

Earth Heritage

The Geological and Landscape Conservation Magazine



**Seven more UK
geosites recognised
as Geological
Heritage Sites**

**Revealing the rocks
at Scrabo Hill**

ISSUE
62
Winter 2025

**Earth's Canvas:
Exploring Geology
in Creativity**

**The Evolution
Garden**



Cover: Fern the Diplodocus: The centrepiece of the Evolution Garden at the Natural History Museum, London, is Fern — a life-size bronze skeleton of *Diplodocus carnegii* and also a near-exact replica of the Museum's famous Dippy. Photo © The Trustees of the Natural History Museum, London Find out more in the article on p.28.



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EDITORIAL

Happy New Year and welcome to a bumper Winter issue to start 2025.

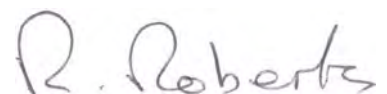
If you are not already a member, why not start the New Year by joining the Geologists' Association (GA) to gain access to a double issue of their Proceedings, which will include write-ups on a number of Quaternary Geological Conservation Review (GCR) sites in southern England. Another publication reviewed in this issue is *The Rocks at the Edge of the Empire*. This book crosses the divide between geology and archaeology to tell the tale of the northern frontier of the Roman Empire. The 5th edition of *The Geology of Scotland*, with 51 authors and an exhaustive reference list, shows the progress and on-going research in Scotland. The final publication reviewed is the 2nd edition of the *Geology of London* which builds on the previous edition with the addition of two new itineraries.

News on improving the condition of sites and accessibility to geologists is always welcome. The TLC given to Scrabo in Northern Ireland highlights the value of site condition monitoring but also the scale of future management required. Similarly, Harrow and Hillingdon Geological Society has improved site access with Pebbles for the People. The impressive mammoth sculpture at Chelmsford, with its polished stainless steel tusks and coat of rusted steel representing the braided rivers of that time is an eye catching and innovative work of art. While the new gateway in to the Natural History Museum, the Evolution Garden, showcases the geological wealth of the UK with stone from across the UK nations, including a beautiful ammonite-covered slab from the Jurassic Coast.

Blast off of the multi-million project Fossil Forest project at Brymbo and restoration of the Marquess of Anglesey's Column are two Geological Conservation Review sites in Wales that have received Heritage Lottery funding and will showcase Wales' geodiversity.

We finish off the issue with looking at geodiversity and the arts. Natural England have been developing geoanimations to look at the relationship between nature and geodiversity. While Mrs Mantell's Tooth is a Geologists' Association funded stage performance. Finally we have a report on collaboration between the Geological Society of London and the arts community to look at creative innovation between science and art.

The Editorial team hope you enjoy Issue 62 and put the call out for more wide-ranging content. Please contact the most appropriate Editor listed on the left.



Raymond Roberts, Editor

Coming in early 2025 in the PGA: The Quaternary of Southern England Geological Conservation Review

With publication of a double issue of the *Proceedings of the Geologists' Association* early in 2025 a substantial part of the Geological Conservation Review (GCR) coverage of British Quaternary sites will be described and explained.

These are sites that were chosen to represent the full range of depositional environments and climatic events embodied in the Quaternary record of Southern England. These span two GCR blocks, Quaternary of South-Central England (22 sites) and Quaternary of South-East England (26 sites), with one site (Selsey East Beach) also selected as part of the Pleistocene Vertebrates block (see map).

The GCR was initiated by the Nature Conservancy Council in 1977 to assess and document the most important parts of Britain's

remarkably rich geological heritage. This record of the current state of knowledge of nationally and internationally important Earth science sites in Great Britain was then to provide a firm basis upon which site conservation could be founded in the years to come.

Publication of the GCR, which began with a series of books, continues in the *Proceedings of the Geologists' Association* (see *EH 47* for further information). Sites are still being added or amended to keep this register relevant and useful.

Highlights include recently added river terrace sites within the Kentish Stour system, including Bishopstone to Reculver Cliffs, at the top of which a staircase of Stour terrace gravels, some yielding Palaeolithic artefacts, can be seen above a Paleogene sequence that is also of GCR status.

By Becky Briant (Birkbeck, University of London), Colin Whiteman, Andrew Haggart (The University of Greenwich)



Bishopstone to Reculver Cliffs, showing the capping of terrace gravels descending in height eastwards, towards the towers of the former monastic church at Reculver, visible in the distance. The inset image records a Geologists' Association excursion to the site in July 1912. Photo by Peter Knowles with inset from the Geologists' Association Carreck Archive, courtesy of the British Geological Survey.

Further reading: *An Introduction to the Quaternary of southern England Geological Conservation Review sites* - ScienceDirect.

Differential weathering of rhythmically layered ultrabasic rocks on the Isle of Rum; one of seven UK sites that have entered the second round of the world's top geological sites prepared by the International Union of Geological Sciences (IUGS) and you can find out more on p.17. Photo by Lorne Gill/NatureScot.



The Rocks at the Edge of the Empire

The Rocks at the Edge of the Empire. Ian Jackson. 2024. Northern Heritage Services Ltd. ISBN-10: 1739486145

The Rocks at the Edge of the Empire is the latest book written by Cumbrian geologist Ian Jackson. After a long and successful career surveying the geology of parts of northern England for the British Geological Survey, Ian has since collated a selection of his favourite rocky places in his ever-popular Northern Rocks trilogy, published by Northern Heritage. His first three books focussed on the counties of Northumberland, Cumbria, and Durham, telling the story of their landscapes, history, heritage, culture, and wildlife through a series of 160 geological sites. Ian's latest book builds on this work by skilfully crossing the divide between geology, history and archaeology to tell the story of the Roman frontier and to understand the fabric of its various components for the first time. This book explores how the coastal plains of what are now the Solway Firth and the River Tyne, the remote Pennine hills, and the rugged mountains of the Lake District shaped the Roman occupation of Britain from AD 43 to AD 410. It introduces how the geology of northern England most likely influenced Roman strategic decisions regarding the location of their infrastructure and defences, and the exploitation and trading of available resources. It also highlights the relevance of geology to the dating, provenance and preservation of their remains and environment.

Following a similar format to the Northern Rocks trilogy, this book comprises an eye-catching collection of full-colour, full-page photographs which offer an insight into the northern frontier of Emperor Hadrian's Empire through a geological lens. Each double page is devoted to an individual site and the 50 sites are grouped into four themes based on the prehistoric times leading up to the arrival of the Romans, the natural resources they exploited during their occupation, the everlasting marks they made on the landscape, and the scientific tools used to determine the age and origin of the artefacts they left behind. Each site is accompanied by a couple of paragraphs which describe the unique geological opportunities and challenges presented by the landscape (e.g. building materials, minerals, water resources, effective route lines, treacherous ground, and river crossings), and how these helped shape the day-to-day lives of the Roman occupiers and, at times, tested the resilience of their infrastructure. These include interesting discussions ranging from the instability of the easternmost part of Hadrian's Wall caused by weak clay foundations at Wallsend, the likely extraction of coal seams at Benwell for smelting metals and for heating bath houses, the unresolved origin of jasper and cornelian gemstones discovered in a Roman drain at Carlisle Cricket Club, and the probable sources of the sandstone and volcanic millstones used to process grain to feed the Roman army that are now preserved at Chesters Fort.

As in Ian's previous publications, the text is clear, jargon-free and is written in an accessible manner that is understandable to anyone interested about how the geology of northern England shaped the fabric of Hadrian's Wall and the livelihood of its occupiers. The photos are attractive and vary in scale, with some wider scenic shots, such as the one of Housesteads Fort perched on the doleritic Whin Sill ridge, and other more cropped images that focus on detailed features, such as the Roman inscriptions found in the St Bees Sandstone beside the River Eden at Wetheral. Each site also includes a small insert from OpenStreetMap, showing the location and Ordnance Survey grid reference of the rocky places and the archaeological features, making this book a useful companion for those interested in exploring the sites in person.

Ian's latest book provides an excellent overview of the ancient history of northern England as seen through the eyes of a professional geologist, a perspective which will undoubtedly inspire readers to get outside, explore the spectacular landscape of Hadrian's Wall Country and uncover how the local rocks shaped Roman campaigns and their everyday livelihoods. Ian's book also supports a good cause, with all proceeds raising funds for the Society of Antiquities of Newcastle upon Tyne. The Rocks at the Edge of the Empire was published by Northern Heritage Services Ltd in November and will make a special gift for any hobbyist or professional interested in geology or archaeology this festive season.

By Jonathan Hall, Natural England

The Rocks at the Edge of the Empire

50 extraordinary rocky places that tell the story of the Romans and the landscape of their northern frontier

Ian Jackson



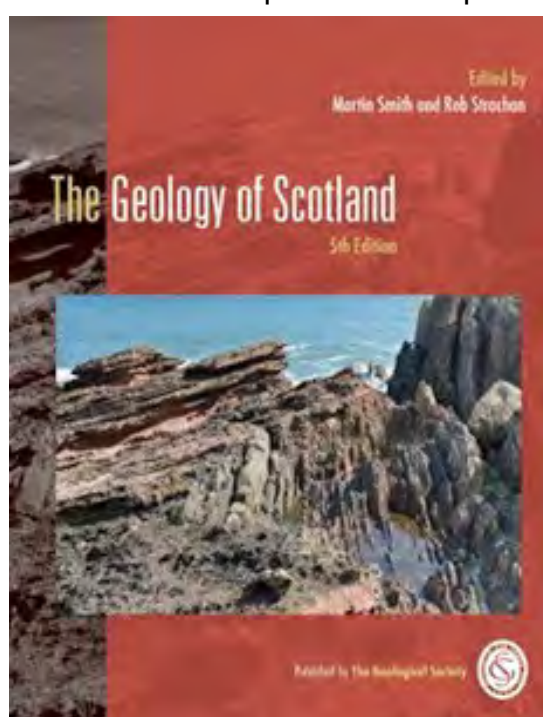
The Geology of Scotland 5th edition

Edited by Martin Smith and Rob Strachan. Published July 2024 by the Geological Society of London. Hardback £130, paperback £90. ISBN 9781786206138

Many of us will have met the Geological Society's "The Geology of Scotland" – not only has it been a mainstay of undergraduate excursions to Scotland since it was first published in 1965, but the wide scope and clear explanations of previous editions have made them the go-to reference books for Scottish geology. This, the 5th edition is much needed, as the 4th edition is now old enough to be graduating from university! The volume contains twelve all-new chapters on geology in chronological order, accompanied by five chapters outlining the significance of Scottish geology.

The publication has attracted many of the big names in Scottish geology. Their chapters follow familiar geological divisions, although the terrane-based chapters of the 4th edition are replaced with more robust chronostratigraphic chapter titles. This means that the 2024 chapter "Late Mesoproterozoic – middle Neoproterozoic" is much more similar in scope to the 1965 edition's "Torridonian and Monian" than the 2003 edition's division between the Hebridean and Highland terranes. This structure demonstrates that the volume is bang up-to-date on recent developments in the interpretation of Scotland's geology – the BGS only reclassified these Precambrian units into megasequences in 2022. The range of expertise brought to bear in this book is shown by the diverse fields and methodologies used to understand Scottish rocks, from the scale of offshore seismic lines to geochemical analyses. This scope makes the volume stronger but may perhaps alienate some audiences as the volume has little room for detailed methodologies.

Whilst each chapter is a worthy summary of its respective field, one of the most remarkable aspects of the volume is how well-connected the different chapters are, especially considering that there are 51 authors. Each chapter begins with a paragraph explaining how it connects to the previous chapter, and the figures use a broadly similar colour scheme throughout, which should help beginners to visually join chapters. This ensures that this volume has the authoritative tone of the previous four volumes and presents its topic confidently without descending too far into academic debates.



Perhaps some more experienced geologists will be unhappy with how their favourite theories are treated – the ever-shifting terminology of the Precambrian is likely to draw some grumbles – but the volume's coherent geological history of Scotland is more detailed and accurate than can be found anywhere else. This is not to say that the volume shies away from debate: each chapter has a page-sized "topic box" in which the authors discuss some of the more controversial aspects of their chapter's subject, and the exhaustive reference lists provide access to both sides of many academic arguments.

The book is certainly a worthy successor to the previous volumes and demonstrates how much progress there has been in Scottish geology over the last 20 years, perhaps best represented by the replacement of three chapters on economic geology with chapters instead highlighting the role

of geology in renewable energy; in a Scottish sense of place; and in inspiring the next generations of geologists. Colin MacFadyen's geoheritage chapter serves as an excellent summary and conclusion, as it draws the book together to emphasise what a wonderfully geodiverse country Scotland is.

By Ben Tindal, Natural England

Rounded glacial roche moutonnée cut into Torridonian Sandstone and Lewisian Gneiss. Bay of Enard, Northwest Scotland. Image by Ben Tindal.



The Geology of London 2nd edition

The Geology of London 2nd edition. 2023. Compiled by Diana Clements. Geology Association Guides no 68. ISBN 9781999675769

Thirteen years after the first edition, the Geologists' Association has released the second edition of *The Geology of London*, compiled by Diana Clements. This new edition builds upon the already comprehensive field guide, updating the initial ten itineraries and providing two additional new ones: Harrow Weald Common and Braeburn Park. Intended for amateur to professional geologists, it now represents all but one of London's geological Sites of Special Scientific Interest (SSSIs).

The itineraries, ranging from London's Cretaceous chalk pits and mines to Crystal Palace's geological landscaping and sculptures, were written by one or more of the sixteen expert authors. Each section provides clear instructions on travelling to its various sites, for both cars and public transport. Clear

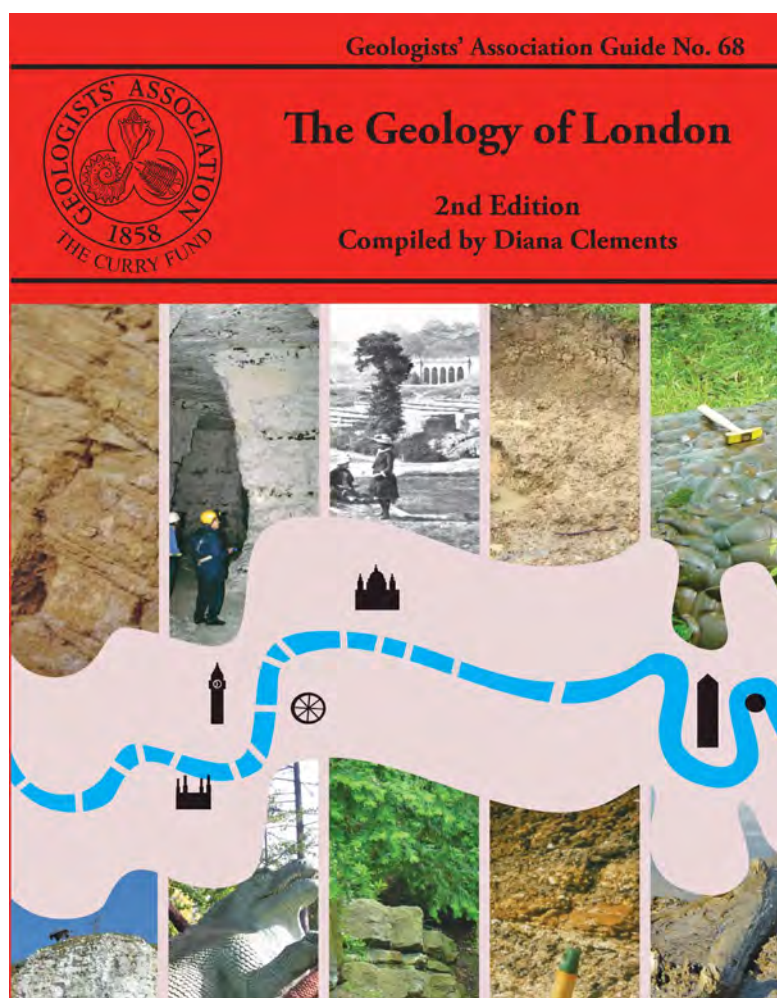
maps and Ordnance Survey grid references also help guide the reader to each locality with features of interest, making the guide easy to follow in the field.

The straightforward layout of each itinerary also further enhances the ease of use. Each section opens with objectives and often an overview to provide the context for the itinerary and local geology. This is followed by detailed descriptions of geological features at individual stops. In addition, I found one of the most enjoyable aspects of the guide is the sharp, full-colour maps, photos, and diagrams accompanying each section. They are a great resource in themselves, meticulously captioned and annotated, and often prove vital in identifying geological features in the field.

The guide's broad scope encapsulates well-known and lesser-known geological sites, providing a varied overview of the city's geological interests and features at different scales. This encourages the reader to explore parts of the city, potentially off the beaten track. For example, Itinerary 10 stops at several sites along the length of the River Thames, while Itinerary 2 delves into the underground mines at Pinner (although the mines at Pinner are currently inaccessible). This makes it versatile, with field trips for any ability. This versatility is further reinforced as, although designed to serve as a practical field tool, it can be just as well read selectively for specific topics or even be enjoyed without stepping outdoors.

While principally focused on geology, the book also proves insightful into how London's urban development has influenced and revealed its underlying geology from Roman times to today. Most notably, it showcases much of London's industrial and mining heritage.

I also enjoyed how, the guide highlights numerous examples of the often-unsung efforts of geoconservationists in London, whether that be the interpretation or fossil-collecting areas of Abbey Woods, the geo trail of Harrow Weald Common or the viewing platforms at Gilbert's Pit.



On a more practical note, after carrying the book in my backpack while I read it over the past few months, I've found the binder less durable than I expected. The spine bent over time, causing pages to fall out that needed reinserting, a problem that could perhaps be solved with a paperback or hardback version of the guide.

However, despite this, I highly recommend this field guide to anyone who wants to explore and understand London's fascinating geological history. Whether for personal interest, group field trips, or for the working geologist, this field guide provides an excellent in-depth geological and historical overview of a landscape that might initially seem unremarkable for geological excursions.

By Joshua Smith, Natural England

Carsaig arch, an artwork by Calum Wallis, an artist who spoke at Earth's Canvas: Exploring Geology in Creativity. This conference brought together diverse disciplines, cross-cutting the practice of geoscience and the arts, to explore the impact of geology on creative observation, articulation, expression and outreach. Find out more on p.50.



Revealing the rocks at Scrabo Hill

Michael Dempster, Northern Ireland Environment Agency

Scrabo Hill, with its iconic tower, lies just outside the town of Newtownards in Northern Ireland, around 16km east of Belfast. Overlooking the Strangford and Lecale Area of Outstanding Natural Beauty, it is visible for miles around, having survived the ravages of the last ice age which shaped Scrabo and the rolling hills that surround it.

The hill was quarried mainly for its Triassic sandstone (Sherwood Sandstone Group) from the seventeenth century, reaching a peak in the nineteenth century. 'Scrabo stone' was much prized, being used for many grand buildings along with housing stock in and around the Belfast area and beyond. The presence of cross and planar laminated bedding, desiccated mudstone, ripples, erosive channels and rip up clasts indicate mainly fluvial deposition of the sediments in a hot terrestrial environment, with periodic shallow water bodies.

The sandstone outcrop is capped by a transgressive Palaeogene age dolerite sill and numerous dykes that cut through the sedimentary rocks, intruded as the Earth's crust was being stretched during the opening of the North Atlantic Ocean. An explosive volcanic vent agglomerate which pre-dates the intrusion of the sill and dykes is also present at the site (Preston, 1962).

The geology of Scrabo Hill is an important part of Northern Ireland's natural heritage. The former quarries on the south and north sides of the hill were declared as Scrabo Area of Special Scientific Interest (ASSI) in 1995, solely

All images © NIEA

Scrabo Hill and Scrabo Tower. The tower was built in Scottish Baronial style as a memorial to Charles Vane, 3rd Marquis of Londonderry in the 19th Century. After its completion in 1859 it was inhabited by the Scrabo quarry foreman and his family as caretakers. His descendants ran a tearoom in the tower until 1966. The author's father-in-law laments that his parents couldn't afford to buy him a sausage from the tearoom when he visited as a child in the 1940s!!



The main face of the south quarry at Scrabo. The dark bands crossing the paler sandstone near the top of the face clearly show the transgressive nature of the dolerite sill that also caps the hill.



for the geology found there (DAERA, 2015). The geological ASSI features are Palaeogene igneous, Triassic stratigraphy and Upper Palaeozoic Palaeontology. The palaeontology feature reflects historic trace fossil finds, including a single tetrapod footprint (*Chirotherium?*), though the potential for more discoveries remains (Buckman and others, 1997). The ASSI is entirely within Scrabo Country Park and formal paths provide public access to the whole site.

Geology and sustainable development

The Triassic sediments exposed at the site are from the Sherwood Sandstone Group. The sandstone is Northern Ireland's best groundwater aquifer and at the time of writing is the focus of active research into its potential as a geothermal energy source (Geo Energy NI, 2024) <https://geoenergy.ni.org/demonstrator-projects/>. Using these potential resources sustainably would make a significant contribution to reducing greenhouse gas emissions in the region.

Scrabo ASSI contains the best vertical exposures of the Sherwood Sandstone in Northern Ireland so is a key field locality for researchers and where geologists, engineers and policy makers involved in developing groundwater or geothermal resources can examine its properties above ground. Scrabo ASSI is therefore a perfect example of how geology makes a vital contribution to sustainable development goals and has great potential to demonstrate this, the principles of geology, and the importance of geoconservation to the public.

Time for some TLC

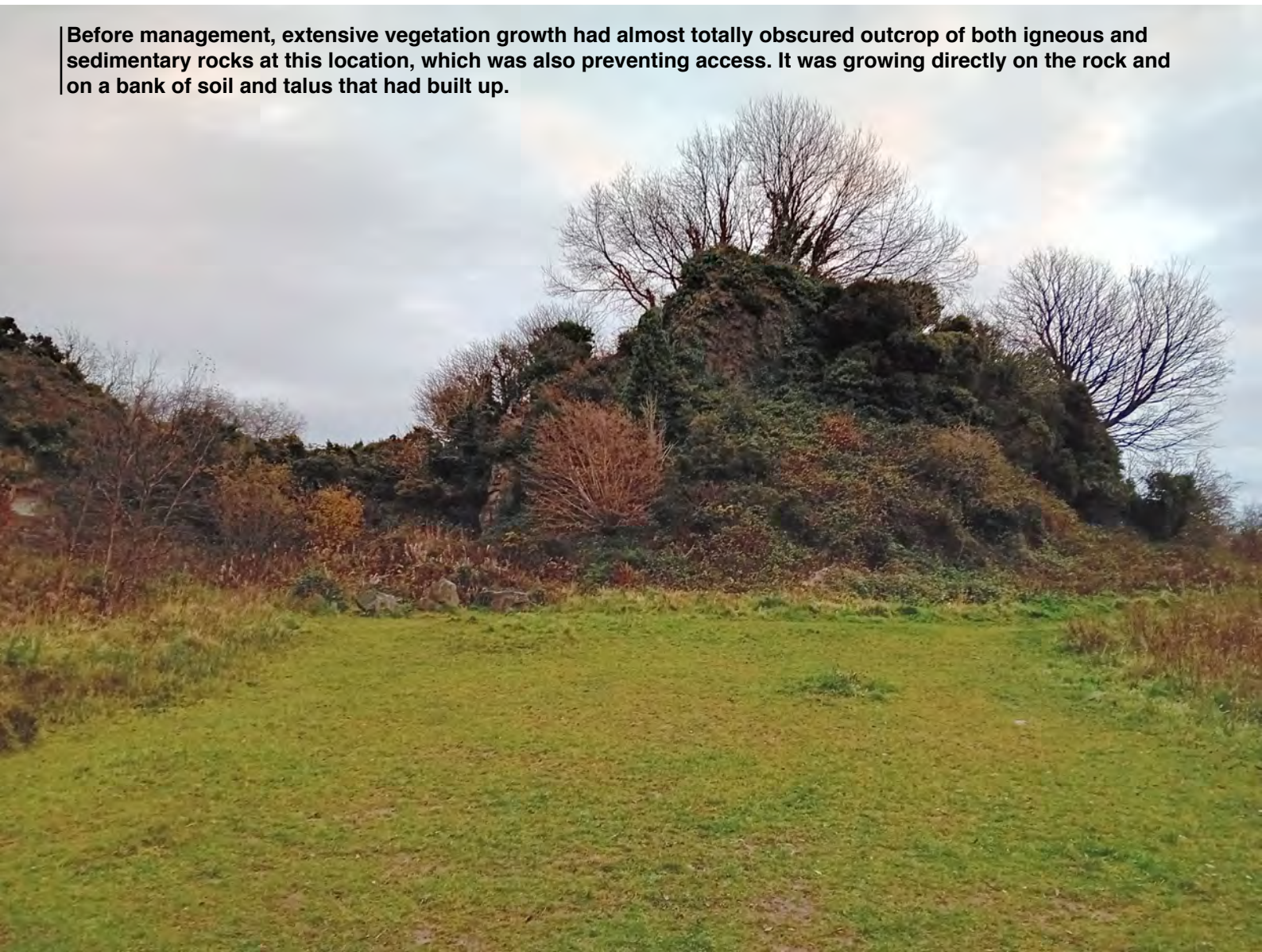
All ASSIs in Northern Ireland undergo regular Condition Assessment by Northern Ireland Environment Agency (NIEA) to determine the conservation status as either favourable or unfavourable. In 2019, the features at Scrabo ASSI were assessed as being in unfavourable condition, primarily due to the growth of vegetation through the site. This was preventing visibility of, and access to, the important geology of the site so management of this was recommended.

It was recognised that managing vegetation across the whole site, an area of almost 26 hectares, as one project was not possible for financial and logistical reasons. There is also little experience of such practical management on geosites in Northern Ireland, so with that in mind, a pilot management project was initiated as a first phase to inform and develop approaches to further work phases.

A section of the south quarry was chosen for the pilot project as it was known to contain representative elements of the sedimentary and igneous site features, with the added benefit of being readily accessible to vehicles, facilitating contractors and their equipment.

Vegetation growth was extensive in this area and the plan was to remove it from on and in front of the rock faces using hand tools or chainsaws as required. The south quarry also hosts a population of Common Lizards, Ireland's only native reptile, so an area of vegetation was left in place to maintain

Before management, extensive vegetation growth had almost totally obscured outcrop of both igneous and sedimentary rocks at this location, which was also preventing access. It was growing directly on the rock and on a bank of soil and talus that had built up.





Left and Below: After management, the same locations as in the previous picture. The management work has re exposed and provided access to sections of sandstone and one of the dykes in Scrabo ASSI. Much work remains to be done in the site, but now representative elements of the stratigraphy and igneous site features are once again visible and accessible.



habitat for them. The lizards also dictated when the work could take place – outside their breeding season and main period of activity – so it was completed in January-February 2024. This also avoided the bird breeding season.

When the work started, it quickly became apparent that the vegetation in many places was growing on a bank of soil and talus that had accumulated over the years. Disposal of this off site would have quickly used the available budget but, luckily, the clearance works also revealed a depression that was large enough to accommodate this material. This had the added benefit of providing level access to part of the cleared area.

Much of the removed vegetation was taken off site, with the larger trees and scrub being chipped on site and used as mulch in front of one of the rock faces to slow the growth of vegetation.

The clearance work was completed over six weeks and the contactors found the work relatively straightforward, though the soil and talus meant more time in a mini digger than anticipated! The work has successfully re exposed one of the dykes in the site and sections of the Triassic sediments.

Next steps

The pilot project has demonstrated that removing vegetation from geosites in Northern Ireland is both practical and can deliver good results for geoconservation in a short period of time. As mentioned above, the area chosen contained a range of site elements, had easy access and was logistically straightforward to work on.

The work has improved access to and visibility of the geology in part of the site, however further management is required to return Scrabo ASSI to favourable conservation condition. The remainder of the site is in general more technically and logistically difficult to manage as it has restricted access, high vertical faces and many, many more trees to consider! At the time of writing, information is being gathered to draft a multi-year plan for Scrabo ASSI that will permanently expose the key geological features and provide ongoing management, interpretation, safe access and viewing areas for visitors to the country park.

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Seven more UK geosites recognised as globally important Geological Heritage Sites

Colin MacFadyen, NatureScot, Jonathan Larwood, Natural England, and Raymond Roberts, Natural Resources Wales

Issue 58 of *Earth Heritage* magazine reported that in October 2022 three iconic geological locations in the UK, namely, The Giant's Causeway, Ynys Llanddwyn on Anglesey and Siccar Point were included in a list of the world's top 100 geological sites prepared by the International Union of Geological Sciences (IUGS). 'The First 100 IUGS Geological Heritage Sites', was a significant advance in international collaborative efforts to audit and promote geological sites for conservation and promotion in the global context. Each site is iconic and recognized by the international geoscience community as a reference for the impact and contribution it makes in understanding the Earth and its history.

'The First 100' represented a milestone in achieving the long-held aspiration, of members of the geoscientific community, for the development of a global network of sites of highest conservation value internationally. It was anticipated that this work would develop to encompass a much larger network of Geological Heritage Sites. Such was the positive reception of 'The First 100', with the value and role of having such a network being widely realised, that the IUGS embarked on a second round of site selection. More than 700 specialists representing different disciplines of Earth Sciences, based in nearly 80 nations across the world, worked to propose candidate sites and a reconvened team of international geoscientists evaluated the merits of each site to produce 'The Second 100'.



Metamorphic Barrow Zones in Scottish Highlands: A view of the River North Esk, Glen Esk, within the Southern Grampian Highlands, northwest of Montrose, not too far north of the Highland Boundary Fault. The Dalradian metamorphic geology here illustrates a series of mineral assemblages, in metamorphosed mudstones, that demonstrate increasing metamorphic grade to the northwest away from the fault. British Geological Survey geologist George Barrow mapped the mineralogical variation in the early 20th century and established the eponymous 'zones'. Glen Esk, with the Barrow zones in evidence, has become a classic field trip locality. Photo by Owen Weller-Gibbs.

'The Second 100', announced by the IUGS, in August 2024, includes three locations in England one location in Wales, and three locations in Scotland. There are now 11 IUGS Geological Heritage Sites in the UK. The recent additions are:

Brittle Structures of the Somerset Coast – spectacular faults and folds exposed on the foreshore and cliffs of Kilve: a classic demonstration of the complex process of fault and fold formation across time in response to global and local earth movements. [Category: 'Tectonics'].

Granite Landforms of Dartmoor – the iconic Dartmoor granite tors which are today considered a benchmark for understanding the evolution of upland granite landforms in response to glacial and post glacial change. [Category: 'Geomorphology and active geological processes'].

Jurassic Coast: Lyme Regis – the classic Lower Jurassic Lyme Regis coastline, made famous by the fossil collector Mary Anning. Today, it remains among the most prolific sources of marine invertebrate and vertebrate fossils and is part of the Jurassic Coast World Heritage Site. [Category: 'History of geosciences'].

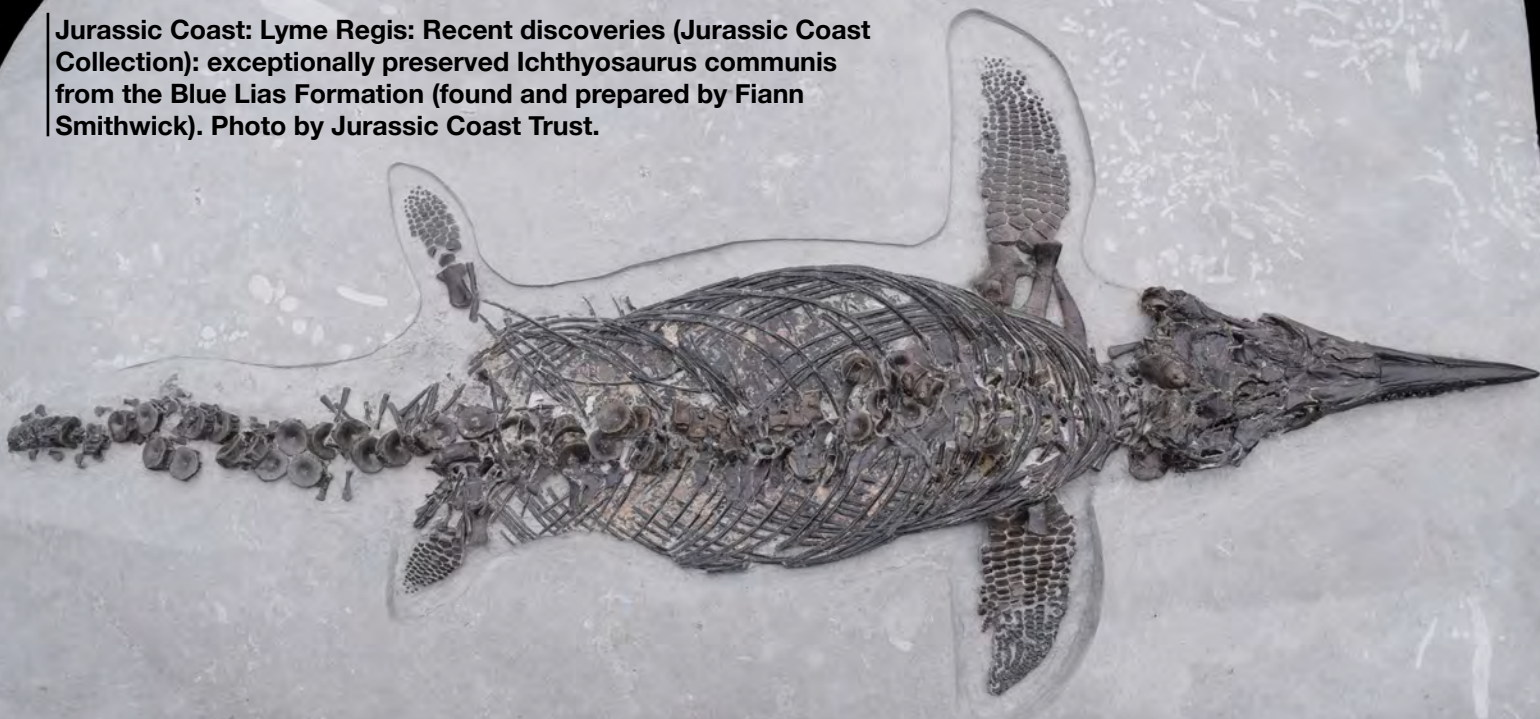
Cavansham Ferry and Llanstephan Quarries – an important site in the history of geological sciences where Sir Roderick Impey Murchison identified the outcrops on the banks of the River Wye as "the first true Silurian". [Category: 'History of geosciences'].

Metamorphic Barrow Zones in Scottish Highlands (Glen Esk and vicinity) - the Glen Esk area was where the first systematic study of regional metamorphism, through analysis of index minerals in metamorphosed mudstones, took place. [Category: 'History of geosciences'].

The Parallel Roads of Glen Roy - an iconic suite of glacial lake shorelines that underpinned the development of the Glacial Theory in the 19th century. [Category: 'History of geosciences'].

The Rum Igneous Complex - a superb array of shallowly emplaced ultramafic to felsic igneous rocks that differentiated in an open system and concentrated precious metals. [Category: 'Igneous and Metamorphic petrology'].

Jurassic Coast: Lyme Regis: Recent discoveries (Jurassic Coast Collection): exceptionally preserved *Ichthyosaurus communis* from the Blue Lias Formation (found and prepared by Fiann Smithwick). Photo by Jurassic Coast Trust.





Granite Landforms of Dartmoor: The coarse-grained granite tor at Haytor. Weathering has occurred along both vertical and horizontal joints in the rock to give the tor its characteristic shape. Dartmoor is a benchmark site for studies of the evolution of granite landforms and periglaciation of uplands. Photo by Michael Murphy, Natural England.



Brittle Structures of the Somerset Coast: Cliffs and foreshore at East Quantoxhead showing the brittle deformation structures. The Somerset coast displays fantastic exposures of faults, folds, veins and joints in Permo-Triassic marls and sandstones and in Liassic shales and limestones. © Jamie Foster/Geckoella Ltd (2024).



The Parallel Roads of Glen Roy: Three dominant parallel lines contour Glen Roy, part of which is a National Nature Reserve, at 350 m, 325 m and 260 m. The lines were originally considered to be 'roads' developed along the hillside. John MacCulloch, Charles Lyell, William Buckland and Charles Darwin were among the philosopher luminaries that theorized the origin of the roads with suggestions that the parallel lines, cut into the landscape, were created by shorelines from the sea or by ancient lakes. Louis Agassiz' theories of an 'ice age' later led to the proposal that the 'roads' were formed by lakes dammed by glaciers. Photo by Lorne Gill/NatureScot.



Top: It was at Cavansham Ferry and Llanstephan Quarries that Murchison began to establish what later became the Silurian. He later added “N.B. This was the first Silurian” to the section across the Wye Valley which he drew in his 1831 notebook. This lithograph of Murchison was drawn only a few years after his fieldwork on the banks of the River Wye in mid Wales. Image courtesy of Duncan Hawley.

Below: The Rum Igneous Complex: Differential weathering of rhythmically layered ultrabasic rocks on the Isle of Rum. The layers formed within a magma chamber that was periodically replenished with picritic magma during Paleogene volcanism. The precious metals gold, silver and platinum group minerals are found in association with chromite seams. Various models have been presented to explain the formation of the layering in terms of magmatic sedimentation involving crystal settling and sorting. Studies of the Rum Layered Centre contributed to coining of the term ‘igneous cumulate’. Photo by Lorne Gill/NatureScot.



Underscoring the specialness of the sites is the key benefit of Geological Heritage Site status in the UK context. The appellation provides an opportunity for substantially raising the profile of the geosites, and the importance of UK geology generally, with the general public. Today, it is the unique role of the nature conservation bodies in conserving most of these sites, as SSSIs, that ensures their continued contribution to global research and learning now and for generations to come. Elsewhere, internationally, Geological Heritage Site status will hopefully benefit efforts to conserve important geosites in countries where protection is not as robust as the UK.

Selection of ‘The Third 100 IUGS Geological Heritage Sites’ will be undertaken in 2025 with ratification and announcement, by the IUGS Executive Committee, due in late 2026. Undoubtedly, sites in the UK identified as being of the highest scientific and conservation value as well as being inspiring and extraordinary places, contributing significantly to the development of Geological Sciences, will feature in ‘The Third 100’.

Further information

MacFadyen, C., Dempster, M., Roberts, R., Torvela, T. 2023. Four UK sites included in the IUGS ‘First 100 Geological Heritage Sites’. *Earth Heritage*, issue 58, pages 50-55.

International Union of Geological Sciences (IUGS) : [IUGS | International Commission on Geoheritage](#)

Pebbles for the People! Geology at the heart of the community – an update on Harrow Weald

Liz Chiu, Community Engagement Officer for the Harrow & Hillingdon Geological Society



Geology is best learnt in the field. One challenge in London is the apparent lack of local sites of interest where Earth Science is on show and easy to access – or is it time to dispel that myth? The London Geodiversity Partnership lists almost 100 sites of geological interest within the Greater London area, seven of which are Geological Sites of Special Scientific Interest (SSSI).

To the northwest, Harrow & Hillingdon Geological Society can boast two of London's SSSIs. One is at Harefield Great Pit, a former chalk quarry where rare trace fossils are exposed in a small remnant of chalk; a layer of gravel above this marks a 50 million year time gap and above that is a bed of exquisite golden sand that displays fine cross-bedding. Walking along this stretch of the Colne Valley, local people will notice the clay that sticks to their boots giving way to gravel as the footpath rises; from hilltops they can see geology displayed in the stunning chalk landscape and they can get up close to large flint boulders emerging from the chalk now, as they have throughout history to provide local building stones. Harefield is an excellent training ground for budding geologists and is just a short bus ride from Uxbridge tube station.

The second of our geological SSSIs can be found on Harrow Weald Common, easily accessed by the 258 bus route from either Harrow or Watford. It is designated for the 'Stanmore Gravel' which covers many hilltops across the north of London at approximately 150m elevation. On Harrow Weald Common, near Stanmore, a large plot of private land holds a disused gravel quarry with a historically listed kiln house nearby. The quarry site has been untouched for 100 years and provides an intriguing wild ecosystem within London. Separating the old quarry from the rest of the Common is a perimeter fence on top of a 3m bank.

After work earlier this year, that 3m bank now displays a rare exposure of Stanmore Gravel (see *EH61*). In April 2024 we cleared two small vertical sections to see whether the gravel in the bank had preserved any original depositional features, fearing that it might be just a pile of discarded waste from historic gravel-digging. We found an original deposit with distinctly different beds at three levels and some possible bedding features. Sand, pebbles and bulk samples were collected and taken for analysis at Durham University and Brunel, University of London.

In July we extended the larger section to reach ground level and found some more distinct bedding features including a horizontal sand lens. And on 25th October we went down 1m below ground level at the same site to see if we could reach the base of the Stanmore Gravel deposit. We dug through a metre of undifferentiated grey sandy soil and really didn't expect what came next – a single large flint and a piece of iron-cemented sandstone which, when removed, revealed some rather beautiful, strikingly orange mottled clay. Is this part of the Stanmore Gravel? Or is it the underlying Claygate Beds, marking the top of the London Clay?

We have uncovered a geological mystery that's waiting to be solved. The timeline of the gravel is unknown, extending back through the Ice Ages possibly 2 million years, and certainly including changes

Excavated section exposing Stanmore Gravel at Harrow Weald Common.



in climate back and forth from potentially hotter to much colder than now. The arrival of the gravel in Harrow begs the questions: Where did it come from? How did it get here? What was it carried by? As we start to investigate, we have only questions, no answers yet.

The public love a good mystery. Our 'dig' site attracts plenty of attention from local walkers in this popular and convenient woodland-with-a-view. Brightly coloured signs tell them something of the history and invite them to get involved. Passers-by often stop for a chat to ask what we are doing, what we have found, and what the gravel can tell us about the local area in times gone by. They feel connected because they have been playing with the pebbles since they were children. They are intrigued by the shapes and patterns in the bank and the unexpected colour. And they feel a sense of wonder because they never previously imagined the long journeys through time and space of each individual pebble.

There is really nothing like getting your hands on the active geology of your own neighbourhood, picking up and holding a smooth and colourful stone or finding something in nature with a story to unravel that stretches back through time. This is the 'hook' that might make people want to learn more and could be a way into geology that is more accessible for Londoners than the show-stopping sites on the coast. With this in mind we are looking for ways to connect local people with their pebbles through our Community Science project. We have provided hands-on displays at various exhibitions and our own Earth Discovery sessions, and on 22nd April 2025 we will be giving a Tuesday Talk on the Stanmore Gravel Project for Harrow's Headstone Manor Museum.

One idea is to hold a "Pebble Day" during the school holidays. Younger children could sort pebbles by colour, shape, smoothness, and size. Those who are more focused could try to pick out pebbles that look different from the rest, ultimately searching for anything that is not a flint. In the process, everyone would learn something about geology, such as the origin and some of the properties of flint, weathering processes, iron

enrichment, the effects of cold and hot climates, or simply what connects local geology to local industry, buildings, and history.

In September, a workshop was held at Brunel University for members of the Stanmore Gravel Project. Dr Phil Collins hosted us and provided training using equipment for sorting, inspecting and randomising samples. The bulk samples from Harrow Weald Common were sorted into grain sizes using Endecott sieves, and the fine material will go for tests. Two project members used tweezers to pick out black grains of sand which stood out from the mostly clear quartz grains. These could be tourmaline, and one possible source for tourmaline in the gravel would be reworked Bagshot Sands, noticeably absent at Harrow Weald Common according to official records. Dr Peter Taylor and Prof David Bridgland guided the pebble counting and analysis. Project members filled in record sheets detailing sets of pebbles of specific sizes for comparison with previous studies: 11.2-16mm and 16-32mm. A short video shows highlights from the day's activities: [Pebble Analysis Workshop at Brunel University](#).

Leveraging skills learnt that day, might local adults be trained in some similar activities and potentially contribute to our research? This is much harder to prepare for and control as scientific rigour would need to be achieved, but we are starting to consider ways of introducing sufficient supervision and cross-checking into the system. If such an event could develop enthusiasm for science in the community, that in itself could be a goal worth aiming for.



Left: Stanmore Gravel on display at the Festival of Geology, Burlington House, 2nd November 2024.

Below: Training workshop at Brunel University, 9th September 2024.

All photos by Liz Chiu.



A mammoth arises near Chelmsford

Ian and Ros Mercer, GeoEssex

A mayoral launch of this mammoth piece of artwork for the Channels housing development near Chelmsford, Essex, took place in September this year. Local geologist Ros Mercer, secretary of county geoconservation steering group GeoEssex, was given the opportunity to present the geological story behind the choice of a 'spirit of mammoth' artwork in a speech to the thirty people assembled.

Imagine the scene half a million years ago – low tundra scrub with a vast unbounded snow-melt swollen river – the ancestral Thames – flowing across it. This was the view at Channels, near Chelmsford in mid-Essex. Grasses and sedges were grazed by migrating herds of cold adapted beasts – giant deer, woolly rhinos and of course mammoths, hunted by sabre tooth cats and humans.

As the climate cooled the ice sheet to the north expanded and edged its way southwards, burying the north Essex landscape in hundreds of feet of ice. When the ice eventually melted, it left a mantle

of glacial boulder clay – a till plateau of ground up rock flour, lumps of chalk and boulders of hard rock from Scotland, Scandinavia and from northern areas of England.

How do we know? The evidence is here beneath the soil. The top of the plateau was good farmland ready limed by the chalky boulder clay brought by the ice sheet. The valley sides were covered in pebbly mud washed down from the tops. This 'hoggin' was useful for road building and pits were dug along Broomfield village in the Chelmer valley.

The quarrying moved across the valley to Channels Farm. One day, the story goes, a large Irish quarryman dug a particularly deep pit and beneath the layer of clay, lovely clean sand and gravel was revealed – 'Essex White Ballast'. This was the bed of the ancestral Thames. Mid Essex Gravel exploited it to the full. But like all good things, it came to an end and other uses for the land were sought.

GeoEssex, the county geological conservation group were looking for a way of bringing this Ice Age story to public attention and here was our opportunity. The conversation commenced in 2008. We kept in touch and waited until the building reached

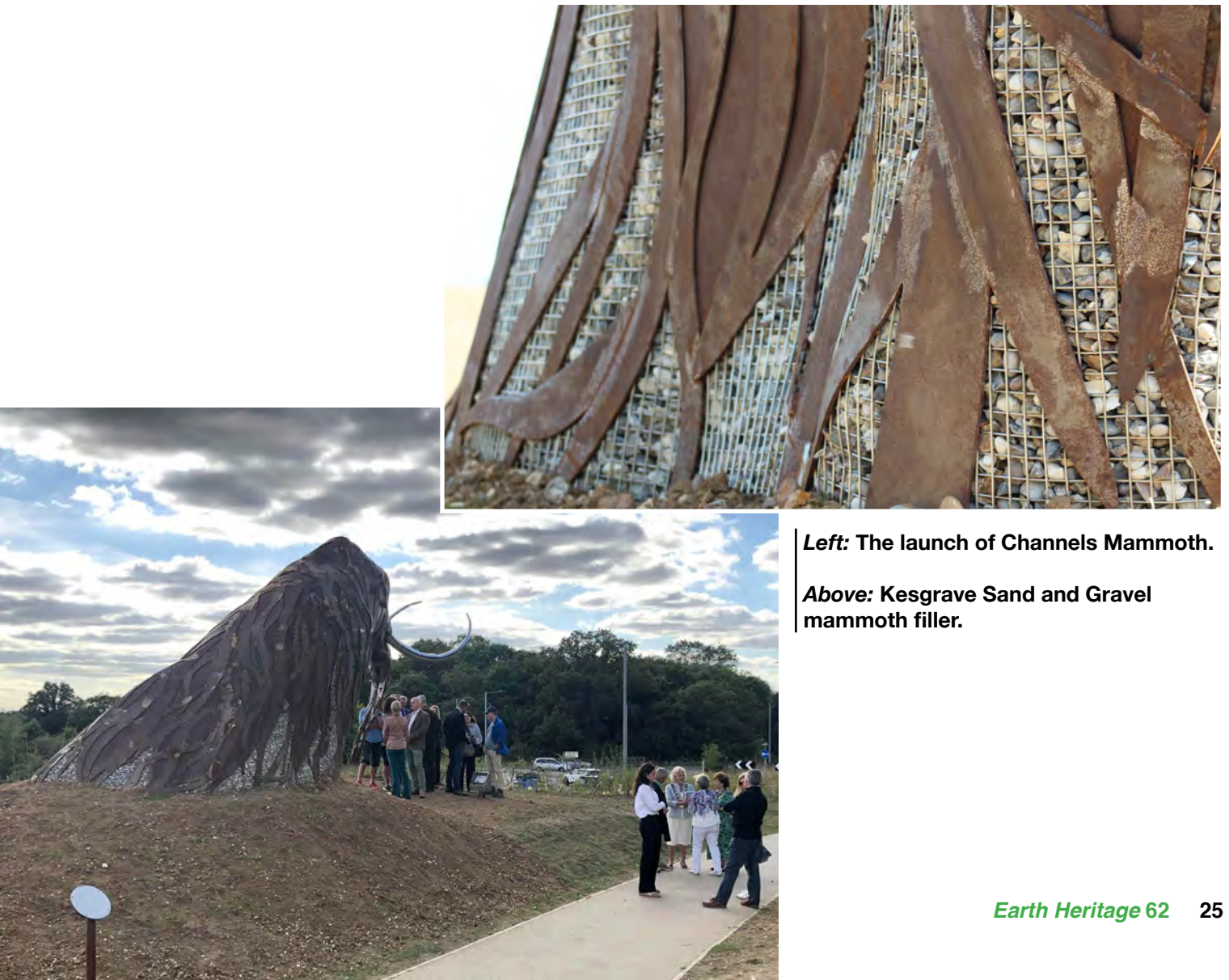


Sculptor Michael Condron with local geologists Ian and Ros Mercer. All photos by Ian Mercer.

the appropriate stage. We talked to the site owners and the developers and we managed to persuade Marden Homes to preserve a section of the old quarry wall where the chalky boulder clay is still visible – the only publicly accessible exposure in Essex as far as we know. They have put in a path and we have installed a sign board to tell the story of the ice. There's also a large puddingstone there, one of several from around the Channels site that were found at the bottom of the Thames gravels. These and the sarsen stones have their origin in a global heating story, which is told on a signboard by another puddingstone by the village green.

The site owners told us that there might be a chance to tell more of the Ice Age story through the artwork that was an integral part of the planning permission. We waited for the opportunity and Ian and I were invited to the initial meeting at the Chelmsford City Council to consider a theme that would be comparable to the deer in Henry VIII's palace grounds at the nearby Beaulieu estate. There was silence round the table as we wracked our brains – 'How about an Ice Age theme', we said, 'how about a rusty mammoth', said Ian. The seed was sown and here we are.

Now, rising out of a prominent knoll close to the roundabout on the busy A131, this real-size 'Spirit of Steppe Mammoth' reminds us of the effects of the huge climate changes through this ice age and the resulting layers of gravels, sands and glacial till underlying the landscape. The polished stainless steel tusks contrast with the rusting steel 'braided river' streams of its coat. Rising out of the grassed gravel bank, its wire mesh base is filled with ancient Thames gravel from the Kesgrave Sands and Gravels Formation at nearby Bulls Lodge quarry. Its eyes are polished vein quartz cobbles from the same deposit. Floodlit at night, its tusks shine out above the skyline.



Left: The launch of Channels Mammoth.

Above: Kesgrave Sand and Gravel mammoth filler.

Articles from the Geologists' Association's Magazine

David Bridgland, The Geologists' Association

The Geologists' Association (GA) includes geoconservation and geodiversity amongst the interests it fosters. It should be no surprise, then, that there is much of relevance to *Earth Heritage* readers in the pages of the GA Magazine, which is supplied as part of membership of the Geologists' Association. The magazine has a new editor in 2024, Cathryn Symons. Cathryn replaces Liam Gallagher, who became the GA President in May 2024. Here are some of the relevant highlights from the first GA Magazine to be produced by Cathryn: Volume 23, No. 3, September 2024.

In 'From the President' Liam reports that one of his first duties as GA President was to visit the National Stone Centre in Derbyshire (see <https://www.nationalstonecentre.org.uk/>), where the Mary Anning maquette was installed for the months of May–July inclusive as part of the tour to different venues around the country of this model made prior to erection of the partly crowd-funded statue overlooking the cliffs at Lyme Regis (see <https://geologistsassociation.org.uk/maryanning/>). The National Stone Centre, which coincides with the Colehill Quarries SSSI, notified for Carboniferous Limestone interests, has appeared in past editions of *EH*, most recently *EH* 32, p. 19; *EH* 24, p. 5. The GA President was clearly impressed with the range of geo-trails and family activities it has to offer.

A further highlight is a report on a field trip to Bulls Lodge Quarry, Chelmsford, led by Peter Allen, Ros Mercer and Ian Mercer. This combined a re-enactment of a GA field trip to Chelmsford in June 1895 (appropriate 'fancy dress' was donned by several participants), with inspection of potential geo-conservation initiatives in the context of rapid disappearance of exposures in unconsolidated Pleistocene strata. The party also inspected a mammoth artwork statue, part of the impressive and commendable range of geologically inspired features incorporated into a new housing development that is part of the Channels Estate at Chelmsford (see p. 24, this issue, for a report on the mammoth).

Also on view were blocks of puddingstone, a supposed glacial 'dropstone' and an exposure, tastefully sheltered beneath a canopy of vegetation, called the 'Ice Age Cliff'. This is a section through the approximately 0.5 million-year-old glacial deposits that were once quarried here; perhaps it sets a marker for the style of future conservation exposures.

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The Extinction of a Giant Apex Predator: Implications on a Food Web Structure | Evolution Garden at the National History Museum | Absence of Regional Stratigraphic Hiatus in the late Carboniferous in the Northern Variscan Foreland | Wealden 'Smokejacks' brickworks field report | Mrs Mantell's Tooth | All About Ammonites | The Discovery of a Dragon | Hampsted Heath field report | Bulls Lodge Quarry field report | Rockwatch





Two highlights from this issue of the GA magazine:

Left: The 'Ice Age Cliff', with explanation board and nearby recumbent puddingstone boulder.

Below: A re-enactment of a GA field trip to Chelmsford in June 1895 led by Peter Allen, Rosalind Mercer and Ian Mercer.

Photos by Rosalind Mercer.



The issue also includes:

- An update on the SchoolRocks! initiative, reporting on increasing activity and new themes, such as evolution (see also *EH*48, pp 46–47).
- An illustrated report by Diana Clements on the new Evolution Garden at the Natural History Museum in London, opened in the summer and accessible free of charge, see this issue of *EH*, p.28 for our own report.
- Reports on previous GA Evening lectures.
- A report linked to the 2022 GA Richardson award documenting detective work that has traced the source location of important plant fossil specimens; this is by Christopher Cleal and Bernard Besty, who note that their topic could be referred to as 'ex-situ geoheritage'.
- A report by Ed Jarzembowski and Pete Austen on a GA field trip led by them to the Wealden 'Smokejacks' brickworks, with excellent illustrations of fossils from this site (which is otherwise known as the Ewhurst Brickworks or the Smokejack Clay Pit SSSI).
- A Curry Fund project report on Mrs Mantell's Tooth – see this issue of *EH*, p. 46 for more details
- A report on a guided geological walk on Hampstead Heath, led by Di Clements and Dee McLean, coinciding with the launch of the Second Edition of the GA Guide 'The Geology of London' (see this issue *EH*, p.9 for a review of the publication).



View through the Evolution Garden towards the Natural History Museum. All images © The Trustees of the Natural History Museum, London unless otherwise stated.

The Evolution Garden

Paul Kenrick, The Natural History Museum, London

The Natural History Museum reopened its gardens on 18 July 2024 following a redesign of the 2-hectare site that has transformed it into an engaging, accessible, and free-to-visit green space in the heart of London.

On the east side, a new Evolution Garden explores 2.7 billion years of Earth history through an immersive timeline of plants, geology, and representations of animals in brass and bronze. On the west side, the Nature Discovery Garden supported by The Cadogan Charity showcases biodiversity found in the UK's urban spaces and is home to curated habitats including chalk grassland, meadow, and a pond traversed by a sunken pathway. Between these gardens, and framing the main entrance on Cromwell Road, are two large planters that contain a flora from Macaronesia, reflecting our historic collections and ongoing research by Museum scientists in this volcanic archipelago in the North Atlantic.

The Natural History Museum welcomes over 5.5 million visitors annually, and the Evolution Garden is the busiest part of our site connecting to South Kensington tube station via a tunnel link and a ramp from street level. This garden gives us an opportunity to engage the public in new ways and to improve the visitor experience. Our aims are to help visitors gain a sense of the scale of geological time, to convey some of the great changes in Earth's flora and fauna, and to draw connections between the evolution of life and geological processes.

The visitor journey through the Evolution Garden is scaled to the Phanerozoic Eon, with 1 metre equivalent to 5 million years. Geological periods are marked in the path by brass strips and in the

landscape with rocks of appropriate age. Over 30 different rock types are included, all but two from the UK, including pieces from all four nations.

The Transport for London tunnel entrance opens into a canyon clad in our most ancient Precambrian rocks from Scotland. This Evolution Timeline supported by The Evolution Education Trust includes 2.7-billion-year-old Lewisian gneiss from the Western Isles, Torridonian sandstone from the Applecross Peninsula, and a greenschist from Argyll and Bute. The protolith of the gneiss is so ancient that it was laid down before there was free oxygen in Earth's atmosphere.

This sequence is followed by a Cambrian quartzite from the Northwest Highlands; outcropping as a thin layer from Durness to Skye it is very similar to rocks in East Greenland, Svalbard, and Newfoundland, all once part of the ancient continent of Laurentia. The quartzite abuts a Welsh purple and blue-grey slate, a roofing material extensively quarried and now recognised as the UNESCO Slate Landscape of Northwest Wales World Heritage Site.

Moving along our timeline, we encounter a light grey Ordovician granite from Aberdeenshire followed by a green Borrowdale slate from Cumbria. In the Silurian there is a pink granite from the Highlands, and in the Devonian a deep-red sandstone from Herefordshire, and so forth through the garden. This geological sequence can be read simply as a colourful array of rocks of varied textures and hues, but it also showcases some of the UK's distinctive geodiversity and tells a story of the opening and closing of ancient ocean basins and the collisions of continents. These are geological processes that have shaped our islands, lending character to some of their most distinctive terrains.

Plants are used to create a sense of place, to help convey the narrative of change, and to tell their own evolutionary stories. In the Carboniferous Period, tree ferns and smaller herbaceous ferns are

planted in an area bordered by a low retaining wall of quartz dolerite and a swale filled with a granular mulch of Derbyshire Dove Holes Limestone with horsetails growing through.

In contrast, the Jurassic Period is dominated by conifers with a ground cover of small ferns and cycads set in a mulch of Portland Stone. Flowering shrubs and herbs emerge in the Cretaceous, palms in the Paleogene create a feel of warmer climates, and in the Neogene grasses and flowers in the daisy family signify the development of open grassland communities. These changes in flora influenced the evolution of animals, and examples across insects, dinosaurs, and mammals can be seen in the associated interpretation.

Animals are represented as bronze sculptures in the landscape, as brass inlays on the paths, and in cut faces of Portland Stone boulders. Each carries an evolutionary interpretation. In the Carboniferous, there are two giant arthropods represented as life-size inlays: a 2-metre-long millipede that is the largest land arthropod and a relative of the dragonfly with a wingspan the size of a woodpigeon's. Four instances of the evolution of flight are shown,

Fern the Diplodocus: The centrepiece of the garden is Fern — the life-size bronze skeleton of *Diplodocus carnegii* is a near-exact replica of the Museum's famous Dippy.





The Transport for London tunnel entrance opens into a canyon clad in our most ancient Precambrian rocks from Scotland.

In the Jurassic section of the garden the viewer points to a pterosaur perched on a window ledge, wings folded. Down in the garden, this terracotta figure is interpreted on a nearby panel.



A brass inlay on the path of a Carboniferous 2-metre-long millipede.

A bronze cast of the dinosaur *Hypsilophodon foxii* perches on a stone in the shrubs.





Left: Undercliffs NNR: South Kensington Evolution Garden.

Below: Undercliffs NNR: Monmouth Beach ammonite pavement.

All photos on this page by Jonathan Larwood.



Ammonites rescued....

In 2017 a Natural History Research Team visited the Undercliffs National Nature Reserve to the west of Lyme Regis the Jurassic Coast World Heritage Site. Their purpose? To rescue blocks of 'ammonite pavement' damaged by winter storms.

The ammonite pavement is well known to NNR visitors – large *Coroniceras* ammonites, up to 70cm across, are preserved on the lowermost Jurassic limestone beds of Monmouth Beach. They represent a moment in time when marine ecosystems were gradually returning to normal following the end Triassic mass extinction some 200 million years ago.

This post-extinction ecological recovery has been the subject of NHM research for some years and the opportunity to rescue whole pavement slabs (a complete Jurassic ecology) was not to be missed. Working with a team of volunteers, and staff from Natural England and the Jurassic Coast Trust, a number of slabs, each weighing around 250 kg, were transported from the beach and then taken to the NHM in London for detailed analysis.

Seven years on a new opportunity presented itself and slabs, rescued from the ammonite pavement, now represent the earliest Jurassic in the South Kensington Evolution Garden - a unique piece of National Nature Reserve and World Heritage Site, brought to London to tell the story of life's evolution.

Watch the ammonite rescue: [Operation Ammonite](#)

Jonathan Larwood, Natural England

first in Carboniferous insects, then in extinct pterosaurs and birds in the Jurassic, and finally in bats in the Cenozoic Era.

The centrepiece of the garden is Fern — a life-size bronze skeleton of *Diplodocus carnegii* supported by Kusuma Trust. This is a near-exact replica of the Museum's famous Dippy. At 4 metres in height, it towers over visitors and plants alike. A second much smaller bronze cast of the dinosaur *Hypsilophodon foxii* perches on a stone in the shrubs behind. This is based on original fossil materials discovered on the Isle of Wight in the 19th century and now housed in the Museum's own collections.

Real fossils are incorporated into the landscape. There is an example of a Silurian coral reef from Shropshire; the same fossil rich limestone is found at Wren's Nest National Nature Reserve in the West Midlands. Other fossils include dinosaur footprints, trunks of wood, and large ammonites from Dorset and Wiltshire. Ammonites are among the most recognisable and iconic marine fossils of the Jurassic Coast World Heritage Site. On display are three slabs from the famous ammonite pavement of the Axmouth to Lyme Regis Undercliffs NNR which were rescued by the Museum and a team of volunteers led by Natural England during recent winter storms (see inset).

The influence of geological process on the evolution of life is referenced in several places. The end Paleozoic–Mesozoic mass extinction is marked by jagged pieces of red Permian sandstone from Dumfries and Galloway. A border of scoria mulch, a pyroclastic volcanic rock from Iceland, reflects the massive and sustained volcanic eruptions that drove this extinction and produced the flood basalts of the Siberian Traps. Towards the end of the timeline, Paleogene global warming led to the development of a subtropical climate in what is now the London area. A contributing factor was the opening of the North Atlantic Ocean and the consequent massive outpouring of lava and carbon dioxide. Here basalts from Londonderry alongside columnar basalts from Iceland reference those of the famous Giant's Causeway World Heritage Site.

The Evolution Garden sits in front of the iconic Natural History Museum building that was designed by the architect Alfred Waterhouse, first opening to the public in 1881. The building is clad in terracotta, embellishing its eastern wing with stylised depictions of extinct animals. To bring the building into our garden's story we have carved viewing windows into rocks that direct your gaze onto the animals on the façade. In the Jurassic section of the garden the viewer points to a pterosaur perched on a window ledge, wings folded. Down in the garden, this terracotta figure is interpreted on a nearby panel, and a modern view of a pterosaur in flight is depicted in a brass inlay.

An important aim of the Evolution Garden is to provide an engaging, living gallery for visitors to explore before they enter the Museum building. It is also a new green space with ample seating where visitors can relax and enjoy. There is step free access throughout the gardens and into the museum buildings. A new restaurant called the Garden Kitchen nestles in the background providing meals and refreshments and serving as a space for evening functions.

Acknowledgements

We thank all funders of the Urban Nature Project including Amazon Web Services, The National Lottery Heritage Fund, Evolution Education Trust, The Cadogan Charity, Garfield Weston Foundation, Kusuma Trust, The Wolfson Foundation, Charles Wilson and Rowena Olegario, Royal Commission for the Exhibition of 1851, Clore Duffield Foundation, Workman LLP and Accenture.

Blast off at Brymbo Fossil Forest...

Raymond Roberts, Natural Resources Wales, **Tim Astrop** and **Tom Hughes**, Brymbo Heritage Trust

On the 9th of September 2024, almost 34 years to the day of the closure of Brymbo Steelworks, contractors moved in to start work on the multi-million pound development of *Stori Brymbo* (Brymbo's Story). With a vision for the conservation, restoration and celebration of Brymbo's rich natural, industrial and social history, *Stori Brymbo* will be a world-class visitor attraction and community hub which chronicles a 300 million-year-old journey from the Carboniferous Coal Measure forests to the exploitation of the area's rich natural resources during coal mining and iron and steel-making in the 18th, 19th and 20th centuries.

Background

Industry dominated the landscape of Brymbo for more than 200 years with centuries of iron- and steel-making, and coal mining leaving a sprawling complex of buildings and associated infrastructure. Following closure, the vast site lay derelict for many years until reclamation and re-development of the 100ha site began in the early 2000s. A small part of the site was earmarked to conserve the most important industrial heritage which contained a suite of scheduled and listed structures. The remainder was classed as a brownfield site to be developed for housing, small industrial units and a school. However, in 2004 excavations unearthed *in situ* fossils which were part of a Coal Measure forest of international importance (*Earth Heritage* 26 and 43).

Plans were already afoot to retain a Heritage Area and bid for money to develop an attraction for visitors to see the important industrial heritage. The addition of an *in situ* Carboniferous forest which could be excavated and studied in controlled conditions would arguably be the unique selling point for a world-class visitor attraction.



Brymbo Steelworks in 1990. A vast complex of buildings with the oldest structures dating from the late 18th Century. The Fossil Forest was discovered beneath the former office block (marked). Photo courtesy of Brymbo Developments Ltd.



Stori Brymbo

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- Public Engagement Volunteer
- Education Volunteer

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Hard work pays off

Fast forward 20 years from the discovery of the Fossil Forest and the project has finally started. A dedicated team organised by Stori Brymbo consisting of countless volunteers and students have worked tirelessly with the support of Brymbo Developments Limited, Wrexham County Borough Council, Natural Resources Wales, Cadw and many others. The total cost of the project is expected to be some £10 million, most of which is covered via successful National Lottery Heritage Fund bids.

It is hoped that Fossil Forest Building will be one of the first elements of the project to be completed with an opening planned for Easter 2025. In *EH 63* we will report on even more progress and showcase the Fossil Building in all its glory.



Since the site was notified as a SSSI in 2015 the removal of fossils has been severely restricted until there is a suitable structure to allow excavation in a controlled environment. However, removal of some fossils was unavoidable.

Left: Following construction of a link road through the site a large *in situ* giant clubmoss, the ‘Stig’, had to be rescued to prevent deterioration and theft (see *Earth Heritage 45*).

Right: Following pain-staking conservation work the ‘Stig’ is now on display at National Museum Wales, Cardiff (see *Earth Heritage 46*). Photos by Peter Appleton.



Top Left: In preparation for the construction of concrete pads for the Fossil Forest building to sit on, excavations were undertaken by university students and local volunteers which were supervised by BHT's Fossil Co-ordinator Tim Astrop. Each pit was lined with dual layers of specialised fabric and Teram membrane to both protect the *in-situ* fossils and allow the concrete to be removed when the fossil excavation area is expanded in the future.

Top Right: During site preparation each step has been carefully recorded, surveyed and also shared on social media. Sketchfab images, (right hand image) are particularly useful to monitor changes and keep others abreast of development.

The Fossil Forest building has been designed as a modular construction which can be extended to cover more of the site as the project develops and further funds secured.

Below left: This mock-up gives an idea of the extent of the building and the challenges of the terrain. The machine shop, blast furnace and charging wall which form part of the industrial heritage can be seen beyond the fossil forest area.

Below right: Working is now moving apace with much of the focus on construction of the Fossil Forest building.

All Photos by Brymbo Heritage Group unless otherwise stated.



New era for Classic Anglesey Precambrian blueschist site

Raymond Roberts, Natural Resources Wales; **Rob Crossley & Stewart Campbell**, GeoMôn; **Peter Davies**, The Anglesey Column Trust; **Katherine Fornash**, Ohio University

For more than 200 years the Marquess of Anglesey's Column has been a striking landmark on the skyline along the Menai Strait, allowing visitors to climb the 115 steps to the top and enjoy panoramic views of Anglesey, the Menai Strait and Snowdonia. The Column is constructed of local Carboniferous limestone and sits on Craig y Dinas, a prominent outcrop of the world-renowned Precambrian Anglesey blueschist. The natural crags and former quarries are part of the Marquess of Anglesey's Column Geological Conservation Review (GCR) site and are notified as part of the Sgystau Glas Ynys Môn SSSI, along with adjacent road cuttings bordering the A55 and inland outcrops near Pentraeth.

Following safety concerns relating to public access, the column was boarded up and parts of the site closed to the public in 2014. This culturally and scientifically important site was in danger of being out of bounds to geologists and the public. The Anglesey Column Trust had already been set up in 2007 to pursue a plan for the restoration of the Column and surrounding woodland as a tourist attraction, but the closure of the site to the public highlighted the urgent need for restoration work on the iconic

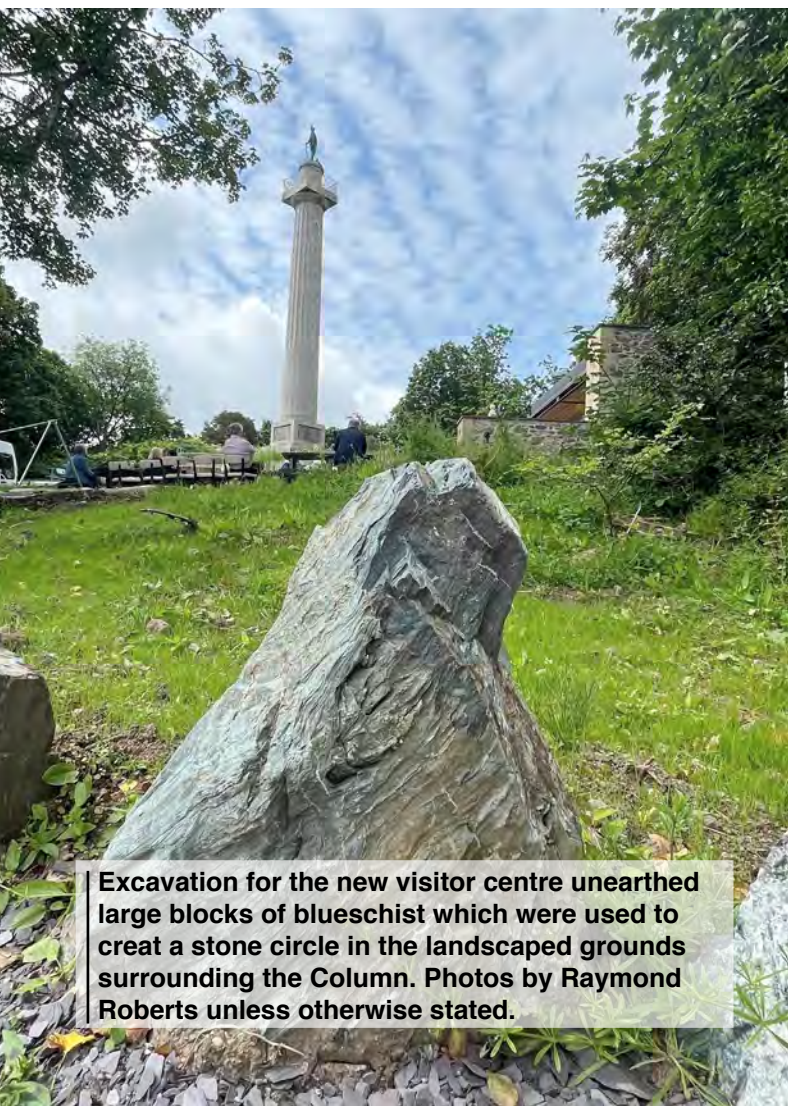
structure. Ambitious plans were drawn up and a campaign was started to seek funding to restore the Column and develop a World-class visitor attraction.

History of the Column

The Column was built to mark the valour of Henry Paget, Earl of Uxbridge, who fought at the Battle of Waterloo and was second in command under Wellington. During the battle, Paget lost a leg and in recognition of his bravery the Prince Regent made him the first Marquess of Anglesey. Following Waterloo (1815), the local communities of Anglesey and Caernarvonshire raised the funds and commissioned the erection of the Column.

Ambitious plans and fundraising

The main mission of the Trust was to preserve the site and celebrate its significance through the re-opening of the Column for public access, education programmes and community engagement. Work would involve restoration of the Grade II* listed Column, renovation of the



Excavation for the new visitor centre unearthed large blocks of blueschist which were used to create a stone circle in the landscaped grounds surrounding the Column. Photos by Raymond Roberts unless otherwise stated.



Designed by Thomas Harrison and opened in 1817, the Column consists of Carboniferous limestone quarried from Moelfre on the east coast of Anglesey. The bronze statue of the 1st Marquess rises another 3m above the top of the Column plinth and was added after his death. Note Craig y Dinas which was largely treeless at the time. Images courtesy of Anglesey Column Trust.

small Grade II listed keepers' cottage with an extension to provide a café, toilets and interpretation space. The campaign to secure the funding necessary to complete the project was launched in 2018. Managing the project proved to be both time-consuming and challenging, as the Project Team negotiated the complicated requirements of a heritage building site. The Covid-19 pandemic in 2020 presented additional problems and had an impact on the project's timescale and budgets. However, thanks to a major award from the National Lottery Heritage Fund and generous support from other funders, work started on site in November 2022.

Opportunities for geoconservation

The main driver for the project was to restore and conserve the Column and keepers' cottage and to showcase the historical significance of the site and its links to the Napoleonic Wars (1803-1815). However, the site also includes the Marquess of Anglesey's Column GCR site, which is one of three individual areas of blueschist making up the Sgistau Glas Ynys Môn SSSI. The GCR site includes natural outcrops around the base of the Column and a series of quarries on the wooded flanks of Craig y Dinas.

The bulk of the construction work centred on building a lower-gradient ramp access to the base of the Column, replacing the wooden steps within the Column and a complete revamp of the area around the cottage to develop visitor facilities. Through discussions with NRW, the Column Trust was able to seize on opportunities to improve access to the blueschist. The old approach path to the Column was steep in parts and the whole area had become very overgrown with little blueschist visible. The new path gave the opportunity to clear the area of vegetation and, where possible, small cuttings were created rather than using infill to maintain the required path gradient. It was also agreed that any excavated blueschist was retained on-site. For example, when infill was unavoidable, gabions were filled with rock obtained from the site, retaining the blueschist on site. When fresh blueschist was excavated during construction of the visitor centre, larger blocks were used to create a stone circle ideal for future educational activities.

Research

The Marquess of Anglesey's Column GCR site has a long history of research into the mineralogy and origin of blueschist, see Blake (1888) and Greenly (1919). It has also been a key site for investigating the significance of blueschist at subduction plate boundaries, helping to interpret the tectonic history of Anglesey. There are only 20 locations in the world where the metamorphic assemblage exclusively comprising blueschist plus lawsonite have been reported (Whitney and others, 2020). The Anglesey occurrences (Gibbons and Mann, 2003) are of global interest in that they have a late Proterozoic to early Cambrian age (Kawai and others, 2006), which is older than any reported blueschist plus lawsonite occurrence of any association.

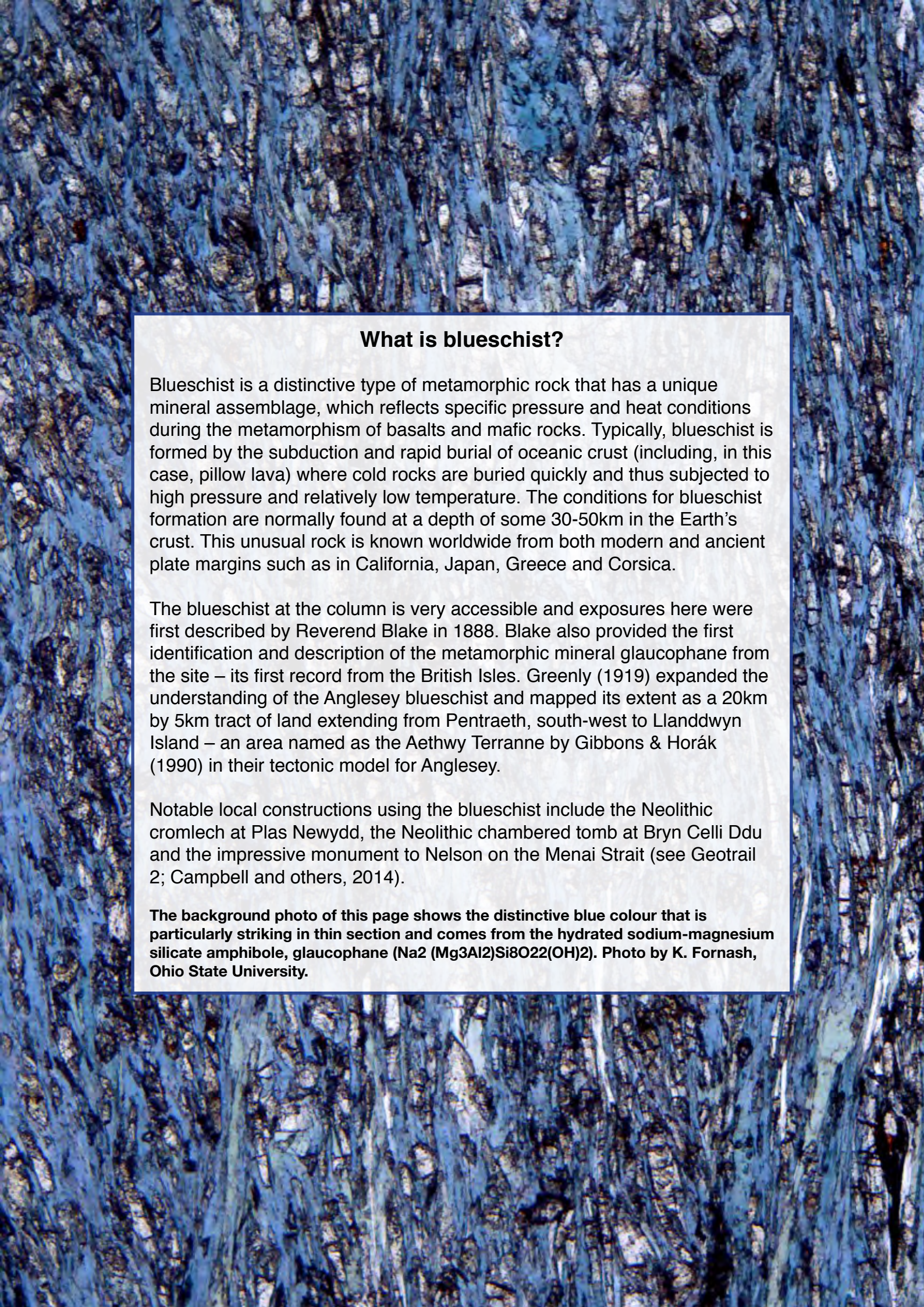
A team at the University of Ohio is currently applying new techniques to the analysis of mineralogy and geochemistry from Anglesey blueschist samples to compare them with their extensive blueschist



Left: The GCR site includes a series of disused quarries below the Column. NRW, The Anglesey Column Trust and GeoMôn hope to develop a geodiversity plan to identify key outcrops which will be managed within the woodland to allow access for geological research and education.

Below: Weathered exposures in the disused quarries below the Column offer opportunities to study the mineralogy and deformation history of the blueschist; locally there are fabrics in the rock which may represent the 'pillow' shapes of the protolith spilitic lava before it was subducted and metamorphosed to form the blueschist. Note how the low-light and damp conditions in the woodland have led to algae and lichen masking the distinctive blue colour of the blueschists. Photos on this page by Stewart Campbell.





What is blueschist?

Blueschist is a distinctive type of metamorphic rock that has a unique mineral assemblage, which reflects specific pressure and heat conditions during the metamorphism of basalts and mafic rocks. Typically, blueschist is formed by the subduction and rapid burial of oceanic crust (including, in this case, pillow lava) where cold rocks are buried quickly and thus subjected to high pressure and relatively low temperature. The conditions for blueschist formation are normally found at a depth of some 30-50km in the Earth's crust. This unusual rock is known worldwide from both modern and ancient plate margins such as in California, Japan, Greece and Corsica.

The blueschist at the column is very accessible and exposures here were first described by Reverend Blake in 1888. Blake also provided the first identification and description of the metamorphic mineral glaucophane from the site – its first record from the British Isles. Greenly (1919) expanded the understanding of the Anglesey blueschist and mapped its extent as a 20km by 5km tract of land extending from Pentraeth, south-west to Llanddwyn Island – an area named as the Aethwy Terranne by Gibbons & Horák (1990) in their tectonic model for Anglesey.

Notable local constructions using the blueschist include the Neolithic cromlech at Plas Newydd, the Neolithic chambered tomb at Bryn Celli Ddu and the impressive monument to Nelson on the Menai Strait (see Geotrail 2; Campbell and others, 2014).

The background photo of this page shows the distinctive blue colour that is particularly striking in thin section and comes from the hydrated sodium-magnesium silicate amphibole, glaucophane ($\text{Na}_2(\text{Mg}_3\text{Al}_2)\text{Si}_8\text{O}_{22}(\text{OH})_2$). Photo by K. Fornash, Ohio State University.



2011



2024

Upper images: Prior to the restoration and clearance work, little blueschist was visible near the base of the Column. Scrub clearance revealed ice-sculpted outcrops of previously heavily vegetated blueschist.

Lower images: Improving accessibility to the Column was a key ambition of the Project. The construction of a new lower gradient route to replace the steep uneven path required excavation of parts of the site. Following discussions with NRW, outcrops of blueschist were cleaned and any loose or excavated pieces of blueschist were retained for use in the gabions.



and lawsonite data from sites across the world – with a view to improving understanding of these unusual rocks.

Further opportunities for geoconservation

The bulk of the work in re-opening the site centred on the Column itself and associated visitor facilities. However, the next stage will look at how to manage the woodland area which includes the Marquess of Anglesey's Column GCR site and is a significant part of the associated SSSI. Discussions have already started between NRW and the Trust with a specific aim of improving the visibility and accessibility of the blueschist exposures which are often covered by vegetation in this part of the site. This will involve an audit of the quarried blueschist faces, natural outcrops and fallen blocks to identify key localities which may require specific woodland management and access/footpath work to make them easier and safer to study.

Further opportunities will also come from increased collaboration with GeoMôn. Geological-specific support for interpretation will be developed over the coming years and will cement the Column as one of GeoMôn's flagship geosites. GeoMôn has already been documenting some of the new exposures revealed at the Column as part of a wider project investigating other Anglesey blueschist outcrops and the relationships between structures and mineralogy in these severely deformed rocks.



Excavation work for the new visitor centre provided blocks of fresh blueschist that were used to create a stone circle. Following advice from NRW, any pieces of blueschist were retained to help with landscaping or stockpiled for use by researchers. Coincidentally, researchers from Ohio University were on Anglesey and were able to collect samples of fresh blueschist. See photomicrograph on p.39 produced from one of their samples. The site was officially opened on the 1st of March 2024 by Alex Anglesey, 8th Marquess of Anglesey and Chair of the Anglesey Column Trust.

The successful restoration of the Marquess of Anglesey's Column and the development of excellent visitor facilities have given a welcome boost to geoconservation, and provided a vastly improved infrastructure for school, university and lifelong-learning groups. The project has also been a catalyst for cutting-edge research and for raising the profile of one of GeoMôn's flagship geosites.

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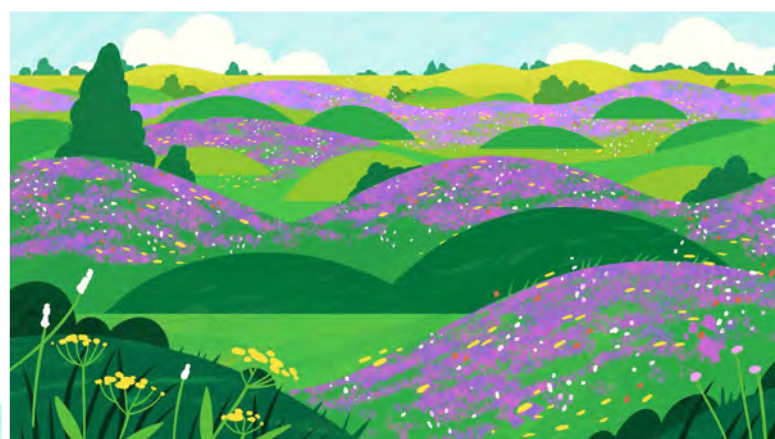
GeoAnimations – using animations to explore geology in nature

Jonathan Larwood, Barbara Silva and Cordelia Spalding, Natural England

The three authors of this article have often pondered the best way to communicate geological and geomorphological messages and share the benefits and opportunities that working with geology can bring. This is even more pressing in the context of the UK government's focus on nature recovery and our wider response to climate and environmental change (see *EH 57*, pp. 14-16). Among the challenges we face is our own understanding and perception of nature and all that it encompasses; where nature is often viewed with a biotic emphasis, rather than a balance of the abiotic (geodiversity) and biotic (biodiversity) (see *EH 59*, pp.). How can we explore and explain this in a way that connects and inspires?

Natural England's Nature Collectives development project gave us the perfect opportunity to research this challenge. We worked with animators 'Damn Fine Media' to produce three short-narrated animations. The challenge we gave the animators was to produce 3 distinct animations to explore which approach resonated best with a general audience. These were based on 3 different geostories, each presented with very different animation styles and with distinct narrators. They were also evaluated by a focus group for their effectiveness in communicating a message – the value of geodiversity in nature.

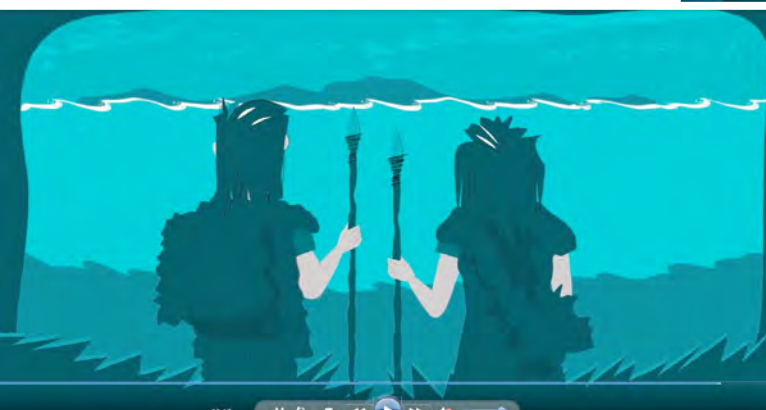
The animations explore the relationship between geodiversity and nature, through contrasting but linked landscapes, the 'natural' narratives they create and the connections to ourselves and place.



Scenes taken from
*Peterborough beyond
biodiversity.*



Scenes taken from *Norfolk and the sinkhole that swallowed a bus*.



The process...

The animations were developed over six months, through a mix of site and virtual meetings. The challenge was to find the ‘happy space in the middle’ where scientist and animator could overlap and agree: what details needed to be retained and which could be left out (a challenge for us!) in conveying complex geological stories that maintain the integrity of the animation style and narration. Reflections from ourselves and Damn Fine Media at the end of the project highlighted that key learnings included the value of:

- **Collaboration** – working across disciplines (the animator, storyteller and the geologist) was demanding and enlivening. Damn Fine Media commented that the project was ‘incredibly collaborative and thoughts and ideas were listened to and shared’. The project was an exchange of knowledge and experience from different viewpoints that, whilst challenging, created new and inspiring stories.
- **Location** – the animators we worked with wouldn’t normally visit a location with their clients, but location was essential to our narrative and commented that, ‘visiting the three locations was a fantastic experience and there is no replacing the real-life connection [and] ...the wealth of knowledge and stories’ that these provided.
- **Words and illustration** – we explored three contrasting approaches of storyline, narrator and illustrator. The stories themselves were very different with one being site specific (Beyond Biodiversity), one focused on a story that contributes to a regional sense of place (The Chronicles of Dudley) and the final one (Norfolk and the sinkhole that swallowed a bus), gives audiences two gently humorous geological snapshots. The different illustrators approached the animations with their own artistic lens that resulted in a range of styles, from a ‘painterly’ look to a more graphic approach and from a broad colour pallet to more restricted tones. The three contrasting narrators also contributed to the ‘feel’ of the animations and brought elements of humour to the stories.
- **Focus group evaluation** – this was a key part of the project design. Initial responses to animation and narration styles were explored at the beginning of the project but also success was evaluated through reflections and responses to the final animations.

- **Key learnings for future projects** - from the very beginning of the project, agree the key animation messages and content guidelines as when working to a budget, it is not always possible to re-draw scenes. Be aware that agreeing on language and tone takes far longer than you would expect. Also, if you are planning social media shorts, this needs to be thought about early on as they will need a different format and possibly a different script.

The animations

Norfolk and the sinkhole that swallowed a bus (narrated by Karl Theobald) considers the impact of our use of chalk and tells a wider 'origins' story of when Norfolk was once connected to Europe in a vastly changing landscape.

'Simple but embracing for everyone to understand...rocks and the history of them still affects life today, in Norfolk' (Focus Group member)

Peterborough beyond biodiversity (narrated by Josie Long) explores the relationship between Jurassic limestone and today's biodiversity in disused quarries, now Swaddywell Pit Nature Reserve and Barnack Hills and Holes National Nature Reserve, on the outskirts of Peterborough. The poet John Clare, who is intimately associated with this countryside, connects the narrative.

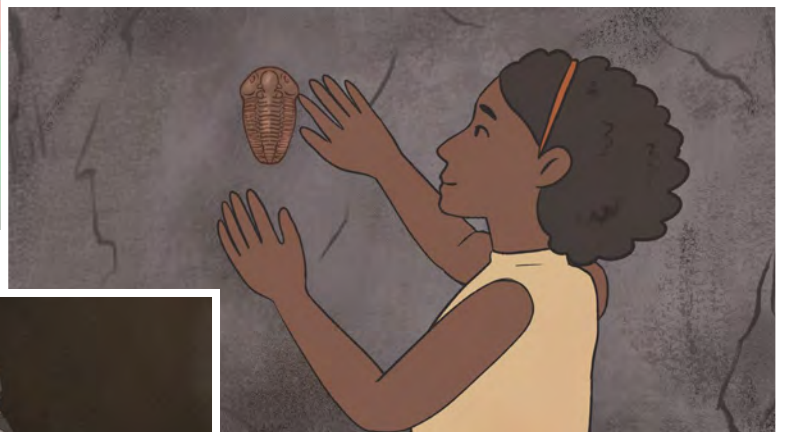
'I learnt that biology and geology can work in tandem and it's a boon for everybody' (Focus Group member)

'I liked some of the description that was used, as it feels like a weird mystical place; you can tell the person who wrote it cares about it a lot' (Focus Group member)

The Chronicles of Dudley (narrated by Sir Lenny Henry) follow the story of Silurian limestone - a 'magic ingredient' in the Industrial Revolution, and the creation of Dudley as we know it today. The narrative is connected to the deep past through tropical limestone fossils still found on the Wren's



| Scenes taken from *The Chronicles of Dudley*.



Nest NNR in the heart of Dudley and the Black Country UNESCO Global Geopark.

'I was definitely left wondering what the magical ingredient was, so was keen to watch more'
(Focus Group member)

The focus group responses highlighted the importance of the story and narration. The biggest stories – buses and sinkholes, limestone and magic ingredients – had the broadest appeal. The more local story – Peterborough and John Clare's limestone – had a greater resonance with the people who live there. Helping communities develop a greater appreciation of their geological context can begin to increase their engagement and appreciation of the benefits that working with geology can bring.

Continuing our research

We're now starting to use and share the animations. The animations were premiered at the Geological Society's Earth's Canvas conference in September (see the article on Earth's Canvas, p.50, this issue) and both the Langdyke Countryside Trust (Peterborough Beyond Biodiversity) and the Black Country UNESCO Global Geopark (Chronicles of Dudley) have been independently promoting them, including a global release on International Geodiversity Day.

We have and will continue to monitor their usage and seek feedback. To date Norfolk and the sinkhole that swallowed a bus has received 4,700 views; the Chronicles of Dudley, 1,400 views and; Peterborough beyond biodiversity, 771 views (reflecting the focus group feedback). A survey across Natural England found that 40% favoured the Chronicles of Dudley with 37% voting for Norfolk and the sinkhole that swallowed a bus and 23% preferring Peterborough Beyond Biodiversity. Comments highlighted the importance of humour and quirkiness and how they could inspire new, positive relationships and interest with place, geology, landscape and biodiversity. We're now exploring wider and different audiences, including the potential for linking into schools and education.

This project has been an invaluable exploration of how Natural England, and indeed those of us working in wider geoconservation, can use expertise in other mediums, and cross discipline approaches to understanding geology, geomorphology and other "hidden" gems of our wider landscape thereby increasing understanding and public engagement. It also provided more specific experience in developing animation as a communication tool as well as three diverse and interesting animations that we can use in our work. We hope, and anticipate, that further animations will emerge, learning from our experience and sharing the wonders of geodiversity and nature.

Further information

Natural England's Nature Collectives project is a multidisciplinary programme of work now entering its' second phase of research and implementation. Nature Collectives are underpinned by the Protected Site Strategies legislation in the Environment Act 2021. For further information about the concept of Nature Collectives and the work of the development project see the following blogposts from Policy Lab and Planning Advisory Service. If you are interested in contributing to Nature Collective development contact david.burton@naturalengland.org.uk.

Mrs Mantell's Tooth

Julia Dunbar McLean, iDOLRiCH theatrerotto

***Mrs Mantell's Tooth* is the title of a performance premiered in Hastings in June 2024. Staged by the puppet and performance company iDOLRiCH theatrerotto - a charitably based organisation - the company tours widely with bespoke shows and has a stellar track record in introducing new work for audiences of all ages, as well providing children with artistic knowhow through educational workshop activities. However, current themes relating to dinosaurs, emerged as result of the awareness of local geology and, more precisely, the cliff falls which occurred in 2018.**

Like the public in general the puppet company had absorbed Dinosauria through the common prism of children's books, videos and the deluge of accompanying merchandise, so it was from this somewhat naive springboard that their first presentation *Fabulous Footprints* was launched just before the pandemic. In this first theatrical incarnation, two, hilarious scientists, *Professor So n'd So* and *Doctor Peabody* argued large and long over the age of a shell sample that had been apparently revealed when the above-mentioned cliffs fell down. The audience - now designated as being a group tour- sets off on a trail of clues which leads to the 'real' yearling *Iguanodon* which has supposedly hatched in the present day. The puppet was 6 feet tall and was operated convincingly by the two

The puppet of Mrs Mantell holds her baby.
All photos by Clive Tag.



scientists who now acted as puppeteer 'carers' for the dinosaur. Children were able to approach and touch this very accessible character, named *GWEN*, made from sponge and canvas and other tactile materials. The puppet was designed and constructed by company lead Julia Dunbar McLean with Julian Rumball and assistants and followed the correct skeletal outline for an *iguanodon*. Carolyn Jackson, a local artist painted the body in light green with some very effective pinkish stippling effects. However, it was around this time that the realisation dawned, as to how important artistry (or Palaeoart) had been to the visualisation of the dinosaurs - described usually as monsters because of their size and beyond the human experience - which, from every source image observed, seemed to show different colouring, or patterning or indeed shape and behavioural impression. It was only after having created the *GWEN* dinosaur that possible feathering of the dinosaur's skin was understood.

While this puppet was based on an image of an adult *iguanodon*, Julia wanted to give it an empathetic, unafrightening demeanour for children and because the character was not a baby but a youngling and she had come

across no illustrations of an example of that age, she made the head more child friendly than may be anatomically correct, as compared to box shaped adult skull dimensions. Unlike Paleoart still life, this puppet was designed to move and interact in a lifelike way through handheld manipulation, but not the limited repetitive mechanised movements and snapping jaws of mechanical imitations.

The 25-minute performance/trail became a full-length show called *Mysterrasaur* for indoor events. In extending it, a 3D flying *Pteranodon* puppet was added into the forest scene and included a 10-minute film sequence which showed a Cretaceous landscape with shadow puppets of *Baryonyx* and *Hypsilophodon* as well as *Iguanodon*. Julia and Heather Leech also met and worked with Phil Hadland from the Hastings Museum and Art Gallery who gave them some insight into the types of dinosaurs likely to have been frequenting the locality. Phil gave permission to use several of his photos of dinosaur fossils and traces taken at Fairlight and Covehurst Bay in the show's filmed sequence (Phil Hadland subsequently discovered the last dinosaur footprints on the beach near Folkestone which was reported on national TV).

And so, Julia came to the back story of how the *Iguanodon* was discovered by Gideon and Mary Ann Mantell. 'Wonderful and inspiring' as the fictional performances were called, they fed inevitably into a curiosity to research the actual beginnings of how the fossils came to be named and identified. Very quickly it was clear that there was a fascinating human story behind the discoveries that lent itself to stage rendering, with colourful main characters and a hiss/boo villain whose antics could be melodramatically replicated through puppetry.

The *Iguanodon* tooth and various bones were first identified 200 years ago and discovered in Sussex very much at the same time as William Buckland was laying claim to the *Megalosaurus* in 1824. Although *Megalosaurus* bones had been around for more since the 1600's they had not been formally correctly identified. Mary Anning had hit contemporary headlines with her lifetime of collecting fossils from 1815 onwards, but Gideon Mantell now appeared as a prolific but somewhat overlooked fossil collector of the period, whose life ended sadly with discredit piled upon him by a rising star of the day, anatomist Richard Owen.

Because Gideon Mantell was a working man holding down a livelihood as an obstetrician and surgeon as well as tirelessly unearthing and recording myriads of pre-historic samples, many of which had not been heard of previously, he did not have the inherited advantages of upper class scientists of his day, rendering his journey of discovery an uphill struggle. His wife, Mary Ann, was a keen partner early on in their marriage, joining Gideon in gathering fossils and in making engravings for

Puppeteers discreetly move the fossil and dinosaur puppets, so they interact with their audience.



their first book *'Fossils of the South Downs'* which was published in 1822. But the strains of bringing up a family of four, housed alongside multitudes of bones, some of them enormous, whilst rich in promise of possible recognition, produced little to no wherewithal in actuality. The marriage finally ended in 1839.

The battles they had to face as a couple were several. Obviously, the financial limitations were paramount. Gideon did his geological work at night, writing his books and recording his finds whilst having a full-time day job as a physician but with little time as a father to the family. The work itself presented a challenge to Christian orthodoxy. Geology was a relatively infant science at the time, taken up by individuals of societal standing and Anglican clerics - representatives of a class which Gideon had not been born into. However, Sir Charles Lyell, twelve years Gideon's junior, and champion of 'uniformitarianism', became a lifelong friend and supporter of Gideon while his wife, the conchologist Mary Horner, also befriended Mary Ann.

Once the Mantell's much loved daughter, Hannah Matilda, died at eighteen, things unravelled. Gideon suffered a carriage accident not long after, which left him with a twisted spine. He took opiates to ease the pain and died of an overdose after some years of debilitating illness. The bitter struggle for prime recognition amongst palaeontologists was made evident when Richard Owen discredited Gideon's lifetime of work in an obituary and made sure that the Mantellian collection was dismembered to museums around the country. This Owen could do, as the founder of the Natural History Museum. Mary Ann outlived her husband and in *MRS MANTELL'S TOOTH* she appears as the older narrator, recounting the highs and lows of this story from her perspective.

One of the main setbacks for Gideon occurred when the 'teeth', found in Cuckfield by Mary Ann on a walk by the quarry, were misidentified by the most respected anatomist of the day, Baron Cuvier, as belonging to that of a rhinoceros. It is perhaps because of this and the necessity for veracity in a competitive forum, that Gideon felt the pressure of producing absolute proof for his findings. The first full size drawing of an *Iguanodon* which he made, illustrates how few real bones he had to work with to visualise the whole creature. Even so, with the thumb spike initially placed mistakenly on the nose, an image which persisted, it took him thirty years to reconstruct a complete *Iguanodon* skeleton. It is not surprising then, that when the opportunity to represent a clutch of dinosaurs as a statue garden/landscape in Crystal Palace arose in 1854 (as by this time dinosaur fever had gripped the nation) Gideon was unwilling to take part if the execution of the sculptures were not going to be accurate, which in eventuality they were not.

The narrative presented in the *MRS MANTELL'S TOOTH* performance is one that underscores the human element - of a couple whose tremendous vision was backed up by hours of minute investigation recorded by hand, through journal, lecture and publications, with illustration in water colour, engraving and lithograph, much of which was done in the middle of the night. A story, against all the odds of class entitlement, peer pressure and family needs, which weighed up almost unimaginable vistas of time, seen through messy collections of dull and misshapen fossilised bone, to envisage how life and landscape might have looked for the millions of years before humans evolved.

This was a mighty endeavour for any individual to embark upon requiring more than one lifetime to complete. It is no wonder that the children had small interest in an undertaking that excluded them, even though Gideon Mantell was most definitely a humanitarian. He only lost two babies in his work as an obstetrician and brought 2,000 into the world safely in 19th century England.

Women in Georgian and Victorian England had big families to look after. Society women were not expected to work or to follow careers. This was for the lower classes, where maids and housekeepers lived downstairs. To belong to the world of geology Gideon aspired to be upwardly mobile even

when his purse could not accommodate it and there was a moment when the family moved to Brighton, where he evidently hoped that life was on the rise. Unfortunately, his geological successes did not produce income so that although his lectures, which were gathered into *'The Wonders of Geology'*, were widely celebrated, his prestige alienated the medical profession in Brighton, who cold shouldered him. For Mary Ann, the new abode in Brighton had become a museum to house the enormous fossil collection and she and the children were squeezed out of satisfactory accommodation. It was no wonder then that her original enthusiasm for palaeontology waned. They were evidently a close and loving couple in earlier years but it is clear that the unending quest and verification of the relics could not sit well with essential family demands, day to day living and finally, the sad loss of their daughter at 18. However, Gideon Mantell can be classed as a visionary, poet and humanitarian who made a wealth of new discoveries and brought to life a hitherto unseen world in vivid colours through his writings and illustration, assisted by Mary Ann.

MRS MANTELL'S TOOTH is presented through the female lens. It brings the chief players and action of the story to life as characterful 18 inch hand puppets: Mary Ann finding the tooth at Whiteman's Green quarry, Baron Cuvier and his investigation of the tooth, Charles Lyell, who delivered the samples to him in Paris, Gideon working to reconstruct the iguanodon skeleton at night surrounded by bones, his legacy sabotaged by a devious Richard Owen. Other luminaries who make an appearance as sculptured heads on the shelf of posterity are: William Buckland, Mary Horner and Charles Darwin. After a concluding voiceover coda from Gideon's *"Wonders of Geology"* the show ends with an unexpected finale for the audience: a thirty-foot *Iguanodon* skeleton, a replica of the *Mantellisaurus Atherfieldensis*, is raised up by the three puppeteer/actors onto its back legs, before its hollow eyes gaze balefully into the audience.

The script was researched and written by Julia Dunbar McLean and includes passages from Mantell's books and writings with salient quotes from some the scientists. Heather Leech embodies the older Mrs Mantell, alternating between narration and playing with the doll's house that represents their Lewes home. The production juggles with scale as it summons up a Victorian style of theatricality with its use of magic lantern imagery and a Pollocks style toy theatre - the podium for Mantell's Brighton lectures. The show had the benefit of outside direction from Samuel Dutton, actor and puppeteer with the Little Angel Theatre Islington, who has worked with the company on several previous productions.

The *MANTELL TOOTH* project also includes an educative workshop strand in the form of a *LANTERN MAGIC ACTION* session where participants learn about the development of the Magic Lantern during the nineteenth century and couple this with their own Palaeoart. They have a chance to handle original Victorian slides and see a Magic Lantern up close, before creating their own dinosaur slides, with a Jurassic or Cretaceous background, on acetate. These are set in frames for projection at the end of the session. Further dates for the show are planned for the festival which celebrates the identification of the *Iguanodon* in February, taking place at the Hastings Museum and Art Gallery and as part of the *Megalosaurus* festival events at Oxford University's Natural History Museum.

The performance was produced with the assistance of: *The Curry Fund of the Geologists' Association*.



The Iguanodon film can be viewed here:

https://youtu.be/4qLZ7_GeQbw

Mrs Mantell on Theatre Rotto:

<https://theatrerotto.co.uk/mrs-mantels-tooth/>



Earth's Canvas: Exploring Geology in Creativity

Jonathan Larwood and Barbara Silva, Natural England

On 17th-18th September 2024, an unusual and unique event took place at the Geological Society, Burlington House in London. The Geological Society, in collaboration with the arts community led by Lucy Williams and Emma Jude, organised a 2-day conference, *Earth's Canvas: Exploring Geology in Creativity*. This brought together diverse disciplines, cross-cutting the practice of geoscience and the arts, to explore the impact of geology on creative observation, articulation, expression and outreach. Nearly 100 geologist-artists and/or artist-geologists attended what was an inspiring and thought-provoking meeting.



Inspiration came from all aspects of geology and the influence of geology on the changing world around us including landscapes, the subsurface, geological processes, deep time, and the Anthropocene. There were in-person presentations and performances exploring art, sculpture and installation, poetry and literature, and music, song and sound. Skills workshops explored different media such as stone carving, creative writing, music and song and an evening concert of original poetry, song, and sound.

Innovatively, Earth's Canvas followed the journey, both artistic and geological, that the artists had taken from their initial inspiration to the final artwork (artwork in its broadest sense). Some of the artists had begun as geologists before developing an artistic practice; the journey of others was reversed.

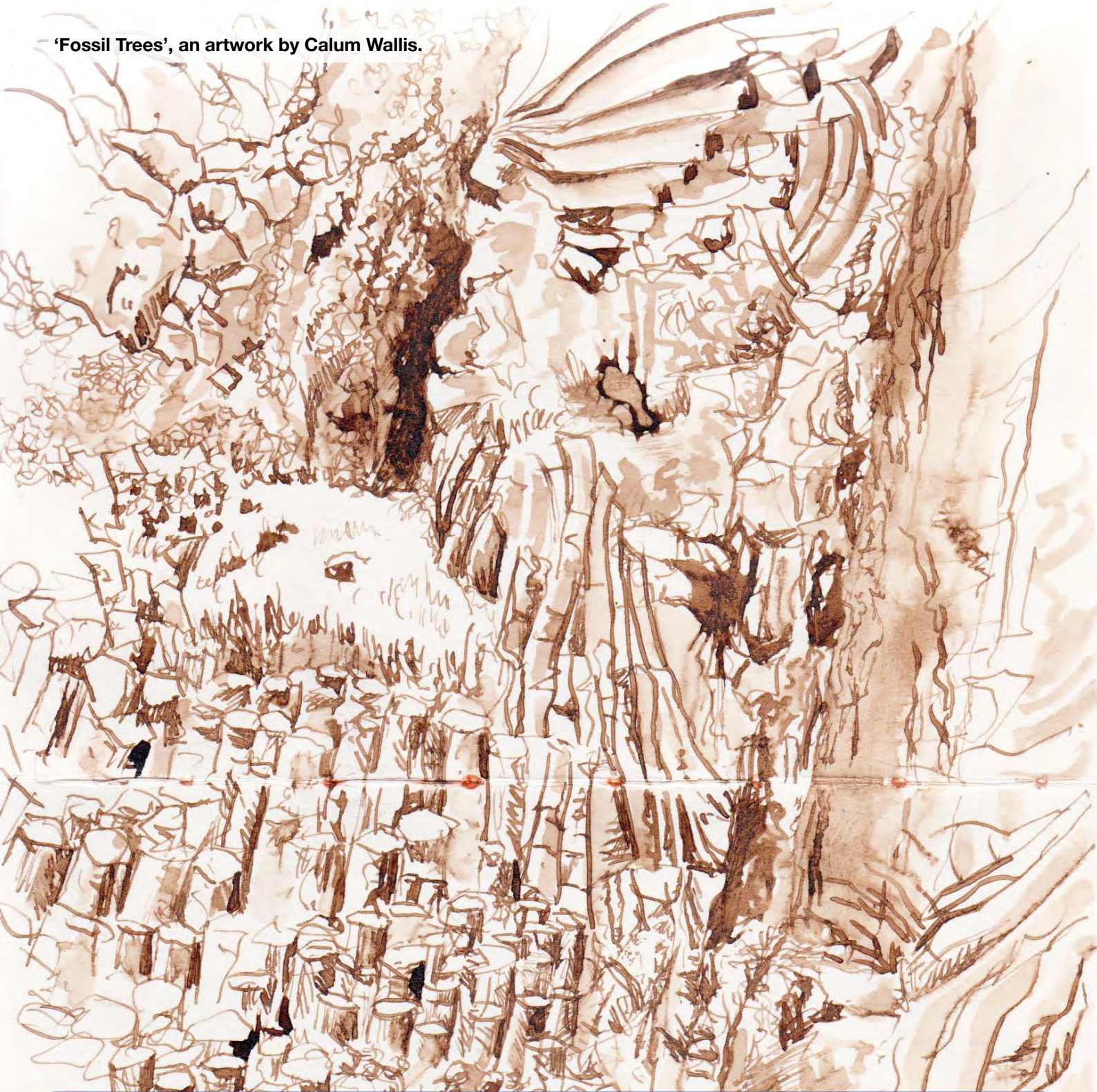
Another success of Earth's Canvas was the Geologists' Association's Curry Fund bursary which enabled six artists to join the event, share their work and make new geological connections at and beyond Earth's Canvas. Several of the presenters had also benefited from Curry Fund support.

A key message that delegates came away with was that the boundaries between geology and art are fluid and permeable, with plenty for both disciplines to learn from collaborations and an open mindedness to different ideas. Earth's Canvas has started to find a common ground of observation and curiosity between geologist and artist, and an overlap of practice which will continue.

Images from top down: conference delegates during a break in sessions (photo by Lucy Williams); a live stone carving workshop, and a display of sketchbooks by Phoebe Sleath. Photos by Emma Jude.



'Fossil Trees', an artwork by Calum Wallis.



***An artist's perspective on the meeting by Calum Wallis
(Curry Fund Bursary recipient)***

Earth's Canvas provided a forum that I had no idea I was in need of. My artwork studies erosion and humanities' place in deep time and it's making necessitates a large amount of time spent in solitude, both among rocks and in the studio. In the solitude of this practice, I had believed this field of inquiry was narrow - until I attended Earth's Canvas.

Here I met like-minded people who were pushing the boundaries of creative engagement with geology in more directions than I could have imagined. The curiosity contained in that room ventured beyond the boundaries of scientific analysis, using geology as a starting point for considering the Western colonial destruction of other cultures' environmental ethos and mythology, and for reckoning with our place and our responsibilities in a collapsing climate. The relevance and timeliness of gathering such thinkers in one room cannot be overstated - such events may be catalysts for new ways of seeing and thinking.

Geologists' Association Geology Photographic Competition 2025

Nick Pierpoint, Geologists' Association

The Geologists' Association (GA) invites amateur photographers to enter the GA's Geology Photographic Competition 2025. This is a great chance to share your photos of geosites and geoheritage.

- You can submit up to three photos on any geological topic.
- Selected entries will be displayed at the Festival of Geology on 1st November, 2025.
- The competition is open to everyone, but only amateur photographers can enter (you don't need to be a GA member).
- Please note the closing date of Friday 22nd August 2025

Prizes: 1st Prize: £150 2nd Prize: £75 3rd Prize: £50

Selected photos may be featured in the 2026 GA Calendar, available at the Festival of Geology and online. Photos may also be used in the Geologists' Association Magazine, and for promoting the work of the Association, with full credit to the photographer.

How to Enter: Download the competition rules and entry form here: [Geology Photographic Competition Entry](#)



Andesitic lava off the coast of Milos Island, Glaronisia (Seagull Islands), Greece, 2020. Photo Stamatina Marinatou.



Earth Heritage in print

Earth Heritage is produced twice-yearly by the Geologists' Association, Natural England, Natural Resources Wales, NatureScot and the Quaternary Research Association.

It can be downloaded free as a pdf file from www.earthheritage.org.uk. You can also purchase a hard copy of any issue via www.geologistsassociation.org.uk/earthheritage. Subscribe to notifications of new issues at www.earthheritage.org.uk/subscribe.

We thank all those who have assisted in preparing the publication, including the voluntary geoconservation sector who are major contributors. The opinions expressed by contributors are not necessarily those of the above organisations.

The geology of Scrabo Hill is an important part of Northern Ireland's natural heritage and has been declared as a Scrabo Area of Special Scientific Interest (ASSI). Over recent years the site has become overgrown and has been the focus of geoconservation works that are described in the article on p33.

