

Earth Heritage

The Geological and Landscape Conservation Magazine



National Nature Reserves Festival



Understanding soil erosion at Trotternish Ridge

ISSUE 58
Winter 2023

International Geodiversity Day celebrations



Where is the Geomorphology in Geodiversity?

New trackways found at Ardley



Cover: As part of the NNR Festivals, Graham Worton (Black Country UNESCO Global Geopark) leads a tour that started in the Silurian reefs of the Wren's Nest NNR and then continued on a canal boat through the Dudley No 1 Canal Tunnel, 2888m long, built 1792. Location 'Chain 40', Dolerite Intrusion. Find out more on p.14. Photo by Graham Worton.



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EDITORIAL

This winter edition of *Earth Heritage* finds us still facing some big challenges. Although the Covid 19 Pandemic seems to have receded into the background, things have not completely returned to normal, although fieldwork and organized excursions are again taking place. The biggest challenge now perhaps is how economic pressures may affect geoconservation and geodiversity interests, with potential constraints on the funding of public bodies and fewer resources for volunteer organizations. Nonetheless, this issue reports on several encouraging initiatives. In the Outcrops section is news of the Welsh Government's online Data Map Portal, of crowdfunding to finance a new museum for the Jurassic Coast World Heritage Site, of the publication of a 'provisional map' (based on an independent amateur survey) for BGS Sheet 180 (Knighton) and of plans to run the ProGEO 2023 international geoconservation symposium at the Charnwood Forest Geopark in Leicestershire.

Under Publications, Alan McKirdy reports on the 3rd Edition of his book on James Hutton and we learn of the first Welsh-language dictionary for the geological sciences. Jonathan Larwood provides an article on the celebrations in 2022 of 70 years since the first National Nature Reserves (NNRs) were declared, pointing to the modest increase over that time span of examples of specific or secondary Earth-science interest and to future initiatives to enhance the profile of geology within these highest-tier conservation localities. We also learn of a proposal to obtain UNESCO World Heritage status for Siccar Point, the coastal unconformity site in Berwickshire that is associated with James Hutton and the earliest understanding of geological principles. Later in the issue we also learn that Siccar Point is one of four UK localities to be selected by the IUGS amongst its 'First 100 Geological Heritage Sites'; another of the four, the Giant's Causeway Coast, is already a UNESCO World Heritage Site.

An obvious highlight amongst activities since Issue 57 was the inaugural UNESCO International Geodiversity Day, which is reviewed by Jack Matthews of the Oxford University Museum of Natural History. There is also a report on the activities related to International Geodiversity Day coordinated by the Geologists' Association as part of its annual autumn Festival of Geology, hopefully the last 'virtual' festival before it returns as a face-to-face event in 2023. There is also an exposition of the National Trust for Scotland's geodiversity policy, by Rebecca Miller, as well as a thought-provoking article by Stephen Tooth, Hywel Griffiths and Dewi Roberts questioning whether geomorphology is adequately represented in the wider appreciation of geodiversity in the UK and whether geomorphologists need to do more to raise awareness of this subject and its role within the Earth sciences.




David Bridgland - Guest Editor

New Data Map portal for Wales

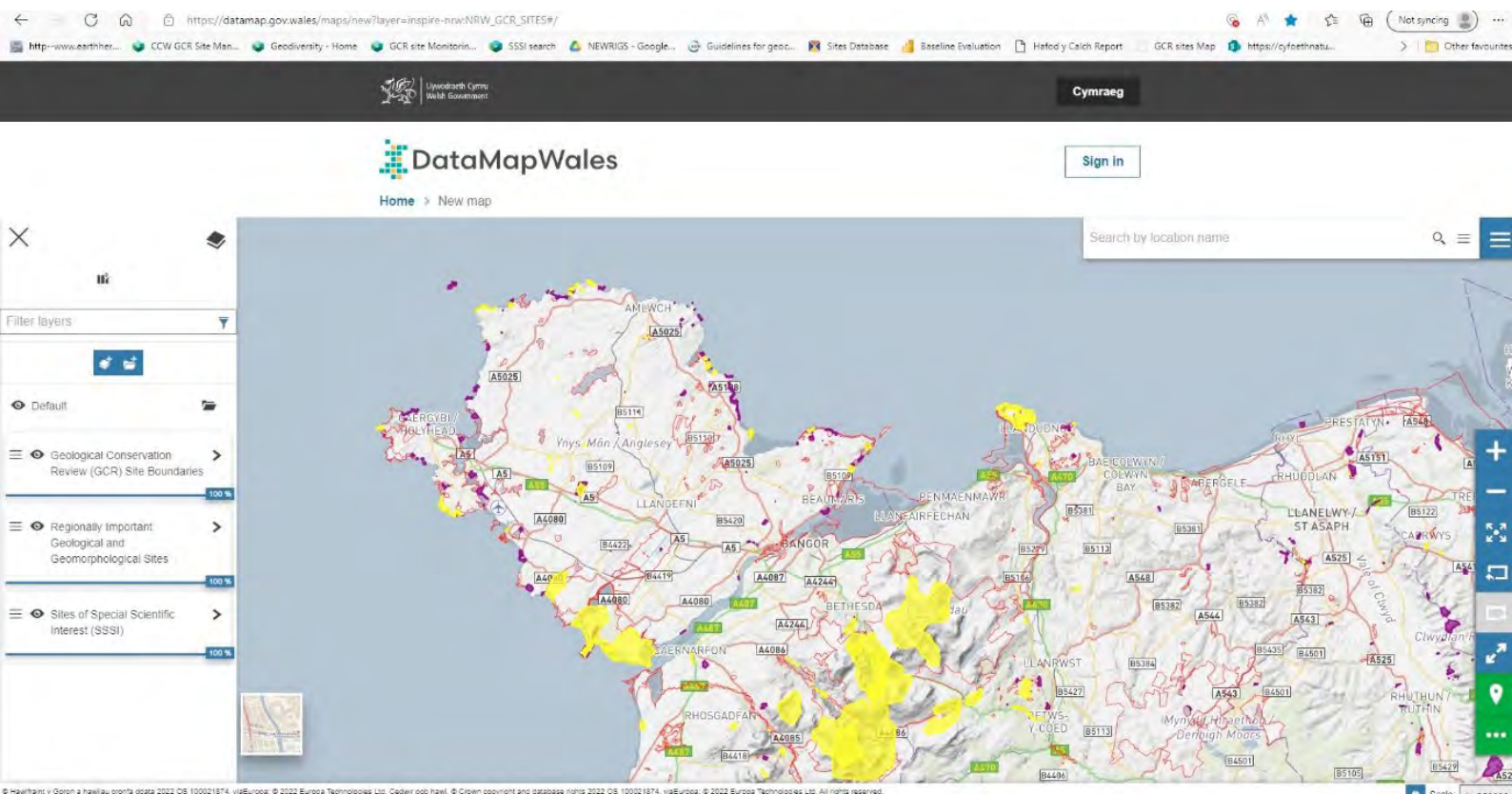
Welsh Government has launched a new online portal where businesses, non-governmental organisations and the public can access a wide range of spatial data for the whole of Wales. Of great value to geoconservation, Regionally Important Geodiversity Site (RIGS) and Geological Conservation Review (GCR) site boundaries are available in addition to the full range of protected sites such as Site of Special Scientific Interest (SSSI), National Nature Reserve (NNR) and Special Area of Conservation (SAC). The site is easy to use, and it is straightforward to switch layers off and on, and to change colour and opacity of the site areas. There is a wide choice of basemaps, historical aerial photographs and LIDAR.

DataMap Wales is a valuable tool for geodiversity practitioners and for those who just want to explore from their desks.

By Raymond Roberts, Natural Resources Wales

 [Home | DataMapWales \(gov.wales\)](https://datamap.gov.wales/)
<https://datamap.gov.wales/>

A screenshot from DataMapWales showing northwest Wales with layers from the Geological Conservation Review, RIGS and SSSI datasets open.



Help make a new museum for the Jurassic Coast a reality

The Jurassic Coast Trust are calling for public support to catapult the development of a proposed new museum dedicated to the outstanding geology, palaeontology and geomorphology of the Jurassic Coast World Heritage Site, with the launch of a crowdfunding platform and a benefit event in early 2023.

The collective vision for this new museum is:

'To create an accessible, inclusive and thriving museum dedicated to public engagement with the Jurassic Coast's unique geological and palaeontological heritage. A permanent collection representing the Site's exceptional and spectacular fossil record will grow over time and drive ongoing specimen acquisition, conservation, research, varied exhibitions, education, outreach and partnership working. Taken together, these will embed the natural heritage of the Jurassic Coast as a valuable catalyst for the local economy and community participation in the continued sustainable management of the Dorset and East Devon Coast World Heritage Site.'

The Trust has an initial target of **£20,000** which will allow for the completion of the feasibility study by March 2023 and enable us to engage with independent heritage consultants to provide clarity on where the museum would best deliver impact, attract diverse audiences and achieve economic viability. To find out more visit campaign on [JustGiving](#).

By The Jurassic Coast Trust



The Knighton Geological Sheet

We are happy to report to you that the geological map for Knighton, covering the area equivalent to sheet 180 of the BGS 1:50 000 series, has been surveyed, mapped and published as a limited edition 'provisional map', by independent amateur survey between 2015 – 2020. There were eight surveyors who were members of the Teme Valley Geological Society, with assistance from The Woolhope Club, Malvern U3A and many other associates as needed, with up to 40 people participated in field work.

The circumstances of the survey were first reported to the Geologists' Association in the *GA Magazine* of March 2016, with a follow up report in December 2019, and also in *Earth Heritage*, issue 49 spring 2018.

It is hoped that this map will inspire further research and interest in the area and we look forward to publication of the definitive map by BGS. Some collaborative research has already followed on (Ray *et al.*, 2021), and we should anticipate more to come.

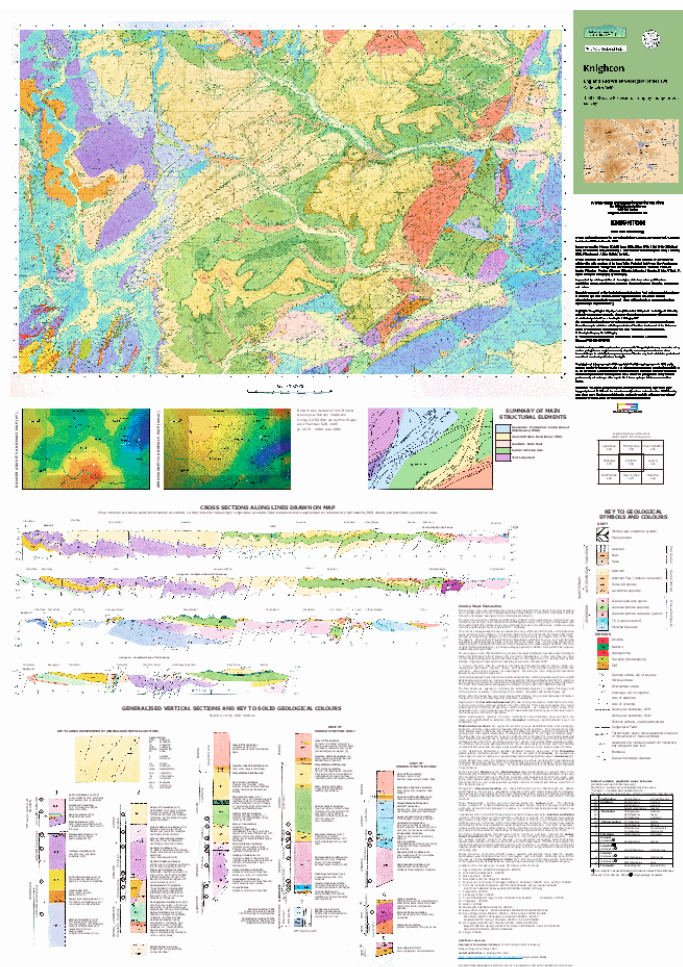
In brief, much of the area has a Neoproterozoic basement, and integrates the geological sequences of the Welsh Basin with those of the Wenlock to Ludlovian Shelf successions. The area illustrates a transgression onto a rocky surface followed by development of clastic facies on a slope and apron from the Ordovician to Silurian, during an era of local and eustatic sea level variation accompanied by environmental change due in part to plate tectonics.

By Arthur Tingley

Further information:

Ray D.C., Jarochowska E., Hughes H.E., Claussen A.L., Tingley A.C, Moseley J. and Bremer O. 2021. *The Silurian Transgression of a Palaeoshoreline: The Area between Old Radnor and Presteigne, Welsh Borderlands Lithosphere*, Volume 2021, Article ID 7866176, 24 pages. <https://doi.org/10.2113/2021/7866176>

A postcard view of the Knighton A0 sized 1:50 000 sheet: The folded A0 map sheet contains the geological map, sections and columns along with a concise explanation, along with a structural interpretation and geophysical map.



Rock fall on Rum

New rock fall from near the summit of Askival, is thought to have happened on or about 6th February 2022 in Atlantic Corrie, on the island of Rum. Intriguingly this large rock fall may be related to a seismic event picked up by BGS on the same date.

The walls of Atlantic Corrie are flanked with steep debris slopes, built from past rock falls, debris flows and avalanches. In February 2022 a buttress collapsed high on Askival resulting in blocks several metres wide falling some 400 m down to the corrie floor. Their downward route is marked by impact craters, where they hit the ground, before they came rest some 400 m from the source crags. In their wake the rock fall left a scattering of razor sharp rock fragments along several distinct paths down the debris slopes beneath the crags. Paleogene igneous rocks like these provide perfect conditions for a range of spectacular mass movement landforms seen in many places along the Scottish West Coast.

**By Colin Wells, Independent Ecological Contractor;
Lesley Watt, Rum National Nature Reserve Manager,
NatureScot; Vanessa Brazier, formerly NatureScot**

A walking pole provides a scale for the huge boulder of layered ultrabasic rock on the Isle of Rum NNR. The boulder landed, in Atlantic Corrie, following a significant rock fall from the mountain of Askival. As it came to rest the boulder bulldozed a path through smaller rocks, soil and vegetation. Photograph by Colin Wells.



Charnwood Forest Geopark to Host ProGEO 2023



**XITH INTERNATIONAL
ProGEO SYMPOSIUM**

9-11th October 2023
Charnwood Forest, UK

ProGEO: the International Association for the Conservation of Geological Heritage, have selected Charnwood Forest Geopark in Leicestershire to host their next International Symposium.

The conference, to be hosted in Loughborough Town Hall from the 9-11 October 2023, will include scientific sessions, field trips, social events, and the ProGEO General Meeting. The symposium is an international event open to scientists, students, educators, professionals, decision-makers, and anyone involved in geoheritage and geoconservation. The meeting will promote communication and collaboration amongst attendees from all over the world, and will feature a special session on the Conservation of Palaeontological Heritage.

Jack Matthews, Geopark Geoheritage Officer, and Chair of the Organising Group said: “We are really excited to be welcoming the world to Charnwood Forest and Loughborough for this international conference. As well as bringing new customers to the area’s businesses, this meeting is a great opportunity to promote the fabulous geological sites we have within the Geopark. We have a great story to tell here in Charnwood Forest – one as old as animal life itself – and we want to share it with the world!”

Previous hosts of the conference have included Rome, Kyiv, Dublin, and Reykjavik. You can discover more about the meeting at: www.progeo2023.com

By Jack Matthews, Charnwood Forest Geopark

Oxford English Dictionary – Geoconservation and Geodiversity added in 2022

Geoconservation

Conservation of the earth’s geological and geomorphological features, esp. of a particular site or region

Geodiversity

Diversity of geological and geomorphological features and physical environments, esp. of a particular region

Murray Gray’s original definition

The natural range (diversity) of geological (rocks, minerals, fossils), geomorphological (landforms, topography, physical processes), soil and hydrological features, including their assemblages, structures, systems and contributions to landscape. (Gray, 2013)

By Jonathan Larwood, Natural England



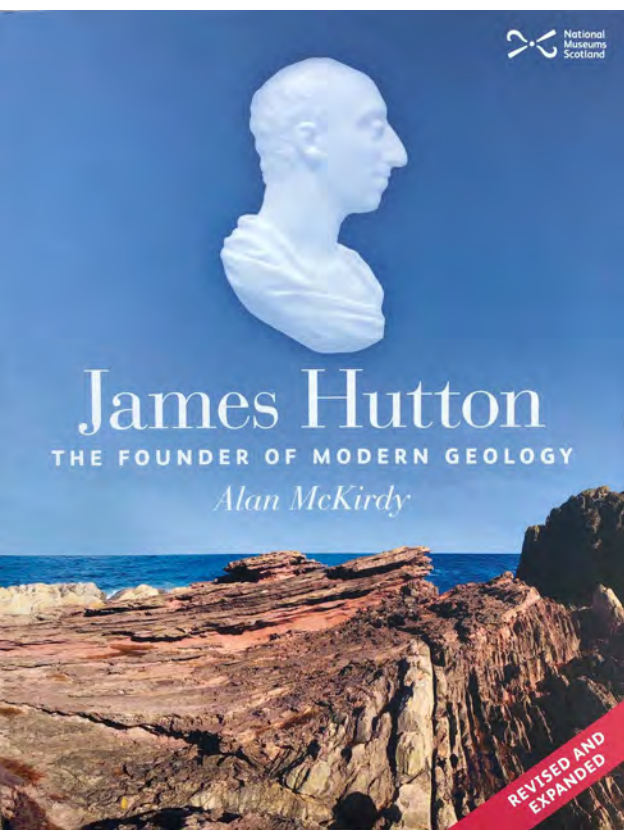
General view of the northern side of Coire an t-Seasgaich, (Hollow of the yield cattle) showing the escarpment below Sgurr a'Mhadaidh Ruaidh (Hill of the Red Fox) and the extent of the soil erosion. Studies aimed at understanding the best ways of managing erosion in this iconic landscape are discussed in the article on p.44. Photo by Richard Birnie.

A journey in celebrating James Hutton amongst a wider audience

Alan McKirdy (2022) James Hutton The Founder of Modern Geology - [NMS Enterprises - Publishing]

Dr James Hutton first strolled into my life in the mid-1990s. I was co-opted onto the organising committee for the conference sponsored by the Royal Society of Edinburgh that took place in 1997 to celebrate the 200th anniversary of Hutton's death. Although well-known in geological circles, we recognised that knowledge of Hutton's achievements had not spread far beyond the academic community. I was asked by Professor Gordon Craig, formerly head of The Grant Institute in Edinburgh University, to write a publication to help popularise Hutton and make his great works more accessible to those who hadn't heard of him or indeed The Scottish Enlightenment. The task was a partnership endeavour with Professor Donald McIntyre (1923 – 2009), who had already spent a lifetime researching Hutton. Donald was an Edinburgh graduate and PhD in geology, but had taught in the sunnier climes of California for the whole of his professional career. In the obituary Gordon wrote of Donald, he said that 'Donald was not merely a scholar of the Enlightenment, but a product and embodiment of it.' So I was in very good hands!

HMSO was the first publisher we approached and they offered us a contract to complete a 10,000 word manuscript on the life, times and achievements of James Hutton. Over the long dark winter nights of 1996 and early 1997, we prepared the manuscript for the first edition. During our regular meetings, alternately at my kitchen table or his, Donald spoke and I listened. He laid out in ever-increasing detail Hutton's contributions to science and the varied subjects covered by his publications. Donald was also keen to place Hutton in the milieu of The Scottish Enlightenment – the friends and 'co-adjutors' (to borrow a word from the times) with whom he interacted and gained validation for his new ideas on geology. The word limit set by HMSO was our biggest challenge. Donald reminded me frequently that it was much more difficult to write a short book than a long one! But we managed to shoehorn all the essential elements of the story into this abbreviated format and the book was published in time for the RSE conference in the autumn of 1997. We 'launched' it at the conference as Donald gave a keynote address to the distinguished audience of domestic and international geologists.



| Front cover of the 3rd edition of the Hutton book.

Donald sadly died in 2009. A second edition of the book followed in 2012, with an additional chapter on Hutton's Legacy. But it still didn't tell the story in a manner that satisfied my wish to describe the man and his achievements in a more fulsome manner. The tercentenary of Hutton's birth was fast approaching in 2026 and the James Hutton Institute was now in charge of the celebrations to mark this auspicious event. Professor Colin Campbell, who chairs the organising committee for the tercentenary celebrations, was enthusiastic about a third edition of the book; as were our new publishers – the commercial arm of The National Museums of Scotland. I have just completed the third edition of our book 'James Hutton – The Founder of Modern Geology' as a solo undertaking. It was published in February 2022.

This new edition is dedicated to the McIntyre family. Donald's wife Ann is a grande dame of over 90 years and she was very helpful in placing Donald's library and papers at my disposal. The James Hutton Institute staff could not have been more helpful during the process of preparing the manuscript with Colin's secretary Anne Pack worthy of special mention. During the final phase of the book production, I worked with Lynne Reilly from NMS Publishing Limited almost on a daily basis and she was responsible for turning my tedious looking Word document into a colourful and attractive book.

Alan McKirdy, geoscience author and historian

Geological first for Wales

Geiriadur Daeareg a Gwyddorau Daear by Dyfed Elis-Gruffydd. Y Lolfa (2021). 215pp. ISBN 978-1-80099-149-1. £9.99

Although there are numerous geological dictionaries available in English, until now there has been no equivalent Welsh-language dictionary available for the geological sciences. Geiriadur Daeareg a Gwyddorau Daear (Dictionary of Geology and Earth Sciences) by Dyfed Elis-Gruffydd now fills a major gap for geologists, teachers, students or anyone else with an interest in geology, geomorphology and geography. The dictionary will be particularly useful for those studying in the medium of Welsh and for those tasked with translating simple geological text or more complex terms used in legal documents such as Site of Special Scientific Interest (SSSI) notification papers. The dictionary is in two parts with the first section defining more than 1,800 technical terms in Welsh and the second consisting of an index of 2,000 English terms with their equivalent in Welsh.

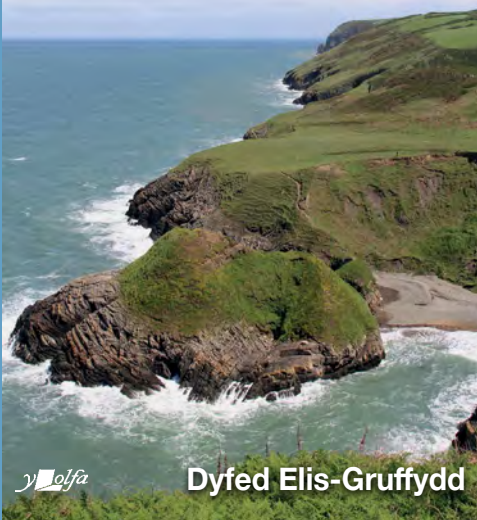
Prif amcan y geiriadur pwnc hwn yw cyflwyno a diffinio'r termau hynny sy'n ymwneud â daeareg yn benodol ar gwyddorau daear yn gyffredinol. Er bod sawl geiriadur daeareg, megis *Challinor's Dictionary of Geology* a *Oxford Dictionary of Geology & Earth Sciences*, i'w cael yn Saesneg dyma'r unig eiriadur daearegol Cymraeg ei iaith.

Mae'r geiriadur hwn ddwy ran, yn gyntaf, geiriadur sy'n diffinio dros 1,800 o dermau Cymraeg, ac yn ail, mynegai Saesneg – Cymraeg sydd yn cynnwys dros 2,000 o dermau Saesneg, ynghyd â'r termau Cymraeg cyfatebol. Gan hynny, rhagweld y bydd y geiriadur o gymorth mawr nid yn unig i ddisgyblion ysgol, myfyrwyr coleg, athrawon, darlithwyr a chyfieithwyr, ond hefyd i'r chwilotwyr hynny a chanddynt ddi-ddordeb arbennig yn y pynciau a ganlyn: daeareg, geomorffoleg a daeryddiaeth ffisegol.

Geiriadur Daeareg a Gwyddorau Daear

Dyfed Elis-Gruffydd

Geiriadur Daeareg a Gwyddorau Daear



If you are interested in learning a bit more about how geology and geomorphology have influenced Welsh place names have a look at [Earth Heritage 47](#).

Raymond Roberts,
Natural Resources Wales

Coastal exposures of folded Silurian turbidites at Castell Bach near Cwmttydu south of Newquay, Ceredigion and the summit of Yr Wyddfa (Snowdon) adorn the cover of the landmark Welsh geosciences dictionary. Photo of cover courtesy of *Y Lolfa*.

The Lake District explained

The Lake District [Landscape and Geology] by Ian Francis, Stuart Holmes and Bruce Yardley. The Crowood Press, February 2022. Paperback £18.99. ISBN: 9780719840111

This volume provides a superbly illustrated and comprehensive review of England's most mountainous region, covering not just landscape and geology, as per the suffix, but also archaeology and the history of human activity and its (not always positive) contribution to the scenery, including historical quarrying and mining for a plethora of rocks and minerals. Also covered is the problematic pollution brought about by the extraction and processing of metal ores. This corner of northern England is of course famous for both geology and landscape and so it is no surprise that there is much to recount in a volume like this. The stated aim, one that is admirably fulfilled, is to provide an accessible text that can be understood and enjoyed by non-experts.

The book finishes with seven geo-themes excursions, to Eycott Hill Nature Reserve, the Skiddaw Granite in Sinen Gill, volcanic rocks in Seathwaite, the Coniston copper mines, Beatrix Potter's Silurian country, the area around Tarn Hows and the limestone landscape at Whitbarrow Scar. The final chapter, prior to the excursions, is Chapter 10 'Protecting a Fragile Landscape', in which there is a section devoted to 'Conserving the geology' that reports on the history and rationale for that activity and on the work of the Cumbria GeoConservation Group in the stewardship of the 150 nationally significant geological sites (SSSIs) and almost 300 'Local Geological Sites' in the county.

This is a book that can be recommended wholeheartedly, for expert and non-expert alike.

David Bridgland, Durham University / Geologists' Association



The deep glaciated trough of Wasdale, seen from Sphinx Rock, high on Great Gable. Photo by Stuart Holmes.

Nearly Wild Weaving is an initiative that takes inspiration from the world around us – landscape, flora and fauna, history, and, of course, geology - and weaves into a tapestry that is discussed in the article on p.34. This image is a tapestry woven at Llanymynech Rocks Nature Reserve, looking at the quarry face, water seepage, cross bedding by Anna Wetherell (inset).



Festival of National Nature Reserves: celebrating 70 years

Jonathan Larwood, Natural England

National Nature Reserves (NNRs) are among our most important places for nature. In 2022 we have been celebrating 70 years since the declaration of England's first NNRs. Established by the 1949 National Parks and Countryside Act, they're primary purpose is to conserve and enhance biodiversity and geodiversity, to foster science and research (they are often referred to as outdoor laboratories), and as places for people to enjoy nature.

The first seven NNRs in England were declared in 1952. Three were considered as 'scientific reserves': Holme Fen (Cambridgeshire), Moor House (North Pennines), and Yarnar Wood (Devon), and three as 'conservation reserves': Cavenham Heath (Suffolk), Ham Street Wood (Kent), and Kingley Vale (West Sussex). The seventh, and first geological NNR, was Piltdown Skull Site NNR in East Sussex, declared on 19th May 1952. However, following the discovery of the 'Piltdown Man' hoax it became the first NNR to have its status revoked on 7th February 1955 - a story that is told in '*Piltdown Man's enduring legacy*' (Earth Heritage, 40, p15). As many readers of the *Earth Heritage* magazine will know, the Wren's Nest in the heart of Dudley now carries the accolade of England's oldest geological NNR, declared on 27th September 1956.

Today there are 221 NNRs in England covering approximately 105,000 ha. This includes six NNRs specifically declared for their geology: the Wren's Nest (Dudley), Swanscombe Skull Site (Kent), Charnwood Lodge (Leicestershire), Hulme Quarry (Staffordshire), Horn Park Quarry (Dorset), and Saltwells (Dudley); over 50 NNRs have designated geological features,

Right: Hunting for fossils (below) in the Wren's Nest NNR reef knolls.

All photos by Jonathan Larwood unless otherwise stated.





and of course all have geology in some shape or form associated with them. It's now our ambition over the coming years to develop the NNR network to better tell England's geological story, through existing NNRs and where there are gaps, new NNR declarations - in 2020 Saltwells NNR was the first new geological declaration and the start of this story-telling journey.

The Festival of NNRs celebrations followed and explored the themes of Nature Recovery, Nature Discovery, and Nature Connection. In this spirit here are two notable geological journeys of celebration, discovery and connection, between NNRs and with the places and communities around them.

Barnack Stone: from Barnack Hills and Holes NNR to Peterborough Cathedral

Barnack Hills and Holes NNR, 11 km northwest of Peterborough, is a remnant of the limestone quarries that supplied building stone - Barnack Stone - to the surrounding villages and built Peterborough and Ely cathedrals. Today the resultant undulating Hills and Holes NNR represents



Left: West Front, Peterborough Cathedral – our best ‘exposure’ of Barnack Stone.

Bottom left: Examining Barnack Stone in detail, Peterborough Cathedral. Photo by Justin Tilley.

Bottom right: Locating Barnack Hills and Holes NNR, following the Middle Jurassic Inferior Oolite from south to north. Photo by Justin Tilley.





Top: Volunteers viewing the Wren's Nest NNR reef knoll.

Middle: Disembarking at Brewin's Canal Cutting, Saltwells NNR.

Bottom: Meganeura stainless steel sculptures in Doulton's Claypit, Saltwells NNR.



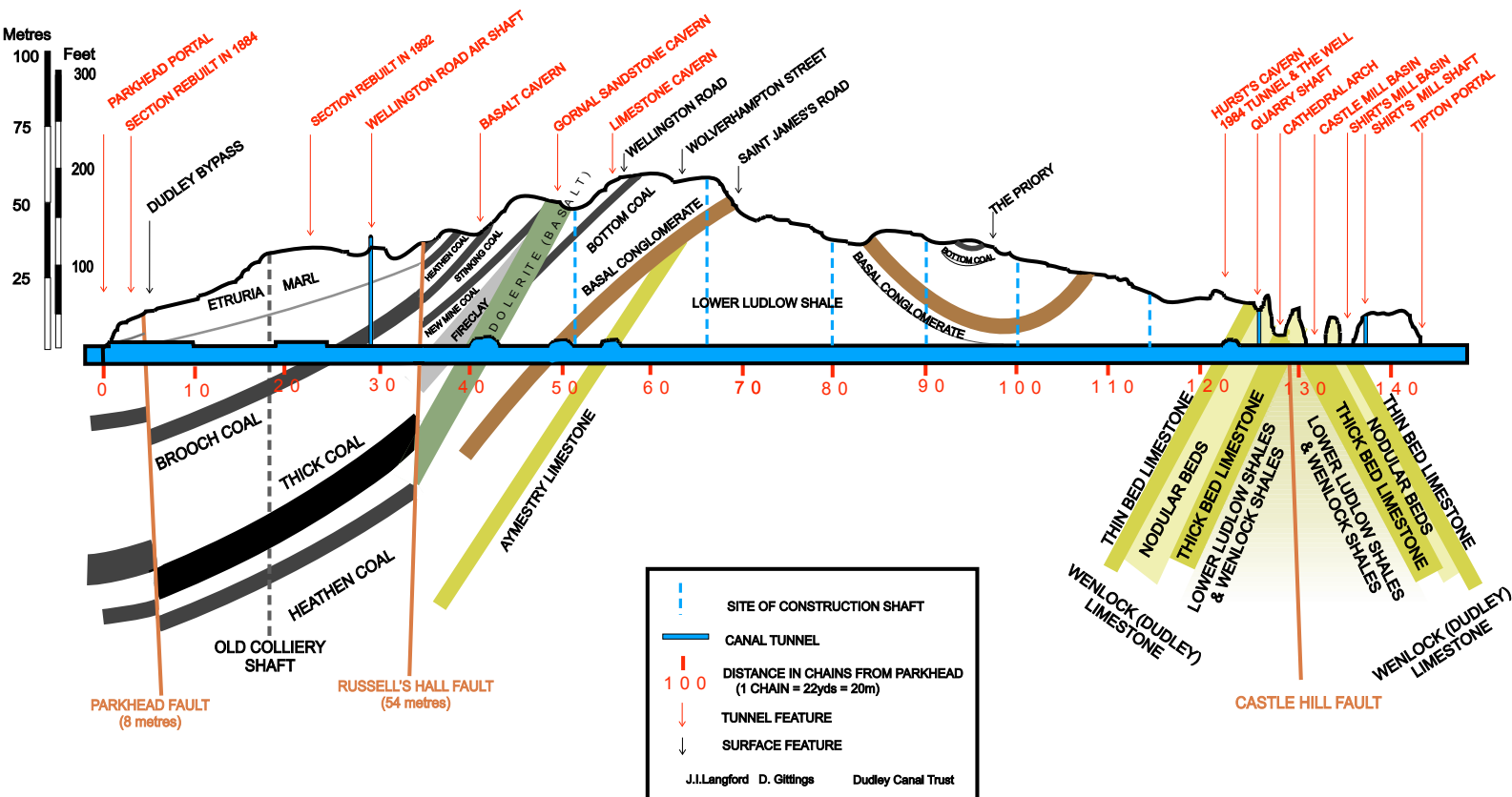
half of Cambridgeshire's surviving limestone grassland and a flora of international importance that includes the spring Pasque flower and eight orchid species. In October, in collaboration with the Langdyke Countryside Trust and Peterborough Cathedral, Natural England led a journey through time, following the route of the Barnack Stone. From tropical lime-rich seas depositing the extensive Jurassic Lincolnshire Limestone (including the Barnack Stone), via a medieval stone industry that built Peterborough Cathedral, to the modern-sheep grazed NNR, we considered the life and times of the Barnack Stone and its influence on the surrounding landscape, history and natural world. We then followed the Barnack Stone's journey transported eastwards via the River Nene to build Peterborough Cathedral founded in 1118 (and then out onto the Fen waterways and beyond). Peterborough Cathedral's spectacular West Front (now the best 'exposure' of Barnack Stone) provided an opportunity to examine in detail Barnack Stone and its oolites, fossils and cross-bedding, alongside the Lower Lincolnshire Limestone Collyweston Slates on the Cathedral Precinct buildings, and the local use of Alwalton Marble (Blisworth Limestone) (from the nearby village of Alwalton) in columns, and carved memorials inside the cathedral.

Great Canal Connection: from Wren's Nest to Saltwells NNRs

On the 6th October we celebrated both NNRs and the world's first International Geodiversity Day connecting the Wren's Nest NNR and Saltwells NNR by foot and canal. We particularly recognised the work of all the volunteers that have made these NNRs so special, bringing together the Wren's Nest and Saltwells NNR 'Friends of' groups, members of the Black Country Geological Society and volunteers from the Dudley Canal and Tunnel Trust. The event was also supported by the Geologists' Association as part of their Festival of Geology.

Led by Graham Worton (Black Country UNESCO Global Geopark) our journey started in the Silurian reefs of the Wren’s Nest NNR, examining its industrial past, and the efforts over the last 65 years of geological trailblazing, management, research, education, and arts initiatives. Onto the canal-side Gongoozler Restaurant for refreshments we then headed for Saltwells NNR via canal boat through the 1792 Dudley No 1 canal tunnel, all 2888m (a route that in its heyday saw 141,700 boats per year). Through Castle Hill, under Dudley Priory and the southern end of the Wren’s Nest Hill we navigated the steeply tilted Wenlock Limestone, Carboniferous Coal Measures, faults and basalt intrusions, tracking our position by 22 yard ‘chain’ markers painted on the tunnel walls. We emerged at the Parkhead Portal and Basin, dropped down two locks, and gently wound our way to Saltwells NNR where we alighted at Brewin’s Canal. Here we examined the Upper Silurian – Upper Carboniferous unconformity (a missing 100 million years), a surface exposure of the basalt intrusion and recent clearance work by the Prince’s Trust. We then concluded at Doulton’s Claypit viewing Coal Measures sandstone, ironstone, silt, clay and coal with steel *Meganeura* dragonflies darting over the natural spring and ponds. We finished with tea and cakes at the Warden’s Base completing the first ever Great Canal Connection between the Wren’s Nest and Saltwells NNRs.

SECTION THROUGH DUDLEY TUNNEL SHOWING THE MAIN GEOLOGICAL STRATA AND TUNNEL FEATURES



International Geodiversity Day 2022: A Review

Jack J Matthews, Oxford University Museum of Natural History

October 6th saw the first iteration of International Geodiversity Day, with an exciting spread of events being hosted around the world. The annual commemoration, officially proclaimed by UNESCO, is an opportunity to promote the many aspects of geodiversity through public and policy engagement.

More than 240 events were hosted around the world, ranging from community field trips at local geosites, to international conferences discussing the conservation of geoheritage. India hosted the most events, including a beach clean-up hosted by the Indian National Trust for Art and Cultural Heritage and attended by more than 100 Indian naval personnel. Members of the Geodiversity Trekking Group of Myanmar hiked to the summit of the dormant volcano Mount Popa, and Chile's National Geology and Mining Service hosted an open day at their Santiago HQ.

The UK hosted at least 29 events. Scarborough's Rotunda Geology Group hosted a public talk on Jurassic micro-vertebrates, the Geological Survey of Northern Ireland ran tours of their core store, and the Geological Association's SchoolRocks! team arranged a workshop for Key Stage 2 classes. Charnwood Forest Geopark ran GeodiversityLIVE, an online broadcast from Bradgate Park featuring live geosite interpretation from Canada, Sweden, Hungary, and South Africa.

The UNESCO HQ in Paris, the Salle Des Pas Perdus, was the venue of an exhibition highlighting the important role geodiversity has in achieving the UN's Sustainable Development Goals. The exhibition was opened by H.E. Laura Davies, UK Ambassador to UNESCO, and welcomed delegates and diplomats during the Executive Board meetings.

UNESCO Director-General, Ms Audrey Azouley, released a special statement on Geodiversity Day, calling on the international community to use this new UNESCO international day to '*view familiar landscapes through fresh eyes*'. She said:

H.E. Laura Davies, UK Ambassador to UNESCO, opens exhibition highlighting the important role geodiversity has in achieving the UN's Sustainable Development Goals. © UNESCO Earth Sciences & Geohazard Risk Reduction.



“As the only United Nations body with a mandate for the Earth sciences, UNESCO has spent the past 50 years fostering international co-operation to encourage better – and more equitable – use of the planet’s mineral resources, through its International Geoscience Programme.

This year, the Geoscience Programme is supporting over 60 collaborative projects, with 379 project leaders across 92 countries. Sixty-one project leaders are from 23 African countries, and 42% of project leaders are women – for more accessible and inclusive science worldwide.

Now UNESCO is stepping up these efforts, with the celebration of International Geodiversity Day every year on 6 October. In line with the decision taken by our 193 Member States at our 2021 General Conference, this new event will celebrate the close relationship between biodiversity, geodiversity, culture and history, raising awareness of “nature’s stage”.

Indeed, geodiversity plays a fundamental role in human well-being, sustainability and the preservation of world heritage, issues affecting the whole planet. On this International Day, UNESCO calls on the international community to galvanize the potential of geological sciences – and view familiar landscapes through fresh eyes.”

Recognising the leading role of Poland in establishing International Geodiversity Day, the Polish Ministry of Foreign Affairs commissioned a new video promoting the day. Featuring a young boy exploring the famous geosites of Poland, the video includes stunning footage of the Tatra Mountains, Masurian Lakes, and the Holy Cross Mountains Geoparks. The video was promoted by the social media accounts of Polish embassies around the world and played an important role in projecting Geodiversity Day to a wide international audience. [International Geodiversity Day - Poland - YouTube](#)

This first International Geodiversity Day may have only recently happened, but it’s never too soon to start planning for the next. As organisations prepare for Friday 6th October 2023, it’s worth checking out the www.geodiversityday.org website, where there are ideas of events from 2022, curriculum resources, and information on the role geodiversity in sustainable development. We now have a day to focus the attention of the world on a vital topic – let’s start building now for an even more successful Geodiversity Day in 2023.

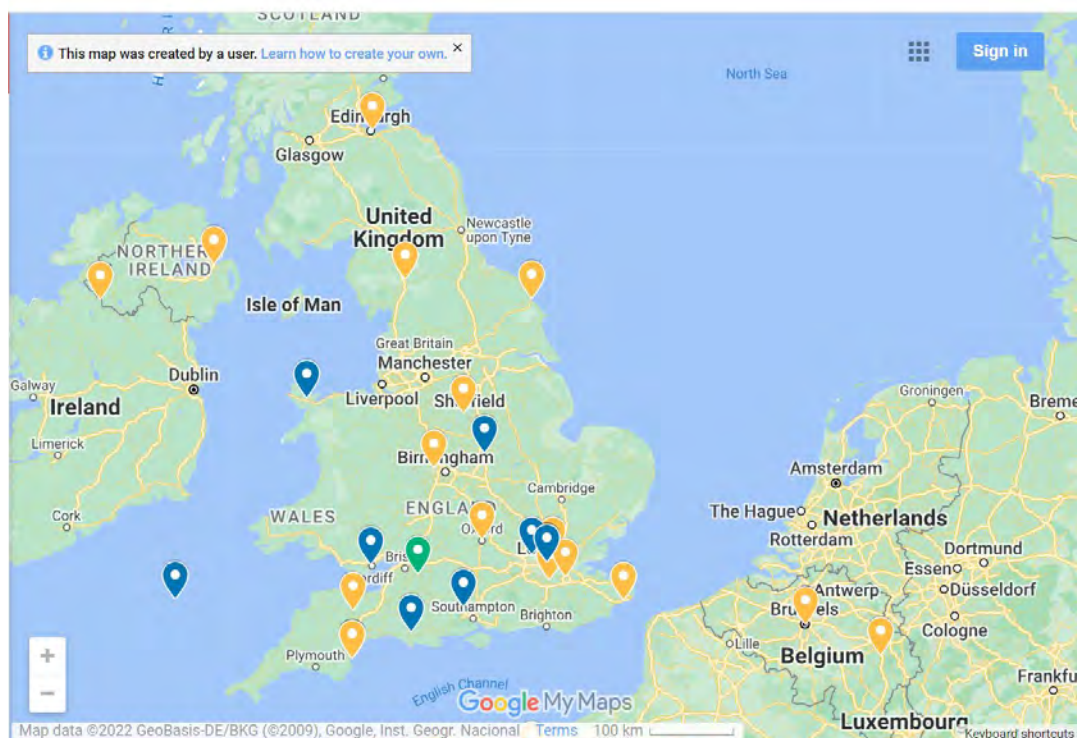


Volunteers at the beach clean up organized by INTACH. © Indian National Trust for Art and Cultural Heritage.

GA 2022 Festival of Geology devoted to International Geodiversity Day

David Bridgland and Colin Prosser, The Geologists' Association

This autumn, instead of hosting a face-to-face Festival of Geology, the Geologists' Association encouraged its regional and affiliated groups to undertake activities to mark the first ever International Geodiversity Day (IGD), which was on October 6th (<https://geologistsassociation.org.uk/festival/>). Participants worldwide were asked to register and advertise events on the IGD website and the GA played a central role the celebrations of IGD in the UK (<https://www.geodiversityday.org/find-an-event>).



A screenshot from the [Find an Event | Geodiversity Day](#) part of the IGD website [geodiversityday.org](https://www.geodiversityday.org).

A number of these were registered on the [Find an Event | Geodiversity Day](#) part of the IGD website [geodiversityday.org](https://www.geodiversityday.org) (see image above). They included the Black Country Geological Society's canal boat trip between the oldest geological National Nature Reserve in England (Wren's Nest) and the newest (Saltwells), grant aided by the GA (see this issue, page 14 for more details). In addition to the Black Country Geological Society the trip included 'Friends Groups' of the two geological reserves and volunteers who support geoconservation work at these sites.

Other events with a strong GA connection were registered by the London Geodiversity Partnership and the London Branch of the Open University Geological Society, the GA Student Symposium, the Harrow and Hillingdon Geological Society, Bath Geological Society, South Wales GA, School Rocks, and GeoLab at Bampton. Rockwatch, the GA's club for children, produced a splendid YouTube video that was also registered as a contribution: 5.21 minutes of broad coverage of geodiversity interests that have grabbed the geologists of the future! See [Rockstars Young Geologists' Competition Showcase 2022 - YouTube](#)

The Rockstars Young Geologists' Competition

Enables children and young people to explore **Geodiversity** in imaginative and fun ways.

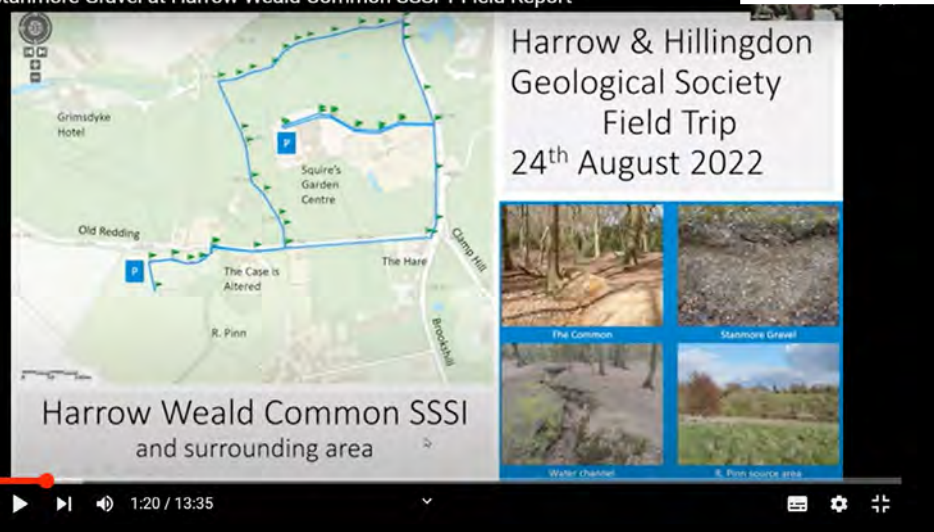
Top: A still from the Rockwatch YouTube video. © Geologists' Association.

Right: Geoconservation day at Riddlesdown. © Diana Clements, London Geodiversity Partnership.

Bottom: A still from one of the HHGS videos as part of their contribution to IGD. <https://www.youtube.com/@harrowhillingdongeologicalsoci>.



Stanmore Gravel at Harrow Weald Common SSSI 1 Field Report



To look in more detail at one of the above examples, the Harrow and Hillingdon Geological Society (HHGS) posted details of their interest in a local geological Site of Special Scientific Interest (SSSI): Harrow Weald Common. Represented at this site is an enigmatic hill-capping high-level gravel, notified as part of the Thames Quaternary GCR coverage. The gravel consists predominantly of rounded flint pebbles thought to have been reworked from the Palaeogene, although the rounded character of the deposit has led many to interpret it as marine in origin. Key to its correct interpretation is the small proportion of the material that is not rounded flint, some of which is reported to be Lower Greensand chert, leading to interpretation as an early south-bank Thames tributary gravel. The HHGS is planning a future investigation, with further analyses and potential luminescence dating: exactly the sort of thing that SSSIs exist to enable!

With International Geodiversity Day now an annual event there will an opportunity to get involved next year too, and the GA is sure to play its part.

A Proposal for Siccar Point (Berwickshire) to be designated as a UNESCO World Heritage Site

Robert W Gatliff, Edinburgh Geological Society & Scottish Geology Trust and
Colin Campbell, Chief Executive, James Hutton Institute

2026 will mark the tercentenary of James Hutton's birth. He is undoubtedly one of the stars of The Scottish Enlightenment and his insights into deep time and geology continue to be relevant around the world today, with implications for subjects including evolution and climate change.

The James Hutton Institute is coordinating a wide group of organisations looking at ways to celebrate his tercentenary. Several new books and publications about Hutton are published or in preparation, and there will be scientific meetings, but there is also a need to increase awareness of his scientific contributions in Scotland and around the world.

We cannot imagine a better way than seeking designation of Siccar Point as a UNESCO World Heritage Site, so earlier this year we applied to the UK Government to seek a place on their tentative list and then if successful, develop a full proposal to UNESCO. Results of the UK application should be announced around the New Year. If successful, then we are on the road to UNESCO.

Siccar Point is already included in the list of the world's most important geological sites, recognised by the IUGS (International Union of Geological Sciences). To get UNESCO World Heritage designation requires more. We need to demonstrate the case on historical and scientific grounds, but also show that there is support within the community, the main stakeholders in the area, and the planning authority. We must develop a management plan and demonstrate sustainability.

Siccar Point is an outstanding location for World Heritage Status. It is a singularly important classic unconformity which is superbly exposed. However, what makes it unique and special is the historical narrative around the visit by three eminent scientists, James Hutton, John Playfair and James Hall. Siccar Point is the site where the immense timescales of geological processes were first demonstrated using scientific methods. This shaped our understanding of Earth history and laid the foundation of the geological sciences. Hutton was the first geologist to produce a plausible theory of the Earth in geological terms.

The site is only 5.7 hectares and within this area there have been no significant changes since Hutton's visit in 1788. Visitors come from across the world to see it, with many geologists considering Siccar Point to be a place of scientific pilgrimage. With inscription Siccar Point would be formally acknowledged as a celebration of globally significant history and science, and the use of logic, theory and scientific proof as a world-changing philosophy. Siccar Point is ideal for explaining how the Earth works to those with little or no knowledge of geology. Visitors are enthused about geology and intrigued at how science was used to explain it.

We have chosen to restrict our application to that of the existing SSSI. We have the support of the landowners, and the tenant farmers. The nearest significant village, where there are options for a visitor centre, is Cockburnspath, and we have the support from the Community Council. We also have support

from the Scottish Borders Council, South of Scotland Destination Alliance, and South of Scotland Enterprise.

Visitors will be encouraged to approach on foot using the existing car park, and an upgraded coastal path. The only change within the proposed site would be a stairway down the steep and slippery slope to the outcrop. This will require funding for construction, maintenance and insurance. Virtual access has been created to allow people to explore the site with a virtual tour and embedded interpretative resources (<https://virtualtours.hutton.ac.uk/siccar-point>), and a BGS video provides another impression of the site (<https://www.youtube.com/watch?v=JCEDCcHcpYE>).

We envisage a management board including representatives of Scottish Borders Council, Cockburnspath Community Council, the landowner and tenants, plus representatives of the James Hutton Institute, Scottish Geology Trust, NatureScot, Edinburgh Geological Society and others. The Scottish Borders Council will be a key member of the management body; their staff support and manage the network of footpaths and the coast and will contribute to the maintenance of the footpaths. We have a thriving local Geoconservation Group and a vibrant community to support path maintenance.



The coastal platform at Siccar Point, Berwickshire made famous by James Hutton following his visit in 1788. The beautifully presented unconformity with its historical association with Hutton, and the development of geological science, includes the necessary elements of Outstanding Universal Value that underpin a World Heritage Site. Photo by Colin MacFadyen/NatureScot.

The National Trust for Scotland's geodiversity policy

Rebecca Millar, Policy Officer, the National Trust for Scotland

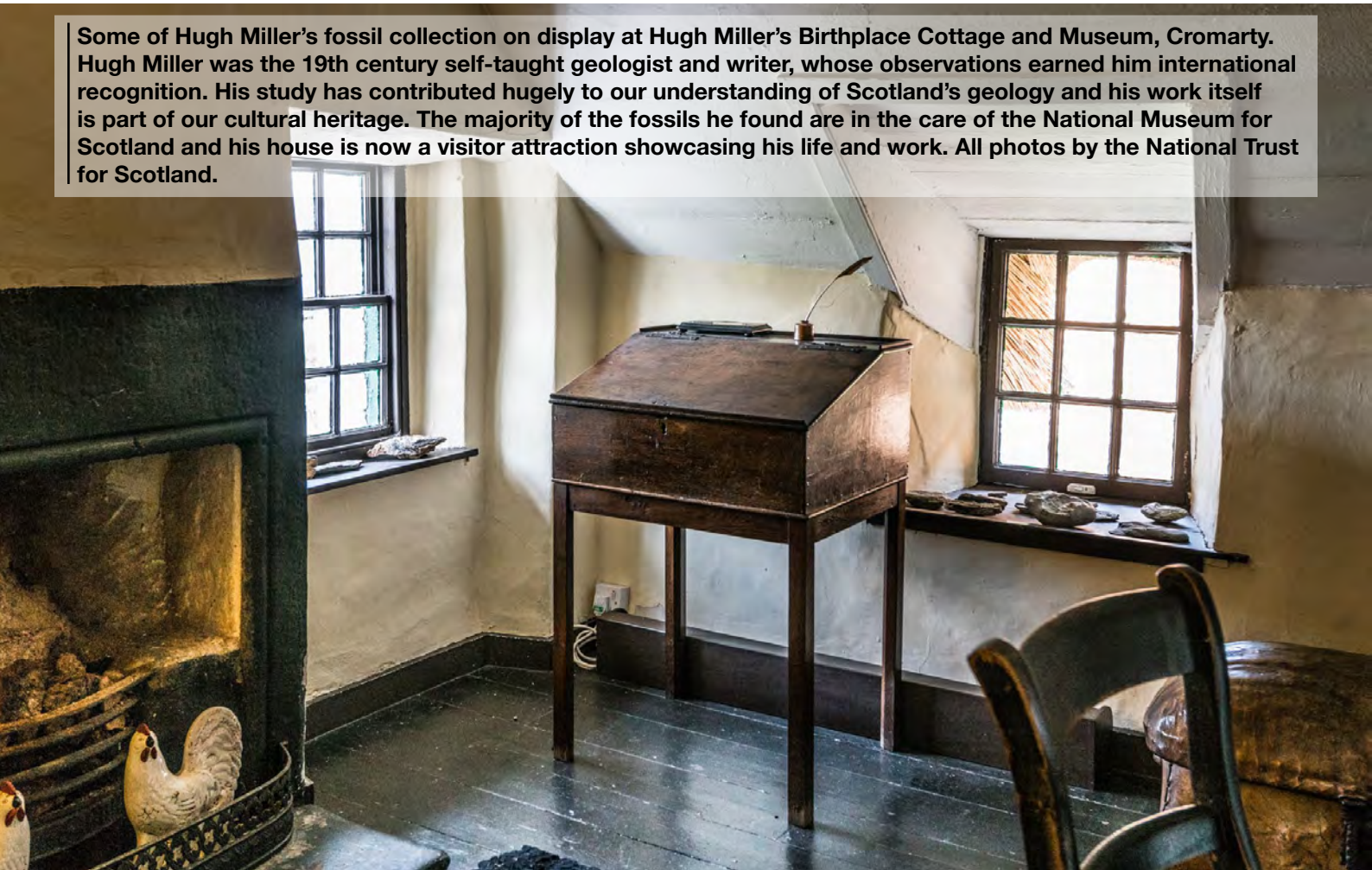
The National Trust for Scotland cares for many sites renowned for their geodiversity. The Trust cares for and conserves these sites for current and future generations, as well as champions Scotland's rich and important geoheritage. We have recently published our Geodiversity Policy which identifies what challenges and opportunities exist for Scotland's geodiversity and sets out how the Trust will fulfil its role as custodian and champion.

Scotland's geodiversity

Scotland's geodiversity underpins Scotland's natural, cultural and built heritage. Our famous landscapes and natural heritage have been shaped by millennia of geological and geomorphological processes, and the character and locations of our built heritage have been influenced by what materials have been available and where people could most productively live.

As well as being physically influenced by geodiversity, Scotland's geological sites and objects such as fossils and landscapes provide us with many benefits such as a sense of place; understanding of natural processes and how humans affect them; community identity; opportunities to enhance health and wellbeing; and economic returns through being a huge tourism draw and supporting rural economies.

Some of Hugh Miller's fossil collection on display at Hugh Miller's Birthplace Cottage and Museum, Cromarty. Hugh Miller was the 19th century self-taught geologist and writer, whose observations earned him international recognition. His study has contributed hugely to our understanding of Scotland's geology and his work itself is part of our cultural heritage. The majority of the fossils he found are in the care of the National Museum for Scotland and his house is now a visitor attraction showcasing his life and work. All photos by the National Trust for Scotland.



Staffa National Nature Reserve in the care of the National Trust for Scotland. The Trust is investing in the infrastructure at Staffa of this globally famous geosite (as illustrated in an article on pages 17-19 in issue 54 of *Earth Heritage*) as well as conservation measures to ensure the island's beauty, wildlife and heritage are protected.



Geoheritage in our care

Particularly valued aspects of Scotland's geodiversity are regarded as geoheritage and the Trust is fortunate in owning a collection of often unique aspects of this, including: Staffa; the landscapes of Torridon and Glencoe; Corrieshalloch Gorge; Falls of Glomach; Killiecrankie; Goatfell; St Kilda; St Abbs Head; Grey Mare's Tail; Iona; Canna; and Mar Lodge Estate.

Our sites are associated with some of the great pioneers of geological science. We care for MacCulloch's fossil tree on the island of Mull off Scotland's west coast, which is named after John MacCulloch who completed Scotland's first geological map. We also have close links with James Hutton, who developed his geological theories whilst on Arran and the coastline north of St Abb's Head. The Trust is also privileged to care for Hugh Miller's Birthplace, Cottage & Museum in Cromarty.

In addition to these sites, the Moine Thrust, which runs through some of the Trust's North-Western sites including Torridon and Inverewe, is of particular global significance. Recently it has been included in the International Union of Geological Science's 'First 100 Geological Heritage Sites' list.

Conservation and engagement are two of the Trust's core aims which guide our activity. With so much of our guardianship covering geologically significant sites, the Trust wants to ensure there is policy and guidance in place to properly guide the long-term management, protection and championing of Scotland's geoheritage and geodiversity.

Our Geodiversity Policy

The Trust recently approved the Geodiversity Policy and Guidance, which can be viewed here: <https://www.nts.org.uk/what-we-do/advocacy/geodiversity>

The rugged and iconic landscape of Torridon which has been fashioned from, and has given its name to, 800 million year old Torridonian sandstone. This is one of many areas of classic Scottish geology that is in the care of the National Trust for Scotland. The geology and geomorphology held in trust provides an insight into many key events in Scotland's deep history.



Our policy identifies the challenges and opportunities for geodiversity and geoheritage in Scotland. Scotland's landscapes are utilised in many activities such as farming, forestry and recreational pursuits. Our landscapes also play a key role in informing our cultural and built heritage. We want to ensure landscape change is positively guided to protect these benefits.

Geodiversity, unlike biodiversity, does not have specific statutory protection in the planning system. Many Local Authorities take Local Geodiversity Sites into account in their Local Development Plans but this is not mandatory. Although many Geological Conservation Review sites are protected through inclusion in designated Sites of Special Scientific Interest (SSSIs), around 200 are not. Additionally, Nature Conservation Marine Protected Areas (MPAs) can offer protection to geological features, however many MPAs allow extractive activities which damage the geodiversity of the seabed.

The Trust will help conserve Scotland's geodiversity through engaging with relevant bodies on processes and regulations that impact geoheritage, such as the planning system or the forthcoming Environment Act. We will also input into how land uses are incentivised through public funding.

The Trust champions Scotland's geodiversity and geoheritage through our membership of the Scottish Landscape Alliance, of which we are a founding member. The Scottish Landscape Alliance promotes the importance of Scotland's landscapes in relation to climate resilience, biodiversity enhancement, Scotland's economy, and public health and wellbeing. We are also a signatory of Scotland's Geodiversity Charter. The Charter commits the Trust to maintaining, promoting and enhancing geodiversity as an integral part of Scotland's natural heritage.

To conserve and learn more about our geodiversity, we welcome responsible geological research on our sites and where geodiversity features are discovered through erosion or development work, the Trust will bring them to the attention of appropriate specialists. By extension, in our management of our sites we will adhere to and promote the Scottish Fossil Code, Scottish Outdoor Access Code, the Ethical Rock Collection Policy and the Scottish Core Code. We operate a minimum interventionist approach by adopting management practices that allow natural processes to occur.

The Trust is also dedicated to showcasing our national treasures and engaging people in our shared heritage. We work with people to experience and value our geodiversity and geoheritage through

providing information about geodiversity and reaching out to the communities in which we are based. For example, Hugh Miller's Birthplace, Cottage & Museum makes downloadable fossil colouring sheets for children and puts on storytelling sessions and walks, as well as welcomes school visits.

In 2022 the Trust launched its ten year strategy *Nature, Beauty and Heritage for Everyone*. Our strategy is based around three pillars- Conservation, Engagement and Sustainability. This underpins the work we are doing to care for and champion Scotland's geodiversity and geoheritage. Through the strategy we are delivering major projects to achieve our vision of being the leading body in Scotland that improves people's lives through access to nature and heritage. For example, we are building a new visitor centre at Corrieshalloch Gorge which will offer visitors a way to further engage with this unique and thrilling fluvial geomorphological site and we are also investing in the infrastructure at Staffa National Nature Reserve (NNR).

Looking to the future

The National Trust for Scotland is here to care for, share and speak up for Scotland's magnificent heritage. We are excited to continue to do this for geoheritage. We will engage visitors at our spectacular places as well as champion the value of geodiversity in relation to climate change mitigation, land uses, biodiversity enhancement, landscape, tourism, Scotland's economy and the cultural identity and health of people. We will also continue to work to protect Scotland's geodiversity and geoheritage, both through our management practises on site and our advocacy work.

We hope to welcome you to one of our sites soon!

The spectacular and rugged coastal scenery at the National Trust for Scotland's site at St Abb's Head. The geodiversity in care here includes two Geological Conservation Review sites of national importance within the St Abbs Head to Fast Castle SSSI. The coastal geomorphological interest has a close relationship to Silurian-Devonian age volcanic rocks the former exploiting the numerous planes of weakness in the lava flows. The textbook geology provides ample nesting opportunities for internationally important numbers of guillemots and nationally important numbers of kittiwakes, razorbills and shags, demonstrating the interplay between geodiversity and biodiversity.



Where is the geomorphology in geodiversity?

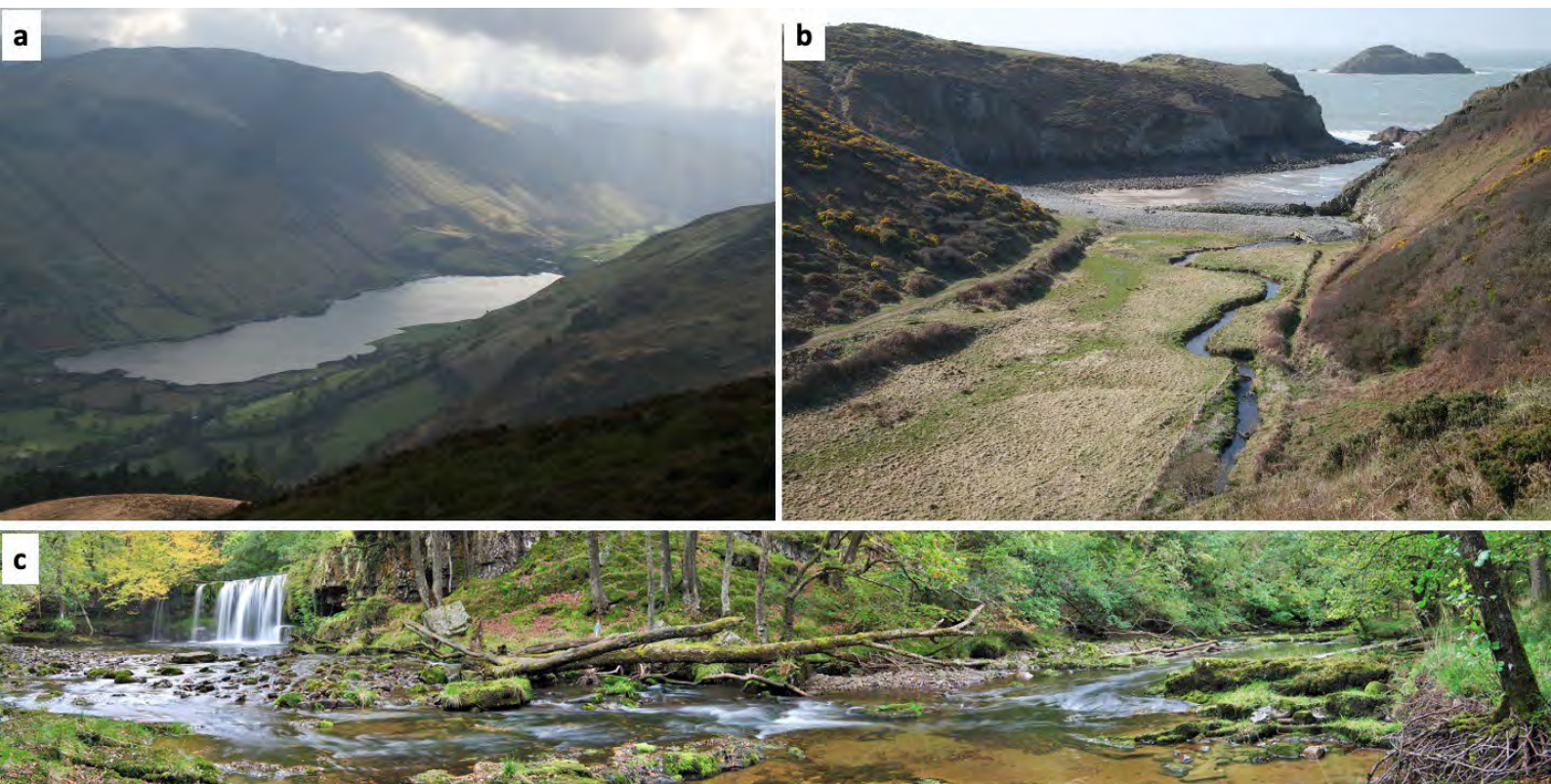
Stephen Tooth and **Hywel Griffiths**, both Aberystwyth University, and **Dewi Roberts**, Independent researcher and freelance education advisor

In her International Geodiversity Day (IGD) message (p18 this issue, and Gray, *EH56*, p30-32), UNESCO Director-General Audrey Azoulay called on the international community to “galvanise the potential of geological sciences – and view familiar landscapes with fresh eyes”. The contention of this article is that geomorphology and geomorphologists can – and should – contribute to this call. Although the term ‘geomorphology’ lacks prominence in IGD documentation, geomorphological perspectives on Earth surface processes, landforms and landscapes can provide new insights into geodiversity to complement those from other disciplines (e.g., geology, geophysics, archaeology, sustainability science). To achieve this potential, individual geomorphologists and geomorphological organisations worldwide need to engage more effectively with a range of non-specialist audiences, including schoolchildren and citizen scientists.

The UK and geodiversity

Given a long history of natural and cultural heritage protection through the establishment of national parks, geoparks and Sites of Special Scientific Interest, the UK is well placed to contribute to international geodiversity efforts. Indeed, the UK made many contributions to IGD, including through activities organised by the Geologists’ Association (see Bridgland and Prosser, p20 in this issue). More could be done, especially by geomorphologists. Many of the UK’s protected areas are designated on the basis of their scenery: landforms and their wider landscapes. In Wales, for instance, many spectacular mountain, river, and coastal landscapes lie within protected areas, and many other similarly impressive landscapes are arguably worthy of protection. These landscapes

Examples of Welsh landscapes in national parks (NP): a) formerly glaciated valley, Talyllyn (Snowdonia NP). Photo by S. Tooth; b) coastal cliffs and beaches, Gwadr Valley, Solva (Pembrokeshire Coast NP). Photo by S. Tooth; c) waterfall and gorge Scwd Ddyli, near Pontneddfechan (Brecon Beacons NP). Photo by D. Roberts.





Examples of geoheritage promotion worldwide: a) on-site signboard explaining the development of inverted channels and saline depressions in the Ebro basin, northeast Spain; b) exhibit of the scientist explorer Francisco Pascasio Moreno in Glaciarium, an interpretation and education centre dedicated to glaciers and ice, southern Argentina; c) information resources developed for the Grand Canyon and other parts of the southwest USA. All photos by S. Tooth.

have developed through geomorphological processes operating over long timescales on diverse geologies, many preserving archives of climate changes, sea-level fluctuations, tectonic processes (e.g. uplift, faulting) and plant and animal activities, including – increasingly – human influences.

Scenery is a primary draw for visitors to these locations but the science behind the scenery is underplayed. Where is the on- or off-site geomorphological information and an explanation of its role in creating geodiversity? In other parts of the world, particularly parts of Europe and the Americas, good-quality geomorphological information is available from signboards, visitor-centre displays, non-specialist publications, and public talks. Geomorphology is commonly labelled as ‘geology’ or ‘geosciences’ but, nonetheless, this information helps to communicate its contribution to geodiversity, including its underpinning of elements of biodiversity, artistic inspiration and other cultural activities, and mental and physical wellbeing.

At many UK landscape attractions, in contrast, information is commonly simplistic, dated, erroneous, or absent altogether. Outdoor signboards weather rapidly and are easily damaged but not always replaced. Some ventures have suffered from lack of funding: closure of the Waterfalls Centre in ‘Waterfall Country’ in the Fforest Fawr Global Geopark, south Wales, provides a disappointing example. Local and regional geological guides are available, and may cover aspects of geomorphology, albeit briefly and selectively. A recent book produced by the International Association of Geomorphologists (Goudie and Migoñ, 2020) outlines the development of over 20

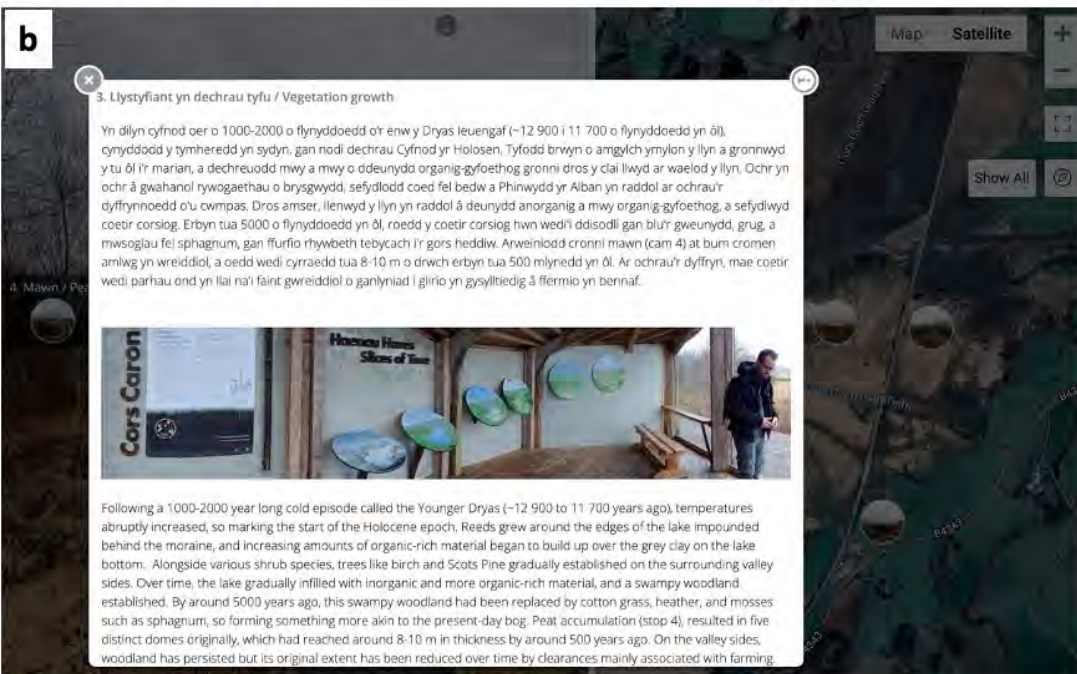
of England and Wales’s landscapes but many key sites are not covered, and the book is behind a paywall, so not readily accessible to the public. Could the development of more durable, accessible geomorphological information – for example, through free publications and digital resources, and various citizen science activities – help to enhance visitor experiences at specific sites, but also contribute more generally by raising awareness of geodiversity and inspiring a new generation of geomorphologists? Below, we provide examples, mainly from our own activities in Wales, to illustrate potential approaches. All the resources have been developed in both Welsh and English to cater for a wide cross-section of visitors (we focus on the English versions here).

Geomorphology in Welsh geodiversity promotion

Devil’s Bridge Falls/Rhaeadrau Pontarfynach is a honeypot visitor attraction about 20 km inland from Aberystwyth, west Wales. The main waterfall is tiered, with five major drops and intervening cascades adding up to a total drop of 91 m, one of the highest in Wales. Also, there are spectacular examples of potholes, plunge pools and gorges. Until recently, however, little on- or off-site geomorphological information was available. Based on focus-group activities with local stakeholders, including representatives from Natural Resources Wales, Ceredigion Museum, geopark and local authority representatives, and local visitor groups, we developed brochures and audio trails that are now hosted on the official website (<https://devilsbridgefalls.co.uk>). These interweave geomorphological information with aspects of ecology, social history and culture by considering questions that many visitors ask about the attraction: how old are the waterfalls?; how have the natural attractions shaped human use of the landscape?; in what ways have the natural attractions inspired cultural responses? Questions about social history or human experience (e.g. Wordsworth’s poetic responses to the waterfalls) are used to provide hooks for discussing the geomorphology; for example, how the scenery contributed to the sense of ‘the sublime’ that was sought by many 18th to 19th century artists.



SeekBeak virtual tours developed for mid Wales landscapes: a) QR codes for the six tours; b) example screenshot from the Tregaron Bog/Cors Caron tour, highlighting on-site artistic panels (‘Slices of Time’) that represent the sequence of late Quaternary landscape change. Photo by S. Tooth.





Example underwater photograph of potholes and bedrock sculpted forms in a Welsh river. Photo by D. Roberts.

Similar approaches have been taken in developing other resources. As part of her Aberystwyth University PhD, Sioned Llywelyn developed an excellent online StoryMap for the Elan Valley/Cwm Elan in mid Wales (<https://www.elanvalley.org.uk/discover/elan-valley-tour>). This visitor attraction is focused around various dams and reservoirs that supply water to Birmingham. By interacting virtually with various stops around the Elan Valley, either before or after visiting, or *en route*, geomorphological information is integrated with questions about the area's importance for water provision, rare flora and fauna, the history of local communities, and why the landscape has inspired cultural responses (e.g. from the poet Shelley).

Along with colleagues at Aberystwyth and Sheffield Hallam universities, we have developed virtual landscape tours for other mid-Wales post-glacial, hillslope, fluvial, and coastal sites using the SeekBeak app. These also integrate geomorphology with ecological, social historical, archaeological, and other cultural information. Reference is made to existing on- or off-site geomorphological information, such as artistic representations of landscape development or the official SSSI documentation.

Finally, rather than focusing on a specific site, we have produced a book on the river potholes of Wales (Roberts *et al.*, 2022). Potholes and related forms are commonly overlooked features of bedrock rivers but by integrating landscape photography, including, crucially, underwater perspectives on otherwise 'invisible' landscapes, we hope to enable readers to see these familiar landscapes through fresh eyes. The book demonstrates how an understanding of pothole geomorphology can enhance appreciation of their significance for long-term river valley development, river ecology, social history, stories and legends, and other non-visual and visual arts. Also, we outline why visiting potholes and bedrock rivers more generally can be important for mental and physical wellbeing, and how this can be a stimulus for educational activities.

Conclusion

In his book entitled 'Unweaving the Rainbow' (1998), Richard Dawkins starts by addressing the poet Keats's accusation that Newton 'had destroyed all the poetry of the rainbow by reducing it to the prismatic colours' (p.xii). One of Dawkins's arguments is that science does not destroy imagination and mystery, but rather can help people to discover wonder and pleasure in the patterns of nature. Similarly, we feel that rather than undermining the inspiration that many draw from scenery, geomorphology can reveal the beauty of the natural world. Consequently, geomorphology can enhance appreciation of geodiversity, including its relation to biodiversity, other aspects of ecosystem service delivery, and human wellbeing. Individual geomorphologists and geomorphological societies all need to engage with the challenge of raising the profile of geomorphology and developing a new, more diverse generation of geomorphological enthusiasts. By doing so, the discipline can play its full part in responding to Azoulay's call.




Further reading:

Goudie, A. and Migoñ, P. (eds) (2020). *Landscapes and Landforms of England and Wales*. World Geomorphological Landscapes. Springer Nature: Cham, Switzerland.

Roberts, D., Tooth, S. and Griffiths, H.M. (2022). *The River and The Rock: River Potholes of Wales*, Gwasg Carreg Gwalch: Llanrwst, Wales.

Acknowledgements

We are grateful to the Coleg Cymraeg Cenedlaethol for funding Sioned Llywelyn's PhD research, as well as other activities related to geodiversity with undergraduate students. We also thank the British Society for Geomorphology for funding the focus group activity at Pontarfynach/Devil's Bridge and the development of virtual landscape tours. Marie Busfield, Tristram Irvine-Fynn (both at Aberystwyth University) and Jonathan Bridge and Naomi Holmes (both at Sheffield Hallam University) also contributed to the development of these tours, and we thank the National Eisteddfod for their support in developing these resources also. The 'Our Picturesque Landscape' partnership scheme was funded by the National Lottery Heritage Fund, for which we are grateful. CUPHAT is funded by the European Regional Development Fund (ERDF) through the Ireland Wales Co-operation Programme.



3D scan of sediment in potholes on the Afon Teifi at Llandysul, captured on a smartphone using the Polycam app. An interactive version can be seen at: <https://poly.cam/capture/E0EB98D6-D05E-4B06-95FB-E1C398161B9C>. Photo by H. Griffiths.

Training a new generation of geomorphological enthusiasts

This article shows how geomorphology can provide a distinctive perspective that can contribute to Azoulay's call to "view familiar landscapes through fresh eyes", at least in a conceptual sense. Better still, we could train a new generation of geomorphological enthusiasts to help with geodiversity efforts, in the same way that many geological conservation projects benefit from the involvement of volunteers. Then geomorphology could make a more literal contribution to the call.

Geomorphologically-oriented citizen-science activities provide one possibility. Currently, we are involved with an Ireland-Wales Co-operation Programme entitled 'Coastal Uplands, Heritage and Tourism (CUPHAT)'. CUPHAT (<https://cuphat.aber.ac.uk>) will help to embed geomorphology alongside geology, ecology, history and archaeology in community-led, sustainable promotion of natural and cultural heritage in parts of the west Wales and eastern Ireland uplands that may be visited less often than some better known areas such as Snowdonia. Drawing inspiration from landscape-based citizen-science activities worldwide (e.g. CoastSnap – <https://www.coastsnap.com>), crowd-sourced digital imagery (e.g. repeat photography from fixed vantage points) will be used to help track changes to river and upland landscapes. The project will also take advantage of rapid technological advancements, including the possibilities of citizens making 3D scans of geomorphological and geological features on mobile phones. These and other planned activities will not only contribute to improved landscape characterisation and monitoring but also help raise awareness of geodiversity, including to people unable to physically access upland features.

There are many other possibilities for broadening inputs to geomorphology, including through improved school liaison activities and participatory art/science approaches. The latter might include landscape walkovers and geopoetry workshops that make links between geomorphology and wider historical and cultural features. For example, in the Clwydian Hills and Lower Dee AONB, 'Our Picturesque Landscape' project has included poetry workshops with local schoolchildren and interviews with stakeholders in river and heritage management, writers and poets. A SeekBeak virtual tour includes poems inspired by six locations (<https://www.clwydianrangeanddeevalleyaonb.org.uk/projects/dee-valley-poetry-tour/>). Broadening geomorphological education and outreach in this way may also help to address issues around equality, diversity and inclusion by showing how geomorphology is a vibrant, relevant and fun discipline, of value not only to geodiversity but also to society more generally.



Woven in Nature

Anna Wetherell, Nearly Wild Weaving

A key challenge with conservation activities is getting people interested in what we wish to conserve, and potentially enthusiastic enough to help out. Generating that initial interest happens in so many ways, however, and it often starts with simply finding activities through which people can notice the world around them.

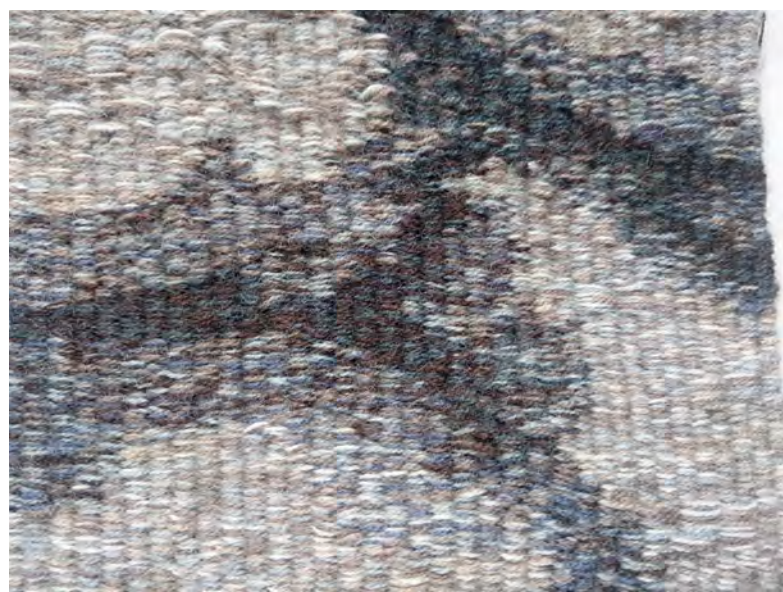
Those of us who have studied geology were often required to draw fossils as a means of observing and recording their characteristic features. We will also have drawn cross-sections from maps, outcrops in the field, potentially logged sedimentary features, and drawn maps recording the geology and structural features of an area. An ability to draw is encouraged – maybe that's what put me off palaeontology! But even if we are not trying to technically record what we are observing, art has become a common way of engaging with the landscape around us, a way to spend time in nature, amongst rocks, and simply appreciate the world around us. The last issue of *Earth Heritage* had an article on *geopoetics* (*EH 47*, p28) – words are also an important means of 'noticing', not just through the text books but through wider forms of literature. So, what about tapestry weaving?

Tapestries have been hand-woven for many centuries. We are often familiar with them from visits to stately homes and castles, adorning the walls and, in the days before central heating, providing portable insulation and draught proofing in a way that demonstrated your wealth and status. They can take months, even years, to weave, requiring a fairly high level of technical skill. They do not need to be woven at that scale, however, and skills can be developed along the way.

Tapestry woven at Leighton Moss, inspired by the reedbeds, with a hint of dragonflies! All photos by A. Wetherell.

Here at *Nearly Wild Weaving* we love to weave outdoors, and encourage others to do so as well. We run *Nearly Wild Weaving Experiences* and workshops where we take our inspiration from the world around us – landscape, flora and fauna, history, and, of course, geology. Much has been documented over the last few years of the health benefits of getting out and spending time in nature. This is another way to do it. Instead of picking up a pencil, paintbrush or pen, we pick up a simple tapestry frame and some yarn. In a few hours or a day, we will not weave something the size of the Devonshire Tapestries in the Victoria and Albert Museum, but we can weave a small something that reminds us of where we were, the sights, sounds and smells, the colours, the textures. We can also engage with others and weave something larger together. It's about being creative, and noticing.

We've run several *Experiences* in Llanymynech, on the Wales / Shropshire border, as Irene has had a base there for several years. From there we can explore Llanymynech Rocks, a Montgomery Wildlife Trust Reserve and SSSI, along with some of the adjacent meadows at Underhill. We can also head down to where the limestone was processed, with the spectacular Hoffman lime kiln near the Montgomery Canal forming part of the Llanymynech Limeworks Heritage Area. There is much inspiration on offer, from the colours of the flora and fauna to the rocks and the heritage. Irene recently ran the Nature Celebration Llanymynech project, with the local community getting involved in weaving elements of it and also taking part in guided walks or simply talking about some of their favourite local plants and animals. The final work was exhibited in the window of the village shop – art in the community.



Top: Tapestry woven at Llanymynech Rocks Nature Reserve, looking at the quarry face, water seepage, cross bedding.

Middle: We can also weave on stones collected on site, or other found objects.

Bottom: Limestone pavement in tapestry.

Waterline in exhibition at Farfield Mill, Sedbergh, with Waterline of the Rawthey in the foreground.



Closer to home, members of my monthly tapestry weaving group had never woven outdoors, but were curious to try it. One Friday afternoon in August we all met at Leighton Moss, in the Arnside & Silverdale AONB and an RSPB reserve – one of the hottest days this year but we managed to find some shade! The reedbeds provided inspiration for some of us, the tree canopy others. A great success, and enthusiasm to do it again. In my mind is the potential to run some events within the AONB relating to the geology. From experience, however, Trowbarrow Quarry SSSI (a disused limestone quarry) is not the ideal venue on a baking hot day!

I also use the local environment for 1-day workshops at Farfield Mill, near Sedbergh. The premise is simple for all of these activities. Take some time to go and have a look at where we are – colours, textures, patterns – then capture what has caught our eye in a simple way in weave. I have already warped up the looms, so we can just dive into the bags of yarn, choosing colours and materials according to what has caught our eye. Techniques are taught as we go, as needed to solve problems or to make it simpler to weave. Complete beginners successfully create a small piece in a few hours, being as adventurous as they like as confidence grows, and often sparking ideas off in each other.

Geology and the natural environment form a key part of my tapestry practice, providing inspiration for much of my work. These are pieces that will take much longer to weave, are more technically demanding, and may end up in exhibition. We recently ran a collaborative project, Waterline, led by Joan Baxter, an internationally known tapestry weaver. The group, based in Canada, the United States, the Netherlands, Ireland and the UK, met on zoom and each wove tapestries inspired by our

local rivers or a river that meant something to us. Each tapestry included a horizontal silvery-golden line, the waterline, along which they have all been hung. My piece reflected the fault patterns we can see in the rocks by the river here, caused by the Dent Fault. But it has also been interesting to see how each of the tapestries reflect their local environment, from the Stour and Avon meeting in Chichester Harbour to the rocky rivers found on Vancouver Island. It's in exhibition at Farfield Mill until just before Christmas 2022, then moves to Gairloch next summer.

Fundamental to all of this is enabling people to make connection with their environment. Even if they find out that tapestry weaving isn't for them, many of them have learned to notice what's around them a bit more, to see the flowers and the stones, to listen to the birdsong and watch the river. They also have a memory of that time in what they have woven. We hope that it will encourage them to connect to nature more in their own lives, and that, we hope, will help us all.

Inside the Hoffman Kiln at Llanymynech Heritage Area and, inset: small tapestry woven inside the Hoffman Kiln.



Nearly Wild Weaving is run by Anna Wetherell and Irene Evison.
<https://nearlywildweaving.wordpress.com>

Farfield Mill
<https://www.farfieldmill.org/whats-on/exhibitions/>



How do we monitor UK national geosites?

Rachel Wignall, Geology Adviser, NatureScot

What do we know about the condition of the UK's nationally and internationally important geosites? And how do we know? The UK is probably unique in having had a monitoring programme for protected sites for over 20 years. The programme covers notified habitat, species, geological and geomorphological features in the UK's protected sites, recording whether they are in Favourable condition, are affected by reversible deterioration and are therefore in Unfavourable condition, or have been irreversibly damaged to a greater or lesser extent and are therefore Partially destroyed or Destroyed. Earth science features in Sites of Special Scientific Interest are included in the monitoring programme, and these encompass the majority of our nationally and internationally important geosites, which are selected through the Geological Conservation Review (GCR) in Great Britain and the Earth Science Conservation Review (ESCR) in Northern Ireland. A recent paper (Wignall *et al.* 2022) explains geosite condition monitoring methodology used in the UK and how it has developed in the four UK countries over 20 years. The many lessons learned will hopefully be valuable to others, globally, wishing to set up geosite condition monitoring systems.

But what do we know about our geosites after 20 years of monitoring their condition? We know that compared to habitat and species features, geosite features record a higher rate of Favourable condition, with monitored geosites in 2019 recording >97% Favourable in Northern Ireland, 94% Favourable in Scotland, 85% Favourable in Wales, and 76% Favourable in England. Despite this we also know that there is continued degradation of geosites, with, for example, 10% of features

Trees within a conifer plantation hindering access and obscuring the Moine and Lewisian rock exposure at Allt Craic Site of Special Scientific Interest, south-west of Glenelg. Conservation management of the site, which is in an Unfavourable condition, could restore the condition of this nationally important geosite to enable geoscience research. © Colin MacFadyen/NatureScot.



in Scotland having required remedial action to return them to Favourable condition, and similarly 10% of geosite features in England being classed as 'recovering'. Irreversible damage to geosite features is also recorded with, on average, more than 3 nationally or internationally important geosite features being irreversibly damaged each year in the UK. Lots of different pressures affect our geosites including fossil and mineral collecting, development, coastal and river defences, afforestation, fly tipping and even graffiti. However, the most common pressure on UK geosite features is vegetation encroachment, which accounts for over half of Unfavourable assessments in England and Northern Ireland, and around a third in Wales and Scotland.

Find out more:

Wignall, R.M.L., Dempster, M., Roberts, R., & Townley, H. C. 2022. *Geosite condition monitoring in the UK 1999–2019*. Proceedings of the Geologists' Association. In press, <https://doi.org/10.1016/j.pgeola.2022.08.002>





Discovering more trackways at Ardley

David Evans, formerly Natural England

During the late 1990s and early 2000s quarrying at Ardley Quarry in North Oxfordshire revealed the presence of multiple trackways, mostly created by sauropods but with a few theropod tracks also present. At least 42 trackways were recorded by Day et al. (2004) from the base of the Shipton Member of the Middle Jurassic (Bathonian) White Limestone Formation at Ardley Quarry. With minor deviations, the sauropod trackways are orientated in an NNE-SSW alignment, and it has been hypothesised that they were either geographically constrained, moving in herd, or a combination of both. It was speculated that the theropods were displaying pack behaviour, probably following the sauropod herd, and potentially preying on them.

Whatever the interpretations of the trackways, there can be little doubt as to their importance and significance, leading to the question of their conservation. It was clear that prolonged periods of exposure of the footprints promoted their degradation while restoration plans for the quarry included landfill which would bury and obscure the trackways. Further, there were proposals for an energy from waste recycling facility to be constructed on the quarry floor. All these factors presented challenges to the conservation of the trackways. Thus, the main purpose of the survey of the trackways was to ensure that these features were recorded for posterity.

As the trackways in the quarry would be lost to planned development, it seemed that there was little benefit in designating this area as a Site of Special Scientific Interest since the permissions for development would have had priority over any subsequent designation intended to conserve the interest features. However, the quarry operators, Smiths of Bletchington, were still working a quarry to the north of the main site and were preparing an application to extend extraction onto land south of the site. As there was a possibility that the trackways extended north and south of the original site, the trackways were added to the Geological Conservation Review. Discussion with Smiths and the landfill operator (Viridor) led to the designation in 2010 of the northern quarry and the southern extension (Dewars Farm Quarry) as a SSSI. Moreover, the restoration of the southern extension is to



Left: Using a high-pressure lance to clean the surfaces of the footprints.

Below: Footprints of the longest trackway under excavation. The trackway extends to the face in the far distance on the right of the image. A discussion regarding the nature of a second possible trackway takes place in the background.



be to agriculture, while there is a condition that extraction was not to extend below the first limestone above the trackway horizon, thus leaving any footprints or trackways present buried and protected from weathering or disturbance.

To determine whether any trackways were present below newly cleared areas, the operators excavated transects down to the top of the trackway horizon, inspecting them in liaison with Oxford University Museum of Natural History (OUMNH) for the presence of footprints. Until 2022, no new trackways had been discovered. In early 2022 trackways were discovered in a newly cleared area of the new quarry and Mark Stanway, the quarry manager notified Hilary Ketchum of OUMNH of the discovery. On the 16th and 17th of June a team consisting of staff from OUMNH, and Liverpool John Moores University visited Dewars Farm Quarry to record the trackways.

Once on site, the first job was to dig out and clean up the individual footprints using spades and trowels as well a pressure washer provided by Smiths. Since these were the first really hot days of the summer and combined with the reflectivity of the quarry floor and walls, this was not easy work, requiring plenty of fluid and access to an air-conditioned refuge provided by Mark. Slowly, the footprints were exhumed to exhibit the depression created by the weight imposed by the foot and the surrounding relief formed by the displaced sediment, sometimes scuffed by the foot as it was raised for the next stride. Following their excavation, the trackways were recorded using photogrammetry. Three sauropod trackways are visible, one of which consists of at least 30 footprints. A second much shorter track runs parallel, and a third track lies at a right-angle to the other two. After recording them, the tracks were reburied to be protected from weathering and conserve them with other trackways that probably underlie this part of the quarry.

The detection and recording of dinosaur trackways in this part of Dewars Farm Quarry justifies its designation a Site of Special Scientific Interest. It also indicates that much additional data is waiting to be discovered at some time in the future should it become possible to excavate the area or be able to detect the trackways using a novel remote sensing method. A more detailed report of the results of recording are to be published elsewhere.

The outcome of this work demonstrates the benefits that can arise from close collaboration between quarry operators, conservation organisations, museums, and universities. While the planning condition specifying the depth to which the site could be worked would in all probability have protected the trackway bed, without the support (both financial and logistical) of Smiths of Bletchington, combined with the assistance of Mark Stanway and others at Dewars Farm Quarry we would have been unable to make these new discoveries. With that assistance, it is now clear that trackways are present, and something is known of their distribution. This knowledge will help with their future conservation, as well as directing future research on the site.

**Reference:**

Day, J. D., Norman, D. B., Gale, A. S., Upchurch, P. & Powell, H. P. 2004. *A Middle Jurassic dinosaur trackway site from Oxfordshire, UK.* *Palaeontology*, 47 (2), 319-348.

'Geo-natter': the Geological Society of Glasgow's latest outreach event

Gary Hoare, Publications officer, Geological Society of Glasgow

Launched on the 13th July 2022, The Geological Society of Glasgow's Geo-natter outreach project aims at providing an informal means for geo-enthusiasts, of all ages, to meet up to chat about geology and fossils. The project was developed by Clare Clark, member of the Geological Society of Glasgow, together with Dr Neil Clark curator of palaeontology at The Hunterian and Council member of the Geological Society of Glasgow. Geo-natter became an instant success!

Geo-natter events were open to anyone with an interest in any aspect of Geology or Palaeontology and advertised through the Society's web site and social media outlets. The public were actively encouraged to come along and join in, membership of the Society not being a requirement. Through the second half of 2022, Geo-natter events ran regularly from July until December, between 1:30 and 3:00pm and were held at the ideal venue of Glasgow's Kelvin Hall. The events utilised the venue's Activity Space, which was an ideal environment providing a relaxed atmosphere – made more so by the provision of refreshments and biscuits that proved as popular as looking at the rock specimens! It was remarkable to learn that many of those that participated had made the effort to travel some distance which was most heartening and welcomed by the organisers. The mid-afternoon timings of the events ensured the attraction of a slightly different demographic for geology events proving popular with people caring for younger children and also for retirees. As well as making it easier for some people to attend, afternoons suited many who would not normally attend evening meetings.

The first Geo-Natter session had 17 participants including the author who demonstrated some recently collected fossil fish from Caithness in a fantastic state of preservation. Many other fossil and mineral specimens appeared either for show or presented for identification. Arguably the most interesting of these being a piece of Zechstein salt and a small fossil fish jaw with a tooth still in place from a Carboniferous rhizodont fish, that had been collected locally. The inaugural event was a delightful opportunity to see some familiar faces as well as some new ones, especially in the wake of the COVID pandemic social distancing restrictions of the last few years.

The second event had 16 attendees and again many interesting specimens appeared and were the focus of the afternoon's natter. The star of the day was a six year old lad who brought his entire fossil collection in to be identified, and what a fantastic collection it turned out to be - a real pleasure to behold. Another highlight was a well preserved articulated gryphaea brought along and demonstrated by Dr Clark who patiently explained the mollusc's way of life and morphology. He also brought along some fossil fish and pieces of Rhaetic bone bed from Somerset, the bone bed was crammed full of fossils and created great interest among the participants. The Society's meetings secretary, Ian Miller brought along a varied and fantastic selection of minerals from his own collection, many of these were collected from various countries. Ian is thanked for his patience in answering the author's questions. Trilobites, dinosaur teeth and early lycopod fossils all made an appearance, the variety of specimens really made the day special.

All subsequent events were well attended and successful with countless fossils, rocks and minerals appearing and being the focus of the natter. It is worth noting and reassuring that all of the specimens

had been respectfully and conscientiously collected and lovingly cared for embodying responsible collector ethos. Many attendees made notes on identifications given by the experts and all were pleased to receive advice on preparing their finds as well as storage and curation. Various leaflets and postcards promoting the Scottish Fossil Code were distributed, and the 'geonatterers' showed an interest in taking part in the public 'have your say' that will guide the completion of the revised Code. The author found it refreshing to see the Code working and being used as a reference point for many collectors.

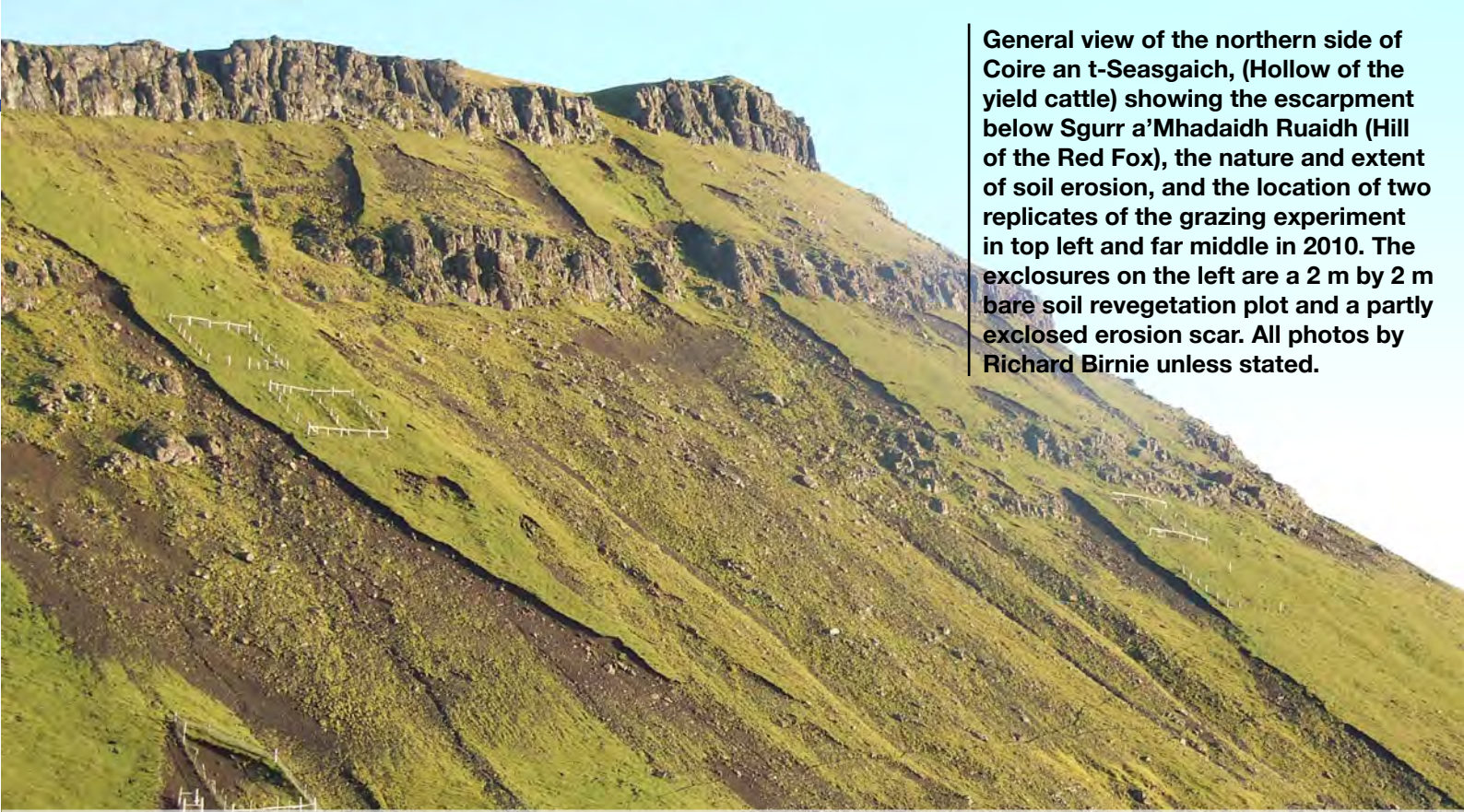
Attendees commented on the laidback atmosphere of Geo-Natter where contacts were established and friendships formed. Participants noted that the events were most welcoming and did not presume a knowledge of geology and palaeontology. The experts found the events meaningful and informative enjoying the geological natter as much as the public that participated. Such events are a great way to make geology and palaeontology accessible to the public and double up as a way to promoting these subjects. They also serve as a vehicle for promoting geoscience more generally, codes of best practice such as the Scottish Fossil Code, the work of the Society, and future events at other locations.

It is the aspiration of the Geological Society of Glasgow to hold more Geo-natter events in the future, with announcements being made on Society's website as well as Facebook and Twitter accounts.

The author would like to thank Claire and Neil for establishing the concept and format of Geo-natter for the Society and for the considerable effort they both invested in the project.



Dr Neil Clark, of The Hunterian, identifies fossil specimens in the collection of a young participant at a Geological Society of Glasgow Geo-natter event held in Glasgow's Kelvin Hall. Photo by Gary Hoare.



General view of the northern side of Coire an t-Seasgaich, (Hollow of the yield cattle) showing the escarpment below Sgurr a'Mhadaidh Ruaidh (Hill of the Red Fox), the nature and extent of soil erosion, and the location of two replicates of the grazing experiment in top left and far middle in 2010. The exclosures on the left are a 2 m by 2 m bare soil revegetation plot and a partly exclosed erosion scar. All photos by Richard Birnie unless stated.

Understanding and trying to manage soil erosion within the iconic Trotternish landscape

Dr Richard Birnie, Independent consultant, formerly of James Hutton Institute, **Dr Clare Brown**, Independent consultant and **Dr Vanessa Brazier**, formerly NatureScot

On the northernmost peninsula of Skye lies the 23km long escarpment of Trotternish Ridge. This is a special place geologically, ecologically and scenically. The whole area is noted for its national and international conservation designations (National Scenic Area, Site of Special Scientific Interest, and Special Area of Conservation). The escarpment is formed by a thick sequence of basaltic lavas of Palaeogene age which overlies weaker Jurassic sediments. Failure of these sediments has resulted in extensive landslips. These have created both the Trotternish escarpment and many dramatic landforms along it, including the Quirang and the Old Man of Storr. This dramatic landscape attract more than 200,000 visitors annually and the Trotternish escarpment is frequently used as a location for adverts and feature films.

The steep talus slopes formed below the escarpment display extensive areas of soil erosion and slope failures, including sheet erosion (general loss of vegetation cover and surface soil), gullying and debris flows. As a result, some of the rare grassland habitats found there are isolated like islands in an eroding landscape. This situation has long been of concern to both conservation and agricultural land management interests in the Trotternish area. In the mid-1990s, a land management study by the Scottish Agricultural College highlighted possible links between the increasing extent of erosion on the talus slopes below the Trotternish Ridge, and the historically high numbers of sheep grazing them. The study suggested that there might be a causal link between soil erosion on the talus slopes and overgrazing by sheep. At the same time academic studies along the ridge confirmed that the talus slopes had had periods of prolonged stability and vegetation cover, after rock fall rates declined following deglaciation. These studies also showed that the talus slopes started to be eroded and reworked by gullying and debris flows and landslides from the mid Holocene onwards. The substrate



Top: 12 m by 12 m enclosures; to the left is “rabbits only” treatment; and to the right is “no grazing” by either rabbits or sheep. The grazing experiment began in 1998 and this photo was taken in 2006. After 12 years there is a significant difference in the “no grazing” treatment in terms of vegetation composition and structure of the SSSI. So much so that it fails the Site Condition Monitoring targets for both vegetation composition and structure because it is no longer is species-rich grassland. There are less obvious but nonetheless significant changes in species composition in the “rabbits only” treatment.

Bottom: Measuring edge retreat associated with gully in the headwall of Coire an t-Seasgaich based on offsets (perpendicular distance) at 1 m intervals to a fixed baseline. The method for marking the baseline evolved, during the project, from using galvanised wire pins (pulled out by grazers), heavy duty galvanised nails (also pulled out by grazers), to heavy duty serrated tent pegs which survived! Note that these slopes average 35°.



on the slopes on the escarpment of Trotternish Ridge are highly susceptible to erosion once it's exposed to the elements. What we wanted to find out is if the risk of erosion could be reduced by managing grazing pressure.

Trotternish Ridge is owned by Scottish Government and tenanted by local crofters who have grazing rights associated with their townships along the peninsula. The communities work together to gather the sheep in, and the area is open unfenced land. Scottish Government commissioned a further study to investigate the origins and dynamics of the erosional features on the talus slopes, and the role of sheep and rabbit grazing in maintaining vegetation condition. This study began in 1998 and is still ongoing. It was undertaken initially by an interdisciplinary team from the Macaulay Land Use Research Institute (now the James Hutton Institute), and more recently by freelance researchers. The project was originally funded through the Scottish Government “agriculture and environment” research budget, and more recently by NatureScot (Scottish Natural Heritage).

Field measurements were made using erosion pins between 2001 and 2017. These were used to estimate rates of contemporary processes in two contexts: un-vegetated bare soil surfaces and un-vegetated soil exposures around erosion scars. Whilst net losses (erosion) predominate on the bare soil surfaces, they also have periods of net gain (deposition), so they are not exclusively erosional features. Average annual surface changes range between a loss of 6.2 cm per year to a gain of 6.4 cm per year, with both maximum values observed at the same site in consecutive observation periods. Scar edges show only net erosion of between 1.5 and 4.6 cm per year (2006-17), with a maximum of 20 cm per year. Analysis of rainfall data from 2001-2016 indicates that the balance between erosion and deposition processes on the bare soil surfaces is possibly determined by the frequency of high intensity rainfall/run-off events.



One of the 2 m by 2 m exclosures placed on a bare soil surface to investigate the nature and rate of revegetation when the surfaces are protected from sheep, rabbits, and the effects of downslope sediment movement. Photo is from 2010 and shows near 100% vegetation cover has established after 12 years of protection.

The constant downslope churn of sediment appears to make the bare soil surfaces hostile to vegetation recolonisation, potentially for decades. Evidence for this comes from a set of 2 m by 2 m exclosures established on the bare soils to investigate re-colonisation. In these, vegetation colonisation only occurred when downslope sediment movement was physically trapped because of the wire netting upslope. In addition, analysis of aerial photography taken in 1947 shows a similar distribution of bare soil surfaces to that observed today in our main study area. These lines of evidence indicate the widespread erosional features on the talus slopes below the Trotternish Ridge have existed for many decades and possibly much longer (up to a maximum of 500 years based on the palaeoenvironmental data from sediment cores in the study area).

Impacts of Grazing Animals on Vegetation Composition and Structure

Pollen and n-alkane analysis of organic matter in the buried palaeosols in the talus deposits below the Trotternish escarpment show that, for around the last 7 millennia, the predominant vegetation on the talus slopes has been a mixture of grass and heath species with a significant herb component. The question is what caused the replacement of these heath and tall herbs by the species rich grasslands on the slopes today? Whilst climate change could be a contributing factor, the most likely drivers of vegetation changes are those associated with land use changes particularly during the 19th century, especially the replacement of seasonal grazing, based on local cattle and sheep breeds, by year-round grazing with breeds of heavier sheep. Whilst it is impossible to provide documentary evidence of the specific effects of these historical changes on the vegetation on Trotternish Ridge, it is possible to examine them in reverse. This can be done by conducting grazing experiments on the present species-rich grasslands to observe what happens to the vegetation composition and structure when sheep are removed. Because rabbits were also introduced to Skye at a similar time to sheep, and are abundant on the talus slopes at present, it is also important to test the impacts of rabbit grazing (ten rabbits grazing are equivalent to a 55 kg ewe).

An experiment to investigate the grazing impacts of sheep and rabbits on vegetation structure and composition was set up in 1998 in Coire an t-Seasgaich. This corrie was selected because it provided a sufficient area of species rich *Nardus* grassland (NVC type CG10/11) to establish 4 replicated sets of 12 m by 12 m fenced exclosures (various combinations of stock fencing and wire netting) and unfenced plots. The results show that complete removal of grazing pressure leads rapidly, in one year, to tall sward. In 5-10 years the vegetation composition changes so it no longer is species-rich grassland. In the longer term, complete removal of grazers is likely to result in succession away from grassland towards a dry heath. This of course raises the dilemma that the high conservation value of species rich grasslands that survive in patches of intact land on the eroding talus slopes would of course change and lose their conservation interest - if grazing was able to be halted. The soil erosion study also shows that while significantly reducing all forms of grazing pressure would allow the land to recover, the process of restoration would be interrupted by periods of erosion during extreme rainfall events. As climate change begins to impact upon the weather, particularly the frequency of high intensity rainfall events, an extra dimension is added to the erosion management challenge at Trotternish.

Coire an t-Seasgaich, showing the range of plots and exclosures across the slope. The plots and exclosures provided three grazing treatments: unfenced “control” plot maintain the existing levels of grazing; “rabbits only” grazing (sheep excluded); and “no grazing” (rabbits and sheep excluded). In addition, several smaller 2 m by 2 m exclosures were installed on bare soil areas to examine the rate of re-vegetation on protected bare soil surfaces in the absence of both grazing animals and surface disturbance by loose sediment moving downslope. Photo by Vanessa Brazier taken in 2016.



Exploring the geology of Assynt – from the inside out!

Dr Tim Lawson, Chairman, Grampian Speleological Group

The beautiful landscape of Assynt, well known to countless generations of geologists and informed tourists, holds a secret that a select band of explorers have exploited for both their sporting interests and scientific research: the Cambro-Ordovician dolostone caught up in the Moine Thrust Belt has formed a thick mass of soluble rock that contains some extensive cave systems.

Visitors to the Allt nan Uamh valley that venture up the well-constructed, armoured footpath will see the Creag nan Uamh, a cliff containing large entrances to fairly short caves. The idea that they were occupied by Upper Palaeolithic people – in vogue in the 1920s – has been disproved, but various excavations have yielded the largest single collection of faunal remains found in Scotland (now housed in the National Museum of Scotland in Edinburgh). Hidden from view, both behind the crag and extending underneath it, is Uamh an Claonaite, Scotland's largest cave with 2.5km of underground passages; farther up the main valley is Allt nan Uamh Stream Cave, a multi-layered warren of subterranean surprises. 4 km to the north is the Traligill Valley, with Inchnadamph at its mouth. Visitors here can enjoy the rather strange experience of a karst landscape bordered by large hills and mountains. The Traligill River and its south-bank tributaries sink and resurge at several places on the dolostone, and inclined thrust planes have been etched into sloping limestone pavements.



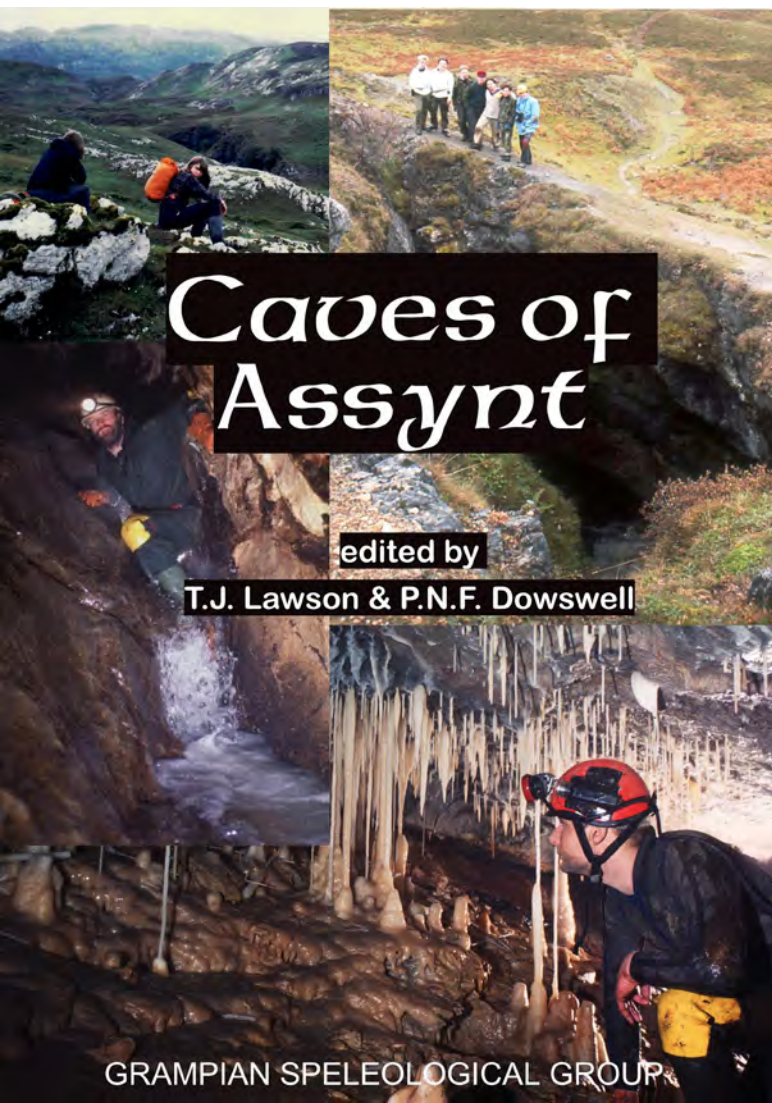
The Creag nan Uamh with the entrances to Bone Cave, Reindeer Cave and Badger Cave (left to right), truncated passages of a high-level cave system that followed the line of the Allt nan Uamh valley, formed beneath a water table some 200,000 years ago. Photo by Alan Thompson.

The Grampian Speleological Group (GSG), Scotland's largest and oldest caving club, has been exploring Assynt caves since the 1960s. Discovering new caves and extending existing ones usually involves digging and clearing loosened rock, and countless tonnes of deposits have been shifted aside over the decades. This has to be done responsibly, of course, and the GSG has benefitted from the support of both the landowner and Scottish Natural Heritage (now NatureScot) who have been kept informed of every new discovery. Several reports have been commissioned over the years to highlight potential management issues as part of the former Inchnadamph National Nature Reserve and nowadays the Ben More Assynt Site of Special Scientific Interest and Inchnadamph Special Conservation Area. With the 'North Coast 500' route passing through Assynt, there has been a noticeable increase in tourist numbers tramping local footpaths, leading to environmental management concerns, such as people climbing down into the fragile environment of the caves in the area and causing unintended environmental disturbance. The main cave networks have been the subject of site condition monitoring surveys, carried out by the GSG at regular intervals to identify changes below ground.

Carefully controlled scientific work on cave sediment sequences, further discoveries of faunal remains including brown bear, feral horse and reindeer, and projects to date speleothem samples (*i.e.* stalagmite and flowstone material) have uncovered important information about the ages of the caves and palaeoenvironmental changes in the Assynt area. The largest, highest caves pre-date the Late Devensian Glaciation, with their origins some 200,000 years ago; the dolostone slopes were seasonally important calving grounds for migrating reindeer herds; the caves provided hibernation sites for brown bears, and even other species of bear, as one skull fragment is believed to be one of only two polar bear remains found in Britain.

To celebrate its 60th Anniversary, the GSG has produced a new book to bring some of the story of exploration and its discoveries to a general audience. The new edition of *Caves of Assynt* brings

together not just a glossary and description of all the known caves but also chapters on the area's geology and geomorphology, the history of exploration in the caves and how scientific work in them is helping us to understand the timing of climatic changes that have shaped this region and beyond. One chapter gives the most detailed account of the Creag nan Uamh Bone Caves currently accessible to the general public. Its A4 format allows the inclusion of 55 detailed cave surveys. Clear area maps identify cave entrances located by GPS. Its 222 pages contain over 300 colour photos as well as some from the archives in monochrome, plus 29 maps/diagrams. Hopefully it will appeal to people interested in this unique area of Scotland, seen from a perspective of darkness, echoing emptiness and roaring underground rivers utilising and plunging down thrust planes.



Caves of Assynt

edited by

T.J. Lawson & P.N.F. Dowswell

Available from the GSG (email chairman@gsg.org.uk). RRP £20 for the softback version, £35 for hardback (plus relevant p&p, currently around £5 for one book). ISBN 978-1-7397635-0-3 (paperback). ISBN 978-1-7397635-1-0 (hardback)

The declaration in late October 2022, by the International Union of Geological Sciences (IUGS), of the 'First 100 Geological Heritage Sites'. The event took on the beach at Zumaia, in the Basque Coast UNESCO Global Geopark. Photo courtesy of IUGS.



Four UK sites included in the IUGS 'First 100 Geological Heritage Sites'

Colin MacFadyen, NatureScot, **Michael Dempster**, Northern Ireland Environment Agency, **Raymond Roberts**, Natural Resources Wales and **Taija Torvela**, School of Earth and Environment, University of Leeds

Four iconic locations in the UK - Siccar Point, Ynys Llanddwyn, the Giant's Causeway and the Moine Thrust, have been included in a list of the world's top 100 geological sites prepared by the International Union of Geological Sciences (IUGS). The announcement took place at Zumaia, in the Basque Coast UNESCO Global Geopark, in late October and marked the IUGS's 60th anniversary.

Production of the list of 100 sites, known as '*The First 100 IUGS Geological Heritage Sites*', is a significant advance in international collaborative efforts to audit and promote geological sites for conservation and promotion in the global context. Each of the sites is iconic and recognized by the international geoscience community as a reference for the impact and contribution made by individual sites in understanding the Earth and its history

More than 200 specialists representing different disciplines of Earth Sciences, based in nearly 40 nations across the world, participated in defining standards and the selection of candidate sites. From an initial list of 181 candidate sites, across 56 countries, a 33-strong team of international geoscientists evaluated the merits of each site and produced the list of the First 100 IUGS Geological Heritage Sites.

The 'First 100' is a major advance toward 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 is anticipated that this work will develop to encompass a much larger network of Geological Heritage Sites recognised globally. This could benefit efforts to enable conservation of classic internationally important geosites in areas where protection is not as robust as in countries such as the UK. The efforts of the IUGS will also substantially raise the profile of the sites not only among geologists who are unaware of the need for geoconservation but crucially will help promote the sites and geoscience to the general public.

Further information: <https://iugs60.org/100-geosites/> .

Siccar Point (Geosite 001) - where James Hutton recognised 'deep time' **Colin MacFadyen**

Siccar Point was chosen, and included within the 'History of Geosciences' category', owing to its huge historical value in the development of geological science. It was used by the famous Scottish geologist James Hutton, back in 1788, to demonstrate the great age of the Earth and the never-ending cycle of geological processes. The site is of global importance, has enormous educational value and attracts geotourists from all over the world. The site was nominated by Colin MacFadyen (NatureScot), Helen Fallas (British Geological Survey) and Martina Kölbl-Ebert (Ludwig-Maximilians University, Munich). Articles earlier in this issue, concerning the bid for Siccar Point's inclusion on the UK's 'Tentative List' for World Heritage Site status and the publication of the latest book on James Hutton, provide additional insights into the global significance that justify its inclusion in the First 100 Global Geoheritage Sites.

Hutton's Unconformity at Siccar Point with a geotourist for scale. The figure is standing on shallowly dipping Devonian rocks that rest unconformably upon steeply dipping Silurian-aged rocks beneath. Photo by Colin MacFadyen/NatureScot.



The Giant's Causeway Coast (Geosite 005) – key in determining the origin of extrusive igneous rocks

Michael Dempster

'One of the best examples of columnar basalt in the world, and a key site in proving the origin of extrusive igneous rocks.'

The Giant's Causeway and Causeway Coast UNESCO World Heritage Site was selected for the First 100 Global Geoheritage Sites under the 'History of Geosciences' category. The nomination for inclusion was made by staff from the Geological Survey of Northern Ireland (Mark Cooper & Kirstin Lemon), Northern Ireland Environment Agency (Michael Dempster), and Trinity College Dublin (Patrick Wyse-Jackson).

The site made the grade due to its substantial contribution to the development of geological science. It was at the centre of the late 18th century debate between the 'Neptunists', who believed all rocks precipitated from sea water, and the 'Vulcanists', who believed some had a volcanic origin. The easily accessible columnar basalt at the Giant's Causeway provided the evidence to support the Vulcanist theory for the origin of extrusive igneous rocks. The site also continues to stimulate new research – a recent study by National Museums Northern Ireland has proposed new ideas on precisely how the Causeway formed for example (Simms, 2021).

The World Heritage Site is owned and managed by the National Trust and is a 'jewel in the crown' for geoheritage conservation in Northern Ireland, attracting over 1 million visitors from across the globe in 2017 and 2018. It is part of the larger Giant's Causeway and Dunseverick Area of Special Scientific Interest (ASSI), and important geological features are found throughout the ASSI, not only within the World Heritage Site area. The site is also within the Causeway Coast Area of Outstanding Natural Beauty, and the North Antrim Coast Special Area of Conservation – designated for its rare and important habitats and species.

In Northern Ireland we already know our World Heritage Site is special, but inclusion in the First 100 Global Geoheritage Sites truly shows the international scientific importance of the Giant's Causeway and Causeway Coast.



Further reading:

Simms, M.J. 2021. *Subsidence, not erosion: revisiting the emplacement environment of the Giant's Causeway, Northern Ireland.* Proceedings of the Geologists' Association, 132, 537-548.

The Grand Causeway within the Giant's Causeway one of the aspects of the locality that helped the site attain UNESCO World Heritage Site status in 1986. Photo by Northern Ireland Environment Agency.



Ynys Llanddwyn (Geosite 068) - globally significant historical reference site for *mélange*

Raymond Roberts

'Spectacular, accessible and well-preserved exposures of late Neoproterozoic-Cambrian Mélange with more than 200 years of geological study'

The inclusion of Ynys Llanddwyn in the International Union of Geological Sciences (IUGS) *First 100 Geosites* is a huge feather in the cap for Wales. This small, geologically diverse tidal island off the south-western corner of Anglesey is managed by Natural Resources Wales as part of Newborough Forest & Ynys Llanddwyn National Nature Reserve and lies within GeoMôn UNESCO Global Geopark (UGG). The nomination was co-ordinated by Natural Resources Wales (Raymond Roberts, Stewart Campbell and Graham Williams), with support from Cardiff University (Niall Groome and David Buchs) and the British Geological Survey (BGS; Alan Holden). Choosing and agreeing on one site to put forward from Wales, itself one of the most geologically diverse and historically important countries in the world, was quite a challenge!

Ynys Llanddwyn is globally significant as an historical reference site for *mélange* and as a key locality for testing geological theories on the formation of *mélange*-type deposits. The chaotic mixture of rocks, including massive and pillow basalt, limestone, chert, sandstone, mudstone and *mélange*-bearing units, is exceptionally well exposed on the island and along the main rock ridge in Newborough Forest. Debate continues as to the exact age, but the *mélange* is thought to be about 500-600 million years old. In addition to the *mélange*, the MORB (Mid-Oceanic Ridge Basalts) are globally significant as some of the oldest and best preserved - including finely crystalline chilled margins and cracked and pitted cooling surfaces.

Ynys Llanddwyn has a history of more than 200 years of geological research, featuring in one of the first geological investigations and mapping exercises in the world (Henslow, 1822) and one of the most recent – a PhD study involving Cardiff University and GeoMôn UGG (Groome, 2022). Over the centuries the site has featured in numerous research initiatives including long-running Japanese-British and BGS mapping/research programmes. Another PhD nearing completion is focussing on basalt-limestone interactions. It is unlikely that anyone will ever be able to unravel fully all the geological mysteries of Ynys Llanddwyn, but each initiative can take us a step closer to understanding its complex geological story. Undoubtedly the site provides ample evidence for more geological detective work.

The inclusion of Ynys Llanddwyn in the IUGS *First 100 Geosite* list caught the public's imagination with a wave of publicity across the world and considerable media interest in Wales, including TV and radio coverage. Hopefully this is the first of many geosites the geoconservation community will nominate from Wales and across the UK.



Further reading:

Groome, N. 2022. *Neoproterozoic-Ordovician Evolution of the Monian Subduction Complex, Wales, UK.* Unpublished PhD thesis, University of Cardiff.

Henslow, J. S. 1822. Geological description of Anglesea. *Transactions of the Cambridge Philosophical Society*, 1-96. Elsevier. Available at: <http://archive.org/details/Henslow1822TransactionsOfTheCambridgePhilosophi>



The pitted and cracked surface of a well-preserved pillow lava, Newborough Forest. Photo by Stewart Campbell.

Late Neoproterozoic-Cambrian mélangé at the south-west tip of Ynys Llanddwyn. Photo by Stewart Campbell.



Pristine pillow lavas on the tidal causeway to Ynys Llanddwyn. Photo by Stewart Campbell.

Enjoying the view of the Moine Thrust Zone towards Loch Glencoul and Beinn Áird da Loch from Quinag within the North West Highlands UNESCO Global Geopark. Photo by Rob Butler.



The Moine Thrust Zone (Geosite 070) – the classic orogenic front **Taija Torvela**

Debate on the origins of mountain belts raged in the 19th and early 20th centuries: the belief that rocks always present themselves in a simple sequence with the oldest layer at the bottom and the youngest at the top was challenged by those who recognised that the story was much more complicated. One key area globally that precipitated this fundamental change in thinking was the geological feature we today call the Moine Thrust Zone. The recognition of thrust tectonics marked a monumental shift in understanding how our planet works, ultimately leading to the establishment of the theory of plate tectonics in the mid-1900s.

The exposed Moine Thrust Zone stretches from Durness in the north to the Sleat Peninsula on the Isle of Skye. It represents a geological history of over 2 billion years: the up to 3 billion years old basement is overlain by Neoproterozoic (c. 900-1000 million years old) sedimentary rocks; these are in turn overlain by Cambro-Ordovician (c. 500 Ma) packages. About 420 Ma ago, the Caledonian Orogeny thrustsed Neoproterozoic rocks of the Moine Supergroup – rocks that would otherwise be found c. 100 km farther east – westwards onto the Cambro-Ordovician rocks. It is this thrusting of older rocks on top of the younger rocks that so confused geologists more than 100 years ago. We now know that this process is a natural consequence of plate tectonics and essential for creating mountain belts.

The Moine Thrust Zone is one of the best-exposed orogenic fronts in the world. There are several localities within the NW Highlands Geopark where the structures can be admired, including the Knockan Crag visitor centre in Lairg, north of Ullapool. I first visited the area in 2009: I was helping out with a geological mapping course in Assynt while I was a post-doctoral researcher at Aberdeen University. Coming from Finland where the ancient bedrock forms a relatively featureless landscape, I was awestruck. I had visited mountainous areas before but I had never seen anything like the Moine Thrust Zone. Here, I could see the thrust front stretching for miles and, most importantly, I could really observe rocks of different ages interacting with each other and with the landscape in three dimensions. It fundamentally changed my perception of geology. I proposed the Moine Thrust Zone to be included in the IUGS 100 Geosites list, together with David Peacock from University of Gottingen, because of its great historic significance but also because the area still has a lot to offer. I am still a very frequent visitor to the NW Highlands but I am not the only one to appreciate the uniqueness of the area: the excellent exposure of the thrust front and the beautiful Scottish Highlands setting continues to inspire students, researchers and amateur geologists to this day.



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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.

Over the last 30 years, quarrying at Ardley Quarry in North Oxfordshire has revealed the presence of multiple trackways. Over the last 20 years, no new footprints had been discovered but this all changed in early 2022 when trackways were discovered in a newly cleared area of the new quarry.

Dave Evans outlines, in the article on p.32, how the newly discovered trackways were recorded and conserved as well as the benefits of collaboration between quarry operators, conservation organisations, museums, and universities.



Quaternary Research Association



Scotland's Nature Agency
Buidheann Nàdair na h-Alba