

| Halstead Lecture: Deep Carbon cycling over 200Ma | Pills & Politics; George Greenough and his geol map | Presidential Address;
Hydrocarbon is a Risky Business | Williamsons Tunnels | Deep carbon cycling through time: evaluating contributions from past
tectonic settings | Thorndon Country Park | Search for an Impact crater in Scotland | The secret life of Starfish | Geoconservation -
Dorset's Important Geological Sites group (DIGS) | Darwins Fossils | Geotrail along the Thames Path from the Barrier to Greenwich |
Building Stone Walk in the City | Excursion to the Yorkshire Coast |

MAGAZINE OF THE GEOLOGISTS' ASSOCIATION

Volume 19 No.1 March, 2020



Magazine of the
Geologists' Association
Volume 19, No. 1 March, 2020
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Editor: DR. LIAM GALLAGHER

The Geologists' Association

Founded in 1858 The Geologists' Association serves the interests of both professional and amateur geologists, as well as making geology available to a wider public. It is a national organisation based in London, but is represented by local and affiliated groups around the country. The GA holds monthly lecture meetings, publishes a journal and geological guides and organises field excursions both in the UK and abroad.

Subscriptions are renewed annually on November 1st.

You can join the GA on-line on our website:
www.geologistsassociation.org.uk/JoiningtheGA.html
admin@geologistsassociation.org.uk

By phone 020 7434 9298 or by post to Sarah Stafford,
Executive Secretary, The Geologists' Association, Burlington
House, Piccadilly, London W1J 0DU.

Research Award Deadline

15 November annually

awards@geologistsassociation.org.uk

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LAST Copy dates for the Circular & Magazine:

March Issue: January 20th June Issue: April 20th

September Issue: July 20th December Issue: October 20th

Items should be submitted as soon as possible and not targeted on these dates. We welcome contributions from Members and others.

gamagazine@geologistsassociation.org.uk

Curry Fund Dates for 2020

Application deadline	Committee date
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May 20th	June 10th
August 19th	September 9th
November 18th	December 9th

curryfund@geologistsassociation.org.uk

**Cover picture: Inside Williamson Tunnels; illustrating the depth and sheer vertical walls of the chambers.
By: Richard Wrigley**

I wish you all a belated Happy New Year for 2020.

The cover of the GA magazine from December 2019 delighted me in that it was so different, and yet reflected the keen eye the GA membership has for how we celebrate our geological heritage. The photo of the commemorative stained-glass window at Manchester University's Sackville buildings was an inspired choice.

In this edition of the GA Magazine there is a broad range of geological themes. There are abstracts for three very diverse monthly lectures, including the Halstead Lecture by Kevin Wong - *Deep Carbon cycling over past 200Ma*. Kevin's impressive talk was voted the best presentation at last years GA Student Symposium (GASS2019). Presentations of this calibre are an endorsement of the event, which I would encourage all GA members to support by attending. To register please go to <https://geologistsassociation.org.uk/gass/>.

Lesley Exton has provided two excellent reports on recent monthly lectures by Mike Simms (*Search for an Impact crater in Scotland*) and Aaron Hunter (*The secret life of Starfish*). If it is not possible for you to attend the GA monthly lectures then there is always the option for GA members to access the talks retrospectively via the GA website.

We also have two field trip reports, one from an excursion to the Yorkshire Coast and, another to Thorndon Country Park in Essex. Further articles include a Geoconservation piece by Alan Halliday on Dorset's Important Geological Sites group (DIGS) and, a book review of *Darwins Fossils* (authored by Adrian Lister) by Haydon & Lucas Bailey.

On to business matters. Like many societies and associations throughout the country there has been a steady decline of membership noticeably over the last 20 years. In order for the GA to respond coherently to this trend, there is a requirement for some hard data on how the Association has been performing to help formulate a plan. Much like the initiative at the turn of the century, the GA promoted the *The Way Forward* strategy which is detailed in *The Wyley History of the GA Association in 50 years (1958-2008)* Bob Symes & Dick Moody (1996-2000) and articulated by Jonathan Larwood in '*The Association*' (Geologists' Association Magazine Issue 4 Volume 2 2003). Not surprisingly much of what was stated then is relevant to our current challenges.

To address the issue a three-phase action plan was proposed to Council and approved. It is as follows:

Phase 1: Intern collated Membership data (August 2019).

Assimilated GA data from 2000 to 2019 on membership numbers, events – monthly lectures, field trips, conferences and publications. Over the last 4 months we have focused on the output of the work delivered by our Intern Rifky Wijanarko, which was presented to Council in December. Rifky is a third-year geoscience student from Imperial College, London and we really valued his contribution.

Phase 2: Workshop on 3rd January 2020 to address themes aimed at sustaining GA membership and attracting new GA membership. These included examining membership benefits, marketing the GA and events, focus on GA membership for students and early career individuals, and as a catch-all (legacies, grants, what are other societies doing?). I would like to thank Vanessa Banks, Rebecca Bell and Adrian

Champion for facilitating the syndicate groups at the workshop and providing such timely and detailed feedback.

Phase 3: This is where we are presently. The Workshop on 3rd January developed ideas for projects to increase membership of the GA. The next stage is to more accurately define the scope, timeline, resources, benefits, risks and success measures for each project in a paper for Council. When the project scope is further defined the Executive will review and hope to approve the projects including funding for delivery.

It is recognised some of the projects are more easily deliverable than others

One objective is to provide Council with continuity and a long-term picture on the strength of GA activities, as we do with Accounts, Risk Register and Safeguarding, etc. In line with other societies GA membership has declined from 2,098 in 2000 to 1,296 in 2019 this is in contrast to Rockwatch for example which moved from 1,033 in 2009 to 1,396 in 2019 which is heading in the right direction; but requires some thought to convert to long term GA membership.

The aim is to provide a report in the summer GA Magazine. The GA must listen to what the membership is saying and respond accordingly in a timely fashion. The Groups Meeting in the autumn provides that opportunity; but for those who cannot attend please feel free to contact the GA through the following e-mail admin@geologistsassociation.org.uk.

There has been much activity behind the scenes at the GA office preparing the Annual Report, Accounts, arranging field trips, and convening the GA Student Symposium (15th May 2020) and the Edinburgh GA Conference (16th-18th October 2020)



Figure 1: Edinburgh Castle; a highlight of the host city for the GA Annual Conference 2020

In early January Vanessa Banks and myself met with Robert Gatliff, President, Edinburgh Geological Society and BGS colleagues to discuss the GA Edinburgh Conference - *The Changing Face of Scotland's Geology*. The advert in this magazine illustrates how the planning is progressing for the event with on-line registration opening in April 2020. The weekend will start with an opportunity to have a guided tour of the Geoscience exhibits at the National Museum of Scotland. On Saturday 17th October, the GA Conference venue is The Surgeon's Hall, Edinburgh with an eclectic range of talks already scheduled.

On Sunday morning a selection of three parallel field trip options are planned - the Geology of Arthur's Seat, Edinburgh's seaside geology and a Building Stones walk in

Edinburgh.

For those contemplating travelling some distance to Edinburgh I would seriously consider travelling by rail given the location of the Conference Venue and the Sunday trips which are all in close proximity to Waverly Station.

Finally, as the days get longer and you start thinking of booking GA field trips, do not delay - they are filling up fast! Book now at <https://geologistsassociation.org.uk/ukfield>

REPORT FROM COUNCIL

By: Diana Clements

The big event for Council in the past 3 months was the workshop we held on 3 January with the objective of looking at ways to reach out to new potential members. It was nearly a full house and it was heartening to see the level of involvement. Many congratulations to the organisers.

The Executive has been looking into the structure of GA Council and Committees with a view to rationalising the number of post-holders to allow additional vacancies for new Council Members. This, too, is work in progress and will be reported on in the June issue of the GA Magazine, along with details of the new members of Council, post the May AGM.

The AGM will be held on Friday 1st May followed by the Presidential address. This will be Nick Pierpoint's final duty in his 2-year Presidency and it is anticipated that he will hand over to our Senior Vice President, Vanessa Banks, at the meeting. The AGM is always interesting as this is when we present the GA Prizes. The Agenda can be found on p.27. The Annual Report will be sent to members in mid April. If you would like a black and white paper copy please let Sarah know as soon as possible, otherwise we will send electronic copies to all those for whom we have email addresses. Please make sure that Sarah has your most recent email, and if you have not already done so, please complete the Confirmation of Details form with your wishes of how you would like the GA to communicate with you and return to the office. It can be downloaded from this link: <https://geologistsassociation.org.uk/about> and

sent electronically to the office. You will be sent the new password for the Members Page on the website in the letter accompanying the Annual Report. It will change on Friday 1st May 2020, AGM day. As in previous years, the Annual Dinner following the Proceedings will be held in the Lower Library of the Geological Society. The prize-winners are invited and there is always a buzz. We do hope you will consider joining us. Full details and how to book can be found with the Agenda on p.27.

We were delighted that Andy Gale's revised GA Guide to the Isle of Wight was out in time for the GA Festival of Geology in November and Andy came along to sign copies. It can be purchased at meetings, through the office or via the website. The reduced price for members is £9. There are still some 2020 calendars available at the knock-down price of £1, featuring geological images from photo competitions and including old photos from the GA archive.

Thank-you to David Ward who took the GA stand along to the Amateur Geological Society Mineral, Gem & Fossil Show in December. The GA likes to have a presence at such events so do please notify us well in advance of any outreach days you are organising. We can also advertise them as Special Events in the GA Circular.

Booking for the Madrid museums trip in October is open. Details are on the website. The trip to Turkey in April is now full. Details of overseas trips for 2021 are currently being planned.

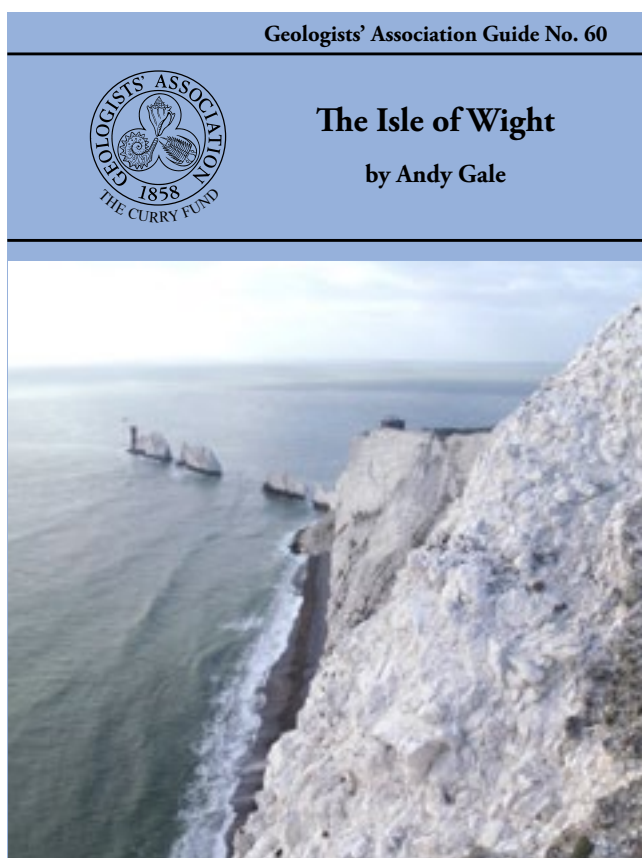


Figure 1: Front cover of the latest GA Guide; The Isle of Wight

Evening Lecture: Environments and Landscapes during the development of the Mid-Palaeocene Hebridean Igneous Province, NW Scotland: contributions from tectonic settings

March 6th, 2020

By: Dr. Ian T. Williamson, School of Earth and Environment, Leeds University

The mid-Palaeocene, roughly the period between 61 and 58 million years ago, saw extensive volcanism along the NW European continental margin, the NW Scottish sector forming the so-called Hebridean Igneous Province. This activity, related to continental rifting and mantle plume activity in the north Atlantic region, manifested surficially in the formation of fissure-fed lava fields, and both shield and composite-caldera volcanoes, and at deeper crustal levels, the emplacement of plutons (Central Intrusive Complexes), sill complexes and regional dyke swarms.

The lava sequences (Skye-Rum; Eigg; Mull-Morvern) are dominated by flows of basalt-intermediate composition with complex architectural styles and stratigraphical and facies relationships. The lava fields are however not wholly igneous in character as they also include an assortment of sedimentary formations demonstrating a range of the syn-volcanic sedimentary facies and depositional environments. Many were deposited during periods of regional quiescence, but some show evidence of interaction with active volcanism. Amelioration in environmental conditions during intervals of longer duration enabled localised biotic recolonisation of the lava fields. Integrating lithofacies analyses of both volcanic and sedimentary units with a limited fossil record allows partial reconstruction of an evolving mosaic of landscapes and palaeoenvironments, and to a limited extent, the palaeoecosystems of both hinterland areas and on the volcanic fields themselves.

Whilst the lava fields were generally of lowish, subdued relief, later volcanism at the main 'centres', manifested as major

volcanic edifices, and landforms more readily associated with composite-caldera volcanoes. These systems were characterized by the eruption of more evolved lithologies, widespread pyroclastic activity and eventual collapse and debris flow/avalanche; examples are seen on Rum, Eigg, Ardnamurchan, Mull and Arran.

Following a brief introduction to the Province, my talk intends to explore this diversity and what we know (surmise) about the environments, landscapes and life on these mid-Palaeocene volcanoes.



Figure 1: Sea stack of Sun Beag on the island of Sanday (off Canna) – basaltic lavas with interbedded sedimentary units; Isle of Rum in the background

We welcome the following new members to the Geologists' Association:

Elected December 2019 – March 2020

Michael Badley	Grace Belshaw	Kiran Chakravarti	Sophie Carter	Colin Cranfield
Paolo Custodie	James Dellar	Lia D'Heldt	Julie Dore	Amy Edgington
Adam Eskdale	Robert Gatliff	Craig Hallam	Anne Karin Holmefjord	
Andrew Hopkins	Gordon Hull	Richard Hubbard	Christopher Jackson	Max Jansen
Pam Jenni	Peter Loftus	Michelle McGrath	Jodie McNamara	Mike Millar
Steve Ross	Rebecca Schlegel	Graham Shields	David Stamp	Carol Tallon
Emma Watts	Ying Zhou.			

We welcome the following Local Groups/Affiliated Society's to the Geologists' Association

Geo-East naomi.stevenson@naturalengland.org.uk
Rotunda Geology Group TheSecretary@RotundaGeologyGroup.org

Deaths

During the past three months we have been made aware of the death of the following members:

Charles Holland

John Potter

Margaret Wenban

Please notify the office if you become aware of the death of a GA member. We are always open to receipt of short obituaries and/or a photograph - so if you would like to write one please get in touch.

OFFICERS

President:	Nicholas Pierpoint	president@geologistsassociation.org.uk
Senior Vice-President:	Dr Vanessa Banks	
Vice Presidents:	Dr Liam Gallagher (GA Magazine editor)	gamagazine@geologistsassociation.org.uk
	Dr Michael Oates (Meetings Secretary)	
Honorary Treasurer:	Dr Graham Williams	treasurer@geologistsassociation.org.uk
Honorary General Secretary:	Diana Clements	

POSTHOLDERS

Chair of Curry Fund & Awards Committee:	Dr Haydon Bailey
Education:	Alison Barraclough
Student Liason & Social Media:	Dr Rebecca Bell
Chair of Publications Committee:	Prof. David Bridgland
Chair of Rockwatch:	Susan Brown Rockwatch@geologistsassociation.org.uk
Council Minutes Secretary:	Dr Sandy Colville-Stewart
UK Field Meetings Secretary:	Graham Hickman fieldmeetings@geologistsassociation.org.uk
Curry Fund Secretary & Archivist	Dr Jonathan Larwood curryfund@geologistsassociation.org.uk
Librarian:	Sara Osman
Awards Panel Secretary	Dr Lucia Perez Diaz awards@geologistsassociation.org.uk
Chair of Geoconservation:	Dr Colin Prosser
Overseas Field Meetings Secretary:	Dr Ian Sutton
Co-opted: Guides Editor:	Prof. Susan Marriott
NON-COUNCIL POSTHOLDERS	
Proceedings Editor-in-Chief:	Prof. Malcolm Hart
Executive Secretary:	Sarah Stafford admin@geologistsassociation.org.uk

ORDINARY MEMBERS OF COUNCIL

Adrian Champion (Governance), Prof John Cosgrove (Secretary to Publications committee), Nikki Edwards (Geolab), David Ward (SchoolRocks!). John Cosgrove and Nikki Edwards will automatically come off Council at the AGM **making four possible vacancies to fill**. In May Liam Gallagher retires from the post of Vice President but remains as a Post-holder. Nick Pierpoint steps down as President and becomes Senior Vice President, while the current SVP, Dr Vanessa Banks becomes President.

CO-OPTED MEMBERS OF COUNCIL

John Cooper (co-opted Facebook), Dr Peter Jones (2019 conference), Gerald Lucy (Photo competition, calendar & fliers), Dr Thomas Phillips (Student representative), Richard Trounson (legal)

Evening Lecture: "Pills and Politics"; a new look at George Bellas Greenough and his Geological Map of 1820

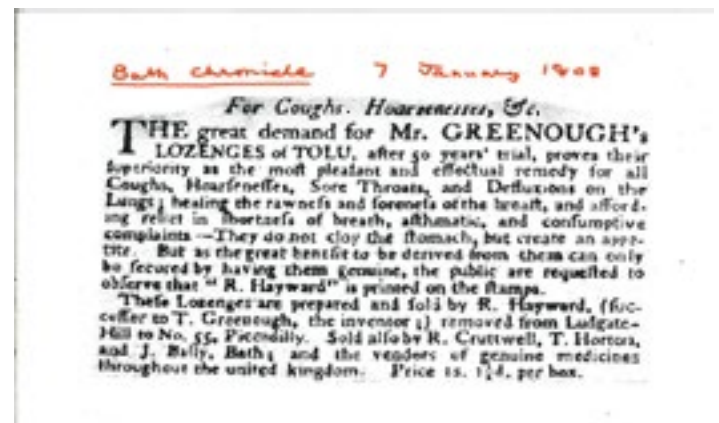
April 3rd, 2020

By: Prof Hugh Torrens, School of Geography, Geology and the Environment, Keele University

George Bellas Greenough (GBG) is a difficult subject, as he published little, and has never received basic biographical study, probably due to the complex history of his own archive after 1907, when it left London for County Cork. There, due to terrible incidents with one of his relatives during the 1916 Easter Rising, their family's three Irish houses were subjected to repeated burnings in the Irish War of Independence, which followed. The great majority of his archive was however saved, and by 1922 had been split between two cousins in Layer-de-la-Haye in Essex where time and rats took their tolls. By 1992 both had reached University College, London, where the second part remains uncatalogued.

The lecture will attempt to explain this; GBG's origins and how his inherited wealth from quack remedies had become worth around today's £20m, by the time he died in Naples in 1855. He studied abroad and became an inveterate traveller, then used his wealth to become an MP in early 1807 for the notoriously rotten borough of Gatton, near Reigate. That same year GBG helped found the Geological Society of London (GSL), but remained adamant that fossils could not identify strata. This brought friction between him and William Smith, and resulted in the Society's rival Geological Map of England and Wales, which then prevented any extensive sale

of Smith's. This mapping was organised by GBG, and helped by a significant GSL group, including Buckland, Aikin and two Conybeares (but who all used fossils in their identifications of strata). In addition Smith's pioneering Orders of Strata from 1797 became the basis for the GSL's new Orderings, through Buckland who had printed eight different, but sadly ephemeral, Stratigraphical Charts between 1814 and 1819, before the GSL's map was ready in May 1820. After 1820 the GSL became fractious and politicised, leaving GBG's real legacy hard to discern.



Presidential Address: Exploring for Hydrocarbons - a Risky Business (Pt 2)

May 1st, 2020

By: Nicholas Pierpoint

The theme of last year's Presidents' address considered the risks involved in drilling for hydrocarbon. The focus was mainly on geological risks in particular pore pressure, although there was brief mention of some commercial and political risk.

Equipped with an understanding of subsurface risk this presentation will focus on a case-study of a well control incident which occurred in the Nile Delta (2004). The prospect to be drilled was well constrained by offset well

data. The potential geohazards, whether identified on seismic or encountered in offset correlation wells were assessed and mitigated against in the well design. In doing so, this should enable the well objectives to be achieved in a safe manner, and hopefully within budget. A reminder - the risk is whether or not there is over pressure - the uncertainty is the degree of over pressure.

The 'black box' data from the rigsite revealed drilling practices prior to the event, which reflected decisions based on a particular interpretation of the parameters. This case study is used to illustrate how vital it is to fully assess accurately geological data near real-time. Following a post well investigation of data recovered from the rigsite it was possible to understand what occurred and why.

Lessons from this incident have been shared across the industry. A critical link is communicating geological uncertainties to the rigsite team in a clear and timely manner. Indeed, real time data feeds from rigsite to office locations facilitate an extra level of surveillance - which has to be good. A drilling rig located over 100 km offshore and drilling in waters depths in excess of 300m can feel a remote and potentially a vulnerable place if things do not go to plan.





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Dr Danny Clark-Lowes is a geologist, educated at Cambridge and London universities, who has given industry training courses on geology at locations throughout the world, as well as publishing scientific papers and books. He is also a mountaineer who has climbed in the Swiss Alps and in the Himalaya. He will lead this tour to Nepal which will look at aspects of the geology and geography of the spectacular Himalaya, and will help participants achieve an understanding of how mountain belts and their associated rock types are created through plate movements.

For a detailed day to day itinerary and booking form please visit:

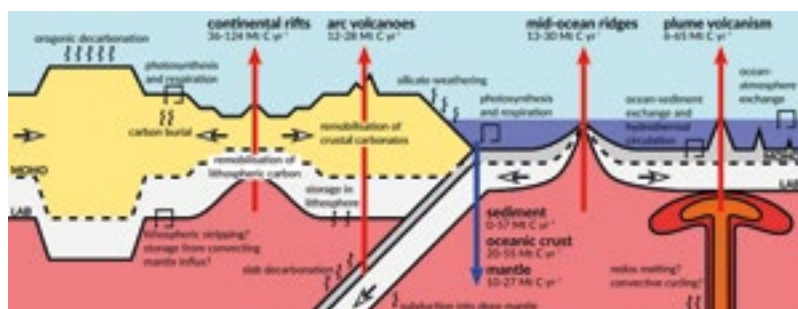
www.indus experiences.co.uk/special-interest

Go to the 'Special Interest' tab and click on 'EarthSciences'

Call 020 8901 7320 or email: holidays@indus experiences.co.uk

We are currently looking to work with Geology trip leaders to create memorable field trips. Please contact us for further details

By: Kevin Wong, University of Leeds



Carbon is a key control on the surface chemistry and climate of Earth. Significant volumes of carbon are input to the oceans and atmosphere from deep Earth as volcanic carbon dioxide (CO₂) and are returned to large carbon reservoirs in the mantle during subduction. Tectonic settings (e.g. arcs, mid-ocean ridges, and continental rifts) are known to emit dramatically different, temporally and spatially variable fluxes of carbon, and represent a first-order influence on carbon outgassing from the deep Earth. The relative abundance of different tectonic settings throughout Earth's history therefore plays a vital role in maintaining the deep carbon cycle on geological timescales. Over the past ten years the Deep Carbon Observatory has made enormous progress in

constraining estimates of volcanic carbon outgassing flux at different tectonic settings. In this talk, I provide an overview of these recent developments to estimate carbon inputs and outputs at present-day plate boundaries. Using this understanding of present-day carbon fluxes in tandem with tectonic plate reconstruction models, I demonstrate how we can estimate carbon fluxes from different tectonic settings through the past 200 million years given what we know at the present day, and highlight some of the key controls that affect the input and output of carbon to Earth's surface. This synthesis summarises our current understanding of fluxes at tectonic settings and their influence on atmospheric CO₂, and provides a framework for future research into past deep carbon cycling.

One highlight of this study is the potential for immense volcanic CO₂ degassing at continental rifts; however, compared to other tectonic settings, the magmatic character of continental rifts remains enigmatic, and so too are the processes that control the release of carbon from continental rifts. In the second part of my talk I present some of my PhD work (and lots of fieldwork photos!) on the volcanically active Ethiopian sector of the East African Rift, the longest active present-day continental rift system on Earth.

2019 GA Conference Field meeting Report: The Williamson Tunnels

Leader: Phillip Firth, Liverpool Geological Society

By: Richard Wrigley

Liverpool Geological Association organised a field trip to the Williamson Tunnels as part of the 2019 GA Annual Conference. The Williamson Tunnels are a labyrinth of underground chambers quarried beneath the Edge Hill district of Liverpool. The project is run by Friends of Williamson's Tunnels, a registered charity dedicated to the preservation and exploration of the Williamson Tunnels and to increasing knowledge of Joseph Williamson's works.

We were met by an enthusiastic group of volunteers who gave us an introduction to the project before leading the groups on an informative guided tour of the tunnel sites.

The City of Liverpool is located on the SE margin of the East Irish Sea Basin. Triassic Sherwood Sandstone Group outcrop is controlled by a series of N-S trending faults that form a several ridges of which Edge Hill is one.

The underground chambers were cut into sandstones and mudstones of the Chester Formation, the lower part of the Sherwood Sandstone Group, deposited in an arid environment with ephemeral rivers on braided alluvial plains and playa mudflats. In the Edge Hill area the Chester

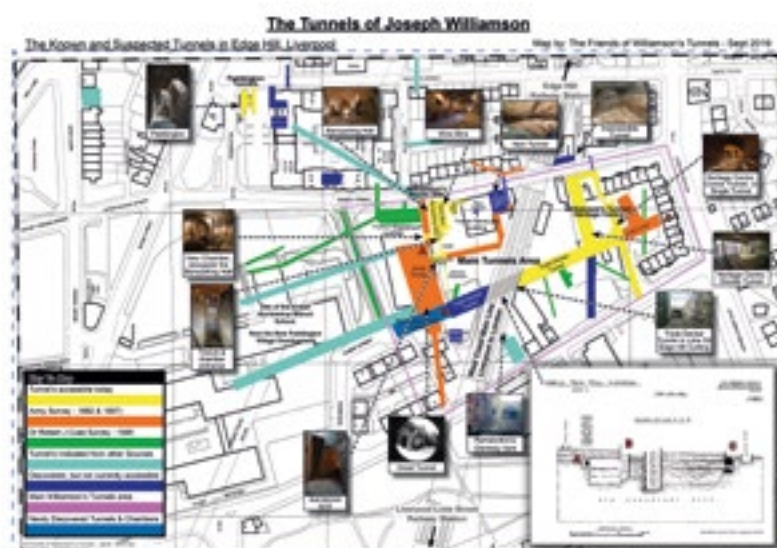


Figure 1: Joseph Williamson's Tunnels – The known & suspected tunnels in Edge Hill (September 2019)

<https://williamsonstunnels.com/the-tunnels/map/>

Formation (formerly known as the Chester Pebble Bed Formation) comprises fine grained red-brown sandstone with sporadic mudstone interbeds.

Regionally the formation shows a progressive change in lithology northwards, from a coarse-grained, typically well

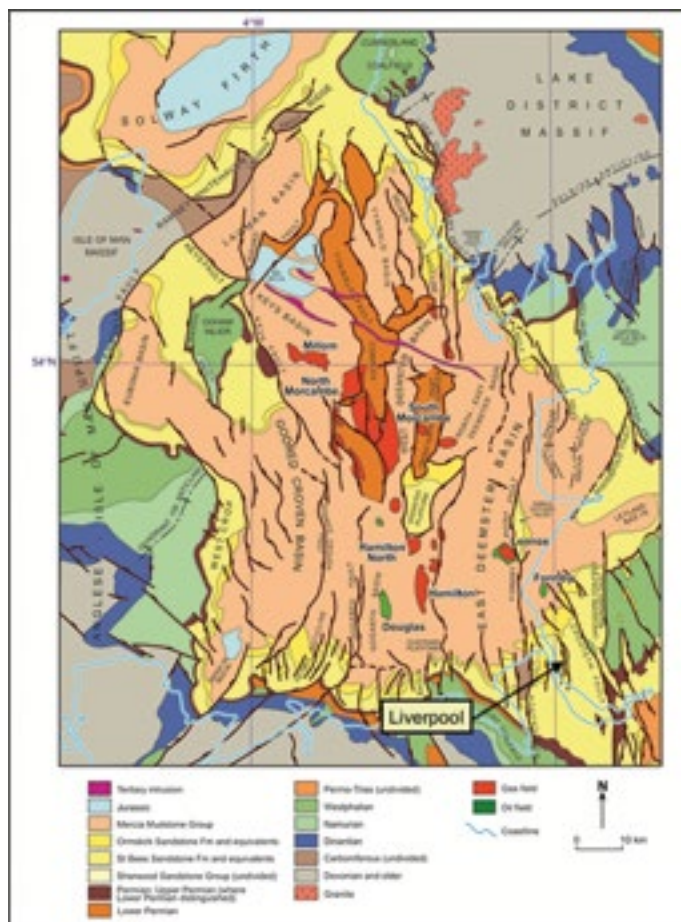


Figure 2: Geological map of the East Irish Sea Basin, N-S fault pattern

-cemented proximal facies in Devon to a fine-grained, less well-cemented distal facies in Cumbria. Gravel beds seen in basins to the south become rare northwards within no evidence of pebbles or gravel recorded in Edge Hill. The vertical quarried faces in the chambers provide good exposure of stacked fluvial channel geometries with occasional thin mudstone beds that form permeability barriers to groundwater flow.

The chambers were excavated in the early 1800s under the control of Joseph Williamson, a wealthy retired tobacco merchant. The purpose of their construction is a topic of debate. Theories range from pure philanthropy; offering work to the unemployed of the district, to religious extremism; the tunnels being an underground haven from a predicted Armageddon. Williamson extracted high quality sandstone from the chambers for use in buildings around Liverpool.

The slot quarry chambers are unusual as they extend vertically rather than laterally as in conventional quarries. The chambers vary in size; the so-called 'banqueting hall' is about 29 metres long, 4 metres wide and over 8 metres high. There are also tunnels which are little over 1 metre wide and less than 2 metres high.

During excavation sandstone pillars were left in-situ onto which brick columns were built to support the arched brick roofs that enclose the chambers. Once the chambers were enclosed with brick arch roofs the reclaimed land was built over.

Sandstone pillars form the base of brick



Figure 3: Sandstone pillars form the base of brick supports and roof arches. Floor of chamber formed of impermeable mudstone

supports and roof arches. Floor of chamber formed of impermeable mudstone.

Although some of the tunnels have been lost over the years, many still exist under what is now a residential area. New sections of the complex are being cleared and renovated by the volunteers before being opened to the public. Several parts of the complex remain closed with many suspected tunnels yet to be rediscovered.

Further details of the Williamson Tunnels Project can be found on their website: <https://williamsontunnels.com>



Figure 4: Photograph showing fluvial channel sandstones with a mudstone interval forming a permeability barrier.

Following two days of indoor activities at the Local Groups meeting and the Festival of Geology, the field excursions on Sunday provided a welcome opportunity to get some fresh air. The wind and rain from the tail end of the tropical storm "Peblo" had blown through and on a bright dry autumn morning our rendezvous was at the central car park in Thorndon Country Park which sits just south of Brentwood in Essex, approximately 2 o'clock around the M25.

Our trip leaders were Ros and Ian Mercer, and Peter Allen from the Essex Rock and Mineral Society (ERMS). They provided an overview of the county geology in front of their impressive poster and of the parkland associated with Thorndon Hall; a distinguished Palladian style country house, once owned by the Petre family who were unable to maintain the estate after WW 1. They sold much of the estate from which a Country Park and golf course have been developed.

The local Groups ERMS and GeoEssex have worked together devising an instructive guided trail within the Country Park, which, incidentally, has ample pay and display parking and a very popular café.

The landscape reflects the environment 450,000 years ago during the Anglian Glaciation when most of the UK was under a considerable ice sheet with the southern limits just north of Brentwood. This was an environment in which fluvial and freeze thaw processes dominated.

The gently rolling topography slopes to the south and south east towards the present-day valley of the Thames and, with a keen eye, it is possible to make out subtle breaks in slope which reflect changes in lithology. On the slightly elevated banks the flints have been smoothed by many cycles of erosion and occasionally it is possible to spot others subject to frost



Figure 1: Essex Rocks poster

action (freeze thaw cycles) which have created pot and pot lids, with frozen water within the flint 'popping' the pebble apart.

The small streams are misfits, as the incised valleys were created during a period of higher water flow. At one location on the trail it is possible to see the interface between London Clay with the overlying sandy-clay of the Claygate Beds where a small stream has exploited the contact. The different units are on opposing stream banks at the same level. This is attributed to the softer London Clay behaving in a mobile fashion pushing up into the Claygate beds forming a convoluted interface between the two lithologies.

Towards the end of the trail we encounter a six-foot-high section aptly named the 'Pebble Wall'. This is a former gravel pit worked commercially until the 1930's. This section reveals a history of wind-blown deposits (Loess), contorted units from a perma-frost environment, mudflow deposits with a mix of Claygate Beds and flint pebbles from glacial meltwater and at the base of the section, gravels and sands which represent an environment close to the ice limit. About 450,000 years ago spreading out from North Wales and Scotland during the Anglian Glacial stage, the ice front spread southwards blocking the original course and diverting the flow of the

Thames towards its present setting. The environment would have been devoid of vegetation and looked very much like the fluvial glacial outwash plains (sandurs) in present day Iceland. The huge braided rivers from the north west deposited coarse material of pebbles (with a well-defined imbricated fabric) mainly flint but occasional exotic fragments from Yorkshire (*Rhaxella* chert) and vein quartz. An informative leaflet has been produced called 'The Pebble Walk'; well worth following if you happen to be in this area.



Figure 2: The group at the Pebble Wall



Figure 3: Peter Allen describing the pebble distribution

By: Dr Mike Simms, National Museums Northern Ireland

The speaker was delighted to be here as it was 40 years ago this month that he joined the GA as a school-boy.

North-west Scotland is the home to some of the oldest rocks in Britain. Some are well preserved others are a little mangled, but how can we understand what has been going on?

The present is the key to the past. If we look at structures in these ancient rocks we will find similar things in modern day sediments. As a whole when you look at the 1,200 MY old Stoer Group sandstones most of them were quite clearly deposited in rivers, probably braided river systems. However, the important thing to remember is at this point in time there was no vegetation, so rivers would have behaved slightly differently to today. Within these layers of sandstone there is the Stac Fada Member, a mix of melted rock, muddy sand and rock fragments. So something has melted the rock and mixed it in with sand and mud. It is between 4-10m thick and when it was deposited it was very hot. The melted bits of rock were deposited on damp river plains which generated steam which has worked its way up creating steam escape pipes which are lined with feldspar. It is possible to get a temperature of when the feldspar was deposited, this is over 200 degrees C. Also, when you go to certain locations e.g. Enard Bay there are lots of pea-like structures very like the accretionary lapilli which you get in some volcanic ash-fall deposits.

So, there is a lot of evidence of molten rock mixed in with mud and sand and then you have accretionary lapilli: the obvious thing is it's going to be something like a volcanic mudflow, a lahar. For decades this is what it was interpreted as, but there was something that puzzled people. There is this deposit that you can trace along the coast for 30 miles north to south and then it's cut off by faults at both ends, but where were the other volcanic deposits you'd expect? It must have been a big eruption, but there is almost nothing else (recently someone has found an ash layer a couple of cm thick in the Stoer Group) in the area. Then postgraduate student Ken Amor from Oxford came along on a student field-trip. He had been to a meteor impact crater in Germany where there is a deposit that contains melted material that was melted by the impact of a giant meteorite. He thought the rocks here looked similar, so he took some pieces back, thin sectioned them, looked down the microscope and found shocked quartz. You only get shocked quartz from giant meteorite strikes: it is the only thing that can generate enough pressure.

What is so special about giant meteorites? They hit the earth at 15-20km/sec and the energy on impact is calculated by $\frac{1}{2}mv^2$. It is the velocity that does the damage. You get pressures far greater than can be generated on the earth's surface and temperatures of 5,000-10,000 degrees C. These are ultra-extreme events, which have never been witnessed and are poorly understood. You can use computer modelling,



firing ball-bearings through high-powered guns, but they only get to about a third of the velocity that the meteorites would be going. The general understanding of what happens, is with the initial contact, the impactor is vapourised and shock waves go down into the ground, then ejecta is thrown out and the crater gets deeper and deeper, all sorts of things are flung out and the rocks underneath are fractured. All this happens within a minute or two, this is instant geology.

There are loads of impact craters on Mars and the Moon, but the Earth has barely 180. This because the Earth is a dynamic planet, so the impact craters get buried, eroded away or the meteorite hits the sea and disintegrates forming a crater in the ocean not on the seabed. All the known big ones are millions of years old, so they are a bit battered and worn. None have been found in the UK, until now. The best example is the Nördlinger Ries crater, Bavaria, which is 24 km across and 14.4 MY old. It was made by a 1km meteorite.

In June 2011 an amateur geologist friend of the speaker, Geoff Steel organized a trip for them to visit the area of the impact in Scotland. They visited four sites, the second coast site had a Stac Feta impact deposit with the sandstones underneath. Scattered all across the surface were huge angular boulders embedded in the sandstone, these were bits of stuff that had been flung out in the first moments of the impact at 4-5 km/sec. This type of deposit can be seen on Mars and at the Ries crater, there rock fragments have been found up to 200 km from the impact. The speaker returned to Scotland in September and found more impact-launched blocks at different sites; some had been shattered, but the bits had not been moved. At Stoer they also found deformed sandstone rafts within the impact deposit, some of which had been folded up like a swiss-roll.

But where is the crater? A giant meteorite impact leaves a crater surrounded by debris. But here there is not a complete ejecta deposit, erosion and tectonics have removed all but a thin sliver of the impact deposit and there is no sign of a crater. What is left is homogenous and there are not many direction indicators. The key one is that in places some of the impact deposit has been forced between the sandstone layers beneath, so the impact deposit was moving east to west. Other things that can be used aren't so clear cut. At Static Point shear planes indicate a viscous flow, slickensides there indicate east-west movement. When you look on top of this deposit you find Ogives (curved fractures that are convex in the direction of movement) which also indicate viscous flow from east to west. At a third site, Enard Bay on top of the impact deposit you have troughs that plunge gently westwards which again indicates movement east to west.

So where was the impact? Is the crater nearby? No, as the impact deposit here isn't thick enough and you would expect

the layers underneath to be horribly contorted or completely mangled and they aren't. So, the crater must be some distance away. If it is coming from the east this raises the possibility that it could be on-shore, but there is a problem, the Moine Thrust. The Moine Schist, which is younger than the impact, was pushed west across Scotland 430 MY ago. If there is a crater to the east it will be hidden beneath the Moine Thrust. But all is not lost, there are ways of detecting impact craters. Gravity anomalies can be used to find a buried crater. Using BGS survey data and looking for a gravity low there is one vaguely circular at Lairg. This is an anomaly as there isn't an obvious explanation for it, is this the remnant of a buried impact crater? This was written up and published in the PGA. The speaker then got chatting to Tori Herridge at a conference and she thought it would make a good programme. So she put a project together 'Walking through time: Scotland's lost asteroid' which was broadcast in September 2016 on Channel 4. This made a difference for Lairg, and the speaker got involved with the local community there to put on an exhibition and worked with a local artist and primary school to produce some boards.

However, the plot thickens. Not all craters are the same. Simple craters are always less than 5 km, complex craters with a central peak are 5-25 km and peak ring craters are >25 km. This creates a problem as the Lairg gravity low looks like a simple crater, no central peak, no inner ring, but it is much too big at over 40 km across. The important thing to remember for peak ring craters is that the diameter of the peak ring is always half the diameter of the crater. The gravity data was then reanalysed by Professor Kord Ernstson, University of Würzburg, which gave a much more detailed interpretation. The cross-sections across the gravity anomaly now suggests a peak ring 50 km across, which implies that the crater was 100 km across. This puts it in the top six in the world, however

there is a problem with that.

A 100 km crater would overlap part of the Skoer Group outcrop. So the impact deposit should be hundreds of metres thick and deformed. But it isn't, so it can't have been that close to the impact. Maybe it was formed further away and moved into position, but how? Anywhere else in the UK that would not work, however, we know the Moine Thrust has moved deposits west so why not a crater through crustal shortening? As continents collide, which happened in north-west Scotland 430 MY ago, rock layers slide over others by thrust tectonics, so things that were once far away can be moved closer.

There are two different types of thrust fault: thin skinned tectonics where the thrust planes remain relatively shallow (like a carpet sliding across floorboards) and thick skinned tectonics where the thrust planes extend deeper into the crust (both carpet and floorboards move). A lot has been written about the Moine Thrust in the last 100 years and there isn't a consensus. The most recent model is that Moine Thrust is thin skinned in the west, where you can see it in outcrop and is assumed to be similar further east, but is it? You don't have to go very far back to find alternative models, Coward (1982), which do suggest the Moine Thrust went quite deep quite quickly. So, the crater could have slid further west.

In summary what the speaker is suggesting is that there is a deeply eroded impact crater that has been moved westwards along a deep thrust fault and is concealed by younger rocks moved westwards along the Moine Thrust. But the only way of proving it one way or the other is to stick a borehole down.

By Lesley Exton

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By: Dr Aaron Hunter, University of Cambridge

It was a great privilege for the speaker to finally to be presenting to the GA as he has been a proud member for a long time. He was very happy to be standing in front of us to explain the research on starfish that he has done over the past 10 years or more. Starfish are a special animal because they have been with us for a long time, 480 MY and we would recognize them if we went back in time-machine. You could say starfish was one of the first modern animals to appear in the fossil record.

The conundrum he set about to solve was how did starfish evolve? What makes them special? What makes them almost alien, because we look for aliens in outer space, but we have some very interesting looking invertebrates on our own planet. Starfish are a key animal that inhabit the reefs, in fact if an alien spaceship did visit us and surveyed the marine realm, they would conclude that starfish are one of the major life forms on Earth. They inhabit a huge area of the deep oceans, reefs, lagoons and are a very versatile organism.

Asterozoa is the blanket term, the scientific term for starfish or sea stars, the Asteroids and also their cousins the Ophiuroids, which are rather like a disc with a series of arms coming out. They are family. We are part of a special group of organisms, the Deuterostomes, which means something that has a head and an anus and so are the Asterozoans. This means they are as complex as we are, they have organs, a blood system, a type of brain --> a nervous ring on the inside. Then they turned on their side and grew into this strange shape: this is what makes Echinoderms look alien. The name means 'spiny skinned', although most don't have this. They are more typified by five-fold or pentaradial symmetry. But what make them very strange is having an internal stereom skeleton. A calcite skeleton, but with living tissue both within and over the top of the calcite plates, so a full body armour. It tends to follow a single crystallographic orientation, and grows in a kind of a mesh, held together by a series of ligaments, so they have an extremely annoying fossil record as they tend to fall apart.

Echinoderms don't have a series of limbs, what they do is move around using things called tube feet. These come out through the skin. The group has enormous diversity, and this has come about by how they have grown. Another animal the speaker works on is the sea lily or crinoid and this is pretty much a starfish on a stick. What they have is the ossicles of the stem with a holdfast underneath. To turn this into a starfish what you do is flip it upside down. Then have a groove where all the tube feet are lined up and a central mouth where most of the prey is sucked in. Most Echinoderms are carnivorous, as are Asterozoans. To eat, starfish lift their stomach out and suck.

But what make Echinoderms really special is their water



vascular system. We have an enclosed circulatory system, blood, which works best if kept within our body, preferably under pressure. Echinoderms keep pressure with the rest of the sea water, so it is in equilibrium with sea water and they use sea water to take their nutrients around their body. They can survive in various salinities, however, if they find themselves in fresh water they hibernate until the salinity increases.

So far, the talk has looked at the general groups that are alive today in our oceans. This is the modern-day story through work that has been done using genetics. In fact, the genome of the starfish is currently being sequenced. So, we have the genetics and know roughly the relationships between them: although there are two rival hypotheses. However, this talk is not really concerned with these recent animals, so we then went back in time to look at the ancient Palaeozoic ones (>400 MY). The only problem is it's an absolute mess, because there are not just the groups already mentioned, there are loads of Echinoderms. In fact, you have all sorts of very weird things, Stylophorans, Ophiocistoids and Eocrinoids. These lived alongside the groups we recognize today.

There are two interesting periods of time, the Cambrian period when there was an explosion of diversity of life with all sorts of unusual looking Echinoderms that don't have five-fold symmetry e.g. a stalk with a helical coil going through. These are the kind of things that are the ancestors of starfish. There is a hypothesis about how pentaradial symmetry involved: a long worm-like animal turning on its side and then being pinched out five ways, but not everyone agrees with it. But not all starfish are pentaradial, there are some that have twelve or nine arms and symmetry can change in a generation. So, there is something in the body-plan than can deviate from the norm.

The story starts with Edrioasteroids, which is dome shaped with tube feet. A simple basic Echinoderm with the appearance of a pentaradial body plan. But then they start to change due to competition. Blastozoa and their relatives, grew a stem, feeding appendages and things called brachioles in order to catch food, as they were all filter feeders. Then they go crazy and develop much more complex arms, so start looking more crinoid-like.

How does this lead to the Asterozoans? Have to get from the complex Cambrian forms to the more basic forms we know today. The main problem in the fossil record is that there are more types and two rival hypotheses. One thinks Ophiuroideans, Echinoids and Holothuroideans are part of one group and Asteroids are on the outside, the other says Ophiuroideans and Asteroids are sister groups as are the Echinoids and Holothuroideans and the Crinoids are on the outside. However, when people have tried to create a

family tree it has become really confusing. Which characteristic came first? Because we don't know what the most primitive characteristic they developed is and what the most derived one is. Also, not only are there Asteroids and Ophiuroids there are also Somasteroids and Stenasteroids. To make it easier for us the speaker had colour-coded the four groups to show us how the skeleton had evolved.

Modern Asteroids have marginals, thick side plates and the ambulacral groove on the underside of the animal where tube feet stick up. You can see the same with the Ophiuroids. But in the past the other groups had extra plates in-between. The speaker then looked at how these reduced down and formed the body plan we have today. Using embryology and the extraxial theory (EAT) researchers came up with a road plan: so, by separating out and coding the different parts of the body then putting them back together they could work out which character came first and which last. They then labelled up all the different parts of the different echinoderms, so now knew what an arm is in each one. The two parts of the skeleton could then be divided up and they could work out how they grew.

They grow away from a terminal plate, so the growth is from the tip of its arm towards its mouth. So, the order of development is now known. The ambulacra is the oldest part, the struts or virgals came next and finally the adambulacra either side. So how do you turn a Somasteroid, the most primitive form into something less primitive? You shorten the virgals until they disappear and that creates the Stenasteroids, continue and you get an Ophiuroid, add more plates and you get an Asteroid. Just need to find the fossil evidence.

In Morocco there are two excellent fossil beds, the Fezouata biota is famous for its Arthropods, but the fossil the speaker was interested in from these beds was a 'bat star'. It has spokes and then has a skin which stretches over them rather like a bat's wing. This is the earliest Asterozoan, and the grandparent of all four groups, because it lacks everything. It is missing the top surface of the plates and the marginal plates. So now have a model for working out how echinoderms relate to each other and can come up with a family tree.

The fossils from the Montagne Noire, France tell the next part of the story. This region was right down near the North Pole and during this period the very unusual Somasteroid turns into the modern-day Ophiuroids and Asteroids. In the St Chinian, the lower part of the Ordovician we see Somasteroid world. It is when you move into the upper part of the Ordovician that you start to see rapid evolution, *Pradysura jakobi* and proto-ophiuroids *Eophiura* and also Asteroids in the Landeyran formation later on. It is deletion of plates that turns a Somasteroid into an Ophiuroid, creating a much simpler body-plan.

What happened next? In the Darriwillian there was a change in the Earth's climate that led to the great biodiversification

event. The speaker had got together with around 25 other scientists and is producing a special publication with the Geological Society of London (SP485) on the fossils from the Tafilat Biota, Morocco from this period. It will document what was going on with echinoderm meadows and should be published the middle of 2020. There are a whole series of deposits the El Caid Rami beds (ECR), which showed a series of animals changing through time. There are a series of echinoderm beds from different regions, so they were able to look at real-time ecology in the late Ordovician. Some of them have similarity to well-known areas, but others don't, and this shows the power of evolution at this time as you can't find the nearest relatives to these forms anywhere. They have evolved in situ e.g. an unusual little starfish, then in the next assemblage weirder looking Ophiuroids with central discs and stubby arms. In each bed there is a different community. There are well over 12 different species described in this starfish bed. In amongst them are other organisms that don't exist anymore. Then in ECR-F6 suddenly the Asterozoans come in.

The speaker has not only looked at the story in Morocco but has gone through time. Still investigating what happened in the Silurian. After that we then see a different migration, we see animals appearing in the tropics and the more primitive

animals migrating away, moving towards the poles. Morphology of a fossil *Protaster* asterozoan, found in the Fox Bay Formation, Lower Devonian, East Falkland is the same as found in the Middle/Late Ordovician and later, so that body-plan worked all the way up until the Devonian and even later. In the Southern Carnarvon



Basin, Western Australia really big Ophiuroids survive until the mid-Permian. They are a snapshot of a lost world as they are the last Ophiuroid from the original early Ordovician forms. The modern type Ophiuroids and archaic ones are living together in the polar regions in the Ordovician, then in the Permian there is a separation and then the archaic ones disappear.

It is very rare to find a whole Ophiuroid in the fossil record. But you can use fragments if you can find them, to reconstruct them and then work them out. That is what they are doing in the Silurian to work out what happened in the gap in those stories.

In conclusion, starfish and brittle stars are complex animals but we are now close to unlocking how they evolved from a common ancestor. They appeared rapidly during the Great Ordovician Biodiversification and these forms survived relatively unchanged for a further 200 MY until the Permian.

By Lesley Exton

Circular No 1023 MARCH 2020

SAFETY IS TAKEN VERY SERIOUSLY should you be unsure about either the risks involved or your ability to participate safely in any of our events, you must seek advice from the GA office before booking. Please make sure that you study any risk assessment or safety briefing and that you have all the safety equipment specified. You must declare, at the time of booking, any disabilities or medical conditions that may affect your ability to safely attend a field meeting. You may be asked to provide further information on any prescription drugs etc that you may use whilst attending a field meeting. In order to ensure the safety of all participants, the GA reserves the right to limit or refuse attendance at field meetings.

EMERGENCY CONTACT if you are lost or late for the start of a meeting, an emergency contact is available during UK field meetings by calling the GA mobile phone **07724 133290**. The mobile phone will only be switched on just before and during field meetings. For routine enquiries please call the GA office on the usual number.

TRANSPORT is normally via private car unless otherwise advertised. If you are a rail traveller, it may be possible for the GA office to arrange for another member to provide a lift or collect you from the nearest railway station. This service cannot be guaranteed, but please ask before booking. Please indicate when booking, if you are able to offer a lift.

PUBLIC LIABILITY INSURANCE for field meetings is provided but personal accident cover remains the responsibility of the participant. Further details are available on request from the GA office.

TRAVEL REGULATIONS are observed. The GA acts as a retail agent for ATOL holders in respect of air flights included in field meetings. All flights are ATOL protected by the Civil Aviation Authority. Field meetings of more than 24 hours duration or including accommodation are subject to the Package Travel Regulations 1992. The information provided does not constitute a brochure under these Regulations.

Graham Hickman arranges UK field meetings and Ian Sutton is responsible for overseas excursions. Website for further details

<https://geologistsassociation.org.uk/ukfield>: <https://geologistsassociation.org.uk/overseasfield>

BOOKINGS AND PAYMENT: These should be made through Sarah Stafford by email: fieldmeetings@geologistsassociation.org.uk phone 020 7434 9298 or preferably through the GA website. Please give an email and emergency contact number. Unless otherwise stated the cost is £5 per day for members. Locations and timings of field trips will be given nearer the time and once payment has been received. Field meetings are open to non-members but subject to £5 per day on top of the normal administration fee. The surcharge for overseas field trips will be equivalent to a year's Membership of the GA which we would recommend is used as membership for that year. (Associate £30, top-up for Joint £25 or £20, Student £20). Priority will initially be given to GA Members. Book online or cheques should be made out to Geologists' Association. Where places are limited, a system of first come, first served will operate so do book early. Some meetings may have restrictions on age (especially for under 16s) or be physically demanding. If you are uncertain, please ask.

GA UK FIELD MEETINGS 2020

Saturday 21 March & Sunday 22 March

GA Dorset Weekend Field Trip

Leader: Prof John Cope

Location: Bridport, Dorset

This weekend trip will examine the upper half of the Lias Group, the Middle and the Upper Jurassic, with bits of Cretaceous and Tertiary thrown in. The best tides are Sat 21 and Sun 22 March 2020. Attendees are to arrange their own accommodation. Bridport is recommended.

Meeting points and further details will be communicated to participants nearer the time. Contact details and emergency contact required at booking.

Cost: £10 GA members, £15 non-members

Friday 3 April (afternoon event.)

GA behind the scenes NHM – William Smith's fossils

Leaders: Jill Darrell & Diana Clements

Location: NHM, London

This event will take you behind the scenes at NHM London to look at the William Smith fossil collection. We are limited to a maximum tour size; however it can be run more than once in the afternoon if required. Afterwards members are invited to make their own way to Burlington House, Piccadilly, for tea at 5:30pm followed by the GA lecture at 6pm. The speaker will be Hugh Torrens talking about the 1820 publication of George Bellas Greenough's geological map, a rival to William Smith's, published in 1815.

Meeting points and further details will be communicated to participants nearer the time. Contact details and emergency contact required at booking.

Cost: £5 GA members, £10 non-members

Saturday 23 May and Sunday 24 May

GA Weekend Field trip to North Somerset

Dr Jonathan Turner

The field excursion will focus on magnificently exposed cliffs and the extensive foreshore between Blue Anchor Bay and Hinkley Point power station, north Somerset. This section provides some of the best outcrops of Triassic (Sherwood Sandstone and Mercia Mudstone Groups) to Lower Jurassic 'Blue Lias', including the transitional Penarth ('Rhaetic') Group recording one of the major marine transgressions of the rock record. It is also one of the best places anywhere to examine faults,

fractures and compressional deformation, which in this area was responsible for uplifting the margin of a major Triassic rift basin – the Bristol Channel graben.

Favourable tides will allow plenty of time to examine the evidence for ancient depositional environments, tectonic structures, oil-related fluids, and a spectacular mud volcano. We should even be able to sneak in a cream tea.

Note: hard hats, wet & warm weather gear, walking shoes/boots are essential. The excursion leader is a fully qualified first aider.

Cost: £10 GA members, £15 non-members

Friday 19 June – afternoon

BGS Keyworth

Leader: John Stevenson

Location: BGS, Keyworth

This tour around the British Geological Survey labs and offices will introduce people to what The BGS does and who funds it. It will include the Library - including some history of the Survey, the Core Store – where a large number of bore holes are kept. The 3D Room Demo Geovisionary followed by a tour of their Geological Walk. Parking is available. There is a fair amount of walking and some stairs, but lifts are available. Much of the tour isn't seated and people will be required to stand for most of the time. There is a canteen onsite that members of the group are welcome to use beforehand if they wish. The maximum group size will be 20.

Attendees wishing to stay on and make a weekend of it by attending the field trip on Saturday 20/06/2020 should arrange their own accommodation and sign up to that event separately.

Meeting points and further details will be communicated to participants nearer the time. Contact details and emergency contact required at booking.

Cost: £5 will be same for both members and non-members

Saturday 20 June

GA field trip to Charnwood Forest

Leader: Dr Michael Howe, BGS

Location: Leicestershire

This trip will examine the Neoproterozoic (Precambrian) and Cambrian rocks around Charnwood Forest. The morning will be spent viewing the Maplewell Group and Whitwick Volcanic Complex around Mount St Bernard Abbey, with a possible visit to the Bomb Rocks, before examining the older Blackbrook

Group in Morley Quarry. In the afternoon we will visit Bradgate Park, and if there's time, hunt *Tychichnus* in Newtown Linford Churchyard.

Attendees wishing to take the 'BGS Keyworth tour' on the Friday afternoon before hand (19/6/2020) should arrange their own accommodation and sign up to that event separately.

Meeting points and further details will be communicated to participants nearer the time. Contact details and emergency contact required at booking.

Cost: £5 GA members, £10 non-members

Saturday 18 July – all day Geology and Art Workshop

Eridge Rocks near Royal Tunbridge Wells Emma Jude

Talk on geological work of fine artists, followed by a practical workshop where participants are encouraged to sketch and take part in guided exercises interspersed with short lectures. How best to keep field notebooks to record observations.

Eridge Rocks is 10 minutes' walk from Eridge Station, which can be reached within a 50 minute train ride from London Bridge.

Meeting points and further details will be communicated to participants nearer the time. Contact details and emergency contact required at booking.

Cost: and max group size to be confirmed

Sunday 19 July – all day

GA field trip - Wealden Excursion to Smokejacks Quarry

Leaders: Peter Austen & Ed Jarzembowski

This trip continues the popular annual Wealden excursions and again will visit one of the sites in the Weald Clay of south-east England. Attendees will need to be sure they can safely cope with the conditions to be found in working quarries.

Meeting points and further details will be communicated to participants nearer the time. Contact details and emergency contact required at booking.

Cost: £5 GA members, £10 non-members

Saturday 12 September – all-day

Geology of Denbies vineyard, Lecture and wine tasting. Surrey

Leader Emeritus Prof. Richard Selley

This trip to Denbies winery, near Dorking, will include: a lecture on 'Geological & Climatic

controls on two millennia of English viticulture', a winery tour and a tutored tasting of 3 different wines. After lunch we will take a Vineyard Tour providing spectacular views of Box Hill, the North Downs, Mole Valley and the Weald. Maximum group size will be 25. Meeting points and further details will be communicated to participants nearer the time. **Cost:** £20 per GA members, £25 non-members. The price includes tea, coffee, soft drinks & biscuits on arrival, use of the Denbies Suite for the talk, the winery tour, with 3 glasses of wine, and the vineyard tour with a glass of sparkling wine. (NB Lunch is not included but can be purchased in the restaurant)

OVERSEAS FIELD MEETINGS 2020

15 - 25 April

Geological and Archaeological trip to the Teke Peninsula of Lycia in Southern Turkey
Leaders: Professor David Bridgland, Dr Robert Westaway and Alison Ure
Booking: This trip is now full but if you would like to be placed on a waiting list please email admin@geologistsassociation.org.uk
Full details on the GA website.

Thursday 8 - Monday 12 October

Madrid Geo-museums

Leaders: David and Anne Bone, and Roger Dixon

We arrive in time to overnight in Madrid on Thursday. On Friday morning, we visit the superb collections of the Museo Geominero including an introductory talk by the museum staff and a visit to their conservation laboratory. Friday afternoon is free time to visit many of the other museums and galleries, such as the Prado, or a city tour. A group tapas meal will be arranged for Friday evening (to be paid for locally). On Saturday, we will have a coach excursion into the area around Madrid, guided by a local geologist arranged by the National Museum of Natural Sciences. Sunday is free time as we are constrained by staff availability at the museums, but Madrid is rich in places to visit and suggestions will be provided. A guided city walk is a possibility that is being investigated. On Monday (a public holiday), we will visit the National Museum of Natural Sciences, where staff will give us an introduction to the history of the museum and its outstanding exhibits. We finish on Monday afternoon for return home. Members of this trip will need to make their own arrangements to get to Madrid and return.

Cost and Booking: Approximate costs Twin /Double £465, Single £740 (this assumes pound-euro equivalence; exchange rate may change). These fees include 4 nights of accommodation and breakfast at the NH Chamberi Hotel, Madrid. Also included are the services of local guides, transport on the day excursion, city walk, tips and entrance fees to the two museums. Further information and booking through David and Anne Bone at david@daibone.plus.com (payments will be made to the Geologists' Association).
To register interest: contact David Bone david@daibone.plus.com

GROUPS (LG) & AFFILIATED SOCIETIES

Amateur Geological Society

<http://amgeosoc.wordpress.com>

March 10 Flint: Origins of a vital substance – Rosalind Mercer.

April 14 Hertfordshire Puddingstone, Querns and the Great Gaddesden project – Dr Chris Green.

May 12 William Buckland First Professor of Geology – Dr Chris Duffin.

Association of Welsh RIGS Groups

www.wcva.org.uk/members-partners/nvo-search/detail?id=906675

Avon RIGS

<http://avonrigsoutcrop.blogspot.co.uk/>

Bath Geological Society

www.bathgeolsoc.org.uk

Bedfordshire Geology Group

www.bedfordshiregeologygroup.org.uk

Belfast Geologists' Society

www.belfastgeologists.org.uk

Black Country Geological Society

www.bcgsg.info

March 7 Geoconservation: Barrow Hill

March 16 AGM + Young Geologists' talks

April 20 Silurian Rocks of the Dingle Peninsula – Ken Higgs

Brighton & Hove Geological Society

www.bhgs.org

March 4 The last British Irish Ice Sheet – Dr Bethan Davies.

March 18 AGM and Members' Evening

April 1 An introduction to the Economic Geology of the Weald Basin – Dr Richard Seaborne

Bristol Naturalists' Society

www.bristolnats.org.uk/geology

British Micromount Society

<http://britishmicromountsociety.homestead.com>

Bucks Geology Group

www.bucksgeology.org.uk

Cambridgeshire Geological Society

www.cambsgeology.org

Carn Brea Mining Society

www.camreaminingsociety.org.uk

March 17 Arsenic in Cornwall – Kingsley Rickard.

April 21 AGM.

May 19 Industries of the St Austell Granite – Ivor Bowditch.

Cheltenham Mineral and Geological Society

<http://cmgs.yolasite.com/society.php>

Croydon Natural History and Scientific Society

<https://cnhss.co.uk>

Cumberland Geological Society

www.cumberland-geolsoc.org.uk

Cymdeithas Daeareggyr Grwp De Cymru:

South Wales Geologists' Association (LG)

www.swga.org.uk

March 21 AGM & Presidential Address: The

changing Early Palaeozoic sea floor – biodiversity or early diagenesis? Lesley Cherns

Cymdeithas Y Daeareg Gogledd Cymru:

North Wales Group Geologists' Association (LG)

www.ampyx.org.uk/cdgc/cdgc.html

Devon RIGS Group

www.devonrigs.org.uk

Devonshire Association (Geology Section)

www.devonassoc.org.uk

Dinosaur Society

www.dinosaur society.com

Dorset Group (LG)

<https://dorsetgeologistsassociation.org/>

March 11 The surface of Mars: ancient and modern processes on the Red Planet – Dr Joel Davis

March 25 5 mile walk in the Vale of Wardour and visit to Chicks Grove Quarry with Steve Hannath

April 8 Carbonate concretions in the Jurassic Coast – Prof Jim Marshall

April 25 Field Trip to Portishead led by Alan Holiday

May 1-4 Black Country led by Noel Donnelly and Graham Worton

June 6 Field Trip to Dartmoor led by Alan Holiday

Dorset Natural History & Archaeological Society

enquiries@dorsetcountymuseum.org

Earth Science Teachers' Association

www.esta-uk.net

East Herts Geology Club

www.ehgc.org.uk

East Midlands Geological Society

www.emgs.org.uk

March 14 Salt Tectonics – Chris Jackson

April 4 The value chain of minerals for the green transition – a reflection on raw materials demand and supply – Dr Karen Hanghoj.

Edinburgh Geological Society

www.edinburghgeolsoc.org

Essex Rock and Mineral Society (LG)

<http://www.erms.org/>

March 3 Tertiary Sand, Mud & Fossils – Ros Mercer & Jeff Saward

March 19 Oil & Gas Exploration – Nick Pierpoint

April 7 Early Human Settlement – Nick Ashton

May 21 Geohazards especially in Essex – Dr Vanessa Banks

June 2 Crystals & Crystallinity – Ian Mercer

June 18 Story of Essex in Rocks – Ian Mercer

Farnham Geological Society (LG)

www.farnhamgeosoc.org.uk

March 13 Last Patagonia Ice Sheet – Dr Bethan Davies

March 28 Mullard Space Laboratory led by Janet Catchpole and Judith Wilson

April 13 Clatford Bottom, Wilts led by Peter Worsley

May 15 Exceptionally Preserved Cambrian Arthropods and their role in understanding arthropod evolution – Dr Greg Edgecombe

May 29 – June 1 Southeast Devon led by Dr Mark Eller

19 June Climate archives of caves and stalagmites – Dr Dave Matthey

Friends of the Sedgwick Museum, Cambridge

www.sedgwickmuseum.org/activities/friends.html

GeoLancashire (LG)

www.geolancashire.org.uk

Geological Society of Glasgow

www.geologyglasgow.org.uk

Geological Society of Norfolk

www.norfolkgeology.co.uk

Harrow & Hillingdon Geological Society (LG)

www.hhgs.org.uk

March 11 Colours of the Natural History

Museum's Gem Collection - Robin Hansen

April 8 Quaternary Rivers and Glaciers in Midland and Eastern England – conflicting views and observable evidence - Prof Jim Rose

May 13 AGM.

Hastings & District Geological Society

www.hastingsgeology.btck.co.uk

Hertfordshire Geological Society (LG)

www.hertsgeolsoc.org.uk

March 12 AGM Followed by short talks by Adrian Champion & Nikki Edwards – Armchair trip to Morocco

April 9 Percy Evans Lecture: Problems in tunnelling in Chalk and the overlying clays through the southern section of the HS2

Chilterns Tunnel – David McCann

May 14 Ups and Downs of the South Atlantic – Dr Lucia Perez Diaz

May 17 Field meeting: William Smith's transects across Hertfordshire – Mike Howgate

June 13 Field meeting: Hadleigh County Park near Southend – Ros Mercer

History of Geology Group

<https://historyofgeologygroup.co.uk>

May 6-7 George Bellas Greenough Map

Bicentenary Meeting

Horsham Geological Field Club

www.hgfc.org.uk

March 11 The Volcanoes of Iceland – Professor Hazel Rymer.

April 1 Geology and ground engineering of High Speed 1 – Nick O'Riordan.

May 13 AGM

June 10 The Economic Geology of the Weald Basin – Dr Richard Seaborne.

Huddersfield Geology Group

www.huddersfieldgeology.org.uk

Hull Geological Society

www.hullgeolsoc.co.uk

April 4 Conservation visit and social at Rifle Butts SSSI led by Mike Home and Stuart Jones

May 9 Rock and Fossil Roadshow at Treasure House in Beverley (part of Yorkshire Geology Month)

May 10 morning geology walk in Hull's Spring Bank Cemetery led by Mike Home (part of Yorkshire Geology Month)

May 21 Afternoon geology walk in Driffield Cemetery led by Mike Home (part of Yorkshire Geology Month)

May 24 The Quaternary and Chalk Geology of Flamborough, led by Rodger Connell and Mike Horne (part of Yorkshire Geology Month)

June 7 Rock and Fossil Roadshow at Flamborough Village Hall (part of Yorkshire Geology Month)

June 30 Evening picnic and boulder survey at Mappleton - Mike Horne

The Jurassic Coast

www.jurassiccoast.com

Kent Geologists' Group of the Geologists' Association (LG)

www.kgg.org.uk

March 17 AGM followed by a talk - Dr Adrian Rundle

April 21 Metamorphism - Dr Anne Padfield

Kingston Lapidary Gem & Fossil Society

Email: kingstonlapidarysocietyhull@gmail.com

The Kirkaldy Society - Alumni Queen Mary (LG)

May 9 Field excursion to investigate 'The Geology around Upware, Cambs' - Dr Simon Kelly

Contact by e-mail: Mike Howgate
mehowgate@hotmail.com

Leeds Geological Association

www.leedsgeol.org.uk

March 19 Yorkshire's own Jurassic Park - Dr Christopher Hill.

April 30 A re-evaluation of glacial Lake Pickering - Dr Laura Eddey

Leicester Literary & Philosophical Society (Geology)

www.chamia.org.uk

Liverpool Geological Society

www.liverpoolgeologicalsociety.org.uk

Manchester Geological Association

www.mangeolassoc.org.uk

Medway Fossil and Mineral Society

www.mfms.org.uk

Mid Wales Geology Club

www.midwalesgeology.org.uk

Midweek Geology Club

<http://mwggvorkshire.org.uk/>

Milton Keynes Geological Society

<http://mkgeosoc.org/>

Mineralogical Society

www.minersoc.org

Mole Valley Geological Society (LG)

www.mvgs.org.uk

March 12 When the Isle of Skye was hit by a meteorite some 60MY years ago - Dr Simon Drake

April 9 10 great geologists - Dr Mike Simmons

Newbury Geological Study Group

www.ngsg.org.uk

Norfolk Mineral & Lapidary Society

norfolkminandlapsoc.homestead.com

Norfolk Geodiversity Forum

www.norfolkbiobiodiversity.org

North Eastern Geological Society

www.negs.org

North Staffordshire Group of the Geologists Association (LG)

www.esci.keele.ac.uk/nsqga

March 12 The post-Carboniferous geological evolution of the Peak District: some insights from temporary exposures - Dr Peter Jones

Open University Geological Society

www.ougs.org

Oxford Clay Working Group

Email: saurian@live.co.uk

Oxfordshire Geology Trust

www.oxfordshiregeologytrust.org.uk

Peak Lapidary & Mineral Society

www.dannatt.org.uk/PLMS/

Phoenix Geological Club

Email: kwaston@hotmail.com

Plymouth Mineral & Mining Club

www.denul.net/pmmc/

Reading Geological Society (LG)

www.readinggeology.org.uk

March 2 Quaternary of the southern North Sea - Dr Andrew Bellamy

April 6 Deep Sea Sedimentary Processes - Prof Javier Hernandez-Molina.

Royal Geological Society of Cornwall

Kowethas Riel Dororiethel Kernow-

Royal Geological Society of Cornwall 1814

www.geologycornwall.com

The Russell Society

www.russellsoc.org

Shropshire Geological Society

www.shropshiregeology.org.uk

Sidcup Lapidary and Mineral Society

www.sidcuplapminsoc.org.uk

Southampton Mineral and Fossil Society

www.sotonminfoss.org.uk

Stamford and District Geological Society

www.stamfordgeolsoc.org.uk

Teme Valley Geological Society

www.geo-village.eu

Tertiary Research Group

www.trg.org

Ussher Society

www.ussheer.org.uk

Warwickshire Geological Conservation Group

www.wgwg.co.uk

March 18 The Anthropocene - Man's impact on our planet - Ian Fairchild

March 29 Field meeting: Nottingham Caves visit - Tony Waltham

April 15 Hydrofracking - Martin Carruthers

April 25 Field meeting: Wren's Nest Dudley - Andy Harrison

May 8-11 Field weekend: North Lincolnshire

June 6 Field meeting: Blockley Quarry - Jon Radley

Welsh Stone Forum

www.museumwales.ac.uk/geology/welshstoneforum/about-the-welsh-stone-forum/

Westmorland Geological Society

www.westmorlandgeolsoc.co.uk

March 18 Cumbrian peperite - the

fascinating tale of magma meeting

wet sediment - Dr Clive A. Boulter

April 19 Field meeting: Skiddaw Group

Structures & Sill in Wythop Woods John

Rodgers

May 6 Field meeting: Shap Beck Quarry -

Jenna Roberts

West of England Group of the GA (LG)

www.wega.org.uk

West Sussex Geological Society (LG)

www.wsgs.org.uk

March 20 The Piltdown Man hoax - Colin Prosser

March 21 Nymans Landscape Gardens led by

David Bone with Greg Thomas

April 17 Why are the Andes so high? - Dr Laura

Evenstar

April 26 Pulborough Ridge led by John Lonergan

May 15 The Sussex Geodiversity Partnership -

Peter Anderton

May 29 - 31 Field trip to the Isle of Wight

June 19 Darwin's fossil mammals - Dr Pip Brewer

June 10 St Mary de Haura Church, Shoreham

led by David Bone

June 21 Down House, Kent (Darwin's home)

The Woolhope, Hereford

www.woolhopeclub.org.uk

Yorkshire Geological Society

www.yorksgeolsoc.org.uk

SPECIAL EVENTS 2020

May

Yorkshire Geology Month

www.hullgeolsoc.co.uk

May 1-3 May

Lyme Regis Fossil Festival

<https://www.fossilfestival.co.uk/>

May 6-7

George Bellas Greenough Map

Bicentenary Meeting

<http://historyofgeologygroup.co.uk>

May 9-17

GeoWeek

www.bgs.ac.uk/geoweek/

May 15

GA Spring Conference

Geologists' Association Student

Symposium

<https://geologistsassociation.org.uk>

October 11-17

Earth Science Week

www.geolsoc.org.uk/earthscienceweek

Upload your own events on to interactive website

October 9-18

Sidmouth Science Festival

www.sidmouthsciencefestival.org

October 16 - 18

GA Annual Conference

Edinburgh

conference@geologistsassociation.org.uk

November 7

Festival of Geology

University College London

<https://geologistsassociation.org.uk>



GASS
2020

Geologists' Association Student Symposium

Geoscience in wider society:
What difference will
your research make?

15th of May 2020

Burlington House, Piccadilly, London, W1J0BG


- ✓ A fantastic opportunity to hear from the geoscience pioneers of the future
- ✓ Expand your network of **speakers for local talks**
- ✓ Keynote speaker: **Professor Iain Stewart**
(Director of the Sustainable Earth Institute, Plymouth University)


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 Geologists' Association
gass@geologistsassociation.org.uk



GeoWeek 2020

Active Geoscience 9-17 May

Just a few more members...

At committee meetings throughout the Local Groups and across geology generally, we hear the same comments – more members would mean better attended activities, some welcome income and added members to the organising committees.

But this will not happen without some recruitment. An excellent way to achieve this is to get your society involved in the GA outreach activities, including Rockwatch, School Rocks, Geolab and Geoweeek....

...Geoweeek – when we stage introductory days in the field, designed for the public and aimed to catch their attention – runs from 9th to the 16th May. Just pick an interesting geological area near you, register on the Geoweeek website and send some press releases to local papers.

David Ward, *Supergroup Representative*

GA Field trip: North Somerset coast

23-24th May 2020

Leader: Jonathan Turner, Radioactive Waste Management

The field excursion will focus on magnificently exposed cliffs and the extensive foreshore between Blue Anchor Bay and Hinkley Point power station, north Somerset. This section provides some of the best outcrops of Triassic (Sherwood Sandstone and Mercia Mudstone Groups) to Lower Jurassic 'Blue Lias', including the transitional Penarth ('Rhaetic') Group recording one of the major marine transgressions of the rock record.

It is also one of the best places anywhere to examine faults, fractures and compressional

deformation, which in this area was responsible for uplifting the margin of a major Triassic rift basin – the Bristol Channel graben. Favourable tides will allow plenty of time to examine the evidence for ancient depositional environments, tectonic structures, oil-related fluids, and a spectacular mud volcano (Figure 1). We should even be able to sneak in a cream tea.



Figure 1: Mud volcano in Lower Jurassic succession of mixed mudstones and limestones, Kilve, north Somerset.

To reserve a place contact the GA Office on 020 7434 9298 or geologistsassociation.org.uk

By: Alan Holiday Chairman of DIGS

Following on from the recent article about the GA and its role in geological conservation (GA Magazine, Vol.18, No.3) we were sent this account of the impressive conservation work undertaken by DIGS. We would love to hear about, and potentially publish, similar accounts of conservation activity from other groups so please do send updates on what you have been doing, or plan to do, to Colin Prosser at conservation@geologistsassociation.org.uk.



Figure 1: Publications, particularly walks leaflets, incorporating DIGS sites

At Dorset's Important Geological Sites group (DIGS) meeting on 24th September we decided that we should make a contribution to the discussion on geological conservation suggested in the latest GA Magazine. The DIGS group has been active since the early 1990s, first of all identifying sites of geological interest (educational and scientific value) away from the coast and not SSSIs, in cooperation with the landowner where appropriate. We currently have around 60 sites across the whole of Dorset and through the stratigraphic column, Jurassic through to Palaeogene. As time passed the group produced publications particularly walks leaflets incorporating DIGS sites, some for sale and some free to anyone interested. Some of these publications were supported by the Curry Fund (Poxwell Pericline walk



and geological trail around Weymouth) as well as Heritage Lottery Fund. The sale of some of these publications has helped to provide the group with much needed financial support helping to pay expenses and for equipment used in Conservation.

Financial support also came through fees for monitoring sites for Natural England through Geo-conservationUK and we regularly contribute to their newsletter. The group also produced



Figure 2: Portesham Farm information panel

information panels for a few of its sites so that passers-by could learn more about the geology and landscape of the area such as the Portesham Farm one (See Figure 2).

Over time the focus of the group has changed due to changes in membership and the interests of members. The group is now very much involved in active conservation and there is normally a practical conservation session once or twice a month so that the geological interest of sites is still visible and not overgrown (see Todber below).

We are still on the lookout for new sites and in the last year a new site has been designated (Rodwell Cutting in Weymouth) and added to our list. The group has extended its conservation activities to other sites which we consider to be important and in need of attention both in Dorset and further afield. These include the Upwey Road Cutting (which is part of the Bincombe SSSI). The site was developed due to a road improvement on the A354 between Weymouth and Dorchester and exposes rocks from the top of the Portland Beds through the Purbeck sequence into the base of the Wealden.

We also work with other groups (Dorset Geologists' Association Group, Wessex OUGS and Somerset RIGS) for



Figure 3: Geoconservation working group at Todber

example carrying out conservation at the Vallis Vale SSSI near Frome in Somerset. The group is affiliated to the Dorset Wildlife Trust (DWT) and we have a planning meeting every two months at the DWT headquarters. We work with DWT practically as well at a site at Kingbarrow Quarry on Portland which exposes the 'fossil forest' horizon also seen east of Lulworth Cove, the latter having been out of bounds for the last 3 years due to the risk of rock falls. The Portland site is not only of geological interest but also because of the ecology (rare limestone grassland).

Most recently we have been carrying out conservation work at the Crookhill Brick Pit SSSI at Chickereil on the outskirts of Weymouth. This site exposes Oxford Clay (*Kosmoceras compressum* Zone and has become very overgrown and inaccessible. We have been working with Natural England and Dorset County Council as the site is not only geologically interesting but also as a LNR and it is a habitat for great crested newts.

We also work with the community contributing to events such as Geoweeek and the Hampshire Fossil and Mineral Show at Lyndhurst.



Figure 4: Kingbarrow Quarry on Portland

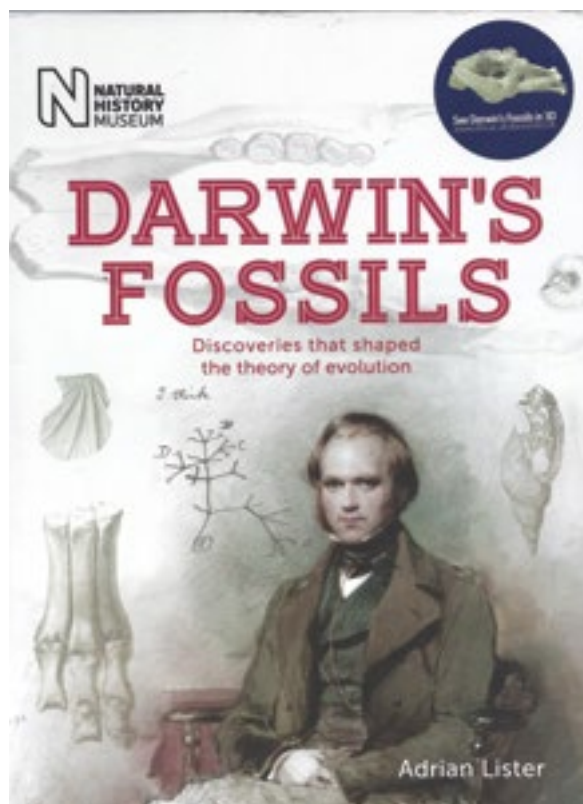
What a gem of a book this clear and well illustrated review of Darwin's fossil collecting is. It's well set out, with a clear type set and excellent colour illustrations. From the outset we want to establish that this review was undertaken by two reviewers, one more senior (Haydon Bailey) and the second a little younger (Lucas Bailey, aged 8) and we trust that it is readily apparent whose views are being expressed where.

Chapter 1 "The making of a naturalist" is an easily readable introduction, which provides the reader with useful insights into Darwin's education, both in Edinburgh and Cambridge, as well as his travels and the opportunities which arose for him to collect highly significant fossils very early on in his journey on the Beagle. There is also a clear introduction into the contemporary status of the thorny subject of geological time. This chapter also includes the first two of eight clearly drafted maps of Darwin's route and excursions which Lucas thought were really helpful.

The primary objective of the Beagle's crew was the surveying of the South American coastline, including the Falkland Islands, and this took over three years of the voyage, principally between 1832 and 1835. Darwin was taken on board initially as a companion to Captain Robert FitzRoy, although his role as the expedition naturalist was always uppermost in his own mind.

The discussion of the "Giant Mammals" and the fossil bones from them which Darwin found in numerous places throughout Uruguay and Argentina (including Patagonia) form the basis for Chapter two. He made three major discoveries of *Megatherium* in his first collecting season (1832) and, although this taxon had already been described by Cuvier, the specimens which Darwin had shipped back to England were regarded as extremely significant and the description of them was made at the British Association for the Advancement of Science in 1833 by no lesser specialist than Richard Owen. Owen named one species as *M. darwini* after Darwin in 1840. So it's clear that Darwin's fossils are beginning to make the name of this up and coming fossil collector, even when he was still in the early stages of his cruise.

Where there exist contemporary illustrations of the specimens Darwin collected, these are included in the book, but Lucas was more impressed to see the wonderful, almost photographic, illustrations of what these extinct animals used to look like and where they lived. We were both amazed by the discovery of the early elephant (*Notiomastodon patensis*)



bones made by Darwin in Uruguay and we also appreciated the map showing the original distribution of this species across the continent. It was interesting to learn that the first specimens Darwin found were so decayed that they fell apart during their extraction, but he recognised them for what they were after reading Cuvier's description of other specimens. In this chapter it was also fascinating to read of Darwin's speculations regarding fossil preservation, palaeoecology and their relative ages, which gave rise to his ideas on the "succession of types". It is clear from Lister's comments that Darwin was already making speculations regarding evolution as early as 1832.

There is a short chapter, entitled "Petrified forests", which covers Darwin's palaeo-botanical discoveries. These included specimens of *Glossopteris* which were to be so crucial in later

discussions regarding the splitting of the supercontinent Gondwana, but this was completely unknown to Darwin at the time.

Both Lucas and I thoroughly enjoyed the "Marine life" chapter, if for different reasons. Lucas loved the excellent illustrations of the actual fossils set against what they looked like in "real life"- he thought they were "amazing". I was impressed by the detailed discussion of Darwin's recognition of the presence of relatively young (Pleistocene) marine shells at different heights above sea level. Darwin became convinced that he was seeing evidence of a wide scale series of coastal uplifts along much of southern South America. It's also nice to read that where Darwin had personal doubts over the origin of some of these fossil remains he was not afraid to express these doubts openly.

Darwin showed a willingness to follow new ideas, particularly those of Charles Lyell, whose three volumes of the *Principles of Geology* were shipped out to him during his voyage. Lister states that Darwin's use of Lyell's terms such as Pliocene, Miocene and Eocene were almost certainly the earliest application of such "European" nomenclature in South America. Darwin found the first ammonites recorded formally from South America, when he collected several Late Cretaceous taxa around Tierra del Fuego.

This book clearly describes how the Beagle voyage wasn't the first of its type as the French had already undertaken similar expeditions around South America, with the young naturalist Alcide d'Orbigny on board. As a foraminiferologist, d'Orbigny is a particular hero of mine, and it was wonderful to learn of the communications between Darwin and d'Orbigny as they compared notes over the specimens they had

both discovered and recorded. Some of the fossil marine shells collected by Darwin 400m above sea-level were suggested to be of Early Cretaceous age by d'Orbigny; an age designation which has been subsequently confirmed by more recent research.

One thing which becomes apparent through this book is how many of Darwin's specimens appear to have been lost during the 180 years since they were so carefully shipped back to England. The Natural History Museum was still a pipe dream for Richard Owen when these specimens first started arriving in this country and they endured several moves between collections and specialists before finally finding their way to the NHM. Lister is acknowledged for making these losses known through this book.

The text does not dwell on the importance of the Galapagos Islands to Darwin as their significance to evolutionary theory wasn't to become well established until much later and Darwin recovered few fossils from these dominantly volcanic islands. The islands which were of much greater significance during the voyage of the Beagle were the numerous coral islands which the ship visited and surveyed on its voyage across the Pacific and Indian oceans.

Darwin was evidently beginning to hypothesise about the origin of coral islands even before the Beagle had left South America. However, his theories really started to crystallise during his surveying work across the Cocos (Keeling) atoll. He drew up a number of cross sections, which Lucas really liked, illustrating the thick growth of coralline carbonates on top of a volcanic basal foundation. This theory of coral island origin would not be proven correct until 1952, by a borehole

drilled on Enewetak Island during the atomic bomb test programme.

The final chapter, aptly entitled "The making of a theory", focuses on the Darwin's use of the fossils he collected during his journey and how he was able to directly compare living forms in South America with their fossil counterparts, thereby providing the foundation for his "Law of the succession of types". His early evolutionary thoughts were already in his notebooks by 1837 when he illustrated his famous branching tree structure for the organisation of species distribution. At this stage he had an "evolutionary" structure, but not a mechanism and then, as Lister makes clear, in September 1838 he read Thomas Malthus's Essay on the Principle of Population from which the seed of an idea emerged regarding the survival of limited individuals from the overproduction of offspring in a population. Natural selection now had a mechanism and, as is often said, the rest is history. Lister gives the detail of this history too, setting out the timetable from early notes to the publication of the *Origin of Species* in November 1859, including the arrival of that fateful letter from Alfred Wallace in 1858.

There is a lot of detail in this book, but please don't be put off by that, because it's a really "easy read", highlighting aspects of Darwin's fossil collecting which are often overlooked because of the dominance of what was to come later in his career. Lucas summed it up really well for me when he said in his notes "I have nothing that I don't like."

Haydon W. Bailey & Lucas W. Bailey

The Buckinghamshire Geology Group presents

Rock & Fossil Day



Bucks County Museum Saturday 4th April 11am – 4pm

*Discover the geology of Buckinghamshire and beyond * Explore hands-on displays*

*Meet members of the Group * Bring in your own mystery items for identification*

Church Street, Aylesbury HP20 2QP Tel 01296 331441 mpalmer@buckscountymuseum.org

Museum entry by donation to support Buckinghamshire County Museum Trust registered charity 1153345

The GA was delighted to have Prof. Peter Rawson and Dr. John Wright lead this field trip to the Yorkshire Coast. Both have immense experience and knowledge of this area and the trip celebrated the new edition of their GA Guide 34, "The Yorkshire Coast". We followed Itinerary 11 of the new (2018) edition of the GA Guide, though in reverse order, on the Saturday and part of Itinerary 9 on the Sunday.

24 participants met in the sea mist on Saturday morning in Reighton Gap car park and were greeted with an introductory overview given by Prof. Rawson. From there we walked along the shore in the SE part of Filey Bay for approximately 2.5km to Speeton Cliffs to examine the Hunstanton Formation ("Red Chalk") and overlying lower part of the Ferriby Chalk Formation.

We then retraced our steps as far as the outcrop of the Lower Cretaceous Speeton Clay Formation and had lunch near some WWII sea defences. The marine Speeton Clay represents most of the Wealden, Lower Greensand and Gault successions of southern England. Numerous belemnites, of alternating both Boreal and Tethyan affinity and pieces of ammonite, principally Aegocrioceras and Paracrioceras were found. The base of the Cretaceous here is a dense phosphatic lag deposit, above Kimmeridge Clay in which the diagnostic ammonite Pectinatites was found. This part of the coastline is actively eroding and the Speeton Clay is often buried by slumps of the overlying glacial till. It took many years for the stratigraphy to be unravelled although the essential bed divisions from Lamplugh's work published 130 years ago still stand. The overlying glacial tills are of Devensian age and yield a great variety of rock types which can be examined



Figure 1: The assembled group, prior to walking to Osgodby Point (background) across Cayton Bay

with overlying sandstones showing cross-bedding and coals. We learned how William Smith (Father of English Geology) had initially thought these rocks were of Carboniferous age, but later with the use of fossils had correctly identified them to be equivalent to the Inferior Oolite and therefore Jurassic in age.



Figure 2: *Paracrioceras* sp. which was recovered the following day, but not in such good condition as shown, since the intervening high tides had inundated the specimen and covered it with 40cm of shingle.

(Lower Oxfordian), with higher, Hackness Rock and Oxford Clay visible in the cliff.

The group returned to the cars and thanked the leaders for a very interesting field trip. A few went on to look at the Upper Jurassic Coralline Oolite at Betton Farm, a nearby SSSI, before returning home, while your correspondents returned to Speeton to excavate the large ammonite discovered the previous day.

in the pebbles on the shore. The Saturday excursion finished with a trip to the "Rotunda: the William Smith Museum of Geology" in Scarborough.

On Sunday morning the group met at Osgodby Hill, before descending to Cayton Bay and walked north to Osgodby Point where we examined Middle and Upper Jurassic sections. Of particular mention are the Millipore beds containing abundant crinoid and occasional bryozoan fragments

The group then walked across Cayton Bay to Red Cliff Rocks at the SE end. We stopped to examine the Tenants' Cliff landslide and saw lots of evidence of recent movement and debris from unfortunately placed holiday homes. Mid-way across the beach we paused at an intriguing fault bounded outcrop of Lower Calcareous Grit which has yielded nodules with beautifully preserved fossils. At the SE end of the bay we examined the whole section from Abbotsbury Cornbrash through to the Lower Calcareous Grit Formation

Festival of Geology Field Meeting Report: London Building Stones walk in the City

3rd November, 2019

Leader: Dr Matt Loader, Natural History Museum

By: Diana Clements

It has become a bit of a tradition that we run field trips in the London area following the Festival of Geology on the first Saturday in November. In 2019 three field trips were organised and the weather on the Sunday was considerably better than at the Festival when it just poured before and at the opening time. Many thanks to our leaders, and to those who turned out early on a Sunday morning, for making them a success.

Matt has led building stone walks for the GA Festival for the last three years. Matt approaches building stones from the angle of an igneous petrologist (photo is of Shap Granite near Cannon Street Station) and his walks are quite fascinating. On this walk it was Matt's intention to begin with the oldest rocks near Cannon Street and finish with youngest ones at the Tower, but interest was such that the group never made it

as far as the Tower. The morning sunshine was a great aid to looking at the polished stones.



Festival of Geology Field meeting Report: Geotrail along the Thames Path from the Barrier to Greenwich

3rd November, 2019

Leaders: Members of the London Geodiversity Partnership

By: Diana Clements

The Thames Barrier looked its best in the glorious sunshine as we set off for our walk along the Thames Path to Greenwich. There was much discussion of the rising sea levels and potential threat to London and what is still being done to mitigate the effects. We discussed the former export of sand, 'ballast' and chalk from the quarries in the Charlton area. The remains of a small rail track from the large 'Ballast Pit' that is now home to Charlton Athletic can still be seen on the tow path; now the fortunes are reversed and sand and gravel is imported via barges and conveyors. We were delighted to have Bob Gatliff on the walk, chair of the Edinburgh Geological Society who will be our hosts for the GA Conference in Edinburgh in 2020. What we didn't know is that Bob is an expert on the origin of the gravels and was able to tell us all about it. It is apparently one of the largest depots in Europe. We examined the foreshore beneath us and the great mounds of sand behind us, looking at modern geological processes. Walking round the Greenwich Peninsula we discussed the big engineering projects under London. The spoil from Crossrail was loaded onto barges at the mouth of the Lea and then transported downstream to Wallersea Island – now an RSPB nature reserve. We also discussed the Thames Tideway super sewer that has just begun tunnelling under the centre of the Thames. When the Blackwall Tunnel was dug under the Thames they came across a deep filled scour hollow, figured in the BGS Memoir to the London maps. We crossed the Meridian on the west side of Greenwich Peninsula, just beyond the Dome and stopped briefly for a group photograph. Then the weather

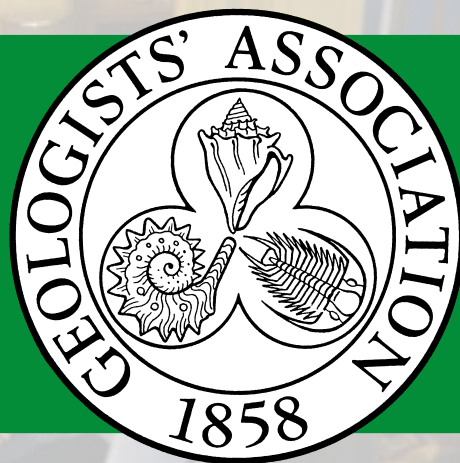


began to turn against us which was disappointing as the pub selected for lunch was very full and the outside benches not all that pleasant. As a result some members of the party left us at this point but the rest of us went on to look up through the Old Royal Naval College to Greenwich Park behind. This was the venue for the 2018 GA Festival walk and for some it was a bit of a résumé. The walk finished near the Cutty Sark with welcome hot drinks for a few of us.

This walk and the one around Greenwich Park will be written up as self-led geotrails in due course and will be put on the London Geodiversity website: www.londongeopartnership.org.uk. The Green Chain Walk Geotrail from the Thames Barrier, eastwards to Abbey Wood is already there.

GEOLOGIST'S ASSOCIATION ANNUAL DINNER

Friday 1st May 2020



GA annual dinner will be held in the Lower Library of the Geological Society.

It is an informal and friendly occasion and is held after the AGM and the Presidential Address.

**£35 per person, sherry reception, two course (3 choices of main!) hot buffet.
Book now either by phone, or email**

The Annual Report 2019 with colour photographs will be available in April when it will be emailed to Members. If you would like a paper copy please contact Sarah

email: admin@geologistsassociation.org.uk or phone 020 7434 9298

THE GEOLOGISTS' ASSOCIATION ANNUAL GENERAL MEETING AGENDA 1st May 2020 at 18:00hrs

1. Minutes of the 2019 AGM
2. Introduce and approve Annual Report for 2019
3. Proposed Officers for 2020/21
4. Proposed Council Members for 2020/21
5. Expression of thanks of the Association to retiring Council Members
6. Presentation of the Foulerton Award
7. Presentation of the Halstead Medal
8. Presentation of the Halstead Award
9. Presentation of the Richardson Award
10. Presentation of the Curry MSc and UKOGL Awards
11. Presentation of the Curry Fund Certificates
12. Presentation of the Research Awards
13. Presentation to Long serving Members
14. Presentation of the President's Medal

Presidential Address for 2020

Mr Nicholas Pierpoint: *Exploring for Hydrocarbons - a Risky Business (Pt 2)*

WHATS NEW FOR 2021

FIELD TRIPS LED BY DANNY CLARK-LOWES



BHUTAN

Join us for an adventure into the Hidden Kingdom of Bhutan, the heights of the Himalayas surrounding us on all sides providing breath-taking views. Glimpse a window into a living culture, relatively untainted by external influences and still dominated by spiritual teachings. On our tour we will explore the geology, natural history and culture of this fascinating sovereign nation. We will travel through a mountainous landscape fashioned from a variety of bedrock schists, gneisses and granites which are folded and thrust into impressively-deformed exposures.



MOROCCO

The North West African history attest that Morocco was a land of many connections between different tribes. During the golden age of all the civilizations including, Al Moahades, Al Moravides, The merinides ...etc , when huge exchanges had happened, lots of trade roots crossed the Sahara north south,meast west , from Agadez, Timbuktu, Dakar ... to Marrakech, fez, Mogador, Zagora, Sijilmassa ... etc



JORDAN

Jordan teems with geological and cultural significance, the two often inextricably intertwined as the landscapes shaped the historical legacy: from the exquisite ancient Nabataean capital of Petra, hewn out of sheer rock faces of beautifully banded sandstone, to the stupifying desert 'Mesa' landscapes of Wadi Rum, through which Lawrence of Arabia travelled during the early nineteen hundreds.



ZANSKAR

Zanskar is a small Tibetan Buddhist Kingdom, lying just north of the main Himalayan range and about 120 miles long. It is part of the former Kingdom of Ladakh, and up until relatively recent times, its two 'Kings', or Gyalpos (precious rulers) mediated local disputes and in ancient times collected taxes for the main King of Ladakh.

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Figure 1: Rockwatch at the National Stone Centre pondering the structure

This is the time of year when we are putting the finishing touches to our events listing for Rockwatch events for the current year. We are delighted that this year we have had new responses from two of our GA affiliated societies offering events for Rockwatch members: a visit to the Shipwreck Museum in Hastings for a video showing of local fossils, followed by a beach walk and fossil hunt and Fossil Making at the Rocky Roadshow in Norwich with the Norfolk Lap & Min Soc. During the spring half-term we've been invited to run a fossil making workshop in the BGS shop at the Natural History Museum in London, followed by a tour of the Earth Galleries, building on the success of a similar event last year. We

are always pleased to accept offers from our local groups and affiliated societies to hold events for our members in their areas, so please get in touch with us if you'd like to offer an event.

And, for readers who are new to the Geologists' Association (GA), Rockwatch is the junior club of the GA. Membership age ranges from 7 years (younger in very special cases!) to 18. We also offer family and institutional membership. We run field trips for members only, from March to October, organise special events for members, for example behind the scenes tours of museums, free entry to many geological events throughout the country and entry to lecture series run by the GA and its many local groups and affiliated societies. We also hold a range of activities for the general public in museums, at Festivals of Geology, and in schools, for example, to help fulfill our charitable status obligations.

We have a number of field trips already planned for the coming year, some old favourites, some first time visits. The following give a flavour of some of the trips



Figure 2: Rockwatch at Ogmere by sea

we have planned in addition to the ones mentioned above: fossil collecting at King's Dyke near Peterborough followed by a 'behind the scenes' visit to Peterborough Museum; a visit to Radstock Museum and Writhlington to hunt for Carboniferous fossils; our annual weekend to South Wales to an exciting new site this year and our annual residential World Heritage Jurassic Coast visit in the summer, this year focussing on coastal protection.

We are also giving early publicity to a field trip to the NW Highlands scheduled for May half-term 2021 for our older members. This is an exciting new venture focussing on geological experiences for our older members, which we hope will be the first of many similar visits. There are a number of other events and trips which will be rolled out during the next few weeks and which I'm sure will be extremely popular with our members.

For readers with children of their own, or those with grandchildren, who you think are interested in learning more of the world around them, you may wish to introduce them to some of these exciting activities that Rockwatch runs for its members then maybe take out a membership for them so they can then enjoy the benefit of all our trips!

These are but a few of the events we have lined up for our members and for the general public. If any of the public events are happening near you, do pop in and join us, we'd really love to see you and have a chat.

For more details our website is: www.rockwatch.org.uk and our e-mail address is: hello@rockwatch.org.uk



Figure 3: My first Rockwatch field trip - South Wales



Figure 4: Rockwatchers show off their fossil finds at Lea Quarry

The Geologists' Association
A forum for amateur & professional geologists

Membership Benefits

Field Meetings: an extensive programme in the UK and overseas led by international experts

Lecture Meetings covering a wide variety of geological topics and available on line and as a live stream to members

Annual Festival of Geology an informative and fun day of talks, exhibitions and displays, as well as the chance to meet other geologists

Annual conference sponsored by Elsevier on various geological themes

GA Student Symposium a prestigious platform for students to communicate the benefits of their research to society.

GA Magazine interesting articles, book reviews, abstracts of lectures, details of trips, field meeting reports and up-to-date information on geological developments

Proceedings of the Geologists' Association our in-house journal, containing scientific research papers of regional and international interest. Members have electronic access to the journal, including 150 years of classic articles from the back catalogue

Research and conference grants for both Full and Student members who may apply for a number of awards specifically designed to facilitate research and encourage attendance at scientific meetings

Library access and borrowing rights from the library of University College London including a wide range of geological maps

GA Guides field guides to specific regions available to members at reduced cost at meetings and through the GA website

Earth Heritage Magazine sponsored by the GA and free to all on the GA website, deals with Geoconservation issues

Geology Today reduced subscription to members

GA website with all the latest information; the GA also has Twitter and Facebook accounts

Rockwatch a nationwide club for young geologists and their families

A united voice for geologists on matters of national importance

Burlington House, Piccadilly, London, W1J 0DU. Tel 020 7434 9298

<https://geologistsassociation.org.uk>



GEOLOGIST'S ASSOCIATION ANNUAL CONFERENCE 2020

Edinburgh



Friday 16th October Afternoon

Guided tour of the Geoscience exhibits at the National Museum of Scotland (Rachel Walcott, NMS)

Saturday 17th October, The Surgeon's Hall, Edinburgh

How geology shapes Scotland (Angus Miller, Scottish Geodiversity Forum)

Geoparks in Scotland (Laura Hamlet, NW Highland Geopark)

The Great Glen Fault Zone - Back and forth for longer than we thought (Dr Eddie Dempsey, University of Hull)

The structure of the Midland Valley and the origins of the oil industry (tbc)

The Midland Valley and geothermal energy (Corinna Abesser, BGS)

Health and Geology (Fiona Fordyce, BGS) – special topic reflecting on the location of the meeting

What triggered the Cambrian Explosion? (Rachel Wood, University of Edinburgh) – with an exhibition of prints generated from Cambrian rocks and fossils by artists from Oxford

Archaeology and isotope geochemistry: Whatever happened to Richard III? (Jane Evans, BGS)

Beneath the waves; a golden age of discovery through mapping our submerged Geology (Dayton Dove, BGS)

Saturday evening dinner

Sunday 18th October Morning: There will be a selection of three parallel field trip options (10.00-12.30 approx):

The Geology of Arthur's Seat (Leader Angus Miller). A walk up and around Holyrood Park to see features of the volcano, Hutton's evidence of sill intrusion and spectacular views of the city.

Edinburgh's seaside geology (Leader Robert Gatliff, President, Edinburgh Geological Society). A traverse through the Middle and Upper Carboniferous (Upper Limestone Group, Passage Formation, and the Lower Coal Measures) with almost continuous exposure at Joppa, Portobello.

The Building Stones of Edinburgh (leader tbc)

