographer who worked on the on the Weald) and P. Allen (who "seems to have worked around the clock" carrying out his geological field work during the days when on night shifts, and when on days carrying out research at night!).

Well worth a read, certainly wide ranging – as was, and is, the approach of different governments to military geologists. The British had handfuls, the Germans hundreds and the Russians thousands.

The Stonehenge Bluestones

John, B.; 2018; Greencroft Books; 256; paperback £15; ISBN 978-0-90555-994-0

This is a book about where the bluestones at Stonehenge came from and is certainly written with feeling. It starts with the geology of Pembrokeshire, and then describes the bluestones at Stonehenge, and evidence for them and their numbers. In 1921, Herbert Thomas proposed the human transport movement of the bluestones, as an aside in a talk about the origin of the bluestones. Then comes the story of the transport theories, and their modern recreations, by land and sea, including the Millennium stone lost at sea then retrieved after an arduous journey on roads as the natural ground meant the first 17 miles took five weekends of pulling. Next is a diversion about Merlin and myths and theories.

The OU was involved in the 2008 dig at the Preseli quarries and BBC Timewatch programmes, in which the archaeologists speculated that they had the quarry from which the Stonehenge bluestones came. This was an archaeological excavation, and when geologist looked at it the stones, wedge slots and faces were seen to be natural not man made. There is a lot of feeling in this section!

The rest of the book concentrates on the stones and geology. This includes the history of the stones, other examples of bluestones found near Stonehenge and glaciation. The author's contention is that the Irish Sea Glacier transported the Bluestones south east from Preseli towards Salisbury Plain, leaving a train of bluestone erratics across the landscape. So, when the builders of Stonehenge needed them, they collected the next nearest large one (there are several rock types in the bluestone circle, including volcanic ash and Jurassic limestone) . And as there weren't enough in the train, they used whatever suitable stones they could get: the monument was repeatedly reorganised and never finished – there were never enough stones to finish it. When Thomas proposed the human transport theory, he was unaware of the extent of glaciation in south west Britain, hence his suggestion.

A good read, with lots of good geology. The story of the modern recreation of the human transportation theory is a story in itself. And a good example of how a good story got in the way of the facts.

Paper, Scissors, Stone

Submitted by Alan Bell

Snippets of geological interest as reported in BBC Sky at Night Magazine (September 2019 to February 2020)

Japanese mission **Hayabusa-2** took its second rock sample from asteroid Ryugu on 11th July. In April 2019 it cleared away the top layers of rock to reveal the pristine material beneath. Hayabusa-2 was due to return to Earth with rock samples in December 2019 but is now scheduled to return sometime in 2020.

The Indian Space Research Organisation (ISRO) successfully launched its second mission to the moon, Chandrayaan-2 on 22 July. However the project was only partially successful as communication with the lander, named Vikram was lost. However the orbiter will continue its scientific studies for a further 7 years. www.isro.gov.in

Mars had a warm enough climate 3-4 billion years ago for substantial rain storms and flowing water, providing conditions for life to form, new research suggests. Professor Briony Horgan of Purdue University, Indiana has compared mineral deposits on Mars to similar on Earth. They indicate that Mars enjoyed long periods of rainy weather after which the water froze. She said "We know that the building blocks of life on Earth developed very soon after the planet's formation, and that flowing water is essential for life's development. So evidence of early flowing water on Mars will increase the chances that simple life may have developed at around the same time." www.purdue.edu

Israel's Beresheet spacecraft which crashed into the Moon's Sea of Serenity in April , was carrying thousands of microscopic dehydrated tardigrades, it has been revealed. The news alarmed planetary protection supporters who warn against dangers of contamination. It is thought the 'water bears' are unlikely to survive under harsh solar radiation and without water and an atmosphere.

The heat probe on **NASA's InSight Martian lander** has popped out of the ground. The probe was supposed to hammer itself into the ground but failed to find a purchase. During October 2019 the InSight team used the robotic arm to 'pin' the probe in place and appeared to be making progress, only for the probe to backup halfway out again.

20 new moons have been discovered in orbit around Saturn, taking the total up to 82.

An instrument capable of looking at 5,000 galaxies every 20 minutes began operation on 27th October 2019. **The Dark Energy Spectroscopic Instrument (DESI)** will look at over 30 million galaxies to measure how fast they are moving away, creating a map of how the Universe is expanding to help researchers investigate dark energy.

The 'tiger stripe' cracks found on **Saturn's ice moon Enceladus** are created by the gravitational push and pull of the planet on the moon, a new study by the Carnegie Institution for Science has confirmed. The first crack appeared at the southern pole where the ice is thinnest, but didn't immediately freeze over. This allowed the subsurface ocean to erupt out, creating three more parallel cracks.

Betelgeuse, the star in Orion is the dimmest it has been in a century and this is of interest to astronomers because it could become a supernova. (although this could occur anytime within the next million years). www.aavso.org

The latest look at **Saturn's moon, Titan,** suggests it's craters were formed by nitrogen exploding to the surface. The moon's atmosphere is largely nitrogen, which can get trapped underground, forming gas pockets. Over time, geological heating and movement can cause the gas to expand and burst through the surface, creating a crater.

A large volcano on **Jupiter's moon Io** could erupt any day now. After 20 years of observations, astronomers have found that the volcano, Loki, erupts about every 475 days. The cycle means the volcano should have erupted in September but we are still waiting.

Scientist's have created a **new geological map of Saturn's moon**, Titan, pieced together using data from NASA's Cassini spacecraft. The spacecraft flew round the moon 120 times and used radar and infrared imaging to pierce the haze and pick out the geological features. Titan has an active methane based hydrologic cycle but despite the differences in materials, the map shows several familiar features found on our own planet. Around two thirds of Titan is covered by flat plains, though the equator is dominated by 100m high dunes, while lakes of liquid methane lie close to both poles. www.nasa.gov

The First Global Geologic Map of Titan Saturn's Moon

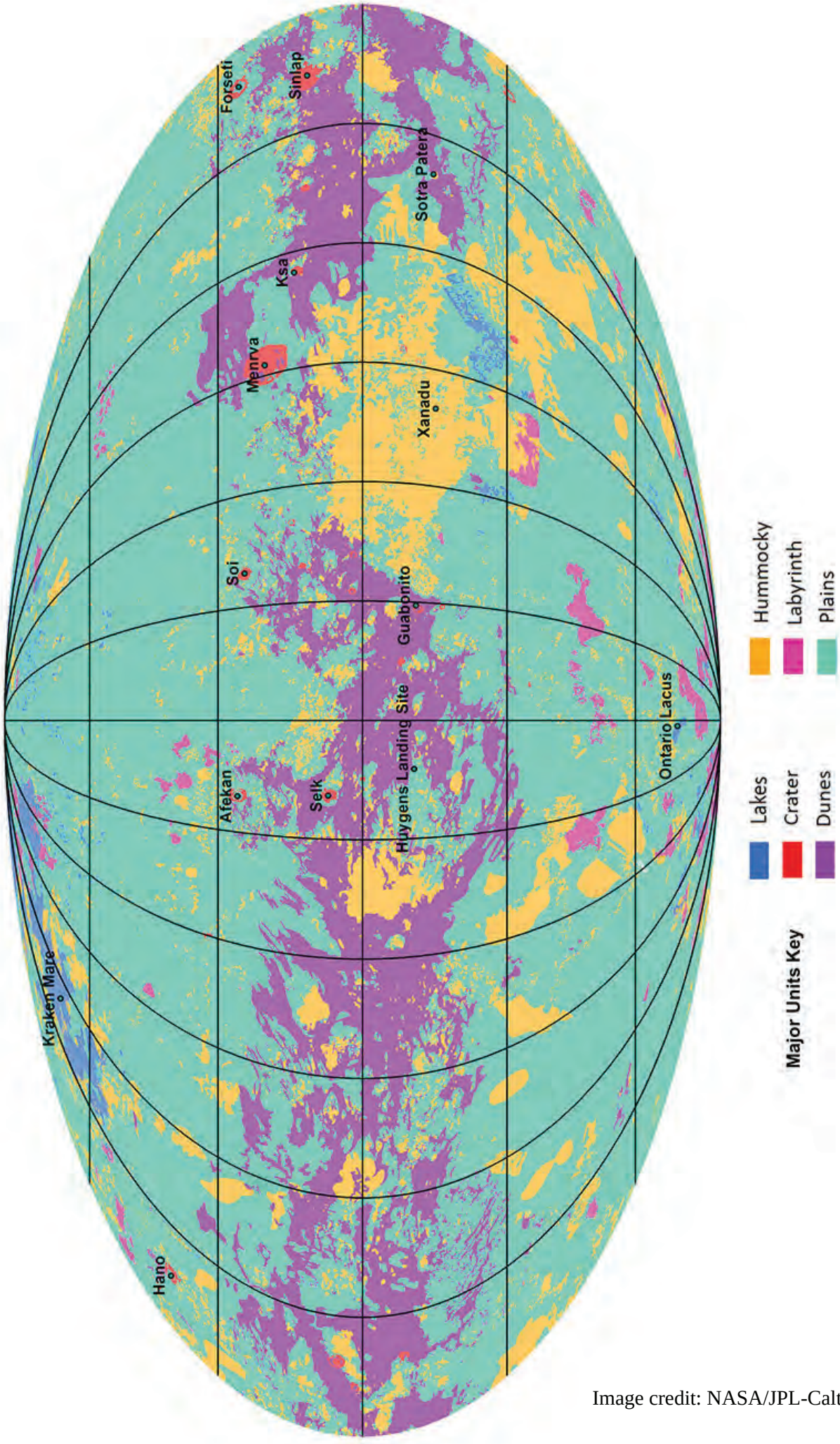


Image credit: NASA/JPL-Caltech/ASU

Donations to WSGS – thank you!

David Bone

Over the past couple of years or so, I have been the recipient of books, maps, specimens and other ephemera that people have been clearing out. Some have come from members whilst other material has come from people contacting the society to seek a good home for items from a deceased family member. Together with items personally purchased from auction and house clearance sales, this has accumulated into around 12 or more large boxes of books, a pile of old geology maps, several boxes of fossils and mineral specimens, and some rather random items that are difficult to classify. An example of the latter is the resin cast of an ammonite-rich bedding plane (see illustration), approximately 600 x 600 mm. Light in weight and with a hanging cord attached to the rear, this has yet to find a home and I'm open to reasonable offers!

Items donated to the WSGS have been given with the intention of helping to raise funds, so it has not been a policy to leave them at the back of the lecture room for disposal and ask for a donation. This seldom attracts any significant amount of money. Instead, although requiring much more effort and taking longer to achieve sales, all the items have been marked up with a competitive second-hand price and appropriate selections taken to events such as the Geologists' Association Festival of Geology, museum events and public talks. A small fossil collection, donated by the family of one of our founder members recently deceased, I sent to auction as the most efficient means of disposal and raising money. Other specimens have found homes as give-aways to children at events or have been used as WSGS raffle prizes.

A large amount of material has yet to find a home and maximise the return to the WSGS. A good example is printed geological maps. These are next to worthless these days due to huge numbers being dumped on the market by academic institutions going digital. But these can be sold as decorative items when suitably framed, so the challenge is to find old picture frames at a low price in second-hand shops. These can then be reused to frame a geological map and sold at a profit. Much better than just throwing them away!

So far, sales have raised an amazing £643.42 for the WSGS and undoubtedly more will be achieved over time. This helps significantly to keep down membership costs and enables us to arrange speakers that would otherwise be beyond the society's budget. Despite a minor storage problem, I am always happy to receive any items that might be sold to raise money. So, please speak to me at a lecture meeting or contact me at david@dajbone.plus.com. Thank you.

Fordite – a different type of gemstone

David Bone

On a recent holiday in the Peak District, Anne and I were looking around a jewellery shop in Castleton, when we came across an attractive variegated gemstone that was new to me. Called Fordite, it showed strong colours in bands of varying thickness, sometimes parallel and sometimes curving and twisting. It was quite striking when set as cabochons in rings and other forms of jewellery. I haven't any photographs, but a Google image search for Fordite will bring up many examples.

Fortunately, a shop explanation sheet came to my rescue, which is augmented here with further information from several websites. It is not a true gemstone! The original Fordite, also known as Detroit agate or Motor City agate, appeared in the late 1900s at the Ford factory in Detroit, hence its name. The material resulted from the accumulation, layer upon layer, of excess enamel paint on tracks and skids in automotive paint shops in the days when cars were hand spray-painted.

The painting process, which involved curing the vehicles in kilns to set the paint, hardened the surplus enamel paint over numerous baking cycles. Eventually, the paint accumulation would become too thick and heavy, and had to be removed. The story tells that some crafty workers with an eye for beauty realized that this unique by-product was worth salvaging. It was super-cured, patterned like psychedelic agate, and could be cut and polished with relative ease! As word got around about this remarkable material, it's been said that people started showing up at the car factories offering to help remove that problematic paint!

The material that we saw in Castleton is imported from Michigan and Minnesota, then cut and polished in the onsite workshop. Unfortunately, the techniques that produced this material are no longer in practice. Cars are now painted using an electrostatic process that essentially magnetises the enamels to the car bodies. This leaves little or no overspray. As one website says, the Fordite "mines" are dry, so get some while you still can!

Stone for a Roman cist

David Bone

I often get asked to identify stone from archaeological excavations, not always easy until the sample has had a wash and a corner knocked off to reveal a fresh surface. But that's not always possible if the stone is an artefact of some importance, however discrete an attack with the hammer and chisel might be! One such item came out of excavations at Warblington, between Emsworth and Havant, where the Chichester and District Archaeology Society have been excavating the site of a Roman villa.

Lying just to the south of the line of the Roman road between Chichester (*Noviomagus Reginorum*) and Southampton (*Clausentum*), the site is a small complex comprising a winged corridor villa with at least one small bath-suite and a timber-framed aisled building, probably a barn, to the east of the house. To the south is a large rectangular building. None of this shows up today above ground but is clearly visible in geophysical surveys. In 2014, excavation of the rectangular building revealed it to be some 35 m long and 8 m wide, incorporating a large central room with smaller rooms to its east and west. Unfortunately, most of the building had been ploughed out below floor level or the stone robbed out for reuse.

It was during excavation of this building that a block of stone, almost cuboid in shape, was uncovered. Investigation soon revealed this to be a small cist, probably made from a single piece of stone, squared off with a 42 mm wide chisel and then split in half (Figure 1). The upper block measures 190 by 185 mm and is 95 mm thick, the lower 190 mm by 180 mm and 100 to 110 mm thick. The bottom half was then hollowed out to provide a shallow recess (Figure 1) in which two small folded lead packages had been placed.

As part of the analysis, I was asked to identify the stone. It clearly seemed to be Oligocene age Bembridge Limestone from the Isle of Wight, which is not an uncommon stone in Roman context along the south coast in this area. But could I prove it without doubt as my name would be acknowledged in the final publication. Hammers not allowed but fortunately there were clean breaks on a couple of edges. Close inspection with a hand lens revealed two key fossil identifiers. One was unclear traces of a gastropod, probably the freshwater snail *Galba longiscata*.

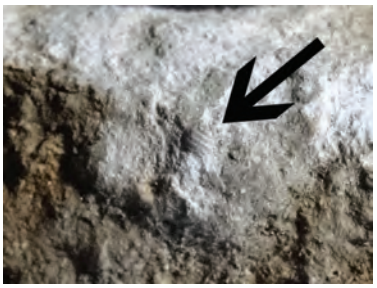


Figure 2.
Detail of a *Chara* fruiting body, a characteristic Bembridge Limestone fossil.
Photo David Bone

The other, however, was unmistakeable although only a single example and pinhead in size. This was a specimen of *Chara*, the fruiting body of a freshwater stonewort. A form of algae, these plants must have grown prolifically in the lake environment in which the Bembridge Limestone was deposited as a calcareous mud. Their tiny spherical fruiting bodies with the spiral curves are distinct (Figure 2). So, I could be confident in my identification.

So, what about the content of the cist? No bone residue, so unlikely to be a burial, and the lead packages were too small anyway. Also, there are no inscriptions on the lead, which isotope analysis suggested to have originated in the Mendips. It is certain that the cist was buried in a purpose-made cavity beneath the floor prior to or during construction of the building. Currently, it is believed that the lead packages were 'curse tablets', buried as part of a ritual. The archaeological excavations are now being formally written-up (with a contribution by me on the geology and building stones) but the cist has already been published because of it is such an unusual and important discovery.

Figure 1.
Lower half of the Roman cist from Warblington villa. Photo David Bone

Reference

Kenny, J. and Davies, T. 2019. A Miniature Cist from the Roman Villa at Warblington, Hampshire. *Britannia* 50: 359-367.

Geological Odds & Ends

Submitted by Betty Steel

Ancient plants blooms in the heat

A prehistoric palm tree-plant has produced male and female cones in Britain for what is believed to be the first time in 60 million years. Cycads dominated the planet's flora 280million years ago, before the arrival of flowering plants. Fossil records show they thrived in Britain during the warm Jurassic period, but as the

climate cooled, they died off in Europe and became confined to tropical areas.

In the UK, plants are only usually grown indoors – but as an experiment, botanists at Ventnor Botanic Garden on the Isle of Wight, which has a climate milder than almost anywhere else in Britain, began growing the plants outdoors 15 years ago.

They not only survived, but after ten years started to produce male cones; now they have produced female ones too, presenting an opportunity to transfer pollen and generate seed. The garden curator, Chris Kidd, thinks it's the accumulative effect of two unusually hot summers, and a string of mild winters – and though exciting, it's not something to celebrate. "Twenty years ago, we couldn't have grown them", he said. "It is a strong indicator of climate change being shown, not from empirical evidence .... but by plants.

From The Week. 7 September 2019.

A giant reptile with leaping power

The fossilised remains of a giant pterosaur – the biggest animal ever to fly – were found embedded in cliffs on the Isle of Wight. Discovered by fossil hunter Robert Coram, the creature is estimated to have lived 125 million years ago, and to have had a wingspan of 20ft. Although it is by no means the largest pterosaur ever discovered – some had wingspans in excess of 30ft – it is unusual in being from the Early Cretaceous period: most giant pterosaurs known to science lived in the Late Cretaceous period (100-66 million years ago). "It might have been the largest flying creature that had ever lived up to that time," Coram said. Pterosaurs were a type of reptile closely related to dinosaurs. The largest were as tall as giraffes and had enormous elongated jaws which may have been used to catch and kill small dinosaurs. One puzzle has been how such mighty creatures, weighing up to 650lbs, became airborne. Computer modelling now suggests that by pushing off from both their strong hind legs and their muscular wings (which they used like a pair of front legs), they were able to leap into the air.

From The Week. 5 October 2019.

Saturn is the new moon king

Saturn has overtaken Jupiter as the planet with the most moons: astronomers have discovered 20 new bodies orbiting the ringed gas giant, bringing its total to 82. Jupiter has only 79. The new moons are each about three miles across, and 17 of them orbit the planet in a retrograde direction – in the opposite direction to Saturn's rotation on its axis. They were spotted by a team from the Carnegie Institution for Science in Washington DC, who used algorithms to identify tell-tale changes in tiny specks of light on images captured by the powerful Subaru telescope on Hawaii between 2004 and 2007.

The team suspects the moons formed in the solar system's chaotic infancy around four billion years ago, when passing asteroids and comets got locked in by Saturn's gravity and repeatedly smashed into one another. "Everything was basically getting hit, and these moons are a remnant of that process," said lead researcher Scott S. Sheppard. There is now a competition to name the moons, with specific rules they must all be named after giants, from Norse, Inuit and Gallic mythology.

From The Week. 19 October 2019.

The long rise of the seas

Global sea levels will continue rising for centuries, regardless of whether the international community meets its agreed climate targets. That is the conclusion of an international study – published in Proceedings of the National Academy of Sciences – that used computer modelling to estimate future sea level rises. According to its findings, even if countries were to meet the 2015 Paris Climate Agreement target of limiting global heating to 2ºC by 2030, and at that point eliminated all their climate beating emissions (which is highly implausible), sea levels would still rise around 20cm by the year 2300. "Sea level has a very long memory, so even if we start cooling temperatures, the seas will continue to rise," Professor Peter Clark of Oregon State University told The Guardian. "It's a bit like trying to turn the Titanic round, rather than a speedboat.

From The Week. 16 November 2019.

Ancient ape had human traits

A new species of ape that lived 12 Million years ago has been discovered by scientists in Germany – and intriguingly, though it was a tree-dweller, it appears to have been capable of walking on two legs. *Danuvius guggenmosi* lived in what is now Bavaria and stood just over a metre tall. With elongated arms and opposable big toes, it shares some features with chimps and gorillas, but it also had straight legs and an S-shaped spine – human-like traits that suggest it combined tree-swinging with upright walking. "It is astonishing for us to realise during the process of research how similar certain bones were to humans, as opposed to great apes", said Professor Madelaine Böhme of the University of Tüningen.

Writing in Nature, Böhme and her colleagues controversially propose that *Danuvius guggenmosi* was a common ancestor of both Homo sapiens and great apes, providing the "missing link" between two evolutionary lines. The theory, if correct, would push back the evolution of bipedalism by some six million years, and shift its origin from Africa – where the first human species are thought to have emerged – to Europe.

From The Week. 16 November 2019.

Woolly mammoths trapped in pits

Archaeologists in Mexico have found remains of what appear to be two prehistoric mammoth traps. A team working in Tultepec, north of Mexico City, found two six-foot deep, 80ft wide pits at a site being excavated to create a rubbish dump – and inside them, 824 bones belonging to at least 14 mammoths. The pit may have been dug by hand, and on some of the 15,000 year old bones indicate that the animals were butchered. This raises speculation that hunters swept herds of the animals into pits dug for that purpose – before killing them.

The finding helps solve a long standing debate, about whether early humans actively hunted mammoths. "There was little evidence before that hunters attacked mammoths. It was thought they frightened them into getting stuck in swamps and then waited for them to die", said Luis Cordoba Barradas, who led the excavation. This is evidence of direct attacks on mammoths. In Tultepec we can see there was the intention to hunt and make use of the mammoths.

From The Week. 24 November 2019.

Humans not to blame for genocide?

The obliteration of the Neanderthals, around 40,000 year ago, has often been laid at the door of humans. It took place about 20,000 years after Homo sapiens began spreading into Europe and western Asia – regions which Neanderthals had long inhabited. Palaeontologists have suggested that the arrival of humans triggered a competion for resources, which humans won, thanks to their superior intelligence.

But according to a new Dutch study, the Neanderthals' demise may not have been human related. Genetic analyses of Neanderthals remains suggest that at the time they only numbered between 10,000 and 70,000 – and were spread out into isolated groups. Small populations are inherently vulnerable, because limited mate choice makes inbreeding common and there may not be enough people to do the various jobs needed for survival. Researchers at Einhoven University of Technology used computer modelling to show that a random event such as a sudden shift in birth rates could easily have pushed the hominids to extinction. "It's certainly possible it was just bad luck", said co-author Krist Vaesen.

From The Week. 23 November 2019.

First ever space junk mission

The European Space Agency has announced the first mission to remove man-made junk from space.

ClearSpace-1, scheduled to launch in 2025, will send a "chaser" probe into orbit, where it will track down a piece of debris the size of a small satellite. Using its robotic arms, it will grab this and then drag it back down into the earth's atmosphere – whereupon both the probe and the junk will burn up. The agency hopes the 120 million euro mission will pave the way for more extensive clear-up operations: in future, probes might cast junk into Earth's atmosphere, then return into orbit to carry on decluttering. There are more than 500,000 items of man-made debris in space weighing an estimated 8,000 tonnes. "Imagine how dangerous sailing the high seas would be if all the ships ever lost in history were still drifting on top of the water. That is the current situation", said Jan Wörner, the agency's director general. "It cannot be allowed to continue".

From The Week. 21 December 2019.

Greenland ice is melting faster

The Greenland ice sheet is disappearing at an even more alarming rate than had been predicted, says The Guardian. In the 1990's, about 33 billion tonnes of ice melted every year from the ice sheet. But in the past decade, the annual average has shot up to 254 billion tonne. The finding from the Ice Sheet Mass Balance Inter-comparison Exercise, was based on 26 separate surveys of Greenland taken between 1992 and 2017. Because Greenland's ice sheet rests on a large land mass, it contributes directly to sea level rises asit melts – unlike the floating sea ice elsewhere in the Artic. From the rate of ice loss revealed by their study, the scientists predict sea level rises around the world will reach 67cm above pre-industrial levels by 2100 – about 7cm more than predicted by the Intergovernmental Panel on Climate Change (IPCC). This will put 400 million people at risk of flooding every year – as opposed to the 360 million estimated by the IPCC. "These are not unlikely events or small impacts", said Andrew Shepperd of the University of Leeds, one of the authors of the Nature – published study. "[They] will be devastating for coastal communities.

From The Week. 21 December 2019

The deepest valley on Earth

The deepest land canyon on Earth has been found buried under the ice of Denman Glacier in Antarctica. Identified during a six-year project to map the bedrock of the Antarctic continent, the canyon reaches 11,500ft below sea level – making it 8.5 times deeper than the lowest exposed land on Earth's continents, the Dead Sea in the Jordan Rift Valley, which is 1,355ft below sea level.

(Although it is one of the deepest valleys in North America, the Grand Canyon lies on such a high plateau, that it is more than 2,000ft above sea level at its lowest point). However, the lowest point on Earth remains the Mariana Trench, in the Pacific, which reaches a depth of almost 36,200ft at its deepest point, the Challenger Deep.

From The Week. 11 January 2020.

Ancient star dust discovered

The oldest material known to exist on Earth has been discovered in a meteorite that struck Australia in the 1960's. An analysis of dust grains from the rock established that they are about 7.5 billion years old – meaning they predate Earth by three billion years. The particles are believed to have originated in stars which died long ago, flinging their contents out into space. "They're solid samples of stars – real stardust", said lead author Professor Philipp Heck of the University of Chicargo.

From The Week. 25 January 2020.

A new glimpse of the sun

The world's most powerful solar telescope has revealed the most detailed images yet of the surface of the Sun. The new Daniel K. Iouye Solar Telescope is located at the top of 10,000ft high volcano on the island of Maui, and has twice the resolution of any equivalent telescope. Opened last month, its first images reveal that beneath its turbulent exterior the

Sun has a surprising structured surface. Scattered across it in a honeycomb pattern are what look like gold nuggets; each roughly the size of France, these cells are made up of roiling plasma. At the centre of each is a bright point where columns of superheated plasma burst out from the star's interior, before cooling and descending back below the surface through the dark channels between the cells. "What we previously thought looked like a bright point –one structure – is now breaking down into many small structures", said Dr Thomas Rimmele, director of the project.

From The Week. 8 February 2020.

The turtle that was as big as a car

Fossil unearthed in a desert region of Venezuela have shed new light on one of the biggest-ever turtles; *Stupendemys geographicus.* First described by palaeontologists in the 1970s, the turtle live between 12 million and seven million years ago in what, at the time, was a vast swampland populated by many other oversized animals, including 11 metre long crocodiles and 700kg rats.

From The Week. 22 February 2020.

Highlights of our activities during 2019

Betty Steel

We've had quite an exciting year – finally, we had a window installed on the Pier. Down the complete length of Worthing Pier is a wind-break in the centre, the upper half is glazed with individual panes of glass. The plain panes are gradually being replaced by decorative 'Windows' representing all manner of groups and some in memory of special people, but more about this later.

The first talk of the year was by Nigel Hoad, Chairman of the Solent Regional Group of the Geological Society about his life, gold mining in South Africa from a geologists view. This subject attracted a large audience and many questions. He spoke of his life in the early days of his career when there was a somewhat different attitude to hazards, health and safety as there is today. Looking back, it appeared to us to be a very different life compared to the "protected" life lead now, surrounded by Health and Safety, rules and regulations. Quite scary at times - as it was told by Nigel during the evening.

In February our Chairman entertained us telling us of his geological excursion around Orkney Islands. This was after we had finished the business of our AGM. Then, we indulged in a cheese and wine social evening. Our interest in geology is not all digging and searching (head down). Just joining a field trip is fun. Anytime a member/ friend finds something interesting, everyone inspects the specimen, followed by many suggestions as to what it is??? Life is so interesting.

Looking back on our many field trips during the past year, our Annual residential trip is always special, this year it was held in May and we were blessed with good weather – at least it was dry! A group of 13 members arrived at Hive Beach, Burton Bradstock to begin our exploration of the Middle Jurassic of south west Dorset lead by Dr Bob Chandler, an expert on this area. A very interesting, fascinating and energetic two days followed.

A visit to Chichester Stone Works in March was intriguing. The stonemasons work involves repairing the eroded or damaged masonry of Chichester Cathedral, a slow and painstaking job, but essential. This is a trade that has not changed over the years – technology has not managed to take over- yet!! As far as possible the stone has to be identical to the existing damaged piece, but this sometimes proves impossible. Quarries, used in the past, have been closed. So a similar type of stone has to be sought, which is quite tricky and some types are not compatible!

The idea of having a "Window on the Pier" was suggested back in 2018 and it was quite a long journey before we had accomplished this project. But eventually, on one of the worst days in August as regards to weather, we held our unveiling ceremony. It was to be in the evening, so we hoped that the storm would have blown itself out – but no luck. All day it rained and a gale blew but 16 hardy members braved the storm, rain, wind, and poor light value but we managed hold our ceremony. Our window represented a cross section of the South Downs with the strata - layers of different rocks, deposited in chronological order, were represented in different colours with an ammonite in the corner. This was appropriately a specimen from the chalk.

This unveiling was followed a week later, on a sunny Saturday morning, by 'Pebbles on the Beach' – a 'field trip' led by David Bone, an expert on all our local geology. We assembled on the beach near Worthing Pier. David sent everybody to collect any stone that looked unusual or interesting , then he gathered the collected items and identified what they were and where they had come from and any other interesting feature. It was amazing – a whole new world on our beach. These specimens were all returned to the beach as it is unlawful to remove stones etc. from the beach. The weather was really "Sunny Worthing"! We are repeating this trip again this summer on Sunday, 16 August 2020.

See our website www.wsgs.org.uk where you will find our lecture programme, field trips and all other information.

Lyell's Childhood home and it's connection to Werner's Nomenclature of Colours

Alan Bell

On a recent stay in the New Forest I was surprised to learn that one can now stay at the historic childhood home of the celebrated Victorian geologist , Sir Charles Lyell, author of the Principles of Geology published in 3 volumes (1830-1833). Lyell was born into a wealthy family, on 14th November 1797, at the family's estate house, Kinnordy House, near Kirriemuir in Forfarshire. The family seat is located in Strathmore, near the Highland Boundary Fault. Round the house, in the strath, is good farmland, but within a short distance to the north-west, on the other side of the fault, are the Grampian Mountains in the Highlands.

Although Scottish his family's second country home was in a completely different geological and ecological area: he spent much of his childhood at Bartley Lodge near Lyndhurst in the New Forest, Hampshire and this is where he spent much of his childhood. The property is now part of the New Forest Hotel chain and is currently being renovated using Werner's Nomenclature of Colours as inspiration. Charles Darwin used this to catalogue the flora and fauna on his voyages on the HMS Beagle starting on 27th December 1831.

Werner's Nomenclature of Colours is a taxonomic guide to the colours of the natural world, cherished by artists and scientists alike for more than two centuries. Each one of the 110 colours were later swatched by Scottish painter, Patrick Syme, most of them using the very minerals Werner described in the original guide.

Sources:

New Forest Collection hotel magazine 'Forest and Home', autumn 19/winter 20

Wikipedia

Cutting from the "i" newspaper 25-26 May 2019

Postscript

Fossil finder will finally be set in stone

Pascale Hughes

A statue of an overlooked 19th century working class woman whose fossil discoveries helped shape the theory of evolution will be erected in her hometown of Lyme Regis after an 11-year-old girl started a campaign. Evie Swire was dismayed when she discovered that her hero, Mary Anning was little known outside of the town, and there were no statues of her.

Evie began campaigning for a statue to be built and secured the backing of Sir David Attenborough. Sculptor Hazel Reeves, who created the statue of Emmeline Pankhurst erected in Manchester last year, has now been commissioned to make the seafront monument. The organisers of the campaign think it will take a year to raise the £175,000 required. Evie is the same age as Anning was in 1811 when she and her brother discovered a large skull beneath the cliffs near Lyme Regis, Dorset. Her brother thought it was a crocodile but Anning unearthed the 5.2 m skeleton of what turned out to be a colossal marine reptile.

"We need justice for Mary", Reeves told the BBC, "She really needs to be recognized as an amazing woman. People are beginning to understand that there were many women over history whose names haven't been in the history books - and Mary is one of them".

Evie said she thought Anning "would be very happy and pleased" if she knew she was finally getting a statue in her honour "seeing this project come to life makes me very happy because I didn't know that an 11-year-old girl could do something like this" she added.

Analysis by the Invisible Women campaign group estimates that public statues of men outnumber woman by 16 to one – a ratio that would be significantly worse if statues of Queen Victoria were discounted.

Ammonite, a feature film about Anning's life starring Kate Winslett and Saoirse Ronan, recently began filming in Lyme Regis.

Tony's day at Worthing College

Janet Penn

The Inaugural Conference of the Wealden Geological Assembly, organised by Tony Brook, took place at Worthing College on Saturday 30th November 2019. It was attended by 90 people. Mick and I did the meeting and greeting and were impressed to find that some came from as far afield as London, Kent, Surrey and even Derbyshire! They were all supplied with a much needed cup of coffee and an illustrated, glossy brochure giving details of the day, speakers and background information about their topic.

The first speaker was Will Richardson from the Hastings and District Geological Society, who spoke about the Extinction at the Eocene/Oligocene Transition at 34 Mya. These are, of course, subsections of the Tertiary. He introduced us to the "Grande Coupure" an extinction event which occurred as the result of drastic environmental and topographical changes, particularly in Antarctica. It is believed that shifting geographical and geological processes, including the plummeting of temperatures, as well as mountain-building along the North American continent, led to the formation of the Polar ice caps. Some animals and flora adapted to the new situation and others did not and became extinct.

We then had a talk by Alison Ure from the Open University Geological Society who spoke about impact craters. She had had her curiosity aroused by geological feature near her holiday home on the Greek/Turkish frontier near the town of Kas and between the Turkish coast and the Greek Island of Kastellorizo. Her quest was to establish if it was of volcanic or impact origin.

Firstly, she set the scene of impact geology. She said this is a relative new science. It was not until 1880, when a bowl shaped hole in the northern Arizona plains was found that interest in this phenomenon was aroused. Shepherds found what later proved to be meteoritic nickel-iron. It then started to be accepted that meteors from outer space could cause a crater. Daniel Barringer, in the early 20th Century, a mining engineer and self- taught geologist, proved this hypothesis was right.

The difficulties she encountered in proving that her area was an impact crater came about, partly due to the fact that part of the area was undersea and other rock formations had covered the zone. She had some help from professional geologists, but as there was no commercial interest finance was hard to find. Drilling rigs do not come cheap, so her investigations continue, but it is almost certain that she is right.

A break for coffee was then followed by the first of three lectures about dinosaurs. Susannah Maidment from the Department of Earth Sciences at the Natural History Museum in London spoke about Jurassic Dinosaurs of the Morrison Formation in Wyoming. Susannah, in her cowboy boots, was an excellent and entertaining speaker. She started by explaining that the Morrison formation is a suite of rocks that were deposited by rivers and by floodplains about 157 and 147 mya in what is now western North America. They were home to the most iconic dinosaurs, including Stegosaurus, Diplodocus, Allosaurus and Brontosaurus. Although dinosaur fossils have been found in this area for many years they are highly fragmented and there is little knowledge of the ecosystems and dinosaur palaeobiology of the time. In 2013 the Natural History Museum acquired its' first almost complete skeleton of Stegosaurus and this has supplied the answer to many questions, such as how many vertebrae in the back and the number of armour plates. Study of the specimen has revealed that it was sub adult when it died, was slow moving and its' bite force was similar to a sheep. At least twelve distinct species of sauropod inhabited the 1.2 million square kilometres of the Morrison floodplain and the question is how can an apparently semi-arid to seasonally wet environment be home to such diversity and volume of large herbivorous animals. There are two possible explanations for this. Firstly, the Morrison rocks are not contemporaneous across the outcrop area. Secondly, the fauna of the Morrison was geographically segregated. The rare Hesperosaurus is only found in the north and Stegosaurus is only found in the south.

The Morrison Formation provides an excellent fossil record for exploring the world of the Late Jurassic.

The second talk, after coffee, was entitled "Submarine slumps and slides, and associated hazards" and was presented by Aggeliki Georgiopoulou from the University of Brighton.

It is much harder to study undersea events than land ones, for obvious reasons. Research is expensive and is undertaken by pooling resources with other interested parties to hire ships capable of carrying out undersea research. The danger of a tsunami being generated leads to funds being more readily available than for purely academic research.

One factor in studying undersea landslides is to decide if there was one slide or a chain of events. One event can be far more damaging than a series of slides.

Multiple expeditions have been carried out to the Rockall Bank Slide Complex situated offshore from western Scotland. The conclusion is there have been three voluminous episodes of slope collapse, a fourth lesser event and other minor events. The oldest happened several hundreds of thousands years ago and the fourth 10ka ago. The most recent minor event occurred within the last millennium. This work is essential for hazard and risk analyses.

It is thought that the much publicised expected slope collapse due in the Canaries, which could cause a tsunami, which could reach the English Channel, will happen in a series of events rather than one cataclysmic one.

We then took a break for lunch with much to think about. Lunch was a good variety of fresh sandwiches, crisps and fruit, all included in the price.

After lunch we had the second and third talks about dinosaurs from Joe Bonsor and Tom Raven, both Ph. D. students from the Natural History Museum.

Joe Bonsor spoke about the early days of Wealden dinosaur

finds, mentioning in particular Gideon Mantell and his wife, Mary. These finds were not classified in the same meticulous way that modern finds are classified, leading to confusion and the need for new phylogeny that will lead to a clearer understanding of the evolution and palaeobiology of Wealden Iguanadon.

He introduced us to the word "holotype", which I see from my Collins Dictionary of Geology is the type specimen with which other specimens are compared, selected because it has the main features of the species.

Tom Raven spoke about ankylosaurs, the armoured dinosaurs (Ornithisca, Thyreophora) with particular reference to the Lower Cretaceous Wealden Group of Southern England. The same problem of classification has arisen as described by Joe Bonsor. The group included some of the most recognisable dinosaur such as Stegosaurus.

There are three named taxa and dozens of specimens known in the Wealden Group. Hylaeosaurus was one of the first to be used to define Dinosauria by Richard Owen in 1842 and was first described by Mantell in 1833. Polacanthus is known from multiple specimens found mainly on the Isle of Wight, although new specimens mean there is a possible overlap with Hylaeosaurus. Horshamosaurus comes from the Barremanian of Sussex. None of the specimens are complete and it has been difficult to construct a holotype. Recent research reveals that Hylaeosaurus and Polacanthus are valid taxa. Horshamosaurus is an indeterminate ankylosaur and there may well be a new undescribed ankylosaur from the Isle of Wight, meaning the diversity of Wealden Group ankylosaurs is greater than previously thought.

After a much needed cup of tea the day continued with two less challenging, but none the less, interesting talks. The first was by Mark Eller, from Mole Valley Geological Society and rounding off proceedings, our own Roger Cordiner.

In 2017 the Mole Valley Geological Society embarked upon a multi-year project to carry out a "Geoviticultural Tour of English Stratigraphy". The idea was to visit vineyards from the whole stratigraphic column and study their geology. They took samples of soil for further analysis. They also sampled the wine. So far they have worked their way through the Quaternary, Tertiary and Cretaceous and are now on the Late Cimmerian Unconformity at the base of the late Cretaceous. Soil sampling was made easier by the fact that the vineyards were regularly weeded. This made it possible to locate soil changes.

Their research revealed that the best wines were located on sunny slopes, that the soil was not so important, as additives could be applied, changing the composition of the soil. Statistics were produced to support their findings.

Further research will be carried out on the 176 vineyards in the Surrey, Sussex and Kent region.

Roger Cordiner has spent many of his retirement years looking at the building stones of Sussex, mainly churches. He has visited 316 medieval parish churches and found stones of varying type and quality, some reused and some exotic. He showed pictures of his findings, including sedimentary rocks with fossils in them, some sandstone and some limestone. Sussex marble from the Weald clay is packed with freshwater gastropod, Viviparus. Fossil burrowas are also found and echinoids and sponges can be found in flint. The Mixon stone is a foraminiferal limestone.

Iron minerals, such as siderite formed in swamps and on flood plains and calcite associated with calcareous sandstones. Glauconite, an iron silicate is common in greensand. Crystalline quartz and chalcedony occurs within flint geodes from the chalk.

This was an excellent day out and I do not hesitate to recommend attendance at Tony's next day out, which will be in Haywards Heath. It will take place on Saturday, 13th November 2021, in Clair Hall, Perrymount Road, Haywards Heath. This is definitely, a date for your diary.

The Fossil Hunt

Alan Bell

There is no sound of the horn at the start of this hunt. No horses hooves pounding on the gravel, no smell of fear sweat on the air.

The quarry lies perfectly still. It may have lain still for millennia but now it has made a break for freedom and possible destruction. There will be no faint movement to give it away no faint breathe on the air.

The hunt draws near, talking, footsteps on the sand. The quarry does not hear nor give itself away. There is a soft sound of waves breaking gently on the shore and the fingers of the tide groping towards the cliff only to fall short and retreat. Then again, but this time closer as the seventh wave comes in. The soporific sound shattered by the occasional scream of a black headed gull. Then the seventh wave washes across the hidden target, It moves fractionally but not enough to draw attention. It lies silently exposed on the shore but then an eagle eyed child spots what he thinks is a crushed bottle top. Still it holds it secrets. It is almost tossed to one side but there is something intriguing about it so it carefully placed in a plastic box.

The search continues for more such finds but the fingers of the sea are scratching menacingly at the base of the soft clay cliff and the rain that had always been threatening has now settled in. The hunters retreat to return another day there will always be more hunting here.

Now back home in front of a crackling fire, for the best hunts are usually in the winter when the weather is at it's worse. The hunters sort their prey. No blood, no fur, just a gentle wash and the dust of centuries past is removed. Now for the first time ever by a human eye the true beauty of the crushed bottle top can be revealed.

No longer a bottle top to be discarded once again, no longer an inanimate object but a key to a vanished world. Now we could see that this was a vertebra but from what? The reference books identified it as a vertebra from a Plesiosaur, a long extinct creature. How many times had this been hunted in the past?

The Shed Bench or Reputation

Wasn't sure what to call it

Alan Winter .... In The Shed,

Time: Corona Virus lock in day 41

Location: In the shed, cataloguing and trying to identify fossils found on previous fossil hunting field trips. Day dreaming. Sandalwood scent stick smoking away gently.

When I am collecting on my own or curating, my mind wanders, my school teachers said I was a day dreamer and had trouble concentrating. Sometimes what you think about is good, sometimes you can get a little melancholy.

The bike is out of the shed. Enough room to swivel the chair.... excellent.

I really do try to keep up with curating my collection, but I have to admit, it is not the most enjoyable bit of collecting. I have learned from other fossil enthusiasts, over the years, that if your collection is to mean anything, particularly from a scientific point of view, you have to record data about your finds. Where, when, etc. The thing about recording data is that, all the time you are around, you can tell people where you found something and the back-story that goes with the find. But when you are gone... so has the info, unless of course you have written it down. I have been honoured over the years, to have inherited some items from other collectors, some donated personally, some posthumously. Some have notes some do not.

Where is the tip-ex.

I have a mammoth tooth, I have no idea where it came from. It is such a shame. This unfortunately is only one of many items.

Anyway where was I? Ah yes shed.

I have had some complicated jobs over the years. Electrical conundrums. Work it out from the diagrams, get the test kit on it, lots of theory, lots of retro-engineering things so you can work out how they should work, so you have half a chance of figuring out how to fix them. Some days three, four, five jobs all coming my way at the same time. Lots of time pressures because we are "losing public service". Some because other people can't do their work while I am in the way and all these faults are waiting for me. It is the way it is and cannot be helped, but it does get you a bit of ribbing, like "when are you going to get on to the job so-an-so wants you to do, not that other job" etc. So the long and short of it is that you developed a reputation. A reputation for taking ages to get things done, they don't mean it in a nasty way, they very much know what side of their bread is buttered and they know that they definitely could do a lot worse. So there you are, "a reputation".

Hmmm.... maybe look it up in "Invertebrate Palaeontology" but which book?

Next item. Ah we are on to the next collection bag. It is not a sophisticated system. When something has been collected, it is invariably brought home in a plastic bag, a bit wet, covered in mud etc. A slip of paper is put in the bag with the date and location on it, then it will wait on the shed bench until I get round to studying it. This slip cross references with the notebooks I keep. In the fieldtrip notebook I write a short extract for each trip, after I get home usually, just stating where I have been and who I was with and any particularly notable finds or occurrences during the trip.

The item, after cleaning and maybe reducing the matrix, is marked with tip-ex so a number can be added to the specimen. This number is partly numerical and partly date so again this can be referenced back to the notebook. This information and all the other info collected or discovered whilst identifying is recorded in the specimen data list (catalogue). There is also a small card, with this information, placed with the specimen in a small bag and is then stored in the appropriate case/cabinet. An explanation sheet so anybody else can understand this is laminated and held in the front of all the folders and on the wall of the shed. The only other information I collate on another list is pit location and when and frequency of visits. That's it, hope that's clear.

Trilobite, river Onny, Shropshire.

Specimen data sheet. Number. Common name. Discovery date. Specific Name. Discovery location. Additional information.

Notebook. Location N 52°27'39.9" W 2°50'38.2"... Field adjacent to river Onny, it turned out we had hammered our tent pegs into the very stuff we were looking for. Field trips then were a very much "roughing it" kind of experience. We lived out of the boot of a Morris Marina which incidentally we had to fix when we got it up there, I don't think it had ever travelled so far on a motorway. The points had failed so we had to strip some bits out and replace them, luckily there was a Halfords down the road in Craven Arms.

Caradoc series Ordovician, or Wenlock series Silurian? A little confusion between my records of where we found these specimens in the river and some notes made by the chap from the Natural History museum, who identified the nearly whole trilobite for us. It looks as if this species may have been around throughout this timescale.

Scissors, cut out small card. Small bag.

Number 1039/9/91

Write out small card and fill in data sheet. Write number on tip-ex square on obscure side of specimen.

Rrrrriinngggggg.

Flippin' heck, nearly jumped out of my skin. Julie has just

rung shed bell which I recently fixed, (another corona lock down job), so dinner is ready I presume, time to wrap it up.

Shut window, turn lights off. Return bike into shed, lock door.

Hang on what was that date?

13 Sept 1991.... Saturday.

No. That means that this specimen has been sitting on my bench waiting for identification and cataloguing for about 28½ years. Cripes, that must have been sitting on the bench in the old shed (that went when this one was built).

28 ? ... I am only 54, that has sat on the bench more than half my life. Chuckling as I walked back in the house for dinner, I told my wife and son. Julie tutted and told me that I am always being told I take ages to get around to things, my son reminded me he was only 28.

Our new car-sized Moon

Betty Steel

The Earth has acquired a tiny new moon – but it isn't going to stick around for long. On February, astronomers in Arizona spotted a dim object moving across the sky. Over the next few days, further monitoring confirmed that it had been gravitationally bound to Earth for about three years. The object is between 1.9 and 3.5 metres across – about the size of a car – and is circling our planet in an oval shaped orbit that lasts 47days. Announcing the discovery, the Minor Planet Centre said "No link to a known artificial object has been found – implying that the object is probably an asteroid that was captured by Earth's gravity as it passed by. If so, it would be only the second "mini-moon" known to have been temporarily captured by our planet: the first was sighted in 2006, and escaped 15 months later. Owing to its unstable orbit, the new object is likely to be flung away from Earth in April.

The Week. 7 March 2020.

Possible Ancient River Cliffs in Findon Valley

Alex Vincent

Findon Valley is a major valley passing through the South Downs between Cissbury to the east and High Salvington to the west. An ancient river cut this valley, which has been dry for tens of thousands of years. The bottom of the valley is now used by the A24 main road and the area was built on in the 1930s.

Roger's Clump

The chalk hills on either side of the valley may once have been ancient river cliffs like those at the Arun, Adur and the Ouse. The hillside by The Gallops to the south of The Zig Zag Path is quite steep giving it the appearance of a river cliff. Looking at the valley from Roger's Clump, High Salvington near the TV mast shows how steep the hill is.

Liverpool Road

The ancient river probably went to the sea somewhere in Worthing. On the east side of Liverpool Road is a bit of raised ground, which may be part of these ancient river cliffs. The river cliffs would have been badly eroded between Offington and Worthing over the centuries. There could once have been an eastury to the south of Montague Street, the sea having been much further out thousands of years ago.

Palaeolithic folk probably utilsed this river and hunted in this area. There could be many artefacts such as hand axes, flint tools and remains of food debris in the area waiting to be discovered. Palaeolithic hand axes were found in Southdowniew Road, Broadwater and at the old aquerna site in the 1960s.

Geo-museum excursions with the Geologists' Association

David Bone

Now deferred to October 2021, as with so many group events, the Geologists' Association (GA) has been promoting an excursion to Madrid (Spain) and its geological museums. Thereby lies a long and interesting story. It all started many years ago, when I was Field Meetings Secretary for the GA in days when the role for both UK and overseas trips were managed by one person and the GA did not provide in-house office administration support. That's all changed these days – apparently, it's now supposed to be too much work for one person so there are two field meetings secretaries and office support.

Anyway, we had a trip organised to see the new geology gallery at Maidstone Museum, but it wasn't complete when the date of the trip approached. We deferred it a year, but then the exhibition contractors went into liquidation and the gallery still wasn't ready. The then curator, Dr Ed Jarzembowski (an international expert on fossil insects), offered yet another deferral or would we like to go to Brussels in Belgium to see the geology museum, behind the scenes and meet the staff that he was working with on a particular project at the time. So, a choice for 2000 – Maidstone (maybe still not complete) or Brussels?

It didn't take much deliberation to decide on Brussels and the trip organisation was underway. A weekend chosen in early December to take in the Christmas Market as well, advertising in the GA publications, group bookings arranged for hotel and Eurostar, confirmation of arrangements with the museum were all sorted. The result was an interesting and rewarding trip attended by 31 people (excluding the one person who forgot to turn up). Memorable events included seeing the superb display of Bernissart dinosaurs (Iguanodon) and meeting Queen Mathilde of Belgium (a coincidence, not specially arranged for us although something our daughter was able to talk about at school). Unanimously voted a successful formula for a weekend excursion, the group asked where next?

That was just the start of a series of excursions arranged principally by myself and my wife, Anne. Help has been provided along the way by Dr Roger Dixon (then living in Suffolk and an expert on the Red Crag) and Prof. Alan Lord (working at the Senckenberg Museum in Frankfurt and an expert on microfossils). Of course, we also rely on a lot of help by the local museum staff and their associates. Trips were initially every year, then every other year as they grew in complexity. The formula now features an October/November trip to a European museum with a geology collection of national importance, a welcome talk by the staff, seeing behind the scenes (e.g. collections in store, archives, conservation laboratories), a day out by coach to see some local geology with an expert guide, sometimes a city walk, but definitely a social event one evening. So, quite a varied content but one that reflects the geology and culture of the country.

So far, we have visited eleven cities and their geo-museums: Brussels (2000), Paris (2001), Leiden (2002), Dublin (2003), Belfast (2004), Frankfurt (2006), Berlin (2008), Copenhagen (2010), Vienna (2012), Lisbon (2014), Glasgow (2016). We now have an attendance of around 25 people, with about two-thirds being regulars. Several times we have said that this would be the last trip because of the amount of organisation involved but we have so far been persuaded to carry on. Every trip has been memorable in some way or other. My recollections fail me on some of the trips, but most are written up in the GA Magazine if anybody is interested.

In Paris, we saw the world's best collections of insects in amber. Leiden Museum had some wonderful modern displays including a storeroom packed with mammoth skulls and tusks dredged from the North Sea, but it was the Teyler Museum in Haarlem, almost unchanged since its establishment in 1778, that was really fascinating. In Frankfurt we saw wonderful specimens of *Archaeopteryx* from Solenhofen and the beautifully prepared and exhibited specimens from the Messel lake fauna of Eocene age. Our day trip by coach took us to Messel where we had the opportunity to search for fossils (mostly unsuccessful) as well as visiting a superb private fossil collection. My strongest memory of the Berlin museum is rows and rows of shelves with jars of natural history specimens stored in alcohol. We were told the story of how the Russian soldiers decanted off the alcohol from the specimen jars and sold it on the black market.

Figure 1. The exhibition area of the Museo Geominero, Madrid, viewed from one of the upper galleries.

In Copenhagen, our day trip took us out to the wintry shores of the Baltic Sea to see the K/T Boundary in the cliffs (somewhere I have a sample of this iridium-rich clay layer that was deposited at the time of the meteorite impact at the end of the Cretaceous). Vienna has some wonderful old museums which we visited in addition to the geology collections, and some good chocolate shops! Lisbon also has an old-fashioned museum with lots of superb specimens and we organised two city walking tours around the historic city. Our day trip took us out on the coastal geology with a local university guide, whilst our social event was a port tasting session.

Glasgow was a late-in-the-day replacement for Geneva which had to be cancelled due to building works. However, we fitted in several Glasgow museums, the geological stores and a site visit to see the remains of Carboniferous trees at the Fossil Grove in Victoria Park. Arranging the minibus hire to shuttle people around the city between venues at set times was challenging! Our day out was hosted by the Glasgow Geological Society and it turned out that it was the first time that the groups had a joint meeting for over a hundred years – opportunity for a small celebration. Our social evening was dinner followed by whiskey tasting accompanied by the resounding tones of bagpipes (Anne had a go but couldn't get enough puff).

For personal reasons, we had to miss a couple of years, but we are now back in the running with Madrid planned for October 2021. We have to start well in advance to make contact with the museums and ensure that we have the necessary local support. We have been to Madrid on reconnaissance, to inspect hotels and meet museum staff and get ideas for what we might include in the weekend. We found some excellent tapas bars, which we think will be the focus of the social evening – Roger Dixon is returning to Madrid to carry out further research on this! We have two museums on the programme; the Museo Geominero (Figure 1) and the National Museum of Natural History. The staff at both have responded well and it looks like it will be a good trip. The collections on display are certainly outstanding and comprehensive, whilst the scenic reconstructions in the National Museum of Natural History are stunning (Figure 2). Several participants take the opportunity of being in the city to extend their stay and take in some of the other museums and galleries. We visited a few, including the Prado, and can certainly recommend places to see in addition to the geology museums. Where we go on the day out by coach is yet to be planned but, again, the museums are helping to provide contacts.

So, if you're interested let me know. Obviously, GA members must be given some booking priority, but the trip is open to non-members as well. Details of the programme and cost will develop over the next few months.

Figure 2. An example of the many scenic reconstructions in the National Museum of Natural History, Madrid. Actual size, about 2 metres high.

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
COMMUNICATIONS	Alan Winter - Facebook page (contributions welcome)
Outcrop Design :	Martin Snow,

An Ode to Geologists

By Jean Corlett and based on a true experience

As I was going to Scarborough Fair
I met some geologists going there
You're going to the Fair, I asked?
No we're not - we have a different task

If not the Fair, then where do you go?
A very fair question I'll have you know
To look at rocks and such like things
At slumps and fossils, all quite amazing

These gradely folk set off at speed
With great big boots upon their feet
And heavy hammers in their hands
And empty sack upon their backs

Onto the beach I saw them go
Behind each other in one long row
With arms gesticulating, eyes to the ground
Some swopped to retrieve - what they have found!

Along they went with great intent
Quite worried I was at this event
As local knowledge I did know
That with tide a running at such a pace
The only way out was up the cliff face

Stupid lot to myself I thought,
Why should I worry about such things
To the Fair was where I was going
To enjoy the roundabouts and swings

The Fair was much about the same
As last year when I came,
All rather boring I must say.
But, as I wend my homeward way
There in front I espied
Those geologists cut off by the tide.

Hi there! Had a nice day I cried to this…
Straggly lot with not much speed.
With great big boots upon their feet,
And heavy hammers in their hands.
But sagging sacks upon their backs,
And in their eyes a glowing spark
Me thought, I'll have to try this geology lark!!!

Figure 2.
Rano Raraku, the ‘quarry’ in grey pyroclastic tuff for the moai statues.
Photo David Bone

Figure 4.
The crater of Rano Kau, Easter Island.
Photo David Bone

Figure 5.
Rhyolitic intrusions forming the islets of (from nearest to furthest) Moto Kao Kao, Moto Iti and Moto Nui, Easter Island.
Photo David Bone.