Earth heritage

The geological and landscape conservation magazine

Geodiversity – it's everywhere!

Changes and reviews at country agencies

ISSUE 41
Spring 2014

Earth Heritage is back in print

Geopark progress in the UK

INSIDE

COVER

The geologically and geomorphologically rich Snowdonian landscape. Geodiversity underpins many aspects of this classic North Wales scenery. Have your say on how geodiversity is to be treated under new Welsh legislation – see page 4.
Photo by Stewart Campbell

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Earth heritage

Earth Heritage is produced twice-yearly by Natural England, Scottish Natural Heritage, Natural Resources Wales and the Geologists' Association for download in pdf format from www.earthheritage.org.uk. We would like to thank all those who have assisted in preparing the publication, including many in the voluntary geoconservation sector who are major contributors. The opinions expressed by the contributors are not necessarily those of the above organisations. This and back issues of *Earth Heritage* can be downloaded as pdf files from www.earthheritage.org.uk

EDITORIAL

Choose how you read us

Welcome to edition 41 of *Earth Heritage*. You can download it free, together with back issues, as pdf files at any time by visiting www.earthheritage.org.uk

Now though, in response to a steady flow of requests, we are also pleased to announce that you will be able to buy a full-colour, laser-printed hard copy of any of the issues on our website (*see page 3*). We are grateful to the Geologists' Association for facilitating this very positive development. The on-demand print option will be available very shortly by following the links from our website.

This issue once again illustrates the sterling work of geoconservationists across the country. Increasingly, geoconservation is about the natural integration of geodiversity and geoconservation with other heritage assets such as biodiversity and archaeology and several of our articles focus on this aspect of work.

It is especially heartening to read about the progress being made by the UK's geoparks and, in particular, the recognition (and vital funding) that has come from the Scottish Government for the Shetland and North West Highlands geoparks. It is also immensely encouraging that Natural England will be appointing a director and directorate for Landscape and Geology. Hopefully, this will have a knock-on effect at other influential organisations in raising the profile and importance of geodiversity and supporting and funding vital geoconservation activities across the UK.

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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Earth Heritage is back in print

We are delighted to say that *Earth Heritage* is once more to be available as a printed publication. Readers who want this publication as a full-colour, laser-printed hard copy can order it shortly via the *Earth Heritage* website, www.earthheritage.org.uk. Clicking on the Print link there will take you to the ordering and payment facility provided by the Geologists' Association.

***Issue 41* 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 small discount for GA members. The price payable covers cost of production, payment processing and delivery and any small surplus from your payment will go to the GA, a voluntary organisation, to further its work in promoting interest in and knowledge of geology and providing educational information about geological conservation.**

Ever since *Earth Heritage* went online only a little over two years ago, with *Issue 36*, we have received a steady stream of requests to continue to make hard copy printed versions available as well.

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.**

Natural England 'refreshed'

From April 2014, Natural England will make changes to ensure that it is best placed to bring about a natural environment which is healthy, functioning and resilient and which provides a foundation for sustainable growth and prospering communities.

Changes in political, economic and social circumstances, new thinking on ecological connectivity, the recent Triennial Review of Natural England and the Environment Agency and Natural England's desire to deliver more effectively in partnership and at a local level have led to what is being termed a 'refresh' of how work is organised and delivered.

The statutory purpose of Natural England around biodiversity, geodiversity, landscape and access will be more visible in the presentation of priorities and in the way that the organisation is structured. There will be, for example, a director and directorate for Landscape and Geology, the first time in Natural England that there has been a director with 'geology' in their role title. Also, and very importantly for geoconservation groups operating on the ground, there will be enhanced local teams probably covering 2-3 counties, and with some flexibility and resources to address local priorities. The building of strong relationships between these new teams and local geoconservation groups should lead to new partnerships, enhanced delivery and benefits for all parties.

Some of the expected changes and the opportunities that it is hoped they will lead to, were set out by Natural England's Directors Jim Smyllie and Maddy Jago at the November meeting of the English Geodiversity Forum. The planned changes, especially the enhanced profile for geodiversity and the new opportunities for local partnerships, were widely welcomed by the Forum. There is much to be done by Natural England and its partners to maximise the benefits from the 'refreshed' organisation but all those at the Forum meeting were very keen to help make it happen.

Colin Prosser, Natural England

Natural resources and the environment in Wales: HAVE YOUR SAY!

A classic North Wales landscape looking south from Mynydd Llandegai with Snowdon in the far distance. Geodiversity dominates almost every aspect of the scene – from the slate tips and quarrying, to land-use and settlement patterns, to the spectacular glaciated terrain which forms the foundation of the all-important tourist industry. Throw in the Dinorwig HEP pump storage scheme, which has its upper storage lake, Marchlyn Mawr, just out of picture to the left, and it's not difficult to see why geodiversity is so important to our lives. Both the Environment Bill for Wales and the NRW Corporate Plan consultations provide a rare opportunity for everyone, but especially geoconservationists, to have their say and to influence the shape of things to come!

Photo by Stewart Campbell

The Welsh Government and Natural Resources Wales are consulting on two key documents which will shape how the environment of Wales is managed. The Environment Bill White Paper and NRW's Corporate Plan consultations provide an opportunity for the geo-community to highlight the importance of geodiversity and geoconservation to the environment. Opportunities to influence legislation and shape an organisation's priorities are rare, so get involved and have your say!

Environment Bill for Wales

In October the Natural Resources Minister Alun Davies announced the publication of the Environment Bill White Paper. The paper sets out how Welsh Government intends to develop a legislative framework that will enable a joined-up approach to managing the natural resources of Wales while delivering lasting economic, social and environmental benefits. There are four key themes to the White Paper:

Theme 1 looks at joining-up the existing statutory frameworks for natural resource planning and management in Wales.

Theme 2 considers proposals to ensure Natural Resources Wales has the right legislative tools to implement a joined-up approach to natural resource management.

Theme 3 sets out actions to ensure Wales' natural resources are used to best effect and to reduce waste.

Theme 4 sets out proposals to simplify, streamline and clarify the law for a number of existing environmental regulatory regimes.

The principles of the ecosystems approach are at the heart of the bill and a key part of the legislation will be a definition of 'natural resources'.

The Environment Bill White Paper consultation runs until 15 January 2014. Access the White Paper and supporting documentation on the Welsh Government website: **http://wales.gov.uk/consultations/environmentandcountryside/environment-bill-white-paper/?skip=1&lang=en**

Raymond Roberts, Natural Resources Wales

Natural Resources Wales Corporate Plan

Central to the delivery of an Environment Bill will be Natural Resources Wales which is currently gathering views on its corporate plan. This will set out NRW's strategic direction for the next three years and is another opportunity to ensure that the key role of geodiversity in all our lives is taken fully into account. Express your views!

The NRW Corporate Plan consultation will run until 10 January 2014. You can access the consultation document on the NRW website: **http://naturalresourceswales.gov.uk/our-work/consultations/list-of-current-consultations/planning-our-future-a-consultation/?lang=en#.UpW3BJgrOM8**

Raymond Roberts, Natural Resources Wales

The 2013 Annual General Meeting of the Geological Society of Glasgow started with the signing of the Scottish Geodiversity Charter on behalf of the University of Glasgow by Professor John Briggs, Vice Chancellor, Clerk of Senate and Professor of Geography (left). Dr Angus Miller, as Chair signed on behalf of the Scottish Geodiversity Forum. The event was hosted by Miss Margaret Donnelly, Vice President of the Geological Society of Glasgow. Also present was Dr Beverly Bergman, secretary of the Edinburgh Geological Society (right).

Photo by Hugh Leishman

Scotland geodiversity charter update

The Scottish Natural Heritage *Sharing Good Practice* event in December, which also doubled as the Scottish Geodiversity Forum annual conference, proved ideal to find what progress has been made under Scotland's Geodiversity Charter and what else could be done to drive the Charter forward.

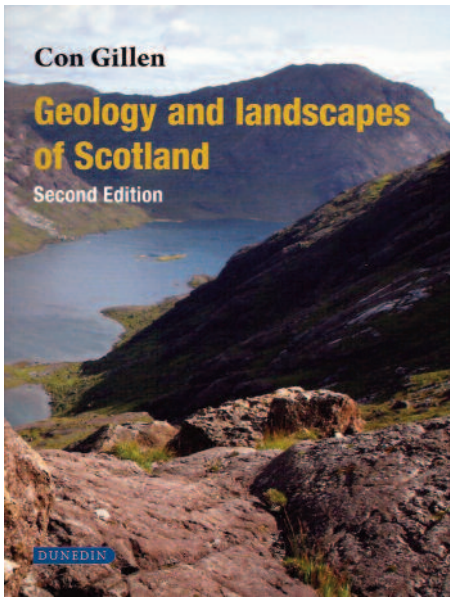
Launched in June 2012 by the Scottish Geodiversity Forum, the Charter sets out a vision that Scotland's geodiversity is recognised as an integral and vital part of our environment, economy, heritage and future sustainable development, to be safeguarded and managed appropriately for this and future generations.

A good number of Charter signatories, local authority representatives, geodiversity promoters and conservationists attended the occasion, which included a keynote address from Professor Iain Stewart.

Following the keynote address there was a group exercise that got participants thinking about the opportunities that geodiversity presents, in the spirit of the Charter, for education, tourism, biodiversity and the economy at several scenario locations: an historic castle, iconic mountain, a stone quarry and an already well developed coastal area. A series of workshops then focussed on: Local Authority audits and action plans; the benefits of considering coastal geodiversity; landscape-scale interpretation; the challenges of maintaining fresh and accessible rock faces; and opportunities to promote the links between biodiversity and geodiversity.

The Autumn 2013 update on progress with implementing the Charter is available at **http://scottishgeodiversityforum.files.wordpress.com/2011/12/charternewsletter2013lowres.pdf**

Colin MacFadyen, Scottish Natural Heritage



Understanding origins of the land

Geology and landscapes of Scotland
by Con Gillen [Paperback and Kindle version] Dunedin Academic Press, Edinburgh.
ISBN-10: 1780460090 ; ISBN-13: 978-1780460093. 2nd edition.
246 pages. £24.99.

In Scotland, the 600 miles between the northernmost Shetland island and the Mull of Galloway in the south contain some of the most interesting geology and most varied landscapes in Europe. This variety was the inspiration for a tradition of geological investigation that stretches back to the earliest Earth scientists.

The origins of the Scotland that is known today lie in five quite distinct geological regions. This book takes the reader on a tour of each of these regions in turn, starting with the Northwest Highlands and Outer Hebrides, which contain some of the oldest rocks in Europe, through the mountain terrains of the Highlands and Uplands to the Lowlands, and then the fringes of the North Sea. One section describes the volcanic provinces of Scotland, another deals with the effects of the Ice Ages, while a final section looks at Scotland's natural resources.

The book will appeal to the professional geologist seeking a broad overview of a much-studied terrain. It will also be a resource for the resident, visitor, walker, climber or angler who wants to understand the origins of the landforms they observe. Now in its second edition, *Geology and landscapes of Scotland* has proved a reliable guide and has been thoroughly revised with the many illustrations presented in full colour. Further reading sections, an extensive glossary and indexes for subject and place-names complete the book.

£21m HLF grant to help conserve precious landscapes

Limestone pavement near Ingleborough in the Yorkshire Dales, one of the nine distinctive landscapes to receive Heritage Lottery Fund grant support.

Photo by Childzy, CC-BY-SA-3.0

The Heritage Lottery Fund (HLF) has announced grants totalling £21m to conserve nine distinctive landscapes. This investment will ensure a boost for rural areas and provide long-term social, economic and environmental benefits.

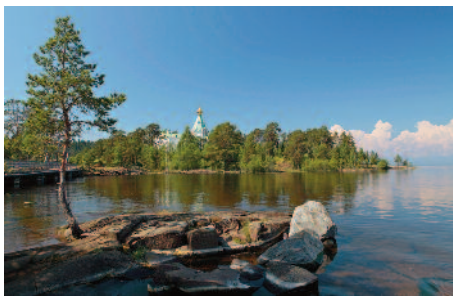
The landscapes are:

- Coigach and Assynt, a beautiful and remote part of north-west Scotland
- New Forest, extensive ancient woodland and heathland with a strong surrounding community
- Humberhead Levels spanning Yorkshire and Lincolnshire, a rare internationally important wetland landscape characterised by significant remains of medieval strip farming and famous for its peatlands
- Ingleborough Dales, a limestone landscape in the Craven district of the Yorkshire Dales National Park
- North York Moors, home of the pioneering ironstone industry and early railways
- Lough Neagh in Northern Ireland, the largest freshwater lake in the British Isles
- Rusland Valley and Fells, in the South Lake District National Park with a strong link to the traditional coppicing industry
- Derwent Valley, a coalfield area in north-east England aiming to harness the potential of its industrial heritage for positive change and tourism
- East Wight, the eastern tip of the Isle of Wight and an Area of Outstanding Natural Beauty

HLF's Landscape Partnerships (LPs) are helping bring together individuals with local, regional, and national organisations to deliver schemes that benefit some of the UK's most outstanding landscapes and rural communities. Grants range from £100,000 to £3m. The next closing date for LP applications is May 2014 for decisions in October 2014.

Find out more about the grant scheme at
www.hlf.org.uk/HowToApply/programmes/Pages/landscapepartnerships.aspx
And more about the successful projects at
www.hlf.org.uk/news/Pages/ninepreciouslandscapes.aspx

Hannah Townley, Natural England



The 14th Century orthodox monastery on the Island of Valaam, Lake Ladoga, Republic of Karelia, Russia. The Valaam Archipelago is a nature park illustrating exposures of Late Proterozoic magmatic rocks mainly represented by gabbro-dolerites, as well as skerries and other traces of the last continental glaciation such as numerous erratics and polished rock surfaces.

Photo by Vladimir Gorbatovsky

ProGEO's European goal

ProGEO
The European Association for the Conservation of the Geological Heritage

ProGEO is an open association working to promote the protection of Europe's geoheritage. Our knowledge of Earth – the landscapes around us, volcanic activity and the building of mountains, the evolution of life, the ascent of Man, and the creation of all the mineral resources on which our culture depends – is based on an understanding of essential rock and landform localities. It is vital that this inheritance can be conserved.

ProGEO intends to give geoconservation a stronger voice in Europe and to act as a forum for the discussion of issues, advising and influencing policy makers. ProGEO has contributed substantially to the Pan European Biological and Landscape Diversity Strategy, is a member of IUCN where we forward geoconservation as a part of nature conservation and an affiliated member of the Union of Geological Sciences (IUGS).

ProGEO issues the scientific journal *GEOHERITAGE* (Springer Verlag) and the newsletter *ProGEO NEWS*, which is published four times a year. ProGEO has recently published *Geoheritage in Europe and its Conservation*, which documents geoconservation activity in 37 countries. For further information visit **www.progeo.se**.

Lars Erikstad, Norwegian Institute for Nature Research

Geology vital in National Character Area profiles

'Bomb Rocks', Charnwood Lodge Site of Special Scientific Interest and National Nature Reserve, one of the important geological sites within the Charnwood Natural Character Area.
Photo by Natural England/Paul Glendell

In April 2013, Natural England published the first revised National Character Area (NCA) profile describing the landscape of the Southern Pennines in terms of its geodiversity, biodiversity, cultural and economic activity and its ecosystem services. We now have 100 published profiles on our website as well as short documents outlining the key facts and data of the remaining NCAs making a total of 159. We aim to complete this ambitious programme by Spring 2014.

National Character Areas follow natural boundaries rather than political ones and usefully for geologists, these tend to be where there are marked changes in geology and /or landscape character, often along a geological formation. An obvious example is the Chalk wolds and downs, divided into 12 different NCAs across the country. Magnesian Limestone is covered by two NCAs and there are three for the larger areas underlain by Coal Measures. Sometimes the changes can be subtle, which is why hard boundary lines aren't always useful and should not always be treated as such but as the best fit.

Each profile provides a description that includes the NCA's key characteristics of landform, topography, habitats, settlement pattern and historic interest. We briefly describe the area's geodiversity and in the 'Landscape through time' section pick up on the NCA's geological and recent Quaternary history and its soils. 'Key facts and data' and 'Analysis' sections provide more detail about land form and process, bedrock geology and superficial deposits, designated geological sites, soils and agricultural land classification, the use of building stone from local sources and built vernacular, water bodies and catchments.

A real improvement from the former NCA descriptions, now over 15 years old, is a description of the key ecosystem services that each NCA contributes to our lives – the natural goods and services like food production, water availability, the regulation of soil and water quality and soil erosion, and the contribution of biodiversity and geodiversity to cultural pursuits like recreation. Combining this knowledge with what we know of the current state of each NCA's environmental assets, we suggest a number of 'Statements of Environmental Opportunity' that if taken can make a positive difference to the natural environment and its use. We outline ways to take these opportunities.

Active quarrying within the Isle of Portland Natural Character Area. The distinctive and decorative stone quarried here is used locally and farther afield in new buildings and to repair historic buildings.
Photo by Colin Prosser

All this information is there to help us better understand and make informed decisions about what we can do locally as individuals or in partnership with, for example, land owners and managers, local authorities, public and voluntary sector bodies and conservation groups. Early feedback has been very positive. The new NCAs are already being used to inform management plans for our protected landscapes, in planning applications and environmental impact assessments, to underpin landscape character assessments, and support project bids to sources such as Heritage Lottery Fund.

Two NCAs that are particularly rich in geodiversity interest are 73 Charnwood and 137 Isle of Portland: **www.naturalengland.org.uk/publications/nca/default.aspx**

Lucy Heath, Natural England

Roadworks present opportunities

Key exposure in a roadside cutting on the A9 north of Bruar in Glen Garry that will be affected by dualling of the road. Tayside Geodiversity in partnership with Scottish Natural Heritage hope to ensure features in existing cuttings are improved and maintained (such as the fold structures shown here) and to secure the establishment of new safe and accessible exposures within any new cuttings.

Photo by Colin MacFadyen/Scottish Natural Heritage

An estimated £3 billion project on Scotland's longest trunk road, the A9, offers many opportunities to enhance existing rock exposures, create new ones and set up viewpoints for landscape features. The Transport Scotland plan to upgrade the 113 mile stretch between Perth and Inverness to dual carriageway by 2025 will affect existing roadside Sites of Special Scientific Interest (SSSI) as well as an un-notified and as yet unprotected Geological Conservation Review (GCR) site. New road cuts in the Highland Border area at the Pass of Birnam are likely to provide good new sections.

Members of Tayside Geodiversity have attended public exhibitions on the A9 dualling project, and met Scottish Natural Heritage staff on site to discuss the likely effect on the cuttings in SSSI at Glen Garry. We want to secure clean, safe, stable and accessible rock faces free of wire mesh and avoid over-enthusiastic landscaping along the route. In addition, we hope that laybys can be sited close to educationally important rock exposures where possible. There may even be scope for interpretation in the form of a geodiversity trail from Perth to Inverness, with localities demonstrating the geological history of the Grampian Highlands and the glacial features of the area.

Tayside Geodiversity is a voluntary group of professional and amateur geoscientists who are interested in making the geology and landscape of the region better known. The group aims to produce leaflets and information boards about local geology and geomorphology sites and to protect and improve these sites. For further information please visit www.taysidegeo.org.uk.

Carol Pudsey, Tayside Geodiversity

Join us for RIGS in SE Wales

Fan Dringarth landslide in the Brecon Beacons has been interpreted as a translational slide that occurred after the Dimlington Stadial, but before the Holocene, possibly due to post-glacial slope instability. The feature is roughly 1km long and has occurred entirely within rocks of the Devonian Brownstones Formation.
Photo by Dilys Harlow

The South East Wales RIGS Group is happy to announce that it now exists and is looking for more members!

An audit of potential RIGS (Regionally Important Geodiversity Sites) took place across south-east Wales between 2008 and 2012, funded by the Aggregates Levy Sustainability Fund and administered by the Welsh Government. From this, a strong network of RIGS and potential SINCs (Sites of Importance for Nature Conservation) has been drawn up, and lodged with the planning authorities. RIGS were selected for their educational, scientific and historical significance and aesthetic qualities in the landscape. They range from large ex-industrial sites such as Big Pit at Blaenavon, to small features such as Pontnewynydd Risings in Torfaen.

Following the audit, the RIGS Group has been formed to advance the preservation and conservation of these sites, and to advance public awareness of Earth sciences. It consists of the volunteers who assisted in the audit, but we are looking to recruit new members who are interested in the region's geology and activities to conserve and enhance sites. The next meeting of the group will be in March 2014 and new members are very welcome. Please contact **southeastwalesrigs@gmail.com** for further details.

Christina Byrne, Natural Resources Wales

Mandela's quarry links cultural and natural heritage

Mandela's Quarry, with 'caves' that acted as secret gathering places. In the foreground is the pile of stones deposited by more than 1,000 prisoners who returned to visit the island in 1995.

Photo by Colin Prosser

The death of former South African president Nelson Mandela has led many people across the world to reflect on what was a truly inspirational life. Mandela showed how it is possible to succeed against the odds and to triumph over adversity.

An undoubted low point for Mandela was his 18 years of imprisonment on Robben Island, off Cape Town. Even this unforgiving prison island has become a positive influence. It has been opened up for education and tourism and was inscribed as Robben Island World Heritage Site in 1999.

Lime or 'Mandela's' Quarry is cut into fossilised shell-bearing sand dunes of Pleistocene age, with a clearly visible calcrete (calcareous soil) formed above. It was here that political prisoners, including Nelson Mandela, were forced to work between the 1960s and the 1980s. Using just picks and spades, the limestone was extracted and mixed with crushed shells and used to pave the roads on Robben Island.

Working in the quarry often resulted in blindness due to the harsh glare from the rock, as prisoners were not allowed sunglasses. Respiratory problems were caused by the fine lime dust. Despite these hardships, the quarry provided opportunities for communication and comradeship between prisoners who were otherwise isolated from one another.

'Caves' cut into the quarry faces by the prisoners were used during the working day both as toilets and as secret gathering places, and are regarded by some as the unofficial birthplace of the South African constitution. The pile of stones in the foreground of the accompanying photograph dates from 1995, when more than 1,000 former political prisoners returned to visit the Island. As a memorial to their years of struggle and hardship, the men, led by Mandela, each picked up a stone and placed it in the pile.

Whilst many of us will be familiar with quarries being conserved on account of their geological, industrial, archaeological or biological importance, Lime or 'Mandela's' Quarry is unique in being officially recognized and conserved because of its importance in symbolising 'the triumph of the human spirit, freedom and democracy'.

Colin Prosser, Natural England

Further Reading

Prosser, C. 2007. *Mandela's Quarry*. Geology Today, 23 (4), 127-128.

New voyage to track Hugh Miller's 1844 journey?

Eigg, one of the four 'Small Isles' of the Inner Hebrides. During his visit to the island on The Betsey, Hugh Miller made an important contribution to Scottish palaeontology with his discovery of plesiosaur remains.

Photo by Colin MacFadyen

The Friends of Hugh Miller and the Royal Scottish Geographical Society are investigating the possibility of chartering a traditional sailing boat in September 2014, to follow the journey of discovery taken by Scottish Geologist and writer, Hugh Miller, on the Betsey in 1844. Built in 1892, the sailing boat *Leader* sleeps 19 people including four crew. The idea is to recruit an inter-generational mix of geologists, geographers, artists, writers, ecologists, storytellers and historians (including Gaelic speakers), which will reflect Hugh Miller's remarkable ability to think across disciplines.

Geology, landscape, people and story will be at the heart of the journey which would begin in Oban. Public events would be planned at a number of localities on the route. For further information contact joyce.gilbert@rsgs.org

Joyce Gilbert, Royal Scottish Geographical Society

Maintaining the pressure for geology within Scottish education

Work is continuing on the campaign reported in *Issue 40* of *Earth Heritage* to ensure geology features in Scottish education. A group comprising Stuart Monro (Our Dynamic Earth), Ruth Robinson (University of St Andrews), and Joyce Gilbert (RSGS) met Minister of Science Alasdair Allan MSP, along with representatives from SQA, the Learning Directorate, Education Scotland, and Annabelle Ewing MSP.

Scotland Science Minister Alasdair Allan MSP has offered to ensure there is a robust place for Earth Science in the curriculum.

Photo – Open Scottish Parliament Licence v1.0

We had previously circulated our request for a new Higher in Earth Science, a great opportunity to do something innovative that builds on knowledge and skills from the 5th year sets of Highers. We argued that there was insufficient coverage of geology in other courses, and we questioned why a subject that is so important to the economy, jobs and our understanding of the planet didn't have a higher priority. Dr Allan took our comments on board but said he would not be in a position to respond until after the summer recess.

In August 2013 both the *Glasgow Herald* and the *Times Educational Supplement Scotland* independently published articles questioning the decision to axe Higher Geology following release of exams results which showed that numbers of candidates this year had risen substantially.

We received a response from Dr Allan at the beginning of November which failed to address most of the key points raised, but did offer to 'ensure that there is a robust place for Earth science in the curriculum'. We have since started to work with Education Scotland to begin to look at ways of improving the Earth science content of other subject areas in the senior phase, and to review opportunities for progression throughout primary and secondary. While we view this as a very positive step, we are making it clear that our position on the need for a new Higher in Earth Science has not changed.

Joyce Gilbert, Royal Scottish Geographical Society

Curry Fund boosts museums' collections

Christopher Green
Geologists' Association

When the Curry Fund of the Geologists' Association was established in 1986, its main objective was to support geological conservation and geological publication – interests with which the GA has a long involvement.

The Curry Fund has made 184 grants totalling £215,000 to a range of conservation bodies. Nearly a quarter were made to preserve and interpret the geological record in the landscape, helping groups to acquire and maintain sites and provide on-site interpretation of the geology. However, a larger part of Curry Fund support, £109,000, has gone towards supporting geological collections in museums.

The fossil pliosaur and model skull at Dorchester Museum give visitors a dramatic insight into what these creatures were like.

Below, the Fund helped pay for this display about Horn Park National Nature Reserve, near Beaminster, Dorset.

Photos by Susan Brown

Grants have been made to more than 50 museums, from Cornwall to Tyne and Wear, and to museum-related organisations. Curry Fund support has been welcomed by the National Museums of Scotland and Wales; by small local museums such as the Cowper & Newton Museum at Olney; by specialist museums such as the Bath Stone Quarry Museum and the Yorkshire Dales Railway Museum; and by local authority-managed museums which have felt a growing need to seek outside support.

One of Curry Fund's first grants, made in 1987, was to the Area Museum Service for South Eastern England (AMSSEE) to fund a peripatetic curator to examine, curate and report on the geological collections within the area's museums. Several similar grants to county museum services and individual museums have enabled them to engage temporary staff to evaluate geological collections. The Horniman Museum, Saffron Walden, Scarborough and Norwich are among such recipients.

Conservation of geological specimens can be costly and the Curry Fund has helped on several occasions, usually with the remains of large Jurassic vertebrates – at Peterborough, a pliosaur and a pachycostasaurus; at Dorchester an ichthyosaur; plesiosaurs at Taunton, Leicester, and at Bristol another pliosaur. Sometimes funding has helped to buy specimens – minerals at the Royal Cornwall Museum and £10,000 to the National Museum of Scotland for the reptile-like amphibian *Westlothiana lizziae*, popularly known as 'Lizzie'. At the time, in 1990, this was the largest grant the Fund had made – and not without some serious heart-searching about the commercialisation of fossil collecting. The Fund has also supported museums undertaking geological archive conservation – including the important Geikie archive at Hazlemere and the Pengelly archive at Torquay, as well as the GA's own photographic archive.

To make the most of specimens, they need to be displayed attractively and the Fund has supported the purchase of display facilities at many museums. Birmingham acquired a particularly interesting item – the cabinet in which Matthew Boulton had kept his geological collection. More usually, funding has gone towards gallery refurbishment, most recently at Beaminster Museum in Dorset; or towards the display of significant specimens, such as the Hippopotamus skeleton (from the Last Interglacial site at Barrington) in the Sedgwick

continued overleaf

from previous page

Museum, or the collection of puddingstone in Hertford. At Dorchester Museum, the Fund supported the modelling of a Pliosaur head to give visitors a better insight into the fossil remains of these creatures. And at Lyme Regis support was provided for a project in which the public could help model a three-dimensional version of the famous water-colour by De la Beche *Duria Antiquior*, depicting life in ancient Dorset. Elsewhere, the Curry Fund has helped museums introduce interactive computers, and has funded equipment such as microscopes and storage facilities.

As the examples above demonstrate, the Curry Fund has a wide-ranging commitment to museums, especially where funding encourages innovative approaches to geology, or helps its understanding and enjoyment by a wider public.

Looking out onto a lost world

Looking east from my office window, along the Jurassic Coast past Golden Cap and on to West Bay and Portland, I'm aware that my perspective is not too different from that captured in 1830 in *Duria Antiquior*, Henry De La Beche's first visualisation of a lost world. I'm also aware that I have probably the best view from any museum office in England!

Of course, *Duria Antiquior* is very important to Lyme Regis. The work, inspired by Mary Anning's discoveries, was painted here and captures what De La Beche envisaged that Jurassic Dorset might have looked like. We are very lucky that with the kind support of Tom Sharpe at the National Museum of Wales we have on occasions been able to display the original artwork here in Lyme. *Duria Antiquior* has been described as the first work of palaeo-art, but I think it is much more than that: it is the 'Jurassic Park' of its day; the digitally created prehistoric creatures who constantly grace our cinema, television and computer screens can all be traced back to De La Beche's wonderful creation.

A section of the model made at Lyme Regis Museum (above) is a vivid reconstruction of the De La Beche original painting of 1830 (below), now housed in the National Museum of Wales in Cardiff.

Photo above by David Tucker

But how do we capture this wonderful illustration and bring its importance home to a wider audience? Lyme Regis Museum was generously funded by the Geologists' Association to enlist local and visiting families, under the guidance of Jurassic Coast artist Darrell Wakelam, to help create a three-dimensional model of the work. For three days Darrell and his drop-in artists laboured in Lyme to create vibrant, three-dimensional models of the marine reptiles featured in the original painting. This was then put on display in the Museum. The model included the large ichthyosaur launching its fatal attack on a plesiosaur. It also included a fair amount of three-dimensional reptile poo on the first step of its journey to becoming coprolite!

The creation was a tremendous success and was only re-homed when the museum acquired its own large fossilised ichthyosaur skull earlier this year. The model has been transferred to St Michael's First School in Lyme Regis where the children can marvel at the creatures that sleep fossilised within our rocks and can giggle at the shocking sight of papier-mâché poo hanging from the classroom ceiling.

Lyme Regis Museum is very grateful to the Geologists' Association for the funding provided for this entertaining and engaging piece of work.

– David Tucker

Bird's-eye views are all about resolution

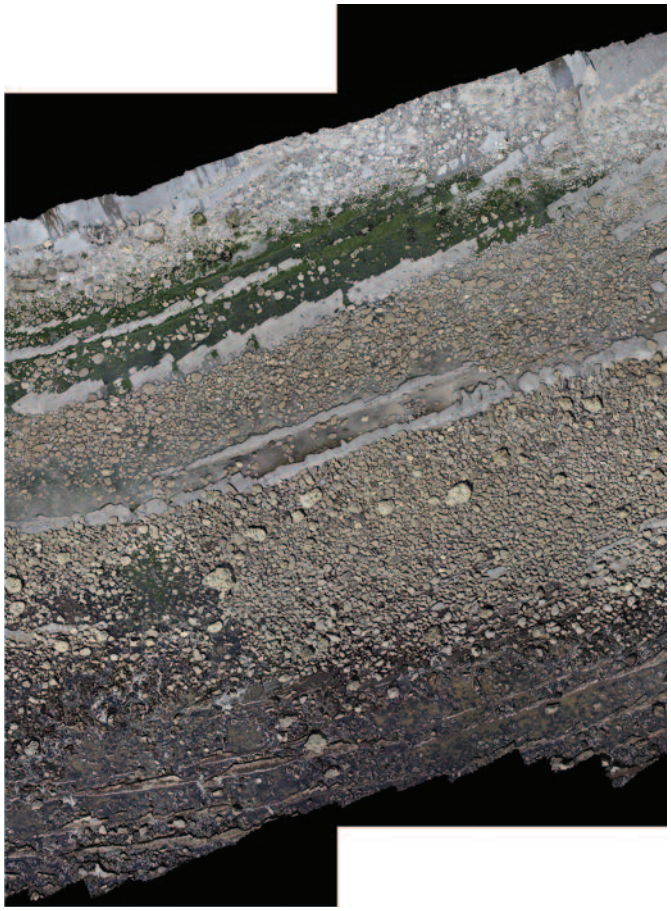
Richard Edmonds,
Jurassic Coast World Heritage Site Team

Surveys and mapping have traditionally relied on OS maps or detailed site surveys utilising, for example, GIS or transects or boxes to sample across or within a habitat. Today aerial LiDAR (Light Detection And Ranging) surveys and photography are increasingly used to map difficult-to-access habitats such as salt marsh. Some of these are integrated into other monitoring projects, such as the Defra-funded National Strategic Coastal Monitoring Programmes. Better still, all these data are open source and freely available at www.channelcoast.org. Aerial photography and LiDAR, sea-bed bathymetry, wave-rider buoys, tidal gauges, post storm surveys; it is all there and the longer it runs the more valuable the data will become.

But what if the subject is small or spread over a big area, or both? The latest photography from the Plymouth and Channel Coast observatories is very high resolution: each pixel covers 12cm of ground. But what if you wanted to map a really complex foreshore where the outcrops of interest are less than 1m long, spread over a kilometre of beach, or where jointing patterns and break-up of foreshore ledges require millimetric resolution? These were the challenges identified by the Jurassic Coast Team on the foreshore of Axmouth to Lyme Regis Undercliffs National Nature Reserve – and two UAV (Unmanned Aerial Vehicle) surveys, sponsored by Natural England, enabled maps to be made.

A shot taken from the UAV over the foreshore in front of the Plateau landslide with 'The Slabs' outcrop in the foreground. Lyme Regis lies beyond the distant headland to the east.

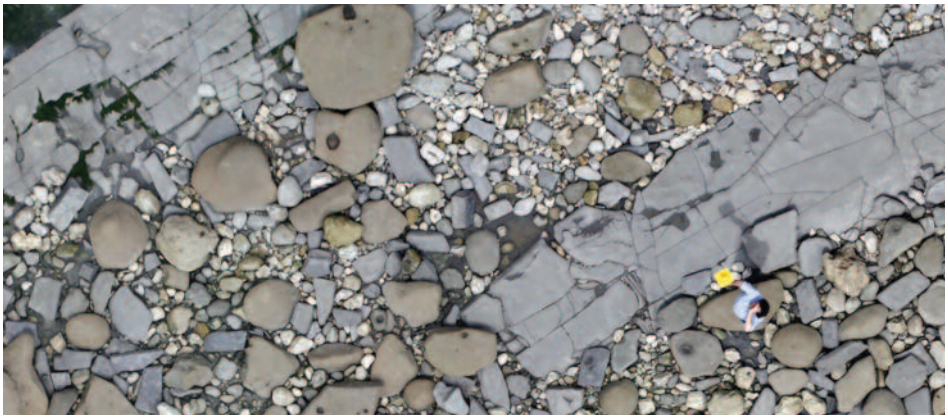
A sample of the UAV photomontage. The area in the image is approximately 20m wide by 60m high at a resolution of about 12mm. The images were shot as RAW files and processed in Photosynth software.



Monmouth Beach, Lyme Regis; bulging and breaking ledges

Years of casual observation led to a feeling that 'something was going on' and this culminated in a spectacular break-up of a 'solid' wave-cut platform. The middle of the ledge literally burst open during calm, hot weather in the first two weeks of July 2011. A similar but smaller event had been observed in the summer of 2010 and another must have taken place in 2007. In addition, some joints appeared to be under great stress, with spalling or flaking taking place along their edges. Paradoxically, other joints were pulling apart. In one area, an old stone quarry railway constructed in 1888, straddled a tight fault but the concrete blocks had been uplifted on both sides of what should have been an ancient and static tectonic feature. What was going on?

To try to answer that question, a UAV survey, flown in May 2012 along a 300m section of the middle and upper foreshore at an altitude of about 40m, generated a photomontage at 12mm resolution. This was georectified so that it could fit within a GIS system or be compared with OS mapping. Three other flights at just 8m altitude generated photomontages at 2mm resolution to study the development of small joint systems and record features such as the iconic ammonite pavement that was starting to break up. The aim was to generate a baseline against which future change could be mapped and to see how jointing might be controlling that change. However, in the extreme wet weather of 2012/13, very little changed and then a massive landslide covered most of the study area. This was a real frustration as the hot summer of 2013 would have been ideal to determine whether thermal stress was a contributor to pavement break-up. However, the survey is in the bag and will, hopefully, one day help to answer this puzzle. *continued overleaf*



Close-up sample of the photomontage on the previous page at screen resolution but not full image resolution. From this it is possible to identify rocks and features down to about 10cm in diameter.

Photos courtesy Jurassic Coast WHS Team

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Mapping the Plateau landslide

The second study was carried out in the spring of 2013 with the objective of generating a detailed montage in order to map a hugely complex foreshore deep within the Axmouth to Lyme Regis Undercliffs National Nature Reserve. The Plateau is a prehistoric rotational landslide involving Chalk and Upper Greensand lying unconformably above Lower Jurassic and late Triassic clays and limestones. Over millennia the sea has eroded a cross-section through this massive landslide complex, affording a view of the inside of the slip, including unique evidence of how that slip may have failed. The challenge here was scale; more than 1km of foreshore up to 80m wide, tidal and remote from vehicular access. High-resolution data were required in order to map the features of interest which extended from the low spring tide through to the base of the cliffs and ranged in size from structures greater than 10m through to small, incomplete outcrops of rock running through the boulder-strewn foreshore. Mapping all of these features enables a wider view of the structure of the landslide and from that an interpretation of the mechanisms that created it.

The UAV used for both surveys was a small (1.5m long) single disk, battery-powered helicopter carrying a digital SLR with a 28mm lens. The survey was carried out by Suave Aerial Photography, a Lancaster-based company. Traffic cones were set up to mark the flight lines and were set out either as two parallel lines 200m long flown out and back or one single line 400 m long used at low tide to capture as much as possible during the same state of tide.

Mapping was carried out in the field using a laptop and it proved possible to identify features and rocks as small as 10cm, but more importantly, the features of interest could be mapped exactly in the georectified photo montage. The Plymouth Coastal Observatory photography at 12cm could have been utilised, but not with such precision. The field mapping was transferred onto the Plymouth Coastal Observatory photography, which included not only the foreshore but the entire landslide complex and sea-bed bathymetry survey of 2012, something that had never been done before at such detail.

The detailed mapping allowed an interpretation of the mechanism of failure that created the landslide in the first place. The most significant finding was that the failure surface, the slip plane, was not consistent; landslides generally happen when a weak surface within the strata fails under the enormous weight of the cliff above, triggered by high water levels that lubricate that surface. Here, as there was no single failure surface, and the Lower Jurassic rocks had been bulldozed in front of the overlying Chalk and Greensand, it is proposed that these overlying blocks failed under their own weight, subsiding and displacing the rocks below. This process may also help explain other puzzling features, most notably the formation of a chasm behind the slipped blocks of both the Plateau, and possibly the nearby (and much more famous) Goat Island or Dowlands landslide of 1839. These findings will be presented as a paper to the scientific community but having a baseline survey, both here and along Monmouth Beach, will also help improve understanding of natural erosion on the sites and possibly also assist should human influences, such as irresponsible collecting, be a factor.■

Working with LiDAR

BENEFITS

- Light, portable, quick, and easy to mobilise (once flight lines are laid out)
- Relatively cheap (around £800 per day)

RESTRICTIONS

- Difficult to cover large areas; realistically probably 1km² per day maximum
- Good weather and consistent light essential

OTHER APPLICATIONS IN THE NATURAL ENVIRONMENT

- Photogrametry; to make 3D models of a surface
- Mapping large areas of habitat to a very high resolution
- Mapping vertical or near-vertical habitats that are inaccessible other than by rope access
- Mapping and monitoring beach movement
- Recording change such as a major development on a habitat (could be vertical or oblique photography)

The joy of caving – Alan Speight of Yorkshire Subterranean Society at a joint junction in the Fairy Holes Cave complex streamway.

Photo by Pete Monk

How Fairy Holes Cave retains its magic

Andrew Hinde, Natural England

Very few people have heard of Fairy Holes Cave and even fewer have ever ventured inside this astonishing Site of Special Scientific Interest (SSSI) in Weardale, County Durham. It is the longest single stream cave in Britain and shows almost perfect geological control of its development. So why has it remained so enigmatic? Shortly after the main exploration of the cave the site became a working quarry and remained off limits to cavers for the next 40 years.

This cave has a chequered past from which we can learn for future cave protection. However, the passage of time illustrates how far attitudes and practices in the extractives industries have changed; the current cave owners, Lafarge Tarmac, have worked diligently to ensure a positive future for this vulnerable SSSI.

History of Exploration

The cave was first explored by J.D. Muschamp and party in 1844, as seen by graffiti in a chamber 411m from the entrance. This was a remarkable expedition for its time using the primitive lighting available to explore a very wet stream cave with multiple deep pools and rock climbs.

Durham Caving Club carried out the main body of exploration in the 1950s and 1960s, some of the most serious undertakings in British caving during that period. Over several visits they unlocked the secrets of navigating the farther reaches of this cave and surveyed up to the current known end of the cave. This point is still several hundred metres distant from the known stream sink, so there is still more to discover. However, the combined effects of flood-prone passages with only a couple of 'safe havens' and the length of this arduous trip make any exploration a serious undertaking. The passages in Fairy Holes have a black coating of a mineral deposit which absorbs virtually all available light and adds menace to an already intense environment. ***Continued overleaf***

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Why is this cave special?

Fairy Holes Cave has developed as a single vadose streamway which follows the shallow dip within an 18m-thick band of the Great Limestone of the Alston Block. It is topped by bands of sandstone and thick layers of shale. The stream follows a system of two joints throughout its 3.2km length. It contains thick layers of coarse sands that contain degraded mineralised sediment coatings. These are deposited and re-worked by regular flood events creating deep pools at the intersection of each joint in the passage. These mineral coatings on soft mud formations have a 'pudding stone' appearance and make them resistant to flood damage and erosion. The mineral coating has preserved a band of rugose coral in the Great Limestone which otherwise would have been eroded. The nature and formation of this coral gallery standing proud of the surrounding rock is worth further study. The cave also has one of the largest biospeleology records dating back to the 1950s when a study of un-pigmented brown trout was undertaken.

Rugose coral etched out of a band of eroded sediment.
Photo by Pete Monk

What went wrong?

The cave entrance was first notified as a SSSI in 1961 although the site of the cave also had an extant planning permission to quarry limestone. Presumably, only the entrance was designated; the cave entrance was duly fenced off and preserved, whilst in line with the planning permission, 600 metres of cave passage behind the entrance were completely removed by quarrying. In 1991 the cave was re-notified as a SSSI. The boundary of the site was redrawn to include the whole of the known cave passage and removed the area of destroyed cave. Unfortunately, between 1988 and 2008, a further 80 metres of cave passage were quarried away.

What went right?

The cave runs parallel to the quarry face and because of its proximity to the face, the quarrying company funded periodic condition surveys to ensure its integrity was preserved. The quarry has been closed in recent years and the adjacent cement works site has been cleared and prepared for regeneration with plans approved for a proposed eco–village development. Collaboration between Natural England and Lafarge (now Lafarge Tarmac) resulted in a protected access to the cave being retained in the development plan.
A disused quarry is one of the most hazardous sites to the public imaginable. The health and safety requirements are much the same as for a working quarry. It is to the credit of Lafarge Tarmac that it chose the difficult option of allowing licensed access to the site for cavers. The quarrying company has spent a lot of time and money protecting the cave entrance from the danger of rock fall by installing a 20m-long steel pipe into the entrance and securing both ends with a steel gate and padlock.

The cave-opening ceremony, left to right, Andrew Hinde, Natural England; Dave Hodgson, Craven Pothole Club cave biologist; Dave Checkley, British Cave Research Association chairman; Lloyd Macinally, Lafarge.
Photo by LafargeTarmac

Lafarge Tarmac worked with the Council of Northern Caving Clubs (CNCC) and other experts to draw up a protocol for allowing licensed access for cavers. The agreement came into effect in May 2013 and is administered by CNCC. At a time Lafarge was merging with Tarmac, the company's resources and legal department were stretched. However, the company ensured the agreement succeeded and laid down a template for the future. Lafarge Tarmac takes its responsibility for the favourable condition of this SSSI very seriously and any unauthorised access to the cave would result in the access agreement being terminated. Walkers are not allowed to leave the permissive path network and enter the quarry.

The future

A cave conservation plan is in development by CNCC and scientific monitoring has begun. The secure gate on the entrance means that scientific instruments can be left *in situ* year round in safety. It is an ideal location for cave science. We hope to undertake studies of the rugose corals and examine the effects of mineralisation with help from Bristol University. It is hoped that the good relations formed between Lafarge Tarmac and Natural England at Eastgate Quarry can be replicated wherever geodiversity or geological SSSIs are under pressure. Thanks to all involved in bringing the project to fruition. ■

Further reading

Waltham, A., Lowe, D. (Editors) 2013: *Caves and Karst of the Yorkshire Dales* Volume 1

Rare rocks, rare plants and climate change

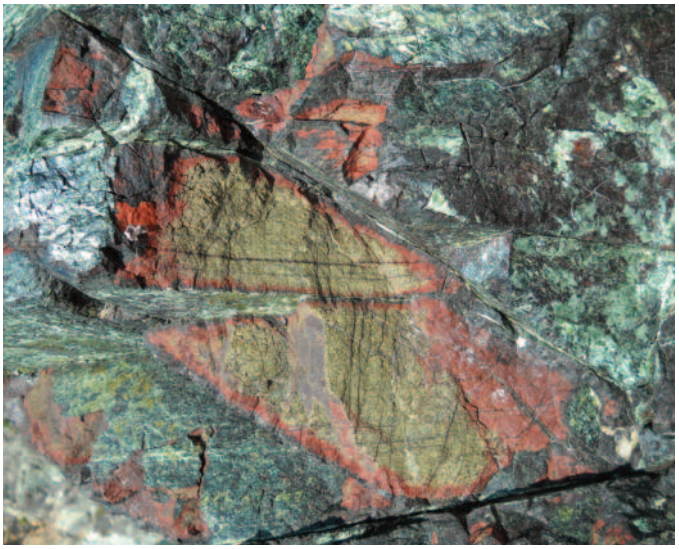
Pat Sargeant, Natural England

What links the largest area of serpentine in Britain, the rare Cornish heath and the most southerly point on the British mainland? No prizes for the answer – The Lizard, home to some of the rarest plants and rocks anywhere in the country. It's also home to The Lizard National Nature Reserve covering over 2,000 hectares of lowland heathland, spectacular coastal scenery and unique geology.

So why is The Lizard so special that it has been selected as one of the key locations for long-term monitoring, especially in relation to climate change?

Links between geology and botany

Geologists have long been attracted to the peninsula's fascinating suite of unusual metamorphic and igneous rocks, resulting in one of the most colourful geological maps in England. The original mapping by Flett and Hill in 1912, with a few minor amendments, is still in use today. However the initial interpretation of The Lizard strata as Precambrian igneous rocks has long been superseded and there is now consensus that The Lizard represents slices of ocean crust (or ophiolite) squeezed up some 360 million years ago. This massive tectonic activity brought with it sub-mantle rocks including peridotite, subsequently altered to serpentinite (or serpentine as it is always referred to on the peninsula), gabbro and basalt. At the same time the existing sedimentary and igneous rocks were metamorphosed into schists and gneisses.



A fresh exposure of serpentine, a rock characteristic of The Lizard, that encourages the growth of select plants like Cornish heath – *Erica vagans* – below.

Photos by Pat Sargeant and Steve Townsend

The lack of calcium and high amounts of magnesium in the serpentine and gabbro have encouraged a collection of plants which thrive in base-metal material. These contrast with the vegetation on the more acidic schists and gneiss. The serpentine soils also have high concentrations of heavy metals including nickel and cadmium, allowing plants like *Minuartia verna* (spring sandwort) to grow on rocky cliff-tops, in complete contrast to their more normal habitat on the lead spoil tips of the Peak District and Cumbria. In addition low nutrient content and poor drainage have made the serpentine soils far less attractive for reclamation and intensive farming. Hence large tracts of heathland are still found on The Lizard.

The peninsula has attracted botanists ever since John Ray, one of the fathers of modern botany, visited in 1667 and discovered 'Juniper or firre leaved heath (Cornish heath, *Erica vagans*) growing beside the wayside between Helstone and Lezard Point'. In all over 20 endangered plant species are to be found on the peninsula, as well as two heathland types unique to The Lizard. You have to travel across the Channel to southern France, Spain or Portugal to find anything similar, so it's no surprise that The Lizard is recognised as one of the top 10 botanical sites in Britain.

One example highlighting the very close association between biodiversity and geodiversity on the peninsula is the rare and colourful Cornish heath which is only found growing on serpentine and gabbro. However, where a veneer of acidic windblown loess prevents the plants reaching the magnesium-rich substrate, the Cornish heath instantly disappears and more acid-loving plants and heathland types take over.

Since the end of World War 2 large tracts of heathland and coastal habitats have been lost to scrub with a resultant decline in some of the rarest plants. However in recent decades all the

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conservation agencies on the peninsula have reintroduced grazing using native rare breeds wherever possible. Visitors have been treated to the company of Soay sheep, Shetland and Exmoor ponies as well as Highland cattle, all gradually munching through thickets of gorse, bracken and blackthorn. Botanists have been delighted to see rare plants return to classic locations, long-lost rocky outcrops are now accessible and views from the coastal path are even more spectacular.

Long-term monitoring

Last June saw a mass influx of volunteer recorders onto the peninsula as part of the Long-Term Monitoring Network (LTMN). It contributes to a wider UK network of monitoring sites known as the Environmental Change Biodiversity Network (ECBN).

As Helen Michell, Natural England's Lead Adviser for the LTMN explains: "The Lizard - with its unique climate, geology, flora and fauna – has been monitored for centuries and so was an obvious choice for inclusion within the Long-term Monitoring Network. The systematic collection of data on climate, air pollution, soils, vegetation, birds, butterflies and land management on The Lizard will be compared with data collected from other coastal grassland and heath sites around England. The Lizard NNR is one of 27 monitoring sites across England currently within the network, which will be expanded to 40 sites by 2015. We hope the project will enable us and others to track and explain over the coming years the impacts of environmental change on this very special area of the country, as well as on the overall biodiversity of England."

Earth scientists already have considerable experience of understanding long-term changes in world climates as continents have drifted around the globe over millions of years. The Lizard itself was hatched from beneath a warm tropical ocean full of primitive fish long before the advent of flowering plants. Over the last 360 million years it has travelled some 8000 miles from its original location about 30 degrees south of the equator, across countless climatic zones to its current temporary resting place at 50 degrees north. Fortunately all this occurred long before humans started the dramatic speed-up of climatic change, hence the need for the current long-term monitoring programme.

Long-term monitoring quadrat on the species-rich cliffs above Mullion Cove.

Photos by Pat Sargeant

Serpentine cliffs and turquoise sea on the west Lizard near to Kynance Cove.

Finally it might also be germane to remember that many states in the USA have adopted an official 'state rock'. California just happens to have chosen serpentine, so is this a portent of warm Mediterranean days and Lizard wines to look forward to?■

Further reading

More information and a guide to the fascinating geology of this unique part of Britain can be found in the booklet *Beneath the Skin of The Lizard* published by Cornwall County Council in 2000.

Rescuing rocks and overgrown relics

Joy Howells,
Stiperstones & Corndon Hill
Country Landscape Partnership Scheme

By 2018, the Heritage Lottery-funded Stiperstones & Corndon Hill Country Landscape Partnership Scheme aims to deliver 15 projects highlighting the mining history and border heritage of the corner of south-west Shropshire abutting Mid Wales.

The largest project, *Rescuing rocks & overgrown relics*, funded through the Biodiversity Action Fund of WREN (Waste Recycling Environmental Limited), takes in six sites – former quarries, mines, and natural rock outcrop and scree – along or adjacent to the Stiperstones quartzite ridge. Four of them are Locally Important Geological Sites (LGS).

These sites are linked by geology and history and their importance for some of the county's rare and notable flora and fauna. The complex mosaics of rock and bare ground, scree and mining spoil, acid grassland, heath, scrub and adjacent woodland provide ecological niches for national, regional and locally important species. In addition to biodiversity gains, the projects provide opportunities to increase access to and understanding of geology by including it within interpretation work.

The Stiperstones Quartzite at Poles Coppice quarry has become badly overgrown (main picture) and the 'Rescuing rocks' project will return it to somewhere near how it looked the last time major clearance work was undertaken (inset) by Shropshire Geological Society.

Photos by Dan Gordon-Lee and Andrew Jenkinson

At Earl's Hill, work to remove trees and scrub from the Uriconian outcrops and screes will benefit the grayling butterfly and some unusual bryophyte and lichen communities. It will also vastly improve the view of the scree slope and rock outcrops from the access path.

Nils Hill Quarry, a fine example of Stiperstones Quartzite is currently completely obscured by scrub. At Poles Coppice, where the Stiperstones Quartzite with some faulting can be seen, the quarry faces are also becoming obscured. The project will restore these quarries to a mosaic of more diverse ecological habitats.

Snailbeach, The Bog and Roman Gravels are three of several former lead and barytes mines west of the Stiperstones Ridge. Maintaining the right balance of open ground, Calaminarian grassland and scrub is critical to conserve the sites' unique biodiversity. At Snailbeach, a knock-on benefit will be the clearance of scrub from the White Tip area of calcite and quartz mine waste to re-expose mineral samples.■

Grayling butterfly is one of the species which will benefit from work to clear the Uriconian outcrops and screes at Earl's Hill.

Photo by Katja Schäfer, CC-BY-SA-3.0-DE

Appreciating the bedrock of civilisation

Simon Cuthbert
University of the West of Scotland School of Science

A motley group of walkers set off from Dalwhinnie in July 2013 on a five-day trek across the central Scottish Highlands, crossing no roads and passing through no towns or villages in the entire journey.

Our ultimate destination was Glen Nevis, but as we groaned under backpacks weighing in excess of 40 pounds this seemed a very long way off! Our route took us along the old Thieves' Road, a remote defile once used by raiders from Lochaber to plunder the rich lands of Moray, but our steps also stitched a story from the fabric of deep time as we passed through the heart of the Grampian mountains, linking two great landforms of the Pleistocene glaciation – Ben Alder and Ben Nevis – and weaving our way through the roots of the Palaeozoic Caledonian orogen.

The Bedrock Walk was a joint initiative of the Royal Scottish Geographical Society (RSGS) and the Speygrian Educational Trust, which promotes outdoor learning. It was one of several events in an exciting RSGS Heritage Lottery Fund project called *Stories in the Land* which encourages people to become collectors, creators and tellers of old and new stories inspired by the epic journeys of the Scottish drovers. The walk took the form of a roving conference; the delegates were a diverse group, artists, writers, dramatists, educators, conservationists and geoscientists whose common bond was a love of walking in wild landscapes and a passion for the stories and images that they inspire.

Mafic (dark) enclaves in granite (two co-existing magmas), upper Strath Ossian. The boulder is probably from the eastern arm of Moor of Rannoch Granite.

Photos by Simon Cuthbert unless otherwise credited

Northern crags of Ben Alder overlooking the Bealach Dubh, on day two of the trek. Inverlair Psammite Formation psammite and semipelite, Glen Spean Subgroup of the Grampian Group (the stratigraphy here is not certain because BGS mapping doesn't match up across the two map sheets covering this area).

The fundamental idea of the Bedrock Walk was that the rocks were the literal foundation of the journey. Under the calm and measured guidance of Jean Langhorne of Speygrian, our multi-faceted group shared, learned, collected and created, exploring the many kinds of narrative that the landscape holds and inspires. We started among the roots of the great fountain of folds that define the mega-architecture of the Grampian orogen, passing over the upturned ends of the tough Grampian Group psammites around Loch Pattack and the Culra Bothy. As the slopes of Ben Alder and Sgor Iutharn (Hell's Peak) closed in around us, it was easy to imagine hearing the ghosts of the Lochaber men cursing just beyond the mist as they hurried their four-footed spoils through the grim glacial breach of the Bealach Dubh. We trudged down Strath Ossian, pausing to watch an eagle soaring over soft schists above the armchair amphitheatre of Coire a Charra Bhig, to admire a waterfall polishing up a pink-veined gneiss and to imagine life in an old stone cottage now gently decaying into the rushes. Crossing the eastern 'thumb' of the great fist of the Moor of Rannoch Granite we arrived footsore at the Loch Ossian Youth Hostel, to be greeted with a feast of food and traditional story-telling from the Stories in the Land team. Huddled in the fug and hubbub we pored over maps of geology and old drover's routes and read extracts from a 'walking library' compiled by one of our Bedrockers, Dee Heddon.

In the soft, damp morning we swung west past Loch Treig and, as the sky cleared, strode up along the sparkling Abhainn Rath, its clear waters spilling over dykes of pink porphyry. Now crossing the strike of the strata we passed over the watershed into Glen Nevis where the

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bleached ribs of the Appin Group quartzites flanked the mountainsides. Ahead, the grey andesite crags of Ben Nevis' alpine north face loomed over the perfect curve of Carn Dearg's arête; in the day's shimmering heat, they never seemed to get any closer, but late in the afternoon we squeezed through the gap between the red granites of Ben Nevis and Mullach nan Coirean and finally quenched plutonic thirsts in the bar of the Ben Nevis Inn.

Camp conference on day 2 in upper Strath Ossian looking west.

As we walked, camped and sat on our packs for the occasional well-earned rest we mused upon what stories, history, music and sounds are 'held' or inspired by the rocks and landforms: How was the landscape made? How does the geology determine what flourishes within it? Why had the Thieves' Road become an important route? What part had been played by human culture, even in this remote fastness? What does time mean in such a context, and what pasts and futures might we imagine for the places we were moving through? How does the physicality and rhythm of long-distance walking help us imagine, comprehend and craft our personal impressions?

As 'resident' geologist it was my task to demystify and create order out of the fragmented patterns in the outcrop and tell creation sagas, ably helped by geographer Bill Taylor. This was by no means a one-way relationship, and the most rewarding aspect of this journey for me was the flood of new insights into ways of perceiving geology and landscape as I saw it anew through the eyes and imaginations of my wonderfully creative fellow walkers: writer Linda Cracknell, poet Gerrie Fellows, artists Catriona Gilbert, Sarah Hughes, Malize McBride and Gill Russell; Dee Heddon (Professor of Contemprary Performance at Glasgow University), Speygrian facilitator Jean Langhorne, tourist/heritage consultant Bill Taylor and Sarah Lewis (Conservation Officer for the John Muir Trust). Storytellers were Claire Hewitt , Essie Stewart and Alastair Taylor and sound artist Barney Strachan. Dr Joyce Gilbert, Education Officer for RSGS , leads the *Stories in the Land* project and made this journey possible.

Geology map tutorial by Loch Treig on day 4. ***Photo by Linda Cracknell***

Work arising from this journey was shown at the *Stories in the Land* exhibition at the Scottish Storytelling Centre, Edinburgh in October 2013 and at the Scottish Geodiversity Forum *Sharing Good Practice* event at SNH Battleby, in December 2013. It will hopefully inspire today's youngsters to engage with our Highland landscapes and make stories of their own.■

Descending upper Glen Nevis on day 5, below Sgurr a' Bhuic and Aonach Beag (Glen Coe Quartzite and Leven Schist).

How Darwin's geology walk was set in stone

John Mason, Geology Consultant

In March 2013, I was in the office cataloguing some igneous rocks I had collected from the Harlech Dome for the University of Nova Scotia when an email arrived from Raymond Roberts of Natural Resources Wales (NRW). The gist was that a new visitor centre (with interpretation) was under construction at Ogwen and as part of this work, a wall alongside the car-park was intended to commemorate Charles Darwin's 1831 journey on foot from Ogwen to Barmouth, during which he made observations on the geology of the district. The idea was to place, along the top of the wall, cut and polished examples of the rock types he may have encountered. Could I help source samples?

The answer was of course yes – anything for a bit of fieldwork – but just how much rock was required? It turned out, over coffee with Raymond, Stewart Campbell and Snowdonia National Park's Alun Gruffydd, that the wall would be over 20 metres long and that the polished rock tiles would be over 20cm wide. That's a lot of rock! Each sample would need to be a sizeable boulder in order to obtain decent polished slices. The next step was to take Darwin's route – from Bangor up the Nant Ffrancon to Ogwen and Cwm Idwal, thence to Capel Curig and on to Ffestiniog before crossing the Rhinogydd somewhere to arrive at Barmouth – and see what the 1:50,000 scale geology maps had to say.

It was immediately clear that the route largely involved Cambrian and Ordovician sedimentary and igneous rocks, but with quite a diversity of rock types. It was also clear that a 100% accurate portrayal of the strata en-route would require a wall several times longer, so it was decided to make it representative. Long sections of the route would have been in monotonous grey mudstones such as those of the Nant Ffrancon Formation: while including such rocks, the emphasis would be on portraying the geodiversity, but still in a rough order of where they were encountered.

Collecting large boulders has limitations

Collecting large boulders has limitations. The bottom line is that they are very heavy, and this limits how far they can be manhandled. An example was the day I walked up into Cwm Idwal, up past the Slabs, intending to locate a boulder of basalt beneath the Devil's Kitchen. It was years since I had been up there and I had forgotten how much of a scramble it was to cross the Idwal stream. Reversing these moves with a 20kg rock in my rucksack would have been foolhardy, so I turned back and settled for a block of lava-breccia from the Lower Rhyolitic Tuff Formation out of one of the stream beds that tumbles down below the path to the lake. Carrying that down was enough of a struggle.

Other collecting sorties were much easier, thanks in large part to Welsh Slate, First Hydro and NRW, who granted vehicular access to quarries, trackside exposures and the Stwlan Dam. At such localities, fresh material was in abundance and one could pick and choose, then load it. On several occasions I was accompanied by Maentwrog stonemason, Joseph (Joe) Jones, who had an array of tools which made the equipment carried by most geologists look positively wimpish. Heavy hammers with tungsten carbide 'blades' embedded in their heads could deliver immensely powerful blows and, with practice, we were able to split huge blocks once a potential plane of weakness was identified. More stubborn boulders fell to a portable rock-drill and that old quarryman's friend, the plug-and-feathers – which were devastating in their effectiveness.

Continued overleaf

Polished tiles of lava-breccia from the Moelwyn Volcanic Formation, collected from near the Stwlan Dam, set in the Darwin Wall. The dam is some 500m above sea-level and First Hydro kindly allowed vehicle access to this remote spot to collect the samples.

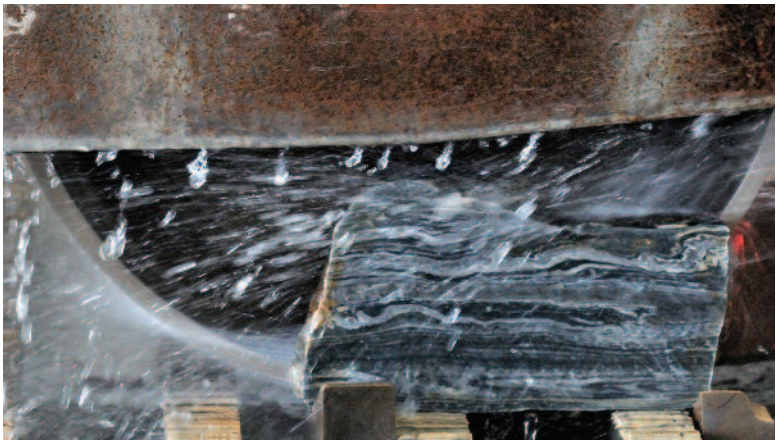
All photos by John Mason

Towards the end of the collecting phase, with the boulder-stash nearing completion at Plas Tan y Bwlch, May 2013. Note the hammer at bottom left for scale!

From preceding page

Day followed day and each would end at Plas Tan Y Bwlch, Snowdonia National Park Authority's educational centre. Here, I had squatted one corner of the car-park, and would drop off the day's finds and look with satisfaction as the stash grew. By the time the allocated collecting days were over, in late May, there were an estimated 2-3 tonnes of samples.

One afternoon, Joe backed his Land Rover and trailer up to the stash to shift them to the workshops of the Cerrig Granite Company in Pwllhelli. I spent several days there with Joss Thomas and the lads, as each boulder was sliced by laser-guided diamond saws. The best slices were selected for polishing and soon there were pallets stacked high with polished slices and offcuts. Now, getting the samples into a running order was the priority.



Cutting a boulder at the Cerrig Granite Company's workshop in Pwllheli. This is banded rhyolite from the Lower Rhyolitic Tuff Formation.

When cutting sliced boulders into rectangular or square tiles, the wastage is enormous. Boulders come as they come, their shape dictated by circumstances beyond human control. This proved to be the hardest part of the entire job. We struggled, even with our 2-3 tonnes, to get enough running footage, but we circumvented the problem by arranging the polished tiles into three runs representing the three key divisions of Darwin's journey, and using slate – which we had aplenty – as spacers. This is by no means cheating: it is actually quite representative of the geology of Snowdonia, where the background sedimentation was largely of mudstone, interrupted by more interesting things like conglomerates, bedded manganese ore and all manner of volcanics. Finally, I had the entire running sequence of polished tiles, inlaid in larger blocks of the pale granite from the quarries at Trefor, laid out in the yard at Cerrig like some vast rocky caterpillar.

Marked-up granite panels with inlaid polished tiles in their correct running order at Cerrig Granite Company.

Different rock types to build different sections of the wall's sides

My hand in the overall project was now complete. It was up to Joss, working with Joe, to get everything into place at Ogwen, which they did admirably. Because Joe had been in the field with me a lot, he had collected his own rock stashes. He used different rock types to build different sections of the wall's sides, and in doing so he used different styles of construction that reflect what you see as you look at stone walls around North Wales. They were always built from what was immediately available, and to a style commensurate with the way they tend to break up. This added a further neat educational touch. Joe allowed himself one touch of mischevious humour... a small piece of pumice he collected from Vesuvius while on holiday now resides somewhere in the wall facing the Visitor Centre! It may generally go unnoticed forever, but I spotted it straight away and it may serve to identify future pedantic geologists!

All in all, this was a most unusual and rewarding project. It got me out in the field to some places I'd not been for years. Seeing how new colleagues worked with stone was an education. One thing that really impressed all involved with the project was the sheer diversity of rock-types and textures that Snowdonia offers. To the public, it often seems that it's all about slate and 'granite'. There's far more than that out there. I hope the Darwin Wall will, among its other purposes, showcase that.

Interpretation is to follow for 2014, firstly by means of a leaflet, but we are hopeful that the tale of Snowdonia's geological evolution may be told in more detail. The oldest *in situ* rocks collected for the wall were laid down when Wales was just a bunch of volcanic islands deep in the southern hemisphere, some 600 million years ago, so there's a big story to relate! ■

Joss Thomas and Joe Jones admire the completed Darwin Wall at its official opening day.

Celebrating Scotland's Time Lords

Stuart K. Monro,
Our Dynamic Earth and University of Edinburgh

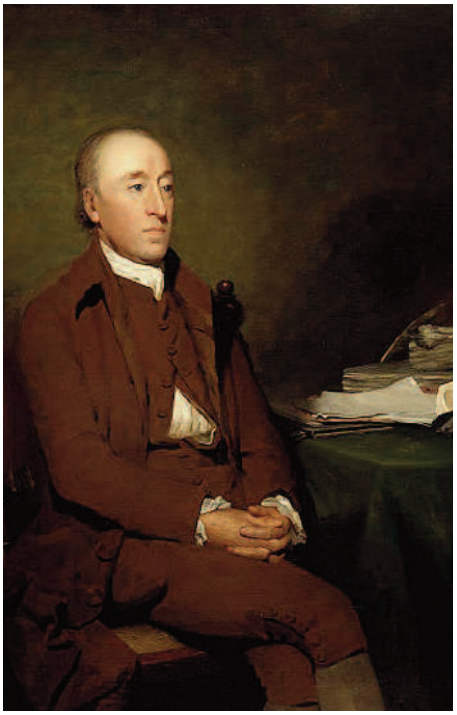
James Hutton, medic, chemist, farmer and the Father of Modern Geology lies at the heart of a new gallery which introduces the story of Our Dynamic Earth. The new gallery will open in Easter 2014 and will build on the Hutton story through the other Scottish geological giants Charles Lyell, Peach and Horne and Arthur Holmes. It will place their work in the context of our modern understanding of plate tectonics. It will be another opportunity to recognize the impact of Scotland's Time Lords on the evolution of Earth science.

The First Time Lord, James Hutton

James Hutton was born in Edinburgh on 3 June 1726, the son of the City Treasurer. At 17, he was apprenticed to a lawyer; but with a greater interest in chemistry, he went on to study medicine at the University of Edinburgh. In those days, chemistry was integral to a medical education. Three years later he continued his studies in Paris pursuing "...with great ardour the studies of chemistry and anatomy" and took the degree of doctor of medicine in 1749 at Leyden.

In 1750 he returned to Edinburgh and resumed chemical experiments with his friend James Davie. Their work on the production of sal ammoniac – ammonium chloride, a salt used in dyeing and working with brass and tin – led to a profitable partnership. Hutton also had a keen interest in agriculture and farmed at Slighhouses and Nether Monynut in Berwickshire, farms he had inherited from his father. Hutton wished to apply his scientific understanding to agricultural practice and travelled extensively to gain new ideas, introducing the Suffolk plough to Scotland.

These travels fostered his interest in the processes that shaped the natural world. He visited Arran on the west coast and Jedburgh in the Borders and discovered the geological relationship, the uncomformity, where horizontal or gently dipping rocks rest on top of more steeply dipping rocks. More importantly, he recognised the story that these exposures were telling. In Berwickshire he had seen the steeply dipping rocks of the Southern Uplands and the more gently dipping rocks around Dunbar. He surmised that somewhere on the Berwickshire coast, these two rock formations would come together. Thus, with two friends, Sir James Hall and John Playfair, he sailed from Dunglass, south along the coast to discover Siccar Point and its dramatic unconformity. Here Hutton revealed the true significance of what they were seeing. He demonstrated to his friends that Earth had to be very much older than 6,000 years – and so started a quest for the age of the planet which continued through to the 1940s when Arthur Holmes produced a revised age akin to that accepted today.



James Hutton, 1726 - 1797. Geologist. A painting dating from around 1776, by Sir Henry Raeburn, Scottish National Portrait Gallery. Hutton is known as the Father of Modern Geology.

Hutton recognised that the dramatic unconformity at Siccar Point unveiled a significant story about Earth's development.

Photo by Lorne Gill/SNH

Hutton's other great controversial idea was that some rocks had been molten and injected into sediments. The evidence for his view can be seen clearly at what is now called Hutton's Section at the foot of Salisbury Craigs. The relationship between the Craigs' rocks and the underlying sediments indicates that the sediments have been forced up and broken off by forceful emplacement of what must have been molten rock.

Charles Lyell, the great communicator

Hutton's ideas were the subject of two lectures given to the newly formed Royal Society of Edinburgh in 1785. However, he did not publish his *Theory of the Earth* in book form until 1794.

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In 1802, five years after Hutton's death, John Playfair tried to explain Hutton's theories in his Illustrations of the Huttonian Theory of the Earth. However Hutton's concepts were not widely recognised until Sir Charles Lyell included them in his *Principles of Geology* in 1833. Charles Lyell was born in Kinnordy, Forfarshire and was the great communicator of Hutton's geological ideas and concepts. His *Principles of Geology* brought Hutton's ideas forward. Importantly, Lyell's book greatly influenced Charles Darwin on his voyage on the Beagle, giving him a framework of deep time in which evolution by natural selection could work.

Charles Lyell was the great communicator of Hutton's ideas and concepts.

Image provided by Our Dynamic Earth

The 'Readers of the Rocks', Ben Peach and John Horne

Left, examining rocks in the field, Ben Peach (centre) and John Horne (left) with Charles Clough.

Photo by National Galleries of Scotland

Fundamental to Hutton's ideas was the concept that rocks would be put into a vertical disposition by major compressive forces, building mountains. Though Hutton surmised this process, he was unaware of the mechanism that could achieve it. During the 19th Century prominent geologists conducted a prolonged and bitter debate, the Highland Controversy, about the geological relationships exposed in the North West Highlands. This was finally resolved in 1907 by mapping geologists from the Geological Survey, Ben Peach and John Horne. Peach and Horne explained the conundrum by the action of a low-angle thrust fault bringing older rocks from the east over the top of the younger rocks. This was evidence of the major compressive forces envisaged by Hutton.

The Second Time Lord, Arthur Holmes

Working in Durham and then Edinburgh, Arthur Holmes used the emerging science of radioactive decay to date rocks and establish a numerical timescale for the events that shaped Earth. For the first time, rocks and the events associated with their formation could be dated accurately and a chronological story of the evolution of Earth could be started. Holmes was undoubtedly the other historical character who could stand alongside Hutton as a 'Time Lord'.

The work of these scientific giants laid the foundations for our modern understanding of plate tectonics and the new gallery in Our Dynamic Earth, funded by the Heritage Lottery Fund, will place their work in a global and 21st Century context.■

Our Dynamic Earth, located below Salisbury Crags, one of the key localities where James Hutton gathered evidence for his *Theory of the Earth*.

Photo by Our Dynamic Earth

The case for gold panning in Scotland

Neil Clark, Hunterian Museum, University of Glasgow

In March 2014, the Hunterian at the University of Glasgow will hold an exhibition of gold in Scotland. Amongst the treasures on display will be the King's Gold Cup from the Leith races of 1751, Queen Victoria's gold collar of the Order of the Thistle, 'cloth of gold' from the tomb of Robert the Bruce, Bronze and Iron Age gold torcs (especially the hoard from Law Farm, Morayshire), a multitude of Scottish gold coins, modern creations by Scottish goldsmith Graham Stewart, and 10 large nuggets found in Scottish rivers.

Water-worn flakes of gold and masses in quartz panned from the Shortcleugh Water, 'Crawford Muir', South Lanarkshire in the 1930s.

Gold has been an important part of Scottish heritage for millennia and makes a significant contribution today with the Tyndrum mine and the more leisurely pursuits of panners at Wanlockhead and Kildonan. Tyndrum is not the first gold mine in Scotland. Extensive mining took place during the reigns of James the IV and V in parts of the Leadhills, mostly between Crawford and Wanlockhead. Nuggets weighing close to 1kg were said to have been found and converted into coinage or used in repairs to royal regalia. Gold mining in the Leadhills ceased in the reign of James VI in the 1620s; only small-scale extraction has taken place since.

In recent times, prospectors for gold in Scotland have been rewarded at some localities previously thought unlikely. Eminent geologists of the 19th Century proclaimed that Scotland had no economical gold deposits as it did not have the right geology. This is clearly wrong as the ore body at Tyndrum proves.

'Bonnet Piece' or ducat of James V (1539), made from Scottish gold from near Crawford in South Lanarkshire. So called because the king is depicted wearing a bonnet, this gold coin is the first to bear a date in Scotland, and Britain.

Both images © The Hunterian, University of Glasgow

Gold rush fever

Scotland has also had its share of gold rush fever. In Victorian Britain, it was fuelled by stories from the Californian gold rush of the 1840s and the Australian Ballarat discoveries of the 1850s. In 1852, the discovery of gold in Fife sparked a rush on home territory. With gold valued at £4 an ounce and a skilled worker earning less than £50 a year, the prospect of making a year's wages in less than a month inspired thousands of labourers to head for the hills around Auchtermuchty and Kinnesswood. Unfortunately, most had no clue how to extract gold nor what natural gold looked like. Their sacks full of gold-glinting minerals mostly turned out to be pyrite. The Fife episode became known as the "Fools' gold rush" and was soon forgotten. Ironically, gold has more recently been found in the area by more experienced prospectors.

In 1868, when Robert Gilchrist had returned from prospecting in Australia and New Zealand to his native Sutherlandshire, he looked for gold in the hills near Helmsdale. Granted permission by the Duke of Sutherland, he found it around the Kildonan Burn. As a result 180 people petitioned the Duke asking permission for the local community to prospect in the hills around the Kildonan. Soon, prospectors from all over the world started arriving in Helmsdale to visit the more famous gold-diggings of Kildonan, walking the nine miles from Helmsdale each day.

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Two townships were eventually erected for the prospectors: Baile an Or (Town of Gold) at the foot of the Kildonan and Carn nam Buth (the Rock Shop) at the foot of the Suisgiull. The Kildonan gold rush was certainly more successful than the Fife gold rush but the cold, wet weather, the licence fee and the cost of tools and accommodation, restricted the operation to about the same scale as the other gold rushes. The 10% tax owed to the Crown resulted in few prospectors lasting the year and gold diggings ceased on 1 January 1870. It is unclear exactly how much gold the prospectors recovered as they did not declare all their finds, but it has been estimated that over 400kg of gold was taken over the year – a small fraction of the Australian and American rushes. Since then, prospectors have made several attempts to find the 'mother lode' of gold. Francis Scot Campbell of Islay suggested in 1869 that the hills drained by the Helmsdale and Brora rivers may hold the source, but the truth is still to be established.

Baile an Or on the banks of the Kildonan Burn, near Helmsdale, Sutherland, soon after the 'diggings' were abandoned and the township removed (photo probably taken in the 1890s).

Images © Neil Clark /The Hunterian, University of Glasgow

Today it is possible to emulate past prospectors by gold panning in the Kildonan burn, thanks to the Sutherland Estates, who allow panning for a few days at a time. Panning is also possible on the Mennock Water in the Leadhills, with a Buccleuch Estate licence that can be purchased from the Museum of Lead Mining at Wanlockhead.

Gaining permission to pan for gold elsewhere is more problematic. Guidelines provided by Scottish Nature Heritage (www.snh.gov.uk/docs/A691325.pdf) suggest that the Crown Estates must be asked for permission before gold or silver is panned in other areas. However, the Crown Estates website explicitly bans all gold panning (www.thecrownestate.co.uk/rural/minerals/our-portfolio/), using the outdated Royal Mines Act and reasoning that panning is known to "damage the aquatic environment and the wildlife" – although this need not be the case.

So who owns gold and where does gold panning stand within the law? A couple of acts in Scotland may have relevance. The Royal Mines Act of 1492, set out by the old Scottish Parliament, states that any mine producing three halfpennies of silver per pound of lead belongs to the king (I think this works out as five parts silver to 1,000 parts lead by weight). The Mines and Metals Act of 1592 (Scotland) and its amendments relating to the Abolition of Feudal Tenure etc. (Scotland) Act 2000 afford the landowner the right to mines or minerals. There are codes of conduct for panners available from the British Gold Panning Association (www.britishgoldpanningassociation.co.uk), and panners should always abide by the Scottish Outdoor Access Code (www.outdooraccess-scotland.com/) when undertaking their healthy outdoor leisure pursuit.

Panning has existed in Scotland since prehistoric times and is an integral part of the rich diversity of uses of the aquatic environment that should be supported, encouraged and protected for the future. The responsible gold panner does little damage to the river ecosystem and may produce more benefits than harm to both geo- and bio- diversity. It would be more productive to develop an environmentally sustainable relationship between stakeholders in the waterways and an agreed code of good practice to include panners, perhaps along the lines of the Fossil Code (http://www.snh.gov.uk/protecting-scotlands-nature/safeguarding-geodiversity/protecting/fossil-code/). ■

Further reading

Clark, N.D.L. 2014. *Scottish Gold*. Neil Wilson Publishing, 226 King Street, Castle Douglas DG7 1DS. £14.99.
ISBN: 9781906000264

The Scottish and British gold panning Championships take place annually towards the end of May at Wanlockhead in the Leadhills beside the Museum of Lead Mining. 2013 was the 25th anniversary of the British Gold Panning Association.

Geopark bodies battle for survival

Robina Barton, Geopark Shetland
Additional contributions **Donald Fisher & Jim Blair**

One hundred territories worldwide are now actively using the outstanding geological heritage of their geoparks to underpin sustainable development in a bottom-up approach, primarily (though not exclusively) through education and tourism. Geoparks take a holistic attitude to interpretation, highlighting the close links between geodiversity and cultural and natural heritage. They raise awareness of key issues facing society in the context of the dynamic planet we live on and they seek to conserve the natural environment.

Scotland was home to the father of modern geology James Hutton. It is the birthplace of the modern science, with an incredible geological diversity spanning three billion years – over half of Earth's known history. It is an ideal place for the geopark model to develop and thrive, yet Scotland's geoparks have struggled for survival and recognition.

View of Quinag from North Kylesku in the North West Highlands Geopark. A glacially fashioned rockscape comprising near-horizontal sedimentary strata of Torridonian Age (1 billion years BP) sitting upon a foundation of metamorphic Lewisian Gneiss (3 billion years BP).

Photo © Donald M. Fisher

Until 2011 Scotland could boast three members of the Global Geoparks Network supported by UNESCO. North West Highlands Geopark is located in the far north of the Scottish mainland. Lochaber Geopark covers a large swathe of the Highlands. Geopark Shetland spans an archipelago of over 100 islands lying 170km north-east of the Scottish mainland – the most northerly lands in the British Isles.

All three Geoparks have engaged with their local communities, with key stakeholders, and with their colleagues around the world to make significant contributions to economic and social development in their regions. This has included levering in funds, creating tourism infrastructure, helping teachers to deliver the Curriculum for Excellence in new and engaging ways, supporting lifelong learning, safeguarding their geodiversity and promoting their regions internationally.

From the high of hosting the European Geoparks conference in Ullapool in 2007, a low was reached in 2011 when Lochaber lost its membership of the Global Geoparks Network due to lack of funds. Whilst Geoparks can do a lot with a little, some core investment is required to generate further revenue and exploit the opportunities that GGN membership affords. With North West Highlands and Shetland also struggling financially, it seemed Scotland was going to lose out.

Fortunately it is not all doom and gloom, and 2013 has seen a huge turnaround. Shetland and North West Highlands Geoparks made a successful funding bid to the Scottish Government, demonstrating their tangible community benefits and highlighting their importance for the nation.

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The Government agreed that Geoparks represent value for money in supporting its strategic objectives to create a greener, healthier, safer and stronger, smarter, wealthier and fairer Scotland. It awarded Shetland and North West Highlands £280,000 over two years. Geopark benefits were further spelt out in a report by the UK National Commission to UNESCO, estimating the seven UK geoparks were worth £18.84 million to the UK economy annually.

The Global Geoparks Network is self-regulating and members must demonstrate every four years that they still merit their membership. North West Highlands and Shetland successfully underwent revalidation this summer. Meanwhile, work is ongoing to bring Lochaber back into the fold.

Shetland, North West Highlands and Lochaber have formed a Scottish Geoparks Partnership, to work in co-operation, share information and ideas, seek development opportunities and strengthen Scotland's position within the wider Geopark network. The Europe 2020 strategy identifies tourism as one of the economic activities with the most significant potential to generate growth and employment within Europe. Scottish Geoparks are well placed to capitalize on European funding opportunities to support and develop their tourism and heritage tourism sectors. In addition there is significant scope for closer co-operation between Scottish Geoparks and industries such as oil and mining that depend on Scotland's geological resources.

So how do the Scottish Geoparks benefit their communities?

Shetland Global Geopark

Geopark Shetland recently developed Shetland's first tourism app for iPhone and Android in a Shetland-led project with Geopark partners from France, The Netherlands and England (www.hintproject.eu). It has created displays, exhibits and interpretative panels at museums, heritage centres and geosites throughout the islands as well as self-guide trails exploring the floor of an ancient ocean and the remains of an extinct volcano. It plays a major role in organising the annual Shetland Nature Festival and has developed an endorsement scheme for tourism businesses.

The 'app' for Shetland Geopark, Shetland's first tourism app for iPhone and Android.

Photo by Robina Barton

The Geopark is working on two ambitious international tourism projects. Northern Georoutes – a collaboration with Geoparks from Norway, Iceland and Canada to promote Geoparks within the North Atlantic Region as tourist destinations and develop travel packages with local tourism providers (www.northerngeoroutes.com). Then there is *Drifting Apart*, a project to map geological heritage in Canada, Greenland, Faeroe, Iceland, Norway, Ireland, Scotland, Finland and Russia for tourism and tour development.

In addition there are efforts for the community, the arts and education. The Geopark supports lifelong learning through workshops, courses and field trips for schools and adult learning night classes. It is a lead member of the Shetland Environmental Education Partnership – a multi-agency group developing activities, resources, and in-service training to benefit all Shetland schools.

A geology course under way on coastal Shetland.

Photo by Rick Barton

North West Highlands Global Geopark

In 2012 North West Highlands Geopark became a Company Limited by Guarantee and Social Enterprise - completely supported by its five constituent communities. By the end of that year, a Geodiversity Audit and related Local Geodiversity Action Plan had been completed. A Scottish Government pledge of two years' core funding ensured continued membership of the Global Geoparks Network at the Geopark's revalidation in July 2013.
Recruitment of two full-time staff is under way to enable the Geopark to deliver against its Development and Action Plan and the Local Geodiversity Action Plan. The Geopark is currently focused on several areas of activity. ***Continued overleaf***

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The 'Rock Route' is a road-trail created by Scottish Natural Heritage in collaboration with the Geopark, with stops at panels that interpret the local landscape. Work is ongoing to promote the route and to develop related 'Pebble Routes' with input from five constituent communities. Educational materials will be developed for both routes.

Within local communities, distance learning in Earth sciences has become important since travel distances within the Geopark are significant. There are currently 16 adults on the distance learning Geology course. The programme is delivered through day schools, including Geopark fieldwork, and distance-learning materials.

North West Highlands is also planning to engage with local stakeholders, especially tourist providers, to establish a Geopark quality brand. Raising the profile of the Geopark locally continues through attending Highland Gatherings and staging events for communities within and near the Geopark.

Split Rock at Clachtoll in the North West Highlands Geopark. These gently inclined sedimentary strata of Torridonian Age (1.2 billion years BP) contain the oldest life-forms (stromatolites) to be found in North West Europe. The two main rock-features were once connected but glacial erosion, exacerbated by later marine action, has caused break-up and removal of the central block.

Photo © Donald M. Fisher

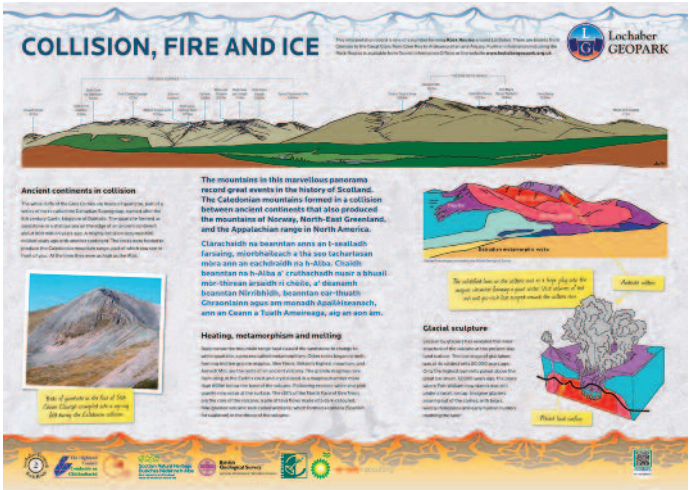
Lochaber Geopark

Despite financial difficulties Lochaber Geopark has continued to enrich the experience of tourists and locals, through projects such as interpretation panels (*issue 39*, p. 15). A new organisation in Lochaber, the Nevis Landscape Partnership, supported by the Heritage Lottery Fund, is supporting the Geopark in a project with the British Geological Survey to produce a geological walker's guide and map for the Ben Nevis area. The Geopark will provide routes, text, illustrations and artwork and BGS will provide maps.

A new video, *The Story of Ben Nevis*, describes Earth's origin and the geological evolution of Lochaber in general and Ben Nevis in particular. It will go on permanent display at the West Highland Museum in Fort William and copies will be supplied free to all schools in Lochaber.

Lochaber is following North West Highlands and Shetland in bidding for development funding from the Scottish Government. If successful, it will have a good chance of readmission to the European and Global Geopark networks.

With so much positive momentum the years ahead look set to see increased development and exposure for Scotland's Geoparks. In spring 2014 Geopark Shetland will host a meeting of the UK Geoparks Forum, involving representatives from the UK Geoparks, Scottish Natural Heritage, Natural England, Natural Resources Wales, the British Geological Survey, Visit Scotland and the UK National Commission for UNESCO. It is hoped that this event will see the launch of a UK-wide *Landscapes in Motion* project that involves local communities in producing a film highlighting the creative ways in which people can engage with the Geoparks landscape. Scottish Geoparks are planning to hold an open day in Edinburgh in summer 2014 to showcase their work and engage the public. They will continue to work with the Scottish Geodiversity Forum to realise Scotland's Geodiversity Charter (*page 5*). ■



One of the recent interpretative panels in Lochaber. For further details see page 15 of *Earth Heritage issue 39*.

Photo by Jim Blair

More information

www.geoparkshetland.org.uk/
www.northwest-highlands-geopark.org.uk/
www.lochabergeopark.org.uk/

GeoMôn gets four years for good behaviour!

Stewart Campbell, Natural Resources Wales
Margaret Wood, GeoMôn

GeoMôn, the Anglesey geopark, underwent its first four-yearly revalidation exercise in July 2013. It was scrutinised by European Geopark Network (EGN) inspectors, Heinz Hollmann (Austria) and Alicia Serna (Spain), who examined all aspects of the geopark's operation – especially its financial status, management structure, geoconservation record and 'visibility' as an organisation.

Over two days, the inspectors met GeoMôn members and partners including Natural Resources Wales (NRW) and Isle of Anglesey County Council (IoACC) staff as well as the local MP, Albert Owen. GeoMôn's HQ in Porth Amlwch was visited along with a series of recently installed geoboards and trails (*Earth Heritage* Issue 40).

Although the GeoMôn team was confident that the inspectors would be impressed with the island's geology, it was not until the September EGN meeting in Italy that GeoMôn learned its fate – a creditable 'green card', giving the island its EGN, UNESCO-approved geopark status for a further four years. Improvements suggested by the inspectors include further geopark signs, more business partnerships and sustainable funding after the current IoACC-led grant runs out in 2015.

Highlights of the field visits were the pillow lavas and mélange at Llanddwyn Island. The inspectors also saw the Pilot's Cottages and the ruins of St Dwynwen's Church (*right*). Llanddwyn Island is a National Nature Reserve and SSSI managed by NRW, whose warden, Richard Williams, explained the painstaking work carried out to maintain and enhance the island's fragile biodiversity and geodiversity whilst creating the best experience for visitors. Those on a trip to the island are now met with a large new two-sided information board. One side explains the island's biological, historical and cultural story, the other side showcases its world-class geology. GeoMôn has developed its geological interpretation for the island with NRW.

The EGN inspectors also visited Cemaes Bay and Llanbadrig in the north of Anglesey. In Cemaes Bay, they saw two new geo-boards (explaining 860 million-year-old stromatolites in mélange and a complex of Palaeozoic dykes) and a newly developed, circular rock trail showing the main rock types found on the island in the order of their formation. The party comprises, from left : Heinz Hollmann (EGN), Cynthia Burek (University of Chester), John Pinnington and Margaret Wood (GeoMôn), Alicia Serna (EGN), Elfed Jones (Cemaes Bay Community Council) and Michelle Humphries (Magnox, Wylfa Power Station). Development of this and the nearby Llanbadrig site has been made possible by GeoMôn working with the Community Council and other key partners such as NRW, The National Trust, IoACC, and the nuclear power station.

Continued overleaf

From previous page

The inspectors were shown the new information board located near Llanbadrig Church and the recently constructed viewpoint for St Patrick's Well and Cave. The GeoMôn team was keen to point out the developing 'St Patrick' connection in the Llanbadrig area, aimed at encouraging international tourism, particularly from Ireland and the United states, via the port at Holyhead and Anglesey Airport at nearby Valley.

The EGN inspectors examined GeoMôn's role in stimulating local economic development. Plas Coch operates a holiday park and leisure complex and, in 2010, sponsored the training of 12 GeoMôn field guides in a strategy to boost the number of geotourists visiting Anglesey.

The successful revalidation gives impetus for new work that will include:

- seven more information boards for geological SSSI and RIGS at Rhoscolyn, Rhosneigr, Parys Mountain, Traeth Lligwy, Red Wharf Bay, Lleiniog and Gallows Point. These boards will showcase partnership geoconservation work between GeoMôn, NRW and IoACC across the island;
- a bilingual educational leaflet explaining the plate tectonic setting of the island's geology (due early 2014);
- a more comprehensive guide to the island's geology (to include trails and walks for all the geo-board sites) will follow in mid-2014;
- a launch of the Cemaes and Llanbadrig boards and trails is scheduled for 19 April (Easter Saturday) 2014. This event will also see the launch of a 'Time and Tide' bell in Cemaes Bay. The bell has been created by sculptor Marcus Vergette and will chime daily with the incoming tide.

All photos by Stewart Campbell except below by Synergy

The geopark is also continuing to develop links with businesses on the island to encourage economic development through geotourism. An example is RibRide, part of Synergy, a marine-tour operator based in Menai Bridge. Using 11-seater ribbed boats, the company offers a range of tours (adventure, educational and scientific) around the spectacular Anglesey and North Wales coastline. The involvement of the geopark means that tours can now include a geological element, showcasing some of the outstanding geosites along the Menai Strait – such as the Tertiary dyke at Plas Newydd – the first place in Britain that the process of contact metamorphism was described (*Henslow*, 1822). ■

Geoconservation sites vital to GA field trips

David Bridgland, Durham University & Lesley Dunlop, University of Northumbria

Excursions at the GA's 2013 Elsevier-sponsored meeting at Durham University's Collingwood College used various geoconservation sites in an area where the protection of geodiversity has always had a high priority. The two-day gathering took as its main topic *Onshore and Offshore Geology – the vital link.*

The Permian rocks of North East England tour, led by Eric Johnson, former BGS geologist, explored the Permian, dominated by the Magnesian Limestone, which is at its thickest and most diverse in this area. All four localities visited were geoconservation sites. First was Raisby Quarry Site of Special Scientific Interest (SSSI), where the party viewed the Marl Slate. On the outskirts of Sunderland, the party visited the Tunstall Hills and Ryhope Cutting SSSI to observe barrier-reef deposits. In excellent weather at low tide, a visit to the coastal locality of Roker Cliffs and Parsons Rocks, a Local Geological Site also within the Durham Coast SSSI, allowed examination of the cannonball limestone, which represents concretionary structures in the dolomite of the Roker Formation. Final call was Trow Point, South Shields, again a part of the Durham Coast SSSI. Here the Roker Formation shows brecciation caused by post-depositional dissolution of the underlying Hartlepool Anhydrite, while the Ford Formation at the base of the cliffs is an off-reef facies with stromatolites.

The Classic Durham Geology excursion explored the North Pennines AONB and was led by Brian Young, also formerly with the BGS and an author of *County Durham Geodiversity* (see below). The North Pennines is also a European and Global Geopark, highlighting its international importance for geodiversity.

The excursion centred on the former lead-mining area of the eastern Pennines, visiting exposures in Frosterley Marble, the well-known Carboniferous fossil tree stump in the churchyard wall at Stanhope and the site of the Rookhope Borehole, in which the Weardale Granite was proved. The borehole site is a Durham County Geological Site.

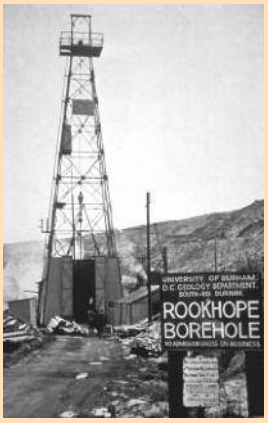
A particular highlight was West Rigg Open Cutting SSSI, a disused quarry that exploited iron-ore formed by alteration of limestone country rock on either side of a mineral vein (the 'Slitt Vein') that had previously been mined underground in search of lead; the narrow shaft dug by the lead miners is visible within the unquarried quartz–fluorite 'Slitt Vein' in the centre of the quarry.

A second SSSI, Greenfoot Quarry, was added at the last minute when the tour coach became stuck in mud at West Rigg. Two farmers who came to the rescue turned out to be award-winning conservationists! They received an English Heritage Angel Award for rescuing industrial buildings on the Low Slit Mine: see www.english-heritage.org.uk/caring/angel-awards/winners-2013/vote2013/best-rescue-of-a-historic-industrial-building-or-site/). Greenfoot exposes the dolerite of the Little Whin Sill, a minor higher-level bifurcation of the Great Whin Sill; the former is found in Weardale whereas the latter famously gives rise to impressive landscape features on a larger scale elsewhere.
More details of all the sites mentioned and many more in the area are in the impressive Durham Geodiversity Audit:
http://content.durham.gov.uk/PDFRepository/County_Durham_Geodiversity_Audit.pdf

The GA Durham meeting was on the heels of the Quaternary Research Association Durham field meeting which visited coastal SSSIs in the east of the county [see following page]. ■

Cannonball limestone at Roker Cliffs and Parsons Rocks Local Geological Site.

At Trow Point, part of the Durham Coast SSSI, the Ford Formation is an off-reef facies with stromatolites.



Rookhope Borehole is a Durham County Geological Site.

Photos by Lesley Dunlop (above), Durham Geodiversity Audit (right) and David Bridgland (below)

West Rigg Open Cutting SSSI was a tour highlight greatly aided by a North Pennine AONB interpretation board.

Buried geology re-exposed for study

Bethan Davies, University of Aberystwyth

A Quaternary Research Association (QRA) field meeting in County Durham in September visited Easington Raised Beach at Shippersea Bay, and the Warren House Formation at Warren House Gill.

The raised beach is an interglacial shoreline deposit dated to 200,000 years ago, sitting on Magnesian Limestone bedrock at 33m above sea level. It contains littoral shells and barnacles, rounded pebbles, some bored by annelid worms and molluscs, and a few (reworked) glacial erratics. Farther south, the Warren House Formation is buried by a colliery waste beach and slumped sediments, which are slowly being eroded.

The JCB moves in to excavate one of the pits to allow access to the Pleistocene geology.

Photos by Bethan Davies

The Durham coast has long been recognised for its cliff exposures of rare and geologically important glacial and interglacial sediments dating from the Middle to Late Pleistocene. The area is designated an SSSI, as well as being (in part) a National Nature Reserve and forming part of the Durham Heritage Coast. The Durham Coast SSSI is also designated for its unique Magnesian Limestone grassland habitat (which is also a European Special Area of Conservation), its exceptional limestone coastal geomorphology, and the important glacial and interglacial sediments, particularly at Shippersea Bay and Warren House Gill. The Magnesian Limestone grassland, the only example in the UK, is a habitat for the bloody cranesbill, Northern Brown Argus butterfly, east minor moth and supports migratory birds such as little terns, turnstone and purple sandpiper.

The area's mining history has had a dramatic impact on the coast; the waste dumped on the beach could be considered an excellent example of the 'Anthropocene'. The beach at Warren House Gill was the setting for the final scene of the iconic 1971 British film *Get Carter*, in which waste dumping was a key dramatic feature. However, in many places the waste prevents the wave erosion needed to maintain fresh exposures of the Pleistocene geology.

In order to re-expose this geology, Natural England gave permission to use a JCB, driven along the beach to leave the fragile overlying grasslands of the Durham Coast SSSI undamaged. In a single day four large, deep pits were excavated and slumped material was cleared from the cliff face. The pits are wide and graded for safety, and were also designed so as to remain open for as long as possible following the QRA visit.

The importance of the Warren House Formation, which lies at the base of a buried palaeovalley cut in Magnesian Limestone bedrock, lies in its unusual origin; it has been regarded as the product of Scandinavian ice. Recent work has shown that it is a deformed glaciomarine to subglacial diamicton and that it contains pebbles from both the north-east North Sea and Scotland, with several igneous erratics that could have come from either Scotland or Scandinavia. Its glaciomarine origin is indicated by numerous broken reworked marine shells, microfossils and graded laminations. It is overlain by an estuarine sediment with temperate marine microfossils, suggesting an interglacial age. Above this are Late Pleistocene subglacial tills deposited during the last glaciation of the area, which extend more widely across the area, including capping the Easington Raised Beach section.

Field trip members study the newly exposed areas. The pits have been purpose-designed to remain open for as long as possible after the QRA visit.

All in all, it was a very successful visit, with much energetic discussion and debate at each of the field locations. Since the site is protected, it can be managed for its geological interest and re-excavated for further research in due course. Thanks are due to Natural England and the landowner, the National Trust, for permission and assistance. ■

Volunteer efforts pay conservation dividend

Alan Holiday,
Dorset Geologists' Association Group & Dorset RIGS

Several different groups were mobilized to carry out much-needed geoconservation work in Vallis Vale Site of Special Scientific Interest (SSSI), near Frome, Somerset. Some 200 hours of voluntary labour were expended over four days in September 2013.

Wessex Open University Geological Society, Dorset RIGS, Dorset Geologists' Association Group and Bath Geological Society spent a day on the De La Beche site, where vegetation had encroached on its famed angular unconformity.

A group of 21 enthusiasts used brush cutters to clear nettles in front of the rock face while others removed brambles and saplings from the main Carboniferous Limestone rock face. A further group cleared a thick accumulation of leaf litter and soil and further vegetation from the unconformity and the overlying Inferior Oolite face. Litter was also picked and graffiti cleaned from the rock face. The work followed a Natural England-funded Conservation and Enhancement Scheme to improve access into the SSSI and remove large overhanging trees 18 months previously.

Photos by Alan Holiday

The Vallis Vale site as it was in 2009 (above) and following the recent voluntary effort to clear it (below).

Some clearance work was also carried out within the SSSI at Hapsford Bridge where vegetation was encroaching over the unconformity between the Penarth Group and the Carboniferous Limestone. Unfortunately rubbish is regularly dumped at this site and it deserves better supervision.

A fortnight later another working party of up to a dozen people spent three days at Tedbury Camp Quarry RIGS. This was the third time in four years that work was carried out under the guidance of Martin Whiteley, from Derby University. Again vegetation was cleared to expose the rock faces. The dip section showing the Carboniferous Limestone and the borings of Jurassic organisms is now more accessible. Work was also carried out to expose the fascinating detail on the unconformity surface that separates the Carboniferous Limestone and Inferior Oolite. Yet more rubbish was removed, but the graffiti proved more difficult.

The work at Tedbury Camp was supported by Wainwright, a local quarry company which provided some equipment and chippings to help maintain the access steps from the East Mendip Way footpath. Further work is necessary.

Unfortunately both of these important geological sites attract more than their fair share of people intent on outdoor partying. It's a never-ending job to clear the debris of camp fires and BBQs. That said, both sites are now in a far better state and continue to attract many geologists and walkers. One regular user is the local Somerset Earth Science Centre; it takes school parties there for a variety of curriculum-focused field trips and welcomes enquiries about its free educational service. ■

Further information on Vallis Vale

Farrant, A.R. 2008. *A walkers' guide to the geology and landscape of eastern Mendip*. Book and map at 1:25 000 scale (British Geological Survey).

Somerset Earth Science Centre. www.earthsciencecentre.org.uk

Whiteley, M.J. 2009. *Tedbury Camp – a geological gem in the Mendip Hills*.

www.esta-uk.net/tedbury_camp_quarry.html

Earth Heritage magazine promotes geological and landscape conservation.
Download a free pdf copy from **www.earthheritage.org.uk**
or order a printed version – see page 3.

A rainbow acts as a dramatic natural pointer to the gold-bearing Crom Allt burn near Tyndrum, Stirlingshire, close to the proposed Cononish gold mine. Scotland's history of gold mining is discussed on page 26.

Photo © Neil Clark / The Hunterian, University of Glasgow