

Earth heritage

HERITAGE

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The geological and landscape conservation magazine



How puddingstone
catches imaginations



How to present a
global geo-treasure?

ISSUE **42**
Summer 2014

Help nominate a
QRA 'Top 50 Site'



Earth Heritage
as a printed copy

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COVER



Delegates to the UK Global Geoparks Forum in Shetland (p. 16) visited the magnificent Sumburgh Lighthouse, on the southern tip of mainland Shetland. The new, multi-million-pound development here showcases some of Shetland's finest geology and wildlife and boasts state-of-the-art educational facilities, displays and on-site accommodation. www.sumburghhead.com
Photo by Stewart Campbell

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EDITORIAL

Make people take notice!

Those of us lucky enough to work in Geoconservation sometimes take for granted the vital task of promoting the fundamental importance of Geodiversity to the whole of society. With diminishing resources, making the public (and politicians) actually NOTICE our subject is critical. Much of the material in *Earth Heritage* 42 focuses on interactive and stimulating projects that take Geodiversity to the people. The recent UK Global Geopark Forum in Shetland (p. 16) showed how our Geoparks are embedding geotourism and educational projects within local communities. Engaging schoolchildren is a critical mission – otherwise who will form the next generation of geoscientists and geoconservationists? A conference for geology students from seven Scottish secondary schools (p. 9) and the voyage of a traditional sailing boat (p. 7) are novel means of stimulating young imaginations with Earth science topics.

Engaging the public at other levels is equally important. Interactive projects, such as the Jurassic Coast 'fossil finder' (p. 8), the Quaternary Research Association's 'Top 50 Sites' project (p. 11) and Natural England's Geodiversity photostream do just that. Linking biodiversity and geodiversity with the re-creation of a Pliocene forest (p. 21) is another creative way to raise profile and extend connections. These and other features in this issue illustrate how the Geoconservation community is rising to the challenge!

As ever, we want to hear your views and to learn of new projects. To contribute, please contact the most appropriate editor (below).

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The Great War memorial at Pentire Head (above) and with The Rumps promontory (below)
Photos by Pat Sargeant



Pillow lavas, unique within the marine Devonian rocks of south-west England, form a key part of the Pentire Peninsula SSSI.



Remembering the Fallen

In 2014 in particular the thoughts and memories of people throughout the world are reflecting on the outbreak of The Great War, in July 1914.

Very early in the war the British Expeditionary Force suffered major defeats and loss of lives at Mons and in other battles. Not long after this the poet Laurence Binyon paid a visit to north Cornwall and walked on the high rocky headland of Pentire Head not far from the mouth of the Camel Estuary. It was here that he was moved to write the words of arguably the most well-known poem of the war "For the Fallen". Today a simple slate memorial plaque on the headland reflects those poignant words of the fourth verse:

**They shall grow not old, as we that are left grow old
Age shall not weary them, nor the years condemn
At the going down of the sun and in the morning
We will remember them**

Standing on this isolated location with its inspirational views of the north Cornwall coast, it's not hard to understand the impact it must have had on Binyon. Several hundred feet below are the crashing waves of the Atlantic Ocean. Just to the north the jagged headland of The Rumps emerges like a primeval reptile. In the distance Tintagel Castle appears through the mist and your eyes are taken to the far horizon.

I remember visiting the site on a late, cold, grey winter's afternoon not aware that there was a memorial plaque here let alone any association with those famous words of Binyon. A simple remembrance cross next to the plaque told me that someone else had already paid their respects. I stood quiet for a moment reflecting on whether even deeper elemental forces had touched Binyon.

Pentire Head is one of the most important sites for igneous rocks in south-west England, formed by hot basaltic lava emanating from submarine volcanoes over 360 million years ago. As the molten lava was rapidly cooled by sea water it formed pillow lava, with metre-wide pillows spewing out, one on top of another. In places the pile of lava and other volcanic rocks is over 450m thick. Imagine the heat, steam, noise and chaos associated with all these elemental processes. Today the lava stands solidified, cold, dark, silent and sombre.

Pat Sargeant, Cornwall

Earth Heritage in print

If you prefer to read *Earth Heritage* on paper, you can order this publication as a full-colour, laser-printed A4 hard copy via www.earthheritage.org.uk. Clicking on the Print link will take you to the ordering and payment facility provided by the Geologists' Association.

Issue 42 or any back issue* displayed on the website can be ordered online with individual copies and delivery costing £7.00, payable (online) to the Geologists' Association. There is a discount for GA members.

Stewart Campbell, Managing Editor

* Early issues may not be reproduced in print to the standard of more recent ones, because production technology has improved over time.



Flickr's of inspiration

They say a picture is worth a thousand words. At Natural England we are putting the cream of our photography online through photo-sharing website Flickr – as geologists, we can use social media to promote our science, our geodiversity and our landscapes far more effectively than we can through words alone.

We can use photographs not only to give a snapshot of a moment in time as with the Mediterranean-looking seas and Morte Slate at Hell's Gate, Lundy (*left*), but also to document changes to our iconic landscapes and access to our geology. Take for example the Wren's Nest National Nature Reserve, in Dudley, where the Seven Sisters caverns have now been infilled – hopefully temporarily – as a safety/stability measure. Pictures really are worth a thousand words in this instance, showing the caverns in a stunning black and white image taken some years ago and the wall of gravel that greets modern visitors. Hopefully visitors will be able to recreate the monochrome beauty of the older image here rather than the far less inspiring colour photo taken recently.

Our Flickr photostream is an ongoing collection – the photos used to illustrate all 159 National Character Area profiles (see them at <http://publications.naturalengland.org.uk/category/587130>), all now published, are still being uploaded and photos from the geologists' photography collection are still being selected and added.

See our photos at www.flickr.com/photos/naturalengland/ and if you can't see your favourite geology there, come back and look a few weeks later!

Naomi Stevenson, Natural England



Above, the atmospheric Hell's Gate, Lundy.
Photo by Naomi Stevenson



Left, the Seven Sisters caverns, Wren's Nest, Dudley, in 1960.
Photo by Geoff Prosser

Left, the caverns are currently infilled for safety and stability.
Photo by Naomi Stevenson



Recording the language of landscape

Established by photographer and writer Dominick Tyler, the Landreader Project aims to rediscover landscape words, recording and collating them as a resource for future generations. With funding support from the Arts Council, over the coming months Dominick will visit, photograph and write about many of the 'landscape words', some familiar, others more obscure and many geological and geomorphological in origin. There is now a website, www.thelandreader.com, for the project and an invitation to send in your own contributions to the growing glossary.

Jonathan Larwood, Natural England

Left, a Dominick Tyler photo of a blowhole at Wheal Coates, Chapel Porth, Cornwall. The website reveals that a blowhole may also be known as a gloop.

London action plan runs to 2018

Following a widespread consultation, the London Geodiversity Partnership has published its Action Plan for 2014 – 2018. It is available at www.londongeopartnership.org.uk.

While the responses to the consultation were limited in number, they were constructive and have been taken into account in finalising the action plan. The Partnership was particularly pleased to have positive responses from London borough councils and it will continue to work closely with them to obtain due recognition of London's geodiversity.

The action plan takes forward the work of the Partnership as recognised at the workshop at the Horniman Museum last year (see *Earth Heritage* 40) and continues to place high priority on the audit of potential sites and of geodiversity archives and resources, regular inspection and reporting on recommended sites and disseminating information about London's geodiversity in various ways.

Appendices to the plan list the regionally and locally important geological sites recommended and summarise the progress made during the initial plan (2009-2013).

David Brook OBE, Chair London Geodiversity Partnership



Etched into the walls of the Green Park tube station entrance are reminders of the capital's geological riches. This work by sculptor John Maine on the Portland Stone cladding is called *Sea Strata*. It depicts carved larger versions of the fossils found in the stone. A particular feature is the Portland Screw (the gastropod *Aptyxiella portlandica*).

Photo by Naomi Stevenson

Building stones of the capital

London Geodiversity Partnership has published its 2014 *Building London* guide to resources on the geology of the capital's building stones – available on its website – with links to pdfs or other websites for walks along London streets and in cemeteries. It also includes geotrails, for example along the Green Chain Walk in south-east London. *Building London* is updated regularly and is available at <http://tinyurl.com/olgvj8j>.

Over the past year Ruth Siddall at University College London has posted 16 new building-stone walks to her Urban Geology site, <http://tinyurl.com/qamgezww>. Some of her writing is inspired by Eric Robinson who continues to send her bundles of notes but much of her work is centred on her speciality, exotic marbles. She will lead a walk around Mayfair and Piccadilly for the Geological Society during Earth Science Week on 18 October. The Harrow & Hillingdon Geological Society is revising the building-stone walks in its area and plans to make them freely available on its website, www.hhgs.org.uk, in due course.

Diana Clements, London Geodiversity Partnership



Mick Stanley on abseil (above) and (below) the civic dignitaries celebrate after the event.

Photos by Steven Archer



Taking a plunge for charity

Brimham Rocks, in Nidderdale Area of Outstanding Natural Beauty near Pateley Bridge, is a striking natural phenomenon, a Namurian (Millstone Grit) sandstone outcrop that in the 17th Century was thought to have been an artificial feature created by druids as temples.

The stunning geology – it is a Site of Special Scientific Interest owned by the National Trust – remains a source of fascination to this day, and at a charity auction, as Mayor of Ripon, I bid for permission to raise funds for my charity by abseiling down about 50 metres of Brimham's gritty faces. I also challenged the mayors of the surrounding districts to abseil with me to generate funds for their own charities. All of them rose to the occasion, and six mayors, a deputy and a consort abseiled down the rock on a very wet and windy Saturday. Over £3,000 was raised for local charities.

Early attempts at interpretation of the features of Brimham Rocks suggested the tors were relict coastal features with boulder clay deposits providing the evidence for marine action. Later geologists postulated deep Tertiary chemical weathering or wind erosion in periglacial conditions. We now know it is probably a combination of chemical and physical weathering during the Devensian that has created this beautiful dramatic landscape. The rocks have been used as a location in the children's television shows 'Knightmare' and 'Roger and the Rottentrolls', and as a backdrop in the video for the Bee Gees' song 'You Win Again'.

Mick Stanley, Geodiversity Consulting

Celebrating canal's slate history

The Slate Isles of Argyll are probably better known for having held the world's largest skimming stone competitions than they are for the slates that once roofed Scotland. Easdale slates, with their characteristic sparkling pyrite crystals, cover the roof of the 12th Century Glasgow Cathedral.

For some 700 years or more slate quarrying was an important part of the economy of Easdale and neighbouring islands. Slate was transported from Easdale, Seil, Luing and Belnahua round the wild north coast of Scotland to towns and cities on the east coast. There was also a long sail right down and round the Mull of Kintyre, to reach Glasgow. In the early 19th Century the building of an ambitious nine-mile waterway, the Crinan Canal, provided a much shorter and safer route between the slate quarrying Hebridean islands and Glasgow and other centres in the growing industrial west of Scotland. Puffers carried goods to the islands, and they returned to ports on the Clyde carrying slate for the

growing towns. Later in the 19th Century competition from slate quarries like Ballachulish, and more recently from cheaper slate from overseas, led to the decline and final end of slate quarrying on the islands. Today the Crinan Canal is a great place for a walk, cycle or a sail.

More about natural and cultural heritage sites to visit in Argyll can be found at: <http://tinyurl.com/p35axdq>
Information on slate isles quarrying can be found at:

<http://tinyurl.com/kyc7t85>

The Crinan Canal can be found at:

www.scottishcanals.co.uk

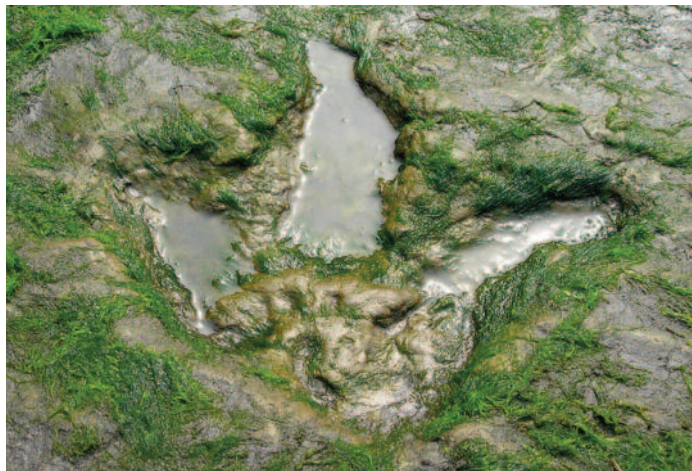
Ness Kirkbride, Scottish Natural Heritage

The Crinan Canal was slate's shortcut from the Hebrides to Glasgow.

Photo by Ness Kirkbride



Drive to safeguard islands' fossils



Skye has become known as Scotland's 'dinosaur isle' because of prints like the one above. Fossil relics help drive the tourist trade.

Photos by Colin MacFadyen, SNH

A public meeting in Portree, Skye, in May 2014 tried to establish voluntary activity to help safeguard and promote the fossil heritage of both Skye and the neighbouring island of Raasay.

The Jurassic rocks of both Skye and Raasay provide a rich source of ammonites and other marine fossils. Being the only location in Scotland where Jurassic dinosaur remains occur, Skye has become known as Scotland's 'dinosaur isle'. To date, the remains and traces of up to eight dinosaur species have been found. Some of the remains are of international significance, such as the dinosaur trackways at An Corran in the north-east of the island, and some of the smallest footprints yet recorded, thought to have been made by newly hatched dinosaurs.

Despite some key areas being notified as Sites of Special Scientific Interest and the existence of the Scottish Fossil Code, a few

collectors have still tried to collect dinosaur and other key fossil remains. No doubt important dinosaurian material, vital for research, has been removed and ended up in private collections. Reckless collecting activity has decreased in recent years since a police investigation, but the threat from irresponsible collecting remains.

To address the threat it has been proposed that there may be enough interested



volunteers in the area to help warden fossil localities and, importantly, report, record and rescue important fossil material as it becomes revealed on the beaches of both Skye and Raasay. The meeting ascertained that there is considerable local interest in the islands' fossil heritage and it is widely acknowledged that it helps attract tourists. However, as with other areas of the UK, securing volunteer effort in straitened economic times, to help safeguard and promote the fossil heritage, will be challenging.

Colin MacFadyen, Scottish Natural Heritage

Celebrating Miller and the Betsey

The 1892 former fishing vessel Leader will follow the 1844 journey of the sail boat Betsey. Photo by trinitysailing.org



The Friends of Hugh Miller and the Royal Scottish Geographical Society have chartered a traditional sailing boat for a week in September 2014, to follow the journey of discovery taken by Hugh Miller in the summer of 1844 on the sail boat, the Betsey.

We have recruited an intergenerational mix of geologists, geographers, artists, writers, ecologists, storytellers, theologians and historians including three young Earth scientists. Our floating manse, art studio and scientific laboratory is the wonderful sailing boat 'Leader' built in 1892, which sleeps 19 people including five crew.

Public events are planned in Cromarty, Fort William and Oban and on the islands of Eigg and Rum. With generous funding from the Geological Societies in Scotland, we are also developing materials for primary and secondary schools and plan to have live links to the boat during the voyage.

Joyce Gilbert, Royal Scottish Geographical Society



An experimental kiln on the Romano-British site in Highgate Wood used clay from the Eocene Claygate Beds.
Photo by Cindy Blaney



This brittle star fossil comes from the starfish bed between Eype and Seatown on the Jurassic Coast. Seafloor currents realigned its 'arms' prior to burial.
Photo by Dave Penman, Bridport Museum



The Chalky Dell volunteers
Photo by London Geodiversity Partnership

Display highlights Highgate geology

There is evidence right around London's Hampstead Heath of brickmaking. Highgate Wood was the site of a Romano-British pottery and in 2010 an experiment used the local clay and fired pots on site (left) with great success.

Brickmaking was an important industry in the 19th Century, when brickmakers made use of the sandier facies at the top of the Eocene London Clay, known as the Claygate Beds, as source material. These lie beneath the Bagshot Sands on the top of Hampstead Heath. However, the BGS 1:10,000 geological map shows no Claygate Beds covering the brickmaking site of Highgate Wood, so did the brickmakers use the inferior London Clay or are the beds over Highgate Wood just not thick enough to be mapped? A soil survey of the area undertaken just before our investigations identified sandy soils as Claygate Beds and borehole and auger/trench analysis close-by suggests that Claygate Beds probably did cover most of Highgate Wood and were thickest at the highest point in the wood – the kiln site.

With the encouragement of Cindy Blaney, Woodkeeper from the City of London Corporation, the London Geodiversity Partnership has put together display boards and a small exhibition to tell the story of the local geology. The working group was convinced that Claygate Beds covered most of Highgate Wood and showed it as cross-hatching overlying the existing BGS map. The adjacent Queens Wood is very different with deep gullies eroded and the story boards address this too. There is evidence of the Anglian Ice advance about half a kilometre to the north in Muswell Hill and clearly the meltwaters from this and subsequent periglacial events must be implicated in the extreme topography in the area. The display, housed in a small hut beside the café in Highgate Wood, is free and open year round.

Diana Clements, London Geodiversity Partnership

Close-ups of 1,000 fossils online

The Fossil Finder is a new database of almost 1,000 fossils from museums in Dorset and East Devon. The database is the work of the Jurassic Coast World Heritage Site and most specimens were found within the site. The Fossil Finder presents photos of these specimens, together with important details and fascinating facts. Visit it at <http://jurassiccoast.org/fossilfinder>

Dell site benefits from volunteers

The London Geodiversity Partnership and London branch of the Open University Geological Society were joined by members of London-based geology groups and volunteers from Lesnes Abbey and Shooters Hill for a geoconservation work day at Chalky Dell. The dell is a small quarry that supplied chalk for the construction of nearby New Road in 1851. A 1925 photograph shows that when operational, the junction between the Chalk and Thanet Sands could be seen. The main aims were to reveal this junction near the top of the scree slope, to cut steps up the scree so that the contact could be seen easily and to expose a section of the Chalk by the path from the entrance gate. All three aims were achieved but the steps will need to be made more durable. The Partnership hopes that Chalky Dell will form part of the education remit for the new visitor centre adjacent to the Abbey ruins. Together with the Lessness Shell Bed Site of Special Scientific Interest, famous for Eocene mammals, there is an interesting geological story to be told in Lesnes Abbey Woods.

Diana Clements, London Geodiversity Partnership

Scotland rocks young geology students

Vaughan Forrest, Robbie Kennedy, Ryan Kerr, Ross Peat, Stuart Roy, Craig Bruce & Dr J.J. Doody
West Calder High School

Scotland Rocks 2014 was an amazing, unique experience which none of us will forget. For two days we were part of a group who shared a collective enthusiasm for geology. Nearly 40 Higher Geology pupils from seven Scottish secondary schools attended the conference, along with over 30 people with many levels of experience and expertise in Earth science, including professional geologists from industry, universities and the British Geological Survey (BGS), university postgraduates and undergraduates.

The Scotland Rocks conference is aimed at school students studying geology. It began in 2013 when Perth High School pupils approached the Royal Scottish Geographical Society (RSGS) with the idea of an event to raise the awareness of the value of studying Earth sciences at school. For us, however, it meant we could be immersed in geology led by people who took time to look at the geology with us. All the professionals and university students had the knack of teaching us by simply talking geology and encouraging us to think as geologists. Brilliant! The atmosphere and learning were just how our teacher (JJD) told us it would be, but to be honest we really didn't believe him!

The first day was mostly taken up by a fantastic field trip to St Monans in Fife which was organised by the University of St Andrews and the GeoBus team, along with geologists from the University of Edinburgh and the BGS. We observed and mapped the Lower Carboniferous rocks, learning about their sedimentology, stratigraphy, structures and volcanic activity. We worked in small groups, each led by at least two geologists.



After a great meal at our comfy hotel in Perth, we all headed to the conference reception at RSGS Headquarters, which marked the start of our contribution to the conference. The conference organiser, Joyce Gilbert (a 'legend'!), had asked West Calder High School to run reception and be generally helpful to delegates. The main event was Professor Iain Stewart (another 'legend'!) presenting the RSGS President's Medal to Dr Angus Miller of the Scottish Geodiversity Forum, for taking the lead on developing the Scottish Geodiversity Charter.

The second day was a conference consisting of keynote lectures, hands-on workshops and other events. After a welcome by Mike Robinson (CEO, RSGS) and an inspirational keynote address by Professor Stewart, we watched a lecture by Professor Gupta of Imperial College, London. His lecture about the Curiosity mission to Mars was conducted via a Skype link. His evidence of sedimentological processes similar to those on Earth was incredible. We really liked his way of talking to us, as if he was showing us how he thought as a researcher.

A field trip to St Monans fired imaginations. See also rear cover.
Photo by Simon Cuthbert

Continued on following page

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His lecture was reinforced by a GeoBus workshop (see *Earth Heritage issue 40*) where we had the opportunity to interpret photographs from Mars. Not many school pupils can include experience of Martian fieldwork in their CVs! Other workshops were optional and covered topics as diverse as minerals and crystal structure, fossils, tsunami sediments and geoparks. The workshops were fun, interactive and informative, helping to equip us with more skills for studying Earth science.

Geologists from different areas of industry and research gave us a clear perspective of the different career paths along which geology can take you, and the range of personalities who work in geology. This happened particularly during the careers speed-dating sessions with people working in or studying geology. We heard about what they did and how you could follow their career choices. The final session was a Question Time format where we posed questions to a panel about future energy challenges. This raised many interesting global and national issues.

In summary, a fantastic two days was had by all at Scotland Rocks. We learned a lot and we thank everyone who contributed. What is clear to us, and missed by other pupils who don't choose geology, is that once you have studied geology you look at the landscape in a new way. It is as if you are seeing more than other people see. More than anything, geology is about telling a good story! Thanks to everyone who made this happen. Can we come back next year?

* Contact author Dr J.J. Doody: ben.doody@wled.org.uk



A busy session in one of the workshops.
Photo by Richard Bracken

Higher Geology Campaign update

Over the past year many people who are interested in Earth science in Scotland have come together to express concern at the very low content of Earth science in the Scottish schools' curriculum. Our main aim has been to lobby the Scottish Government, Education Scotland and the Scottish Qualifications Authority (SQA) to ensure that the planned cessation of the Higher Geology certificate in 2015 is postponed until a new Earth science Higher is created.

While we remain disappointed that Higher Geology remains scheduled to disappear next year, some significant progress has been made. Following a further article in the Scottish Times Educational Supplement in April 2014, our campaign group became formalised and named as Earth Science Education Scotland. Our campaign group consists of teachers, academics, learned societies and industry. A major step forward has been public backing of the campaign from Oil & Gas UK. We are currently gathering cross-party support and hope to have a meeting with Scottish Government Ministers again soon. To pledge your support, visit the Earth Science Education Scotland website www.earthscienceeducationscotland.com.

Joyce Gilbert, Royal Scottish Geographical Society

Help nominate a QRA Top 50 Site

Barbara Silva, Quaternary Research Association

The Quaternary Research Association (QRA) is 50 years old this year. To mark its half century, the QRA is seeking nominations from the Quaternary community to help compile a list of the 50 most significant Quaternary sites within Britain.

The selected contributions will be published at the end of the year in a full-colour booklet highlighting the key sites and localities that have been fundamental to developing our understanding of the Quaternary landscape around us. The data will also be available through the QRA website, qra.org.uk. Any Quaternary site within Britain is eligible and you are welcome to submit more than one. Submissions should include a photo if possible, including any credits. Nomination forms and more information, including already nominated sites, can be downloaded from www.qra50.org or email Barbara Silva, QRA Outreach Officer, at pollenbird@hotmail.com. **The deadline for nominations is the end of September 2014.**

The roots of the QRA hark back to 1964, when correspondence between some of the key Quaternary scientists of the time, Richard Hey, Richard West, Fred Shotton and Russell Coope, led to the first meeting of the Quaternary Field Studies Group. The group continued to meet and became known as the Quaternary Research Association in 1968. The QRA has since grown and diversified. Now, with a much enlarged membership, QRA activities range from field meetings to workshops, providing opportunities to meet and discuss science, supporting outreach initiatives and awarding financial support to students and researchers.

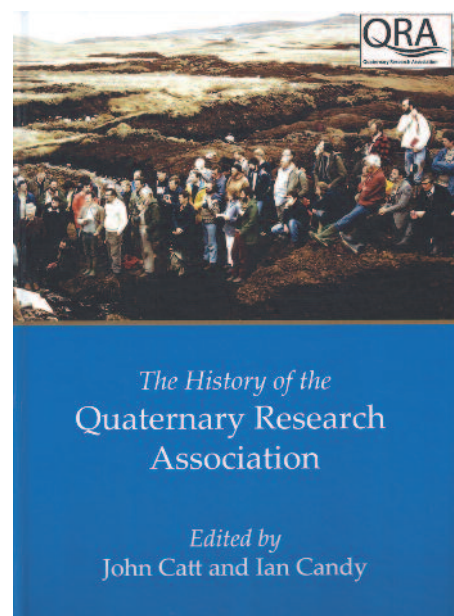
If you need some inspiration for site nominations, here is our first site, nominated by Dr Emrys Phillips from the British Geological Survey:

Overstrand – a classic site

Site name: Overstrand, North Norfolk [National Grid Reference TG 256 405]

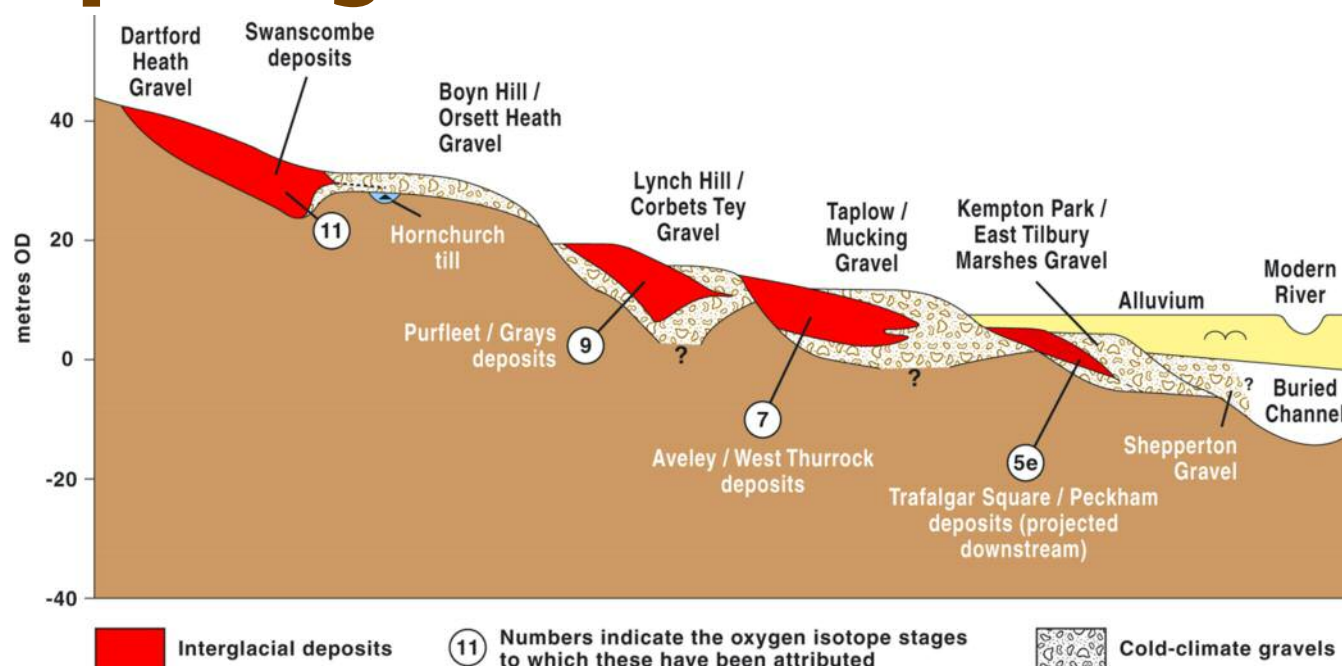
Photo: Rafting of chalk bedrock at Overstrand on the North Norfolk coast (*photograph by Emrys Phillips*)

Overstrand, part of the Sidestrand and Trimingham Cliffs SSSI, is truly one of the classic sites in the UK for glaciectonic deformation within the Middle Pleistocene glacial sequence exposed on the North Norfolk coast, eastern England. Glacial rafts or 'megablocks' are dislocated slabs of bedrock and/or unconsolidated sedimentary strata that have been transported from their original position by glacial action. Such rafts are typically composed of relatively thin slabs of material that may have been transported over distances ranging from tens to hundreds of kilometres. They generally occur as single, horizontal slab-like features, but may be stacked within conspicuous ice-pushed hills of various types. The section at Overstrand is dominated by a large raft comprising Cretaceous chalk bedrock overlain by pre-glacial marine sands and gravels of the Wroxham Crag. The raft is approximately 20-25 m thick and 100 m in length, and was detached, transported and finally emplaced by a major ice sheet flowing from the north, down the North Sea. The chalk and Wroxham Crag within the raft are deformed by a southerly verging anticline which occurs within the hanging-wall of a thrust forming the prominent detachment at the base of the raft. This southerly directed thrust and the deformation associated with the emplacement of the raft are well exposed at the base of the cliff section.



The QRA's 50th anniversary is also celebrated in the above volume, a 450-page, full-colour hardback with over 100 illustrations. It carries a 170-page history of the QRA, plus 10 individual chapters focussing on different subjects within Quaternary science. The book (ISBN 09 077 80873) costs £25 + £6 p&p and can be ordered through qra.org.uk or by sending a cheque, made payable to the Quaternary Research Association, to Val Siviter, Cilgeraint Farm, St Ann's, Bethesda, Gwynedd LL57 4AX.

Exploring the Lower Thames



David Bridgland, Geologists' Association

The Geologists' Association (GA) joins the Quaternary Research Association (QRA), the Essex Field Club (EFC) and the Fluvial Archives Group (FLAG) in a three-day meeting (3-5 October) to celebrate the geoconservation heritage of the internationally important Quaternary record in the lowermost Thames.

The fluvial sequence in the Lower Thames has few equals as an archive of Quaternary environmental change, particularly glacial–interglacial climate fluctuation, during the last half million years. The outcrop of the Chalk, around the Purfleet anticline, has provided flint for the manufacture of stone-age tools, which are important constituents of some of the Thames deposits, as well as the calcareous groundwater that has facilitated the preservation of mammal and mollusc fossils. A staircase of depositional river terraces hereabouts represents the last four glacial–interglacial climate cycles, each lasting about 100,000 years and each with its own characteristic suite of fossils and artefacts.

The catalyst for this latest meeting is the opening of a new home for the collections of the EFC, at one time housed in the Passmore Edwards Museum at Stratford; this has moved downstream to the Green Centre, at the Wat Tyler Country Park, Pitsea, near Basildon, which will be the venue for a day of lectures (4 October, 2014). The enhanced role of the EFC in the promotion of geology and Earth heritage in its area is exemplified by its website [www.essexfieldclub.org.uk], which houses considerable information of Essex geodiversity and geosites. The site is also host of a Quaternary Lowermost Thames site trail, launched in connection with this meeting.

The meeting, which also coincides with the QRA's celebration of its first 50 years (see *preceding page*), will include field excursions (3 October) to look at the wider Quaternary context within Essex and to the classic site of the Thames terrace staircase (5 October), the second of these visiting sites on both the Essex and Kentish side of the river, the latter including the Swanscombe Skull National Nature Reserve (one of only a handful of Earth science NNRs in Britain). The field programme will rely heavily on geoconservation localities, especially in the highly developed areas close to the Thames estuary (look out for a report of this meeting in a future issue). The meeting will also consider how the use of new techniques has advanced knowledge of the Lower Thames since the QRA meeting in 1995. More details will appear on the GA website (www.geologistsassociation.org.uk).



An iconic sculpture adds to the interest at the Swanscombe Skull site, declared a National Nature Reserve because of its importance to Earth science.

Photo by Natural England

All a-board as GeoMôn celebrates its key sites

Stewart Campbell, Natural Resources Wales

Margaret Wood, Director GeoMôn, Anglesey Geopark

The European Geoparks Network (EGN) was founded in 2000. Initially comprising just four Geoparks - from France, Spain, Germany and Greece - the EGN now (June 2014) includes 58 members and continues to grow. A European Geopark is a territory with a special geological heritage which can support sustainable economic and social development. GeoMôn, the Anglesey Geopark, was formally recognised by the EGN as a European Geopark in 2008 – an accolade recently endorsed by UNESCO. Anglesey can now boast being a Global Geopark!

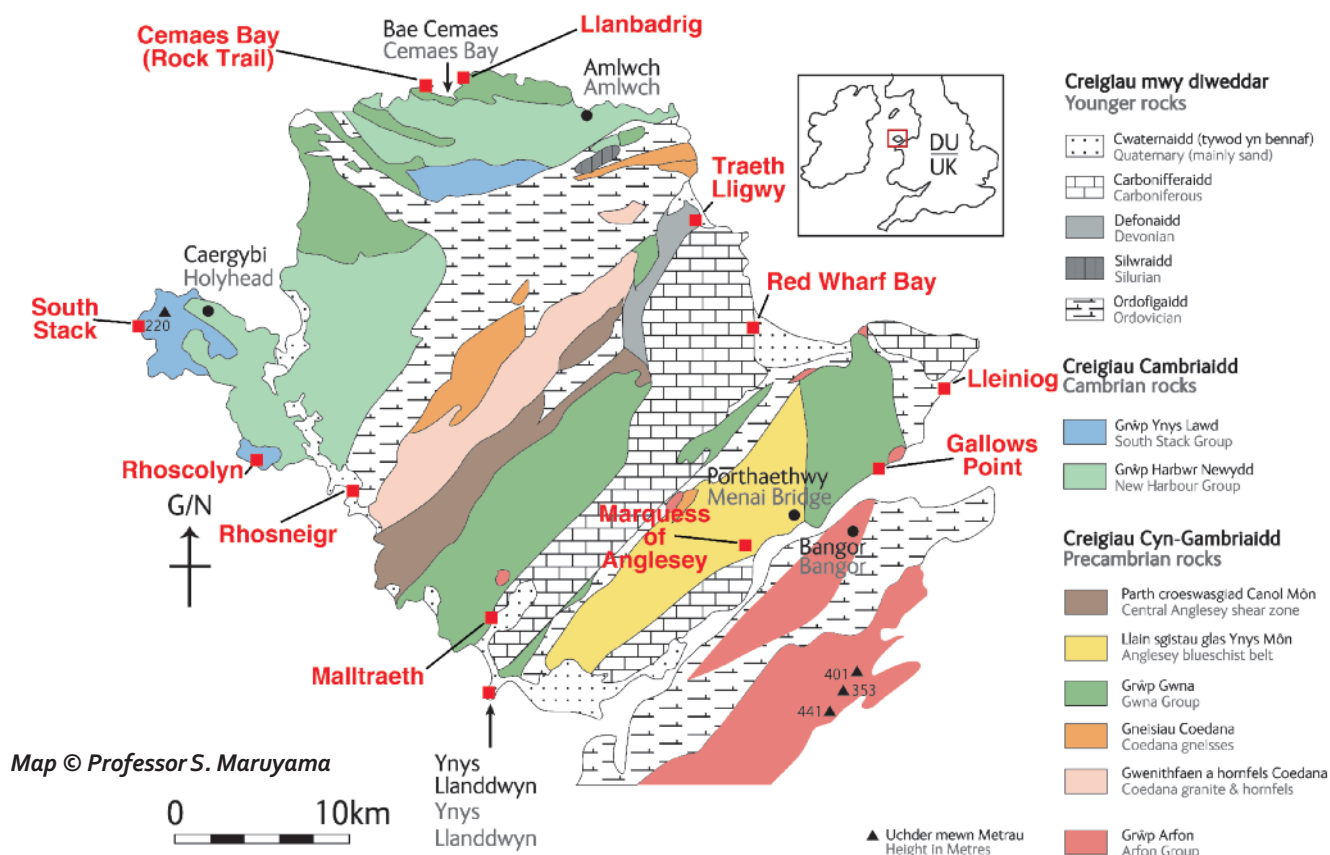
Over the last six years GeoMôn has used the island's outstanding geological heritage - a rich diversity of rocks extending back over a billion years and encompassing all but two of the commonly recognised geological periods – to promote geotourism and education for the benefit of the island's economy. Its most recent project has been to develop a series of geological information boards (geoboards) at key sites on the island. In partnership with Isle of Anglesey County Council (IoACC) and supported by Natural Resources Wales (NRW), the Geopark has erected geoboards at 13 key sites – covering everything from the evolution of ancient life in the Precambrian to glacial landforms and deposits of the ice ages and even the formation of the 'Isle' of Anglesey itself, as recently as 5,200 years ago, with the creation of the Menai Strait. The geoboards are located at some of Anglesey's most iconic geological sites, many of them Sites of Special Scientific Interest, including Llanddwyn Island, Rhoscolyn and South Stack (see map below).

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Visitors study the newly installed geoboard near Llanbadrig Church.

All photos by Stewart Campbell



CELEBRATING THE BEST SITES

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Located mostly on or close to the island's coastal path and in its Area of Outstanding Natural Beauty (AONB), the locations have been chosen to give visitors the best opportunity to see special rocks from each of the major geological periods at spectacular, easily accessible sites. Showcasing the Precambrian Period are the magnificent pillow lavas and *mélange* on Llanddwyn Island, the much-visited blueschist underneath the Marquess of Anglesey's Column and the oldest

fossils in Wales at Llanbadrig. Cambrian highlights include the magnificent folded strata at South Stack and Rhoscolyn – the latter used by numerous geological students to learn structural geology and field mapping skills. The Ordovician and Silurian periods are expounded at Rhosneigr and Parys Mountain, while Devonian deserts and Carboniferous tropical seas are covered by the geoboard at Traeth Lligwy. Other highlights include ancient potholes at Red Wharf Bay, Millstone Grit along the Malltraeth Estuary and spectacular ice-age sediments and erratics at Lleiniog, near Beaumaris.

The Geoboards follow a standard format – a welcome in seven languages and a fully bilingual Welsh/English account of the key site features. The boards are illustrated with photographs and simple diagrams; some also show trails that visitors can follow. Each carries an explanation of Anglesey's Global Geopark status, access information and safety considerations.

The geoboards have been constructed mostly as waist-high, gently angled plinths. They have been designed to be robust yet unobtrusive in the outstanding landscapes where they are located. To accompany the boards, a rock trail has been constructed on the village green (Bonc y Môr) in Cemaes Bay. This consists of nine small rock plinths, each carrying representative rocks from the major geological periods present on the island, with a small bilingual plaque giving details of the rock types and their ages. To provide context for the geoboards and trails, IoACC and GeoMôn will soon publish a simple guide to the geology of the island – *Footsteps through Time – the geology and landscape of Anglesey explained*.

The boards and rock trail were officially launched in April. The festivities started with a procession, led by the Cambria Band, from Cemaes Bay to St Patrick's Church in Llanbadrig. *Continued on following page*



Above, Albert Owen MP and Dr Margaret Wood, Director GeoMôn, launch the new boards in front of a large crowd near Llanbadrig Church.

Below, One of nine rock plinths located on Cemaes Green that make up GeoMôn's new Rock Trail. Each plinth represents one or more of the major geological periods and their representative rock types. This plinth represents ice-age deposits on Anglesey – erratics carried and deposited by a kilometre-thick Irish Sea ice sheet which submerged the island about 25,000 years ago.



CELEBRATING THE BEST SITES

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Here, Albert Owen MP and Dr Margaret Wood, Director of GeoMôn, launched the geoboard and the newly constructed viewing platform for St Patrick's Cave and Well. The latter is the culmination of many years of work by Cemaes Bay Community Council and GeoMôn with its partners IoACC and NRW. Generously facilitated by the landowner, the National Trust, the new platform allows the historically famous site to be seen safely for the first time and extends excursions along this section of the coastal path to take in some outstanding geological features and cultural heritage.

Following the ceremony here, the party and marching band returned to Cemaes Bay for the launch of a time-and-tide bell. Created by sculptor Marcus Vergette, this landmark tolls as the tide reaches the back of the bay. Again, this is very much a partnership effort with Marcus having conceived and provided the bell, the Community Council having funded its installation and Magnox (Wylfa Nuclear Power Station) providing technical assistance with its installation. From there, the party and marching band moved to the headland and green in Cemaes Bay for the launch of the two geoboards, stone tables and benches and the rock trail. Rhun ap Iorwerth AM did the honours, recognising the hard work of GeoMôn and its partners and the outstanding community spirit and effort of the people of Cemaes Bay. Festivities were concluded with excellent local hospitality in the village hall.

Parts of this article were first published in *Natur Cymru* 51, www.naturcymru.org.uk



Above, the launch of sculptor Marcus Vergette's Time & Tide Bell in Cemaes Bay – designed to toll with incoming and outgoing tides – was dovetailed with the GeoMôn events to maximise publicity and participation.

Below, the Cambria Band scales the Precambrian limestones to mark the launch of the viewing platform for St Patrick's Cave and Well.



Shetland hosts UK Global Geoparks Forum

Melanie Border, Chair, UK Global Geoparks Forum

Robina Barton, Geology Project Officer, Geopark Scotland

Geopark Shetland hosted the 2014 meeting of the UK Global Geoparks Forum (UKGGF) at Saxa Vord Resort, Unst. Shetland became a member of the European Geoparks Network in 2009 and was successfully revalidated for four more years in 2013. The European Geoparks Network is part of a wider Global Geoparks Network supported by UNESCO. It has over 100 members, seven from the UK.

Brian Gregson, Chair of the Geopark Shetland Working Group, welcomed delegates from the English Riviera, North Pennines AONB, Fforest Fawr, GeoMôn, North West Highlands and Marble Arch Caves Global Geoparks. The latter crosses the border between Northern Ireland and the Republic of Ireland.

In addition, there were representatives from the British Geological Survey, Scottish Natural Heritage, Natural England, Natural Resources Wales, Visit Scotland and the UK National Commission to UNESCO (UKNC). Beth Taylor, UKNC Director with responsibility for natural sciences, said: "It's always a pleasure to meet the delegates from the UKGGF, who are without exception enthusiastic, enterprising and highly committed to the success of their very different geoparks across the country. But meeting them in Unst was an added bonus, with its unique geology, stunning scenery, abundant sea birds and warm and welcoming community. It was a great opportunity to see how Geopark Shetland is achieving the key objectives of the geoparks movement, for sustainable development, education and public outreach."

Following the meeting, the Forum members attended a civic reception hosted by Shetland Islands Council. After a rousing performance from local male voice choir 'da shantYellmen', members were welcomed by Council Convenor Malcolm Bell and Keith Connal, Deputy Director within the Scottish Government's Environment and Forestry Directorate, representing the Minister for Environment and Climate Change Paul Wheelhouse. Commenting on his first visit to Shetland, Keith said: "I was very pleased to attend the UKGGF meeting and I congratulate Geopark Shetland for organising such an informative and enjoyable event. It was good to hear about the work of member and aspiring UK Geoparks and to witness first hand the important links that Geopark Shetland has with the local community."

UKGGF delegates on the beach at Norwick on North Unst. Here, visitors can see the junction between the upper mantle and lower crust, a section though the floor of the Iapetus Ocean.
Photo by Austin Taylor



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Representatives from aspiring geopark projects attended on day two to find out more about the existing UK Global Geoparks, learn more about the wider global network, gain support and advice from existing members and showcase their projects to the Forum.

There were opportunities for delegates to enjoy field trips on the islands of Yell and Unst, and meet members of the local community. The eastern side of Unst formed from a stranded section of oceanic crust, called an ophiolite, and has been described as 'an open-air museum of oceanic rocks'. Geopark Shetland has produced a self-guided trail pack and on-site interpretation to help visitors discover more. Members visited Norwick Beach, where continental and oceanic rocks can be viewed side by side, before heading to the Unst Heritage Centre to see a related exhibition and geowall. At the Heritage Centre they also met local knitters and spinners who demonstrated their skills, and viewed the lace knitting for which Unst is famous. The evening was spent at the North Unst community hall, where music was provided by Baltasound School pupils as members enjoyed dinner provided by hall committee volunteers.

On day two, some members visited the Hermaness National Nature Reserve, one of Shetland's main seabird colonies. Others chose to visit Yell to see geopark interpretation at the Old Haa Museum in Burravoe (see *Earth Heritage* 37) and meet pupils from the Burravoe Primary School who helped develop the museum exhibition.

Some delegates were able to attend the Shetland Folk Festival on the island of Fetlar in the evening, so rounding off the Forum in true Shetland style.

UKGGF Chair, Melanie Border said: "Since joining the EGN in 2009 Geopark Shetland has played an active role within the life of the Network so we were all thrilled that they were able to host this year's UKGGF meeting. In addition to dealing with Forum business around the table it was a fantastic opportunity to learn more and experience what Geopark Shetland has to offer." The next UKGGF is to be hosted by GeoMôn in Anglesey in 2015.

Highlands geotours

The North West Highlands Geopark is developing its geotourism profile by planning geotours of a week and a half week in September. More details will be announced via its website, www.nwhgeopark.com.

The NWHG was reformed as a social enterprise company in 2012 and is now led by the area's community councils. Along with Scotland's two other geoparks it attracted financial backing from the Scottish Government in 2013. This funding is being used to employ three staff and progress a plan that includes arranging geotours, preparing for a geocentre and piloting leaflets for self-guided tours.

The European Geopark Network revalidation visit in 2013 provided the guidance necessary to develop further, prior to the next visit in 2015. The aim is to establish a sustainable structure to provide a service to visitors and local communities alike, allowing all to appreciate the geodiversity and how it has influenced the biodiversity and human use of the land.

– Peter Harrison



From left, George Farlow, Chair NWHG, Peter Harrison, Business Manager, Laura Hamlet, Information Manager and Mike Goodwin, Marketing Manager at Knockan Crag Visitor Centre with the statues of Ben Peach and John Horne.

Photo courtesy
North West Highlands Geopark

Benefits of having a regional 'layer'

Keith Williams, Chair of NWGP and Geolancashire

Since the North West Geodiversity Partnership's inception in December 2007, geoconservation in the UK has seen considerable changes. Most have taken place since 2010 and have generally involved reductions of staff and funding at a national level. Despite that, NWGP has proved to be needed, resilient and fulfilling much of its original concept.

First and foremost we are a channel for communication between local groups in our five county or unitary areas. We also provide a critical two-way link between the region and national organisations – GCUK, Natural England and the BGS. The dialogue between local groups has been most important in sharing expertise and best practice thus avoiding wasteful reinventions and at times boosting morale. Groups have been able to help each other in every aspect of their work from recording sites and working with local authorities to designing geotrails and information leaflets and producing Local Geodiversity Action Plans (LGAPs).

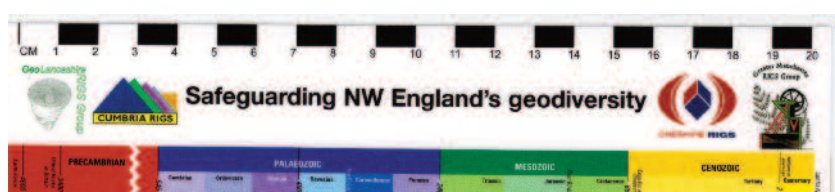
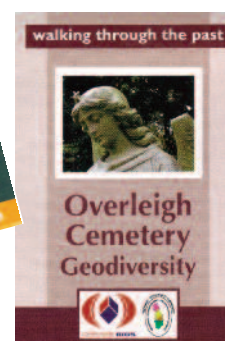
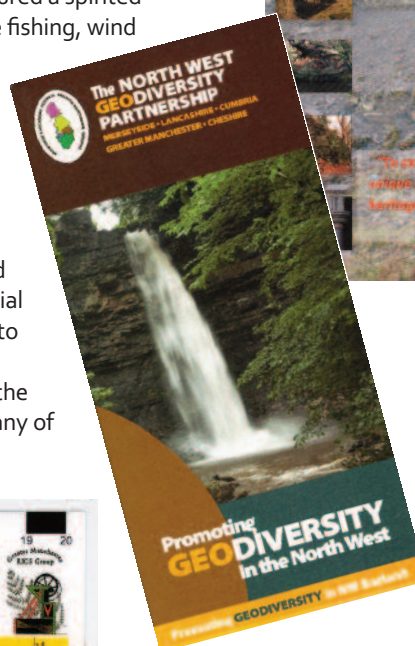
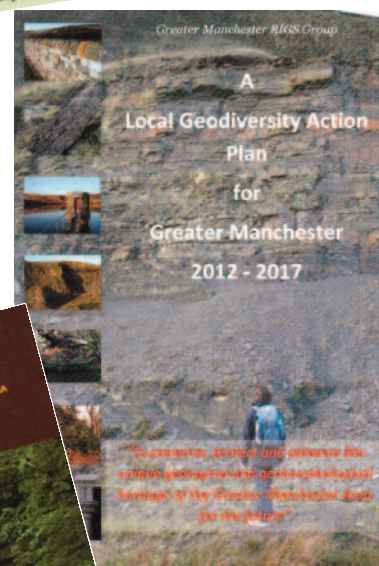
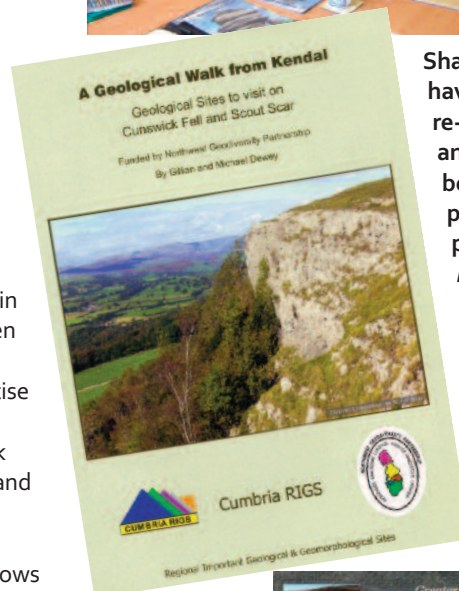
The regional/national link serves a similar purpose at a higher level and also allows local groups to help influence national policy. NWGP has been lucky to have a hot line to feed our experience and ideas to GeoConservationUK since two of our members, Cynthia Burek and Kevin Crawford, are GCUK committee members. This also affords a link to key Natural England staff though we are also of course able to present a regional view directly to them. Our link with the BGS has sadly become somewhat stretched of late but we know that Keith Ambrose is still there and will help if at all possible.

As a regional organisation, we played a key role in the Irish Sea Conservation Zones steering group. This involved many intense working sessions for Cynthia Burek who ensured a spirited voice for geodiversity and geoconservation alongside representations from the fishing, wind farm and cable industries.

All this was greatly helped by some modest but very critical funding from Natural England. That, first of all, enabled the Partnership to function. It paid for our own website (www.nwgeo.org.uk), an information leaflet and bookmark/photo scale. Most of the funding, however, has been channelled to the local groups which in most cases have no regular source of income. It has enabled them to organise their work methodically by developing well-designed LGAPs; to identify, survey and record sites thus leading to at least some potential protection; and, above all, to spread the word about our amazing geodiversity to the wider community. This has resulted in website developments and improvements – a key means of communication these days, and a doubling in the number of geotrail guides and related publications already being produced. Many of these are now downloadable as pdfs as a result of the online improvements.



Shared experiences have saved re-inventing things and yielded benefits, particularly in publishing.
Photo by NWGP



The Curry Fund of the Geologists' Association is named after Dennis Curry, who bequeathed a substantial sum of money to the GA in 1986. It has enabled the GA to support many and varied geological projects over the years and should continue to do so for many more. This article illustrates one case and the following article details how to apply for Curry Fund grants and interest-free loans.

New life for historic geology archive

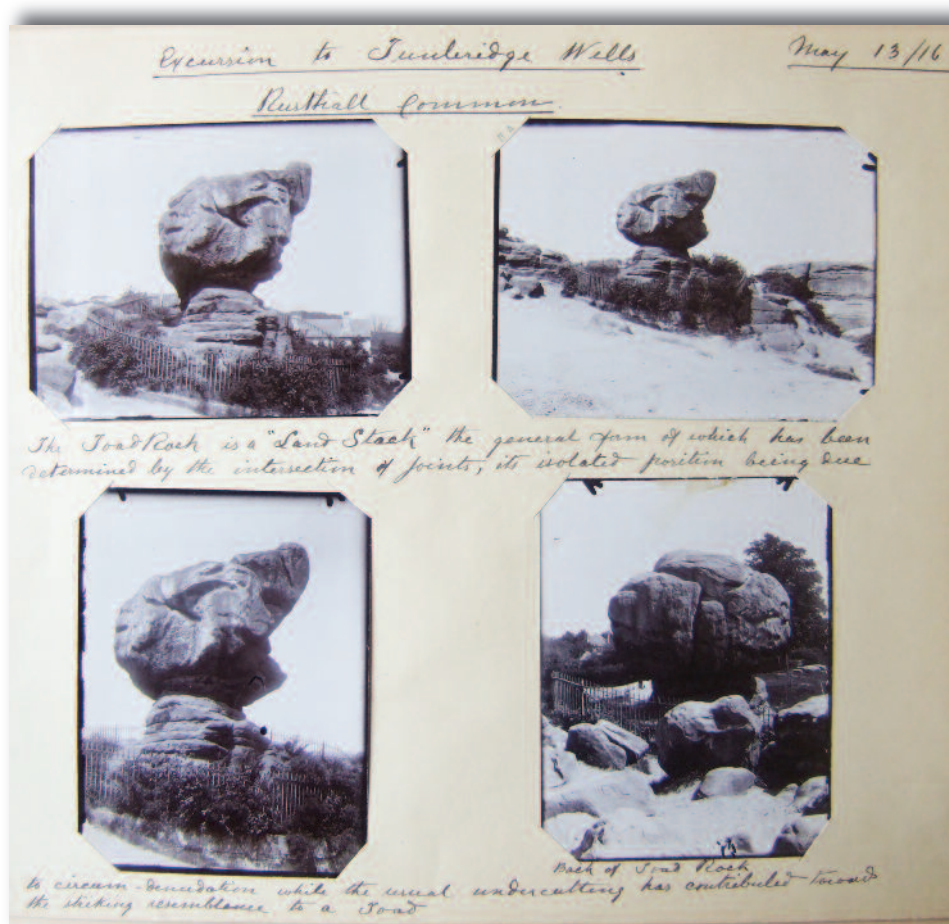
Jonathan Larwood,
Geologists' Association Archivist

The Geologists' Association (GA) has always recognised the importance of recording its activities. Perhaps most familiar are the accounts of field meetings in the *Proceedings of the Geologists' Association* (PGA). Less well known is the record held within the GA Carreck Archive – but this is about to change.

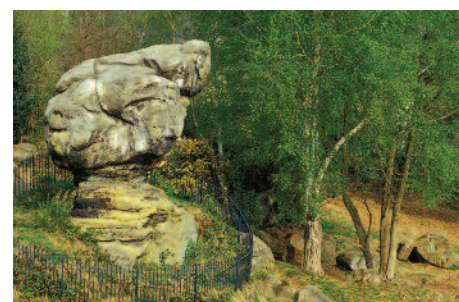
The GA Carreck Archive is a remarkable resource that includes well over 10,000 photographs, many presented in albums, together with letters, postcards and other ephemera. Named after Marjorie Carreck, who looked after the Archive from 1955 to 2010, it documents GA activities, in particular field meetings, from the 1870s onwards. Not only is this a record of the places visited but, in many cases, it illustrates and names the people taking part and is very much a social history of geological field excursions. Two stand-out album collections illustrate the places and people depicted in the archive.

PLACES – between 1907 and 1919 Thomas William Reader photographed every GA field meeting. This meticulous and skilled photographer compiled his photographs into a series of 12 albums, ordered by excursion with the geology and locations carefully labelled. Over 100 of T.W. Reader's photographs were also used to illustrate field excursion reports in the PGA and today his albums bring to life these accounts. The spread on this page from a T.W. Reader album and a recent colour photograph of the same site demonstrate the importance of the Carreck Archive in documenting how geological sites change over time and it provides a visual record of sections that are no longer available.

continued on next page



T.W. Reader photographed Toad Rock during an excursion to Tunbridge Wells, Rusthall Common on 13 May, 1916. The 2003 colour photograph by Mick Murphy shows a more wooded but still visible Toad Rock, now part of the Rusthall Common SSSI designated for its periglacial erosion of Wealden sandstones.



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PEOPLE – Miss Mary Sophia Johnston looked after the GA photographs from about 1910 through to 1955. She bequeathed two personal albums which have always attracted attention. The M.S. Johnston albums provide a record of the field meetings she attended between 1890 and 1937. They include photographs, drawings, autographs and letters. In contrast to T.W. Reader she was particularly interested in the people taking part and took great care to label them, often with detailed keys and added notes on what was happening in the picture (see photograph, right).

Marjorie Carreck continued the Johnston theme, encouraging many donations. She compiled two albums documenting some of the more notable people of the GA and field trips up to the 1990s. Today the archive is an invaluable resource and its significance ranks alongside the BGS's photographic records and the geological photographs of the British Association for the Advancement of Science.

Archive conservation

Between 2008 and 2010 the Carreck Archive underwent a complete conservation assessment and restoration, with the aid of a Curry Fund grant. The condition of the archive was carefully assessed and a conservation plan drawn up. Undertaken by a paper conservator, conservation included the cleaning of photographs and repackaging of loose photographs into transparent envelopes. Repair of damaged albums was undertaken and the more unstable photographs were carefully separated. Where beyond repair, new loose leaf portfolios were commissioned. These included the T.W. Reader albums, which had started to deteriorate through years of use. Album pages were mounted in individual transparent wallets and ring-bound into portfolios. This retains the integrity of the pages, protects the photographs and makes them far easier to examine. Lastly, the entire collection has been re-housed in bespoke drop spine boxes making it easier and more stable to store and transport.

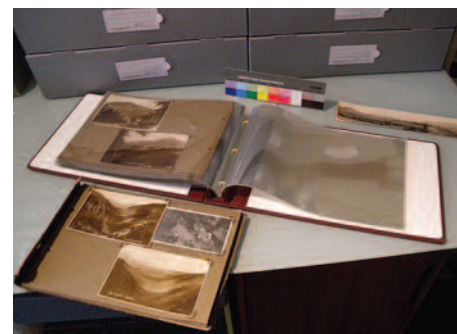
Archive – what next

The newly conserved Carreck Archive is now located at the BGS (Nottingham) which, through agreement with the GA, has taken responsibility for its long-term care and storage. The archive and associated information captured by volunteers is now being gradually digitised by the BGS. Having done this, aspects of the archive will be published on the BGS Geoscenic website (<http://geoscenic.bgs.ac.uk>) and an archive section is also being developed on the GA website (www.geologistsassociation.org.uk/archive.html). While the archive will still continue to be exhibited at the annual GA Festival of Geology, digitisation will make it more accessible to everyone as well as reinvigorating interest in how it can be used and added to with 'traditional' photographs and new digital images.

If you would like to know more about the Carreck Archive then please get in touch:
jonathan.larwood@naturalengland.org.uk



A GA field excursion to Lyme Regis, here seen visiting Hardown Hill on 14 April, 1906 (from Miss M.S. Johnston's album).
Photo by D.V. Lang



Album pages have been remounted in transparent wallets held in loose-leaf binders. The whole archive has been re-housed in bespoke stage boxes (seen in the background).
Photo by Richard Weedon

Grants that helped grow a Pliocene forest

Susan Brown, Curry Fund Secretary

Grants from the Geologists' Association Curry Fund have been instrumental in helping GeoSuffolk advance a unique project to help re-create a Pliocene forest at Sutton Knoll, part of the Rockhall Wood Site of Special Scientific Interest (SSSI).

The SSSI is on private land that, thanks to a very co-operative owner, has been actively managed by members of GeoSuffolk since 2003. Much geoconservation work and original research have been undertaken and the group has organised many field visits there.

Sutton Knoll is a 'fossil island' of Coralline Crag which rose above the Pleistocene Red Crag Sea around 2.5 million years ago – see *artist's impression*. This island site, with its wave-cut platform, cliffs and boulders, has been written about frequently for more than 170 years and is one of Suffolk's prime geological sites.

In addition to the Knoll's research value, GeoSuffolk members wanted to augment its potential for education. After much thought, the idea of a 'Pliocene Plantation' took root! With that in mind, it had to be determined what flora would have lived on the island during the Pliocene. Pollen analyses are not common from these heavily oxidised, coarse Crag sediments, but with the help of Professor Richard West who collected pollen from the nearby Orford borehole, it was discovered that many modern English genera as well as many that were lost after the last Ice Age had an identifiable pollen footprint. Some of the 'lost' species are found today in North America and Eastern Asia including *Sequoia*, *Sciadopitys*, *Tsuga*, *Picea* and *Abies*. Some of these and others including juniper, a range of grasses and heathers have been planted at Sutton Knoll. As reported in *Earth Heritage* 38, with permissions from Natural England and the landowner, the 'Pliocene Forest' project was launched in 2008, beginning to create the lost forest that might have been found on the Knoll during the Pliocene.

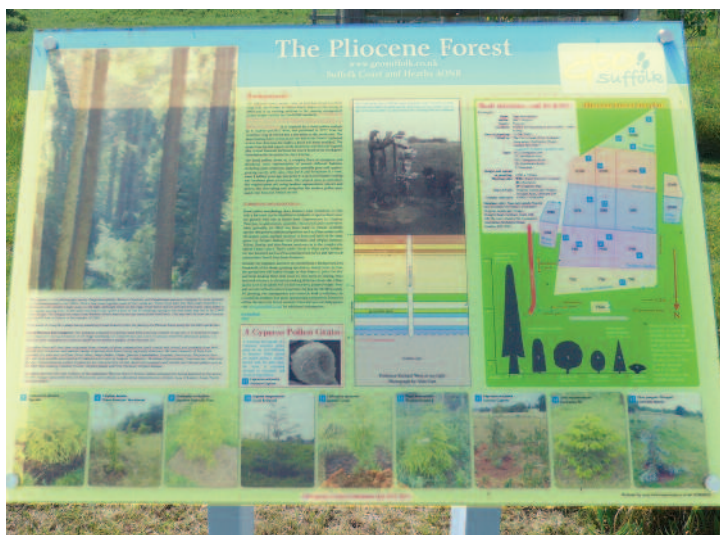
As part of its ongoing education programme, GeoSuffolk produced an information board about Sutton Knoll and also identified a partially fenced area of the site suitable for planting a selection of Pliocene trees. A small trough still connected to a water supply ensured the new plantings could be nurtured in the site's fast-draining sediments, and the landowners allowed GeoSuffolk to erect a deer- and rabbit-proof fence. All that was needed now were the appropriate saplings, identified with advice from Professor West.

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Suttona Antiquior, a visualisation by Louis Wood of life around an island of Coralline Crag during Red Crag Sea times, reproduced by permission of Roger Dixon



The GeoSuffolk information board at Sutton Knoll provides details of the Pliocene Forest.





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A grant of £372 from the Curry Fund bought the young trees and subsequent management and enthusiastic project guidance was undertaken by Barry Hall, GeoSuffolk member and horticulturist. The trees Barry purchased initially were: *Sciadopitys verticillata* (Japanese Umbrella Pine), *Tsuga heterophylla* (Western Hemlock), *Tsuga canadensis* (Eastern Hemlock), *Liquidamber styraciflua* (Sweet Gum) and two grasses, *Stipa tenuissima* and *Stipa gigantea*. Over the following months, other Pliocene trees were planted thanks to donations and sponsorship, many from friends and colleagues.

The official opening ceremony celebrated the creation of the Pliocene replica 'forest'.

Photos by Judith and Barry Hall

The GA Curry Fund plaque was installed on this newly planted Pliocene Forest at around the time of the unveiling of the Sutton Knoll illustrated information panel in 2009.

The 'forest' proved a rapid success as an educational resource attracting geological groups and non-specialists alike. The idea of expanding the Pliocene Forest to a much longer-term project as part of the site management plan was soon mooted and permission was duly granted by the landowner and Natural England.

So GeoSuffolk applied to the Curry Fund for a grant to fence the expanded area of some 900 m² against deer and rabbits and was awarded £1,692. By happy coincidence, the fencing contractor was a geologist so had a particular interest in the project. A 'grand opening' of the site extension was performed by David Bone, as a representative of the Curry Fund Committee, during the GA field trip to the Bawdsey Peninsula in May 2010.

One of the young trees, safely behind a deer- and rabbit-proof fence.

The Sutton Knoll Pliocene Forest continues to grow apace, even being incorporated into the Sutton village open gardens event in 2014. At the time of writing some 184 trees have been planted in the forest. Should readers wish to sponsor a tree, please contact GeoSuffolk (www.geosuffolk.co.uk) who will be delighted to give you details.

For those with projects that may benefit from GA Curry Fund support, guidelines for applicants and an application form are available to download and/or complete online on the GA's website, www.geologistsassociation.org.uk. We look forward to hearing from you.



How to present a global geo-treasure?

Colin MacFadyen, Scottish Natural Heritage
Angus Miller, Chair, Scottish Geodiversity Forum

In 1788, James Hutton accompanied by fellow geologists, John Playfair and James Hall, set foot on the rocks at Siccar Point on the Berwickshire coast. Hutton's insights into the geology there overturned the biblical view on the age of the Earth. Regarded by many as the most important geological site in the world, a challenge for us today is to determine how it should be presented and interpreted for allcomers – local people, casual visitors and geotourists.

The importance of the site to geological science is reflected by its statutory legal protection as a Site of Special Scientific Interest (SSSI). Internationally the significance of Hutton's discovery at Siccar Point is evidenced by the full-sized replica of a section of rock face showing the unconformity. The replica is housed in the American Museum of Natural History, New York as one of 11 full-scale reproductions of classic outcrops from around the world in the Hall of Planet Earth.

The proposed construction of an outfall pipe within view of the Hutton site led geologists worldwide to express their concerns at the potential visual and other impacts of the development.

Siccar Point is one of three unconformities that bear Hutton's name; the others are near Jedburgh, 60km to the south-south-east and at the north end of Arran on Scotland's west coast. Of Hutton's three eponymous unconformities, Siccar Point is the most famous. Nobody knows how many people visit Siccar Point each year. It is certainly well used by university groups and many overseas visitors make a pilgrimage.

However, many local people have no knowledge of the importance of this spectacular section of coast, few local schools visit the site, and if you ask for directions locally, you may well be met with a blank look. In terms of interpretative provision for visitors, there is a leaflet in production by Lothian & Borders Geoconservation, and a panel at the top of the steep slope above the locality. The panel location represents a stopping point on the signposted Berwickshire Coastal Path, which runs from Cockburnspath to Berwick upon Tweed. Beyond this there is little other provision apart from very welcome car parking availability at a nearby vegetable processing factory, where another panel provides information and directions for visitors. In addition, the locality has an entry in the Edinburgh Geological Society's Scottish Borders Geology excursion guide, with limited information also available on websites, including www.scottishgeology.com.

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Part of the replicated rock face from Siccar Point displayed in the American Museum of Natural History.
Photo © AMNH, R. Mickens

The Siccar Point unconformity.
Photo by Colin MacFadyen, SNH



The point of Siccar

Siccar Point demonstrates the relationship between two groups of rocks that differ in age by about 55 million years. The older rocks are early Silurian sandstone and mudstone that originated as loose sand and mud deposited in a deep marine environment about 443-417 million years ago. That was the Iapetus Ocean, which once separated the rocks of Scotland and England. The joining of the land masses led to the formation of the Southern Uplands and the Scottish Highlands. During ocean closure, the sedimentary rocks that formed in the ocean were mildly metamorphosed, folded and uplifted. They were subsequently worn down to a hilly undulating terrain. In Late Devonian times, perhaps around 360 million years ago, conglomerate, sandstone and other sediments were deposited on top of the deformed and steeply tilted Silurian rock layers.

James Hutton was the first person to appreciate the time gap represented by the junction between the Silurian and Devonian rock sequences, now called an unconformity. Hutton used this locality to demonstrate the cycle of sediment deposition, folding, erosion and further deposition that the unconformity represents. In doing so Hutton had discovered the great antiquity of the Earth, and his theory eventually led to his recognition as the founder of modern geology.



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So what else could or should be done to present Siccar Point – arguably the most important geological site in the world – to visitors who range from the casual to those with a deep specialist interest? The possibilities are the subject of an almost perennial discussion.

Whether or not there should be provision of safe access to the intertidal area visited by Hutton forms the focus for much debate as Siccar Point is at the foot of a steep and potentially slippery grassy slope. Safe access presents a difficult engineering challenge. Thoughts have included a wooden stairway and a stone or concrete path with switchbacks, with or without hand-rails. Establishing and maintaining a fixed access route would be expensive, perhaps prohibitive. Such a construction could also conceivably introduce geoconservation issues through introducing slope instability leading to slumping of material onto the outcrop below.

An opposing camp regards any engineered path as visually obtrusive, even sacrilegious, at such an iconic site. It is argued that a cliff-top viewpoint is adequate for most visitors, with wear and tear implications on Hutton's key exposures if increased numbers of visitors turn up. One wonders if Hutton could have imagined on his visit in 1788 that visitors to the site would represent an erosional mechanism on this world-changing locality.

LET US HAVE YOUR VIEWS regarding what could and should be done regarding access to the Siccar Point site and its interpretation. Email colin.macfadyen@snh.gov.uk

NEXT PAGE: The genius of Hutton and his associates



Top, a party of visitors sets out down the steep grassy slope at Siccar Point to experience Hutton's Unconformity. The hillside plunges steeply down to the key coastal rock exposure. Providing safe access is a real challenge.

A wooden stairway, or a stone/concrete path with switchbacks would aid access, but would be costly and its construction would be controversial.

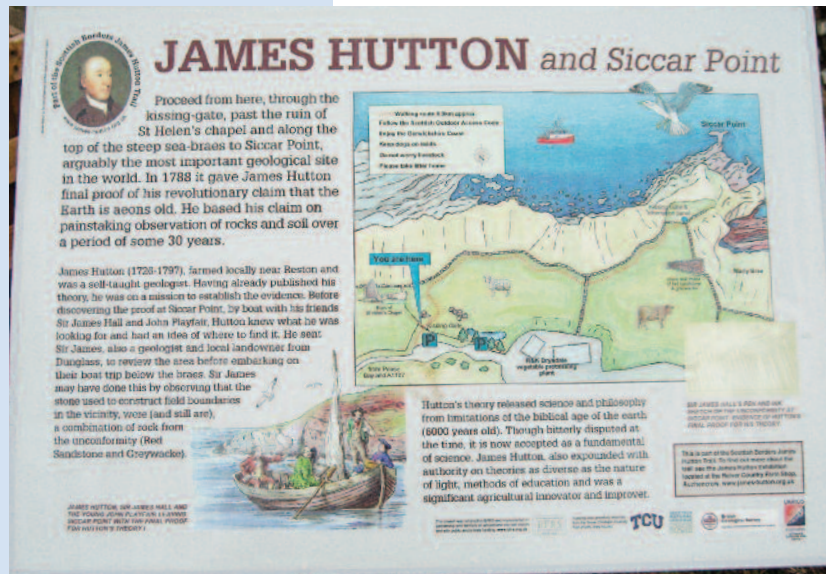
Photos by Angus Miller (top) and Colin MacFadyen, SNH

The genius of Hutton and his associates

JAMES HUTTON (1726-97) was a key figure in the Scottish Enlightenment. He read chemistry and medicine at university and was an agriculturalist farming in both Norfolk and Berwickshire. A partnership in a chemical factory in Edinburgh provided Hutton with the income to pursue his geological research.

Hutton's experience of farming demonstrated to him that soil washed from the fields ends up in the sea and that the decay of rocks gives rise to soil. By extension this led to the view that all land would in time be levelled by erosion with the resulting sediment ending up on the sea floor.

He was also well travelled and noticed the differences in Scotland's geology between the Midland Valley and the rocks in the Highlands and Southern Uplands. He concluded that the rocks of the former, which were generally gently inclined and softer, were younger than the harder and contorted rocks of the latter areas. With this idea he set out to find evidence, the junction between these 'primary and secondary strata', to confirm the age relations, and that search brought him to Siccar Point.



JOHN PLAYFAIR (1748-1819) was a mathematician and natural philosopher whose interest in geology was stimulated by Hutton. He was one of the original members of the Royal Society of Edinburgh and championed the cause supporting Hutton's *Theory of the Earth* with his own 1802 publication *Illustrations of the Huttonian Theory*. In 1805 he wrote of his visit to Siccar Point with Hutton in 1788 and realizing the significance of the unconformity, Playfair noted that: "We felt ourselves necessarily carried back to the time when the schistus on which we stood was yet at the bottom of the sea, and when the sandstone before us was only beginning to be deposited ... An epocha still more remote presented itself, when even the most ancient of these rocks instead of standing upright in vertical beds, lay in horizontal planes at the bottom of the sea ... The mind seemed to grow giddy by looking so far into the abyss of time."



JAMES HALL (1761- 1832), who became Sir James Hall, was the founder of experimental geology who devised high-temperature experiments to prove Hutton's theories of the volcanic nature of rocks.

Bringing Mousehold's geology to life

Tim Holt-Wilson

Norfolk Geodiversity Partnership

Mousehold Heath is an area of woodland and heath overlooking the valley of the river Wensum as it flows through Norwich. The hummocky, unkempt greenery of this urban green lung attracts joggers, dog walkers and illicit dirt bikers as well as birders, botanists and strollers. Thickets of birch woodland contrast with tracts of gorse, heather and grassland.

Despite its urban milieu, the Heath has enough space for people to lose themselves for a welcome hour or two. Surprisingly it does not show many signs of abuse, though fires are an occasional problem in summer. It has been a valued resource for the people of Norwich for over a thousand years: it has provided turf and timber, grazing land, and huge quantities of brickearth, chalk, sand and gravel for building. Indeed, much of the Heath could be described as 'brownfield' land, a former mineral extraction site with a long history of disturbance. 'Stone myne pits' are marked on a Tudor map of the city, and there are 18th Century records of people who lost their lives in its gravel workings. Mineral extraction intensified after 1850 when the city's population swelled and many new red-brick streets were built. It finished in 1883 when a large area was designated a 'people's park' under civic management, although quarrying for sand and gravel continued at the eastern end of the Heath until the 1960s.

Mousehold Heath Earth Heritage Trail began as an idea by members of the Geological Society of Norfolk (GSN) to commemorate the late Professor Brian Funnell. Brian's research work at the University of East Anglia had made a big contribution to the micropalaeontology of the Crag rocks of East Anglia, and he had written a paper on the geomorphology of Mousehold.

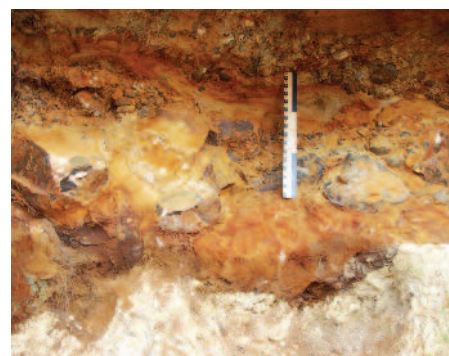
I was commissioned to work on the trail in 2011, undertaking research, copywriting and conceptual work. The trail was launched in 2013, with the aim of interpreting the links between geology, landscape and biodiversity for a non-specialist audience. It was a partnership project between Norwich City Council, Norfolk Biodiversity Partnership and Norfolk Geodiversity Partnership (NGP), and was funded by the Norfolk Biodiversity Project Fund, the GSN and the Mousehold Heath Conservators. 18 points of interest were waymarked with 12 numbered posts, and a colour leaflet and 25 web pages were published. Funding is still needed for a printed booklet and a smartphone version of the trail. The points of interest can be visited in any order. With help from volunteers and a hired mini-digger, geological features were re-exposed to provide windows on the inside story of the Heath. The new exposures will benefit wildlife such as lizards, ground-nesting bees and plants of disturbed ground, and will support endeavours by the wardens and conservators to remove encroaching trees and scrub. The newly revealed geology helps explain the merits of scrub clearance to some members of the public who are convinced the Heath has always been wooded and are hostile to heathland restoration.

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St James' Hill, with a view over Norwich. The dry-valley slopes have been modified in past centuries by quarrying for sand and gravel.

All photos by Tim Holt-Wilson



A section through the early Pleistocene seabed: sands, clays and massive flints of the Norwich Crag basement bed overlying an undulating surface of chalk bedrock.



Former gravel workings on the plateau area of the Heath.

ACCESS & INTERPRETATION

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Researching the Trail involved delving into local history records as well as specialist geological papers. Combining this information with field evidence, some key interpretative storylines were developed:

- Mousehold is a remnant of a glacial outwash plain (a 'sandur') dating from the Anglian glaciation about 450,000 years ago; variations in sediment may be seen, ranging from silts to coarse 'cannon-shot' gravels, and reflect different environments of deposition.
- Chalk and Crag form the bedrock underlying Mousehold and outcrop along the sides of the Wensum valley; chalk has been quarried for lime and flint; the last working lime kiln in Norwich (1968) is preserved below ground at Gilman Road.
- There is a section through the Crag seabed two million years ago at St James' Pit, showing a wave-cut platform in chalk bedrock.
- Various silty deposits were used to make the celebrated 'mussel bricks' of Mousehold, and some brick kiln sites may survive under areas of landscaped spoil; can we locate any remaining deposits of the classic Norwich Brickearth on the Heath?
- Are there any surviving land surfaces unaltered by human activity? Many parts of Mousehold have been quarried away, notably the north-western side where two windmills stood.
- A large dry valley meanders through Mousehold, along with a system of tributary dry valleys; there are various hypotheses about when and how these may have formed.
- Fine-grained silty deposits mantle the slopes and infill the heads of the dry valleys; these may be windblown late Pleistocene coverloam and/or anthropogenic Holocene colluvium.
- A distinctive hand axe found on the Heath is evidence of local Neanderthal settlement in Middle Palaeolithic times.
- The Heath is a County Wildlife Site, and demonstrates the links between bare or disturbed sandy soils and characteristic heathland species.

Since the Trail's launch in 2013, several guided walks have each drawn over 30 people keen to know more about the nature on their doorsteps. It is not clear how many people follow the Trail apart from such events; the uptake of leaflets is not monitored although 750 have been distributed. The website visitor statistics suggest an average of over 350 individual page visits per month. Analysis of website search words suggests that information about recreational walking is an important factor for people visiting its pages.

The Trail has suffered a few unfortunate incidents, for instance two of the waymark posts were uprooted, and bizarrely all 'cannon-shot' flints visible in one exposure were smashed to splinters. For the future, ideas have been mooted for an application to the Heritage Lottery Fund for an 'Our Heritage' project investigating the Norwich brick-making industry, through a combination of archive research, oral history, archaeological excavation of a buried kiln and experimental kiln firing. This could build on good working relations established between partners and between the project and the Mousehold Heath Defenders (a local advocacy group); however further funding would be needed to research and write the bid.

As well as industrial archaeology, the Trail could have spin-offs for geological research – it is surprising how little is actually known about the stratigraphy of Mousehold. There is also a potential link-up between the Trail and GCSE Physical Geography content in the National Curriculum. Clearly, the geodiversity of Mousehold has many more stories to tell.

To find out more, go to:
the NGP website <https://sites.google.com/site/norfolkgeodiversity/news/mheht>, to download a copy of the introductory trail leaflet;
Norwich City Council's web pages at <http://www.norwich.gov.uk/mouseholdheathtrail> for in-depth information about Trail features.



Volunteers re-exposing glaciofluvial gravels at Birch Walk.



Coarse glaciofluvial gravels outcropping at Chestnut Drive.

Scotland's 'Little Ice Age' glacier mapped

Martin P. Kirkbride, University of Dundee
Ness Brazier Kirkbride, Scottish Natural Heritage

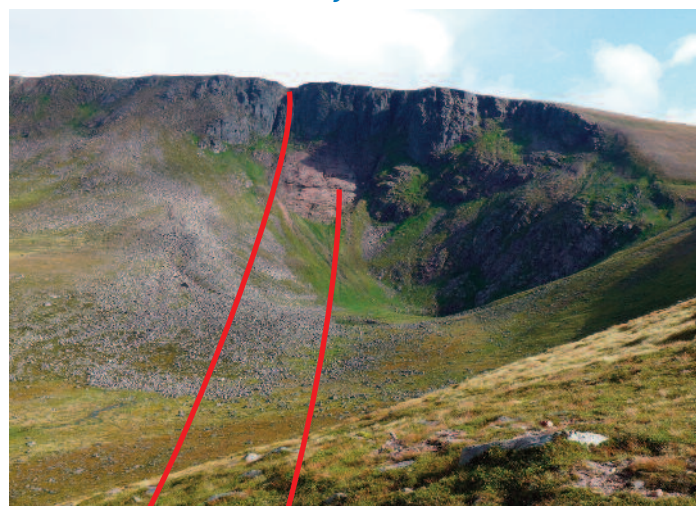
The Cairngorm Mountains are held in high regard for their wild, sub-Arctic high expanses. Indeed, scientists have explored the possibility that some corries were snowy enough to contain small glaciers during the cold decades of the 17th and 18th centuries, a time popularly called the Little Ice Age. This was a period of hardship for crofting communities, with short growing seasons and long, hard winters, caused by a weaker sun and made worse when aerosols from cataclysmic volcanic eruptions (such as Laki in 1783, and Tambora in 1815) cooled the atmosphere further. Historical accounts describe year-round snow-lie on the Cairngorms for many years. But until now evidence for corrie glaciers has proved elusive.

New research has mapped glacial moraine ridges bordering the Great Slab in Coire an Lochain on Cairngorm. Isotopic dating of rock samples shows that the moraines were deposited by a glacier in the later postglacial period. While it has not yet been possible to give a precise age, what is known about the climate of recent millennia points to a likely origin within the coolest part of the Little Ice Age. The discovery attracted much media attention when the paper was published in February 2014. But how significant is the fact that Scotland had a glacier in recent centuries, beyond mere curiosity value?

The glacier was very small, covering the Great Slab and connecting upslope to snow gullies in the surrounding cliffs. Its area of 36 hectares is equivalent to about five and a half football pitches. Glacier reconstructions allow palaeoclimatic calculations of the balance between summer temperature and winter snowfall that allowed ice to accumulate and to survive the summer warmth. The glacier was only able to exist because the calculated average summer temperature at the snowline of 4.1°C was compensated by great depths of winter snow, including drifting of dry snow from the high plateau above. It existed right at the climatic limits of possibility for glacier formation. This makes it unlikely that other contemporary glaciers occupied high-level niches elsewhere in the Highlands, though it will be interesting to explore other possible sites for evidence of recent moraines.

The Great Slab and Coire an Lochain. The small glacier occupied the upper back wall of the corrie, under the crags, covering the Great Slab.

Photo by M.P. Kirkbride



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As (currently) the only known site of a recent glacier in the British Isles, Coire an Lochain provides a useful datum for scientific reconstructions of climate for a period for which there are no instrumental records from the Highlands. The nearest contemporary glacier lay 600 km away in western Norway, so a Scottish glacier extends the known distribution of Little Ice Age glaciation westwards from Scandinavia. It marks the culmination of several millennia of declining Northern Hemisphere temperatures, driven by changes in the Earth's orbital geometry, which had already caused glaciers across European and Scandinavian mountains to grow as mountain climates became cooler and wetter. This 'neoglaciation' did not just encourage the growth of blanket bogs, but also brought the Scottish Highlands to the cusp of a more regional glaciation, just as renewed warming nipped glacier formation in the bud. The disappearance of the glacier represents a significant climatic turning point, from which our climate has continued to warm irregularly ever since.

Scotland's last glacier adds another dimension to the impressive array of climate-related geoconservation interests of the Cairngorm Mountains. The finding of this relatively recent glacier in Coire an Lochain is a 'first' for the British Isles; indeed it will probably be a 'one off', because it occupies such a high niche in Britain's highest mountain range. While evidence of such a rare and recent glacier is intrinsically interesting for geoconservation, in the wider context of the whole range of landforms and related habitats found in these granite mountains, it gives Britain something more akin to an Arctic environment. The Cairngorm Mountains are already well known for their sub-Arctic heaths, mammals and birds, and this small but very recent glacier site adds to the overall conservation value of the mountains. Here we can find the ancient pre-glacial landscape fragments preserved in the sweeping slopes of the high plateaux; the remarkable survival of tors that were repeatedly covered by ice sheets, situated above the deeply incised troughs, glacial breaches and high corries that record the passage of successive glaciations; the veneer of periglacial landforms of blockfields, solifluction sheets, and shallow nivation hollows occupied by late-lying snow on the higher summits and slopes; the isolated large rockfalls and landslides; and steep debris slopes trimmed by the wildest, braided gravel-bed rivers found in the British Isles.

Today's landscape is a snapshot of a long evolution, during which climate cycles have left a varied archive of landform evidence. Much of the landscape value of the massif owes its distinctive quality to the combination of changing geomorphological processes over tens of millennia, to give the characteristic form and relief of the massif, as well as the high-level bouldery heath which supports important species such as the ptarmigan, snow bunting and dotterel.

Further sources on the Cairngorms:

Landscape Fashioned by Geology, The Cairngorms. Published by Scottish Natural Heritage 2006, www.snh.org.uk/pdfs/publications/geology/cairngorms.pdf

Adrian Hall, *Cairngorm Landscapes* [online] [Edinburgh, Scotland] updated February 2014 www.landforms.eu/cairngorms/

Coire an t-Sneachda (left) and Coire an Lochain (right), seen from Glen More.

Photo by M.P. Kirkbride

Glossary

Landforms formed by glacial erosion:

Glacial trough: steep sided U-shaped valley eroded by glaciers

Glacial breaches: where glacial erosion has cut through the watershed and connected formerly separate valley systems, sometimes capturing headwater streams

Corries: often described as 'armchair shaped', corries are steep-sided hollows eroded by small (cirque) glaciers

Landforms formed by periglacial processes:

Blockfields: a blanket of large weathered boulders on summits and slopes

Solifluction sheets: these can be large areas of step-like landforms, formed by mass movement within the surface weathered sediments, forming lobes and sheets with a distinct riser edge

Nivation hollows: hollows that contain late-lying snow, where weathering has been enhanced by snow and snowmelt

New house planned for ancient gem

Fiona McKinnon

Assistant Parks Development Manager, Glasgow City Council

In the south-west corner of Victoria Park in Glasgow nestles a small, inconspicuous museum building. Inside are the remnants of a 330 million-year-old forest – a fossil grove – the sandstone casts of stumps of lycopod trees from the Carboniferous Period. The stumps were revealed in 1887 when a road was being cut across part of a disused quarry in the park. With extraordinary foresight, the Partick Burgh Commissioners decided not to remove the stumps to a museum but to preserve them *in situ* within a building, a rare example of early development in geotourism and conservation.

The site is a Site of Special Scientific Interest (SSSI) and was classified as Glasgow's first Regionally Important Geological/Geomorphological Site (RIGS) in 2007 (see *Earth Heritage* 29). The former quarry west of the building is designated as a Site of Special Landscape Importance (SSLI).

In 1889 the Partick Burgh Commissioners employed the architect Peter Macgregor Chalmers (1859-1922), to design and build a fossil-house which opened in 1890. Chalmers' practice was almost exclusively church work and the original building had an almost ecclesiastical feel. It consisted of brick walls, a wooden roof structure and glazed sections along the roof apex. The wooden roof was replaced early in the 20th Century by a metal and glass structure, and in the 1980s insulated panels were added to help control the building's environment. Further improvements were made in 1993 – the east viewing area was enlarged, new lighting was installed and some small interpretative displays were incorporated. A toilet and a small reception area were created.

Fossil Grove is popular. In the past 10 years, it has received around 12,000 visitors per annum, peaking at almost 20,000 in 2010, from all over the UK and across the world. Visitors range from those who simply remember the fossils from their childhood, to students/academics/enthusiasts, and children who are inspired by stories of giant Carboniferous spiders and millipedes. Given the popularity of Fossil Grove and the expectations of the modern museum visitor, the current building is inadequate. Water ingress and inadequate heating and ventilation systems make the environment unsuitable for both fossils and visitors, and space and facilities are insufficient for education and interpretation.

Glasgow City Council, which manages the museum with the Trustees of the Fossil Grove Trust, has embarked on an ambitious project to replace the building with a stunning, innovative structure which will inspire and support learning and attract visitors. Working with Glasgow Building Preservation Trust and Barham Glen Architects, plans have been drafted and sources of funding are being investigated. The new building will reflect the wooded setting of the Fossil Grove, with diffused light being drawn into the building through columnar structures representing the prehistoric forest. It will be of an environmentally sustainable design and will offer improved access, visitor and learning facilities.

The potential for a huge array of interpretative material and methods will be incorporated into the design, making the site attractive for all visitors and a key destination for schools. Should funding be secured, the new building, due for completion in 2016, will also link with the nearby quarry area to encourage outdoor learning and interpretative material in the building will support this link.



Architectural impressions of how the replacement museum could look on the outside (above) and the interior (below). The new 'fossil house' will be better for the tree trunks and for visitors.

Images © Barham Glen Architects



One of the stumps in the present, outdated museum building.

Photo courtesy Culture and Sport Glasgow (Museums)



Forming a record of short-lived exposures

John Powell*, Gemma Nash and Patrick Bell,
British Geological Survey, Keyworth

*BGS and Geological Society Stratigraphy Commission, jhp@bgs.ac.uk

Scientifically important information revealed in temporary exposures of bedrock and superficial Quaternary deposits is frequently 'lost to science' because exposures are re-buried before the geoscience community can respond.

The Geological Society Stratigraphy Commission recognised that a vehicle was needed to expedite the recording and storing of information observed in pipeline trenches, shallow excavations, road cuttings and embankments. Now the British Geological Survey (BGS) web development team, Patrick Bell and Gemma Nash, have developed a citizen science website channel, GeoExposures (www.bgs.ac.uk/citizenScience/geoexposures.html) through which the geological community can log and detail temporary exposures.

The channel is concerned only with the recording of temporary exposures and also incorporates reporting of landslides, flood events and soils. It is not aimed at documenting long-lived exposures (e.g. inland and coastal cliffs; disused quarries etc.) and the conservation of geological sites will continue to be the domain of Natural England (www.naturalengland.org.uk), Scottish Natural Heritage (www.snh.gov.uk), Natural Resources Wales (naturalresourceswales.gov.uk) and GeoConservationUK (wiki.geoconservationuk.org.uk).

GeoExposures is powered by the new Ushahidi crowd-sourcing software that was developed to assist with communicating events during major emergencies such as the Haiti earthquake ('ushahidi' is Swahili for 'testament').

Using GeoExposures, amateur and professional geologists will be able to locate a temporary exposure on a Google map, briefly log the site geology on a pro-forma, and upload .jpg images via smart phone or computer. Some users may prefer more traditional methods to map, log and record - using notebook, hard copy Ordnance Survey maps or BGS geological maps - and subsequently upload at their convenience from a computer. The essential ingredients will be accurate descriptions and good-quality digital photographs as a permanent record.

To assist recording, the website provides the user with links to background information on the geology and stratigraphy of the UK such as digital BGS geological maps (maps.bgs.ac.uk/geologyviewer_google/googleviewer.html), the BGS Stratigraphical Lexicon (www.bgs.ac.uk/Lexicon/home.html) and the BGS Timechart (www.bgs.ac.uk/discoveringGeology/time/timechart/home.html). In addition, there is a

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GeoExposures web page:
britishgeologicalsurvey.crowdmap.com



converter (www.bgs.ac.uk/data/webservices/convertForm.cfm) to transfer latitude-longitude locations gleaned from a Google image to British National Grid. The *pro-forma* site description can be supplemented with additional information such as a site sketch map and geological log – these can be drawn freehand, and submitted as scanned .jpg images.

We are keen to see this as a geoscience community website and not an official BGS site – our vision is to deploy the software in a useable format for common access and as such GeoExposures is made available under a Creative Commons licence. We hope that professionals in the civil engineering and quarrying industries will also be keen to submit records of short-lived exposures at their sites. BGS will monitor submissions for improbable records such as 'dinosaur footprints found in Cambrian rocks', but we do not intend to verify the records rigorously. There is an opportunity to send in comments and suggestions and we hope GeoExposures will generate vibrant discussions. We envisage any scientific publications arising from GeoExposures records will duly acknowledge the source material.

And finally, permission to enter sites is entirely the responsibility of the individual, as is your and others' health and safety. So, please give it a go, but responsibly!

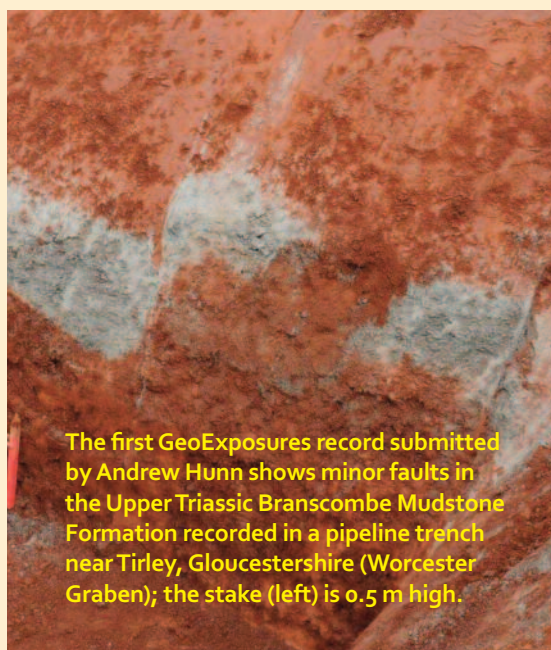
A fuller article appears at <http://dx.doi.org/10.1016/j.pgeola.2012.04.004>. Powell, J., Nash, G. and Bell, P. (In press). *GeoExposures: Documenting temporary geological exposures in Great Britain through a citizen-science web site*. Proceedings of the Geologists' Association (2012).

First response

During development of a 'beta' test site we received an e-mail from Andrew Hunn, an archaeologist, who was logging a pipeline trench near Tirley, Gloucestershire.

Andrew's images and site description became the first external GeoExposures record. Coincidentally, the faulted Mercia Mudstone (Upper Triassic) exposure is the same age and formation as our example site based on exposures of the foundations of the William Smith Building at BGS Keyworth. We hope the 'Father of English Geology' would approve of the latest format for recording geological information.

Andrew Hunn reports that he has 14 years of pipeline records that may be of interest!



The first GeoExposures record submitted by Andrew Hunn shows minor faults in the Upper Triassic Branscombe Mudstone Formation recorded in a pipeline trench near Tirley, Gloucestershire (Worcester Graben); the stake (left) is 0.5 m high.

Right, the GeoExposures website example showing the Upper Triassic Branscombe Mudstone Formation exposed in the excavations for the William Smith Building, BGS, Nottingham in 2008.



How puddingstone catches imaginations

David Bridgland, Diana Clements & Chris Green
Geologists' Association

Puddingstone is the pebbly version of sarsen, the very hard and massive quartzite represented in numerous megalithic monuments, including the main structures at Stonehenge. From a geoconservation point of view it is encouraging to see these iconic rocks providing focal points in villages and even being used as a teaching aid in a school.

Both sarsen and puddingstone occur as concretions or lenses in the Palaeocene strata of the upper Upnor Formation, although they have rarely been observed *in situ*. Exceptions include puddingstone in the shaft of the Pinner chalk mine and near Radlett. Both rocks are familiar in the landscape as residual masses, generally on the dip slope of the Chalk, although they have also found their way into solution features, clay with flints, and Quaternary valley fills and slope deposits. Puddingstone is restricted to a linear zone of occurrence (a palaeo-shoreline?) through Hertfordshire but including small parts of Buckinghamshire and Essex.

Delegates considered all of this at a day meeting for the Geological Society, Geologists' Association and Society of Antiquaries to examine Puddingstone and related silcretes of the Anglo-Paris Basin. The convenors were Jenny Huggett (Petroclays), Chris Green (Society of Antiquaries) and Rory Mortimore (Geologists' Association). Attendees also went on to examine some of the more puzzling features of the sarsens and the flinty puddingstones. The residual masses are much rarer than they were a few centuries ago, having been systematically removed and cut up for building stones and other uses. The most striking use of puddingstone was the manufacture of Romano-British querns (hand flour-mills).

The main types of silcrete formation are soil-forming (pedogenic) processes at or near the palaeo-land surface, and other processes related to siliceous groundwater that can occur at greater depths. The flint pebbles are often iron stained and show concentric banding, as well as intense fracturing that might signify heating. The matrix sometimes contrasts markedly with the highly rounded pebbles in that it can contain very angular quartz and shards of flint.

A follow-up Geologists' Association excursion led by Chris Green, Jane Tubb and Brian Lovell visited puddingstone sites in Hertfordshire and north-west Essex. All sites contained blocks of puddingstone that had been moved, even from their original *ex-situ* positions. Although some have been left in the landscape in their weathered state, others had been used for monuments, illustrating the iconic nature of, and affinity for, this rather special rock.



Feltwell-Southery Fen, Norfolk:

The most striking use of puddingstone was the manufacture of Romano-British querns (hand flour-mills). The hardness of the flint pebbles made for extremely good corn milling, with minimal grit in the flour. Working would probably have required puddingstone or flint as an abrasive, on the 'diamond cuts diamond' principle.
Photo by Chris Green

Bishop's Stortford College: A puddingstone block discovered during building work in the College grounds is on display, with explanatory plaque. The party was shown the specimen by a geography teacher who uses it as a teaching aid. This rock has been partly cut and polished, enabling comparison with other naturally broken parts of the block and more weathered surfaces. The fractured nature of many of the flint pebbles and the red-brown staining are characteristic of puddingstone.
Photo by Ian Mercer



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Arkesden war memorial. An erected puddingstone block with a thin seam of sand (sarsen), representing remnant bedding in a beach or shoreline deposit; members enjoyed a discussion of its original 'way-up'. The numerous stones in this village suggest a little-known Palaeogene outlier, perhaps on higher ground nearby. *Photo by Ian Mercer*



Standon. This puddingstone monument sports a plaque that suggests the boulder was carried by glacial transport. While that is open to question, subglacial processes would have been one means of abrading the pebbles flat at what otherwise seems to be the original surface of the concretion.

Photo by Ian Mercer



Brent Pelham. Puddingstone block used in the outside wall of Brent Pelham Church. Nearby is another war memorial also made from blocks of puddingstone.

Photo by Ian Mercer

Westland Green. A large recumbent boulder, representing an entire concretion of puddingstone, lies in the edge of a wood here. It is notable for an open-framework zone, possibly caused by seams of pea-shingle preventing matrix penetration between the pebbles (important evidence for post-depositional matrix emplacement).

Photo by Chris Green



A10 Colliers End by-pass. Puddingstone blocks excavated during road construction in 2002 were saved for science by private-enterprise geoconservation action when a local farmer gave them a home by making a puddingstone garden. This would be a fine place to start any future research on this enigmatic lithology.

Photo by Diana Clements

Updated blueprint for geoconservation

Geodiversity: Valuing and Conserving Abiotic Nature (Second Edition: 2013)
Murray Gray. Wiley Blackwell. Soft cover. 495pp. ISBN 978-0-470-74215-0

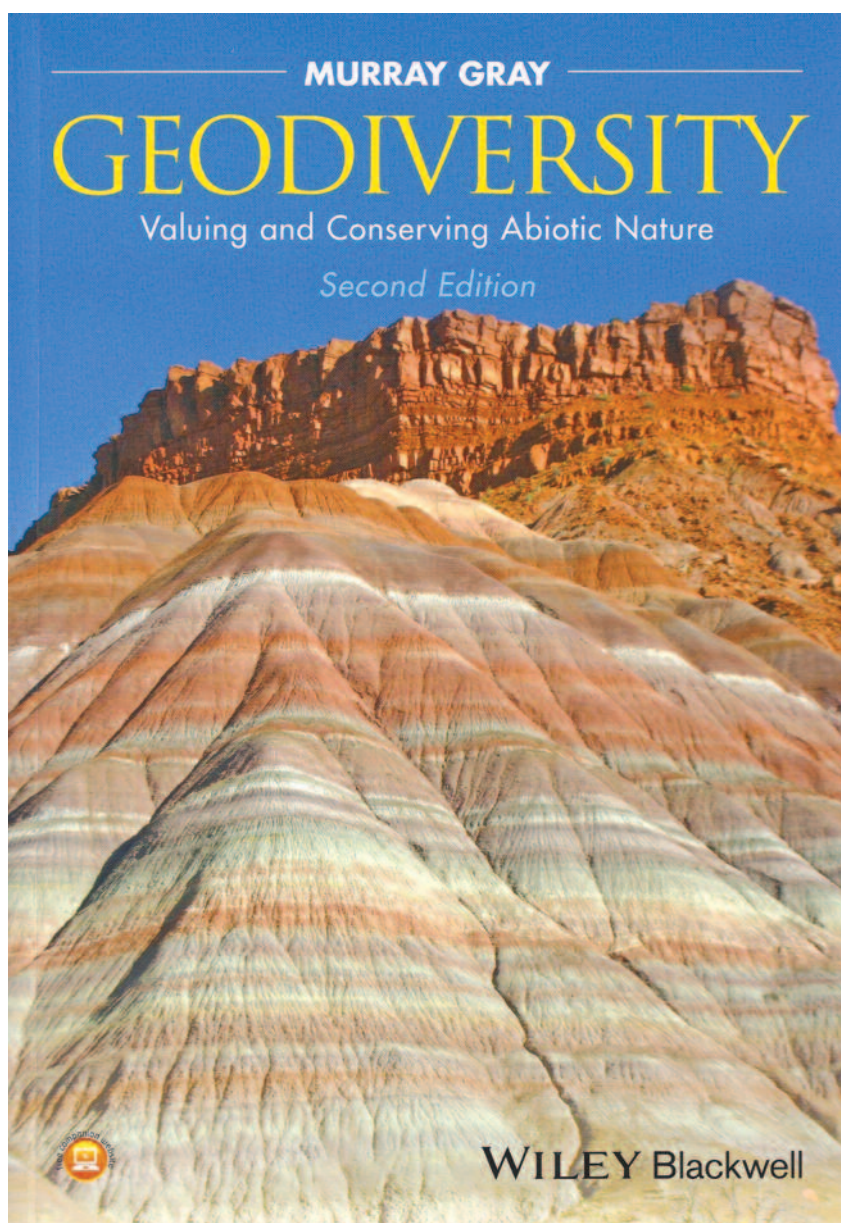
This second edition is a heavily revised version of Murray Gray's original book published in 2004 and reflects the considerable progress made in developing and applying the geoconservation concept since then. For instance, separate chapters are devoted to World Heritage Sites and Global Geoparks to reflect the growing importance of these entities. A further chapter argues the need for conserving Global Stratotype Section & Points (GSSP), further enhancing the international relevance of the volume.

The book is divided into five main sections. *Part I What is Geodiversity* defines the subject matter and looks at geodiversity at global and local scales. *Part II Values and Threats* places geodiversity in the wider context of the currently fashionable 'ecosystem services' approach, and examines threats ranging from graffiti to mineral extraction – illustrating them with some informative case studies from all over the world. Furthermore, the 'ecosystem services' concept serves as a useful paradigm to engage politicians and decision makers about the relevance of geodiversity and geoconservation wherever they are. The international outlook is reinforced in *Part III Geoconservation: the 'Protected Area' Approach*. In *Part IV Geoconservation: the 'Wider Landscape' Approach*, the author delves into the relevance of geodiversity and geoconservation in land-use planning and policy development. *Part V Putting It All Together*, provides an overview of the benefits of holistic conservation programmes, comparing geodiversity and biodiversity and demonstrating how they can be integrated.

This is an extremely engaging, informative and thought-provoking book. Painstakingly compiled and drawing on examples from all over the world, it is a MUST for all practising geoconservationists and environmental decision makers! Well-illustrated with diagrams and photographs (some colour), the book also contains an extensive bibliography. The most comprehensive guide to our subject has just got better!

The edition is also available as an e-book and there is a companion website with additional resources: www.wiley.com/go/gray/geodiversityabioticnature

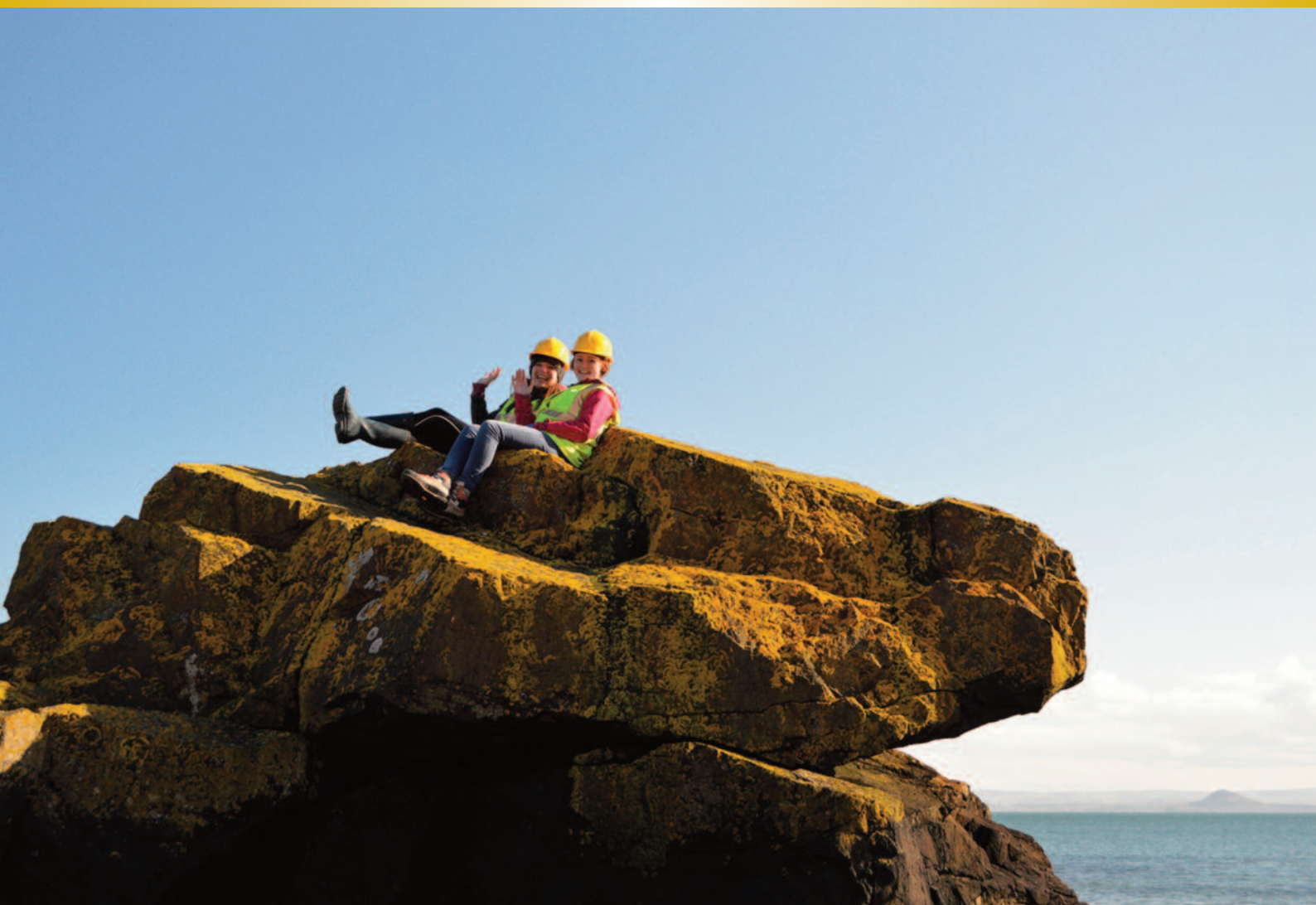
Stewart Campbell
Natural Resources Wales



Earth Heritage magazine promotes geological and landscape conservation.

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or order a printed version – see page 3.



Two school students make the most of an impromptu rock seat during a field trip to St Monans, part of the Scotland Rocks 2014 event. See page 9.

Photo by Simon Cuthbert

