Earth heritage

The geological and landscape conservation magazine

Geotourism

Rock Miles

Sub-sea landforms

Earth science teaching resources

And more!

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Spring 2012

EDITORIAL

INSIDE

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

This issue is testimony to your continued commitment and achievements. Despite the difficult economic conditions, we need constantly to push 'geoconservation' and 'geodiversity' with politicians, planners and other decision makers. We must do likewise with the education and tourism sectors, because these are areas that build underlying public support and engagement. One way to spark collective imaginations may be through the concept of 'rock miles' (in essence the need to source geological materials as locally and ethically as possible). Another may be to start people thinking about the effects of climate change on geodiversity. These are just two of the topics raised in this issue of the magazine. There are many more, on a diverse range of topics. Hopefully, there will be something for you in this eclectic mélange!

Going forward from this issue, we are very pleased to welcome a member of the Geologists' Association to our editorial board. It is further recognition of the strength of *Earth Heritage* as a medium for making a broad readership aware of geodiversity issues.

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

Stewart Campbell

COVER PHOTO
South Stack, with its instantly recognisable lighthouse, is one of Britain's most iconic geological sites. Attracting thousands of visitors every year, the site will soon feature new geological interpretation provided by Geomôn, the Anglesey Geopark, and its partners. See History of Geotourism, page 3. ***Photo by Stewart Campbell***

Earth heritage

Earth Heritage **is a twice-yearly publication produced for download in pdf format by Natural England, Scottish Natural Heritage and the Countryside Council for Wales. The voluntary geoconservation sector is a major contributor. We would like to thank all those who have assisted with the preparation of the publication. However, 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**

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History of Geotourism: do you have a paper?

It hasn't always carried the catchphrase 'geotourism', but travelling the world to enjoy its unique and spectacular landforms and geology is a centuries-old pastime that has burgeoned into a significant part of the modern tourist industry.

Geotourism's roots can be traced to the élite 17th Century travellers who ventured into wild landscapes and visited far-flung caves and mines. Early modern geotourism can be recognised from the start of the 19th Century, coinciding with the emergence of geology guide books and field trips.

This engraving of people admiring Arthur's Seat from St Leonard's is from a drawing from Walter H Paton RSA.
Reproduced courtesy of Peter Stubbs, www.edinphoto.org.uk

Appreciating Physical Landscapes: Geotourism from 1670-1970 is an international conference to be hosted by The Geological Society of London on 22-23 October 2012 to look at the emergence of geotourism and its accompanying literature.

Conference organiser Tom Hose, of the University of Bristol, UK, is seeking papers and presentations for the event. A title, abstract of up to 500 words and related image should be submitted by 30 April by emailing t.hose123@btinternet.com

The conference will examine the reportage of early travellers and look at modern landscape and geoconservation efforts, the development of National Parks, Areas of Outstanding Natural Beauty, National Nature Reserves, the network of UNESCO geoparks and the emergence of environmental interpretation and modern countryside leisure activities.

Further details of the conference will be made available later at www.geolsoc.org.uk/geotourism12

– Tom Hose, University of Bristol

Environmental Impact Assessment for geodiversity

A wide range of geodiversity assets is affected by development (e.g. mineral extraction, flood prevention, road building, urban development, landfill, agriculture). These may be valued in terms of Earth heritage (geoconservation value) and ecosystem services (utilitarian value). They include geology, landforms and land-forming processes, soil and water resources; also the geosystem services which maintain the biosphere and all aspects of human life.

Environmental Impact Assessment – A guide to procedures (ODPM 2000; updated DCLG 2006) sets out the ground rules for EIA in the UK. The preparation of an Environmental Statement is mandatory for a range of development projects classified as 'EIA development'. Elements of geodiversity listed for description and assessment in Appendix 5 include:

- Geological, palaeontological and physiographic features
- Local topography
- Soil quality
- Drainage pattern
- Hydrographic and hydrological features
- Archaeological features.

EIA is commissioned by developers or their agents. It is frequently requested by planners for ecological, hydrological, archaeological and landscape character assets, so some aspects of geodiversity are thus routinely included in EIA. However impact on the full range of Earth heritage and geosystem assets is not routinely carried out.

I have published a poster presenting the elements of an integrated EIA methodology for geodiversity in Norfolk. It draws on a case study of a boatyard development in the Norfolk Broads. It advocates:

- routine inclusion of Geodiversity Impact Assessment (GIA) in the preparation of Environmental Statements
- advocacy of GIA to planners and planning consultants through Supplementary Planning Guidance for geodiversity
- dissemination of a standard GIA methodology as an objective of the UKGAP.

To see a consultation draft of the Norfolk methodology, go to https://sites.google.com/site/norfolkgeodiversity/action-ngap/2-embedding.

I would like to expand on GIA in a future article, but in the meantime I would be pleased to hear from anyone with experience of carrying out GIA in their work, and anyone interested in discussing the way that EIA legislation is being applied.

– Tim Holt-Wilson, Norfolk Geodiversity Partnership
(timholtwilson@onetel.com)

Scottish Geodiversity Forum's first annual conference

The Scottish Geodiversity Forum (SGF) held its first Annual Conference at the Scottish Natural Heritage (SNH) Battleby Centre near Perth in November 2011. Entitled *Scotland's Geodiversity – promoting, celebrating, safeguarding*, the event attracted over 50 delegates from around Scotland.

SNH Director of Policy and Advice, Susan Davies, opened the meeting with a speech entitled *Scotland's Geodiversity – Let's be creative*. Key to the inspirational success of the event was the quality of the three presentations by Colin Ballantyne of St Andrews University (*Rock and ice – geodiversity at landscape scale in Scotland*), Donald Fisher of Northwest Highlands Geopark (*Geotourism – an international perspective, what Scotland can learn from others*) and Stuart Monro of Our Dynamic Earth (*So what? Why geodiversity matters*). Workshops were an integral part of the day with delegates choosing from a range that examined some diverse and topical issues, namely: Working with young people; Engaging the general public; Geodiversity in Planning and Policy; Citizen science; and Geodiversity – more than an interesting narrative.

The Geodiversity in Planning and Policy workshop benefited from Scottish Government representatives who provided valuable expertise on the planning process in Scotland. Their contribution underlines the Scottish Government's support for Scotland's Geodiversity Charter which was unveiled to members for critical appraisal (http://scottishgeodiversityforum.org/charter/). The Forum was due to conclude the work on the Charter early in 2012 following wider consultation. Hopefully the Charter will be published by the middle of the year.

Work on revising the Scottish Biodiversity Strategy is currently taking place. Based on the ecosystems services approach, it is hoped that the continuing work and influence of the SGF will ensure that geodiversity will be an integral part of this new flagship document.

What the delegates said:

- ***Geodiversity sets human experience in the context of the dynamic evolution of Earth, the scheme of life and helps contextualise our place in the universe.***
- ***An awareness and appreciation of the geodiversity will help restore the long-lost links between our human existence today with the environment from which we have been so long separated, something a bio-centric view of the world alone cannot provide – surely this is something that many people would wish to know and care about.***

A full write-up of the conference is at http://scottishgeodiversityforum.org/download/

– Mike Browne, Scottish Geodiversity Forum
– Colin MacFadyen, Scottish Natural Heritage

Submerged forest – but where is it?

In summer 2011 my son and his fiancée were at a car-boot sale in Chester to find a picture frame for the seating arrangement for their wedding. They found a really fancy frame, called back at my house and put the frame's cardboard backing in the bin. I subsequently found it contained this image.

Submerged forests are not uncommon around the coasts of Lancashire – Merseyside and North Wales (e.g. Rhyl, Anglesey, Borth, Barmouth), but I don't recognize the coastline. The tide has gone out quite a long way and there is a structure on the horizon on the right, possibly a bridge, and what may be a causeway leading to it. The coastline seems to bend round to the left with some low-lying hills behind the vegetated sand dunes. Other questions are: What was subject of the photo doing... the net seems very large, was he shrimping? When was this photo taken? The man is barefoot, wearing trousers, a long jacket and a bowler hat with a pack on his back.

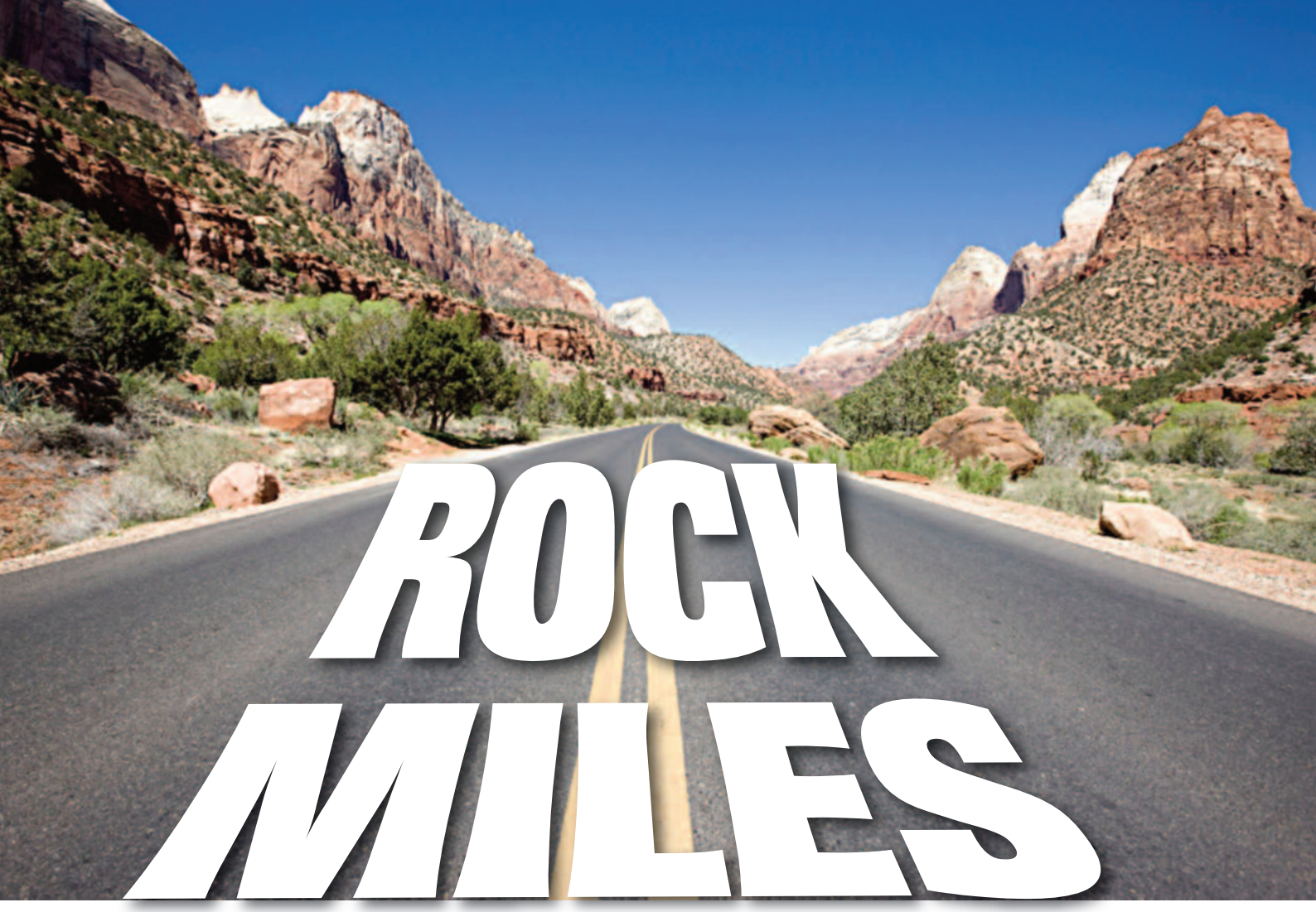
If you have any information, I would be very grateful if you could drop an email to jmalpas@geodiversity.co.uk. Many thanks in anticipation.

– Jacqui Malpas

Scotland's environment? It's all on SE Web...

Scotland's Environment Web (SE Web), launched in November 2011, brings environmental information on Scotland together in one place for the first time. You can search maps which show what is happening with different aspects of the environment; and research reports from all environmental organisations. The 'Our Environment' section provides straightforward descriptions of the state of Scotland's environment and key messages that highlight progress in protecting it. Geodiversity is covered predominantly under 'Land' ('Rocks and Landforms' and 'Soils' sections) and 'Resources' ('Fossil Fuels and Minerals'). SE Web can be found at www.environment.scotland.gov.uk/.
It is managed by SEPA (Scottish Environment Protection Agency) and will continue to be developed over the next four years.

– Rachel Wignall



Should we be keeping a count?

Cynthia Burek, University of Chester

There are many similarities between biodiversity and geodiversity history, procedures and management strategies. Often geodiversity has had the benefit of learning from biodiversity, since public awareness of geodiversity has been lower, and some would say much slower to fire people's imaginations than its biological counterpart. Examples include Local and UK Geodiversity Action Plans being developed from Local and UK Biodiversity Action Plans, and perhaps even the word geodiversity being derived to complement biodiversity.

However a new area that deserves study is the way the biological sciences have taken the lead in a fairer trade of their products. Everyone has heard of food miles, the distance food travels from field to plate. This makes an easily grasped link between how far our food travels and the associated carbon footprint generated – an important concept in this time of climate change and concerns about food security. Indeed, there is a move to introduce labelling on food to give us even more information about travel distances and carbon footprints. This is in addition to the labelling already required on fat content, components, one of your five a day etc. How many people will bother to read this additional information, I wonder, in the plethora of other information?

However, has anyone considered the concept of rock miles: the distance rock travels from its original quarry or mined location on the surface of Earth (I am not here thinking of its actual origins!) to its final destination, whether that is a kitchen work surface or a gravestone, namely the final use to which humans put it? In today's world of sustainability, recycling, re-use and reduction as well as climate-change agendas and carbon footprints, perhaps this is something we should at least think about.

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Rock miles – 2

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Recently leading a local graveyard walk around Rossett village graveyard in north-east Wales for the Sacred Spaces initiative of Wrexham Maelor Borough Council, I was asked where the rock for a particular headstone had come from? I am sure anyone who has led urban walks has been asked this same question.

People seem fascinated about original locations as well as rock types and in a graveyard we are generally dealing with an enormous variety of rock in a small enclosed space, especially in the more recent cemeteries. The variety is astounding, with different granites from all over the world to the military graves all made from Portland Limestone. Local stone seems to have disappeared except in the older, larger, urban, graveyards or

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Cynthia Burek's guided graveyard walk in Rossett.
Photos courtesy Cynthia Burek

Rock miles – 3

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close to older churches. Use of exotic stone, and the concept of rock miles, doesn't just stop at graveyards. Think of McDonald's restaurants with their travertine, originally all from Tivoli, Italy. Then there's the Pietra Serena sandstone, all from one quarry outside Firenzuola, Italy, transported for use in Apple stores worldwide. Then there are countless other public and private buildings either built from or furbished with marble and other fine rock from across the globe.

On our churchyard walk we had a debate about the true cost of transport of the rock we were looking at and the carbon footprint involved. For several years this is something I have raised with my students dealing with Environmental Impact Assessment case studies. It is part of the cost of environmental impact not in our back yard (the NIMBY syndrome), but in someone else's.

What about rock miles as part of geoconservation?

Much of the exotic-looking rock comes from India and China, where working conditions are very different and therefore the production cost is much reduced. However herein lies the conundrum. For many families, this is the only work available and by highlighting the true cost of the stone to people over here perhaps in the future we might be denying these families, often the youngest too, the chance to earn even a meagre income. Thus replicating the food analogy, should we think about the concept of Fairtrade just as we do with food production? Should stone masons and funeral directors as well as builders' merchants need to give us an idea of where our headstones, roof slates, paving stone have come from and how much carbon has been used on the way? I certainly ask but rarely get an answer as often they really do not know and sometimes have never even thought about it. I suppose the saving grace here is that most stone travels by sea not air because of the weight. **What about rock miles as part of geoconservation?** ●

Granite from Portugal now features in Bridge Street, Chester.

The North Pennine escarpment and Cross Fell, the highest hill in the North Pennines. In the foreground are dry stone walls containing local red Triassic sandstone from the Eden Valley.
Photo by Charley Hedley/Natural England

Reading the rocks in the North Pennines

Elizabeth Pickett, North Pennines AONB Partnership

The wonderful landscapes of the North Pennines Area of Outstanding Natural Beauty (AONB) are underpinned by outstanding geological heritage – one of the reasons that the area achieved UNESCO-endorsed Geopark status in 2003. Just as importantly, the accolade also recognises local efforts to make the most of the area's geology and one of our most recent celebrations is a new book produced by the North Pennines AONB Partnership.

Shaped by 500 million years of Earth history…

The geological story of the North Pennines spans nearly 500 million years of Earth history and is incredibly varied. The rocks and landscapes reveal a story of Ordovician volcanoes, Carboniferous tropical deltas, Permo-Triassic deserts and, in the more recent geological past, vast ice sheets. Molten rock became the Whin Sill; its hard dolerite now forms dramatic cliffs and waterfalls. Cutting through the fells and dales are veins of lead ore and other minerals, which crystallized deep underground from fluids heated by a hidden granite.

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Reading the rocks – 2

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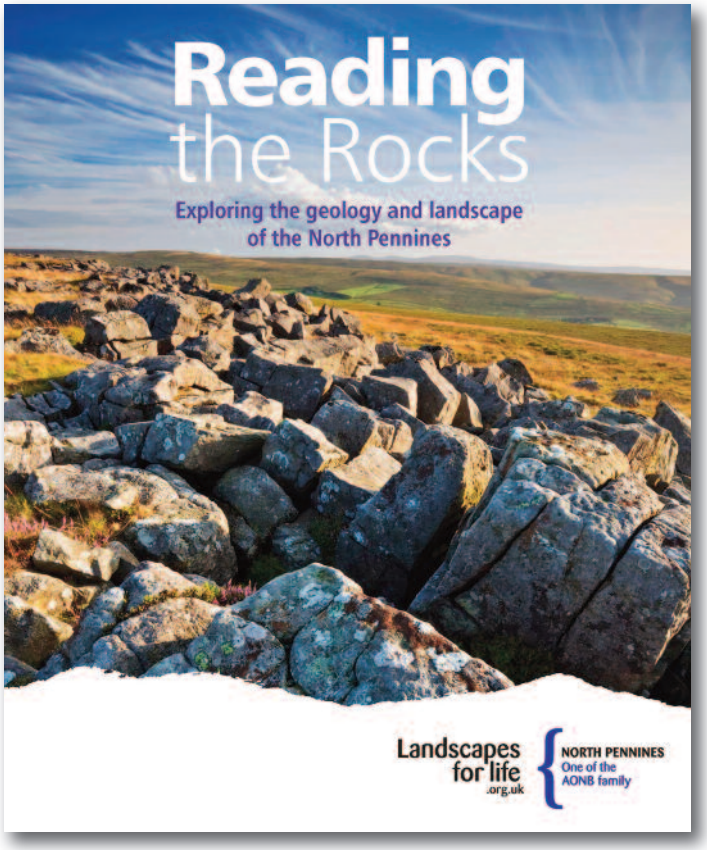
…and moulded by thousands of years of human activity

But the North Pennine landscape looks the way it does because of human activity, just as much as the natural processes that have shaped it over millions of years. For perhaps 10,000 years people have inhabited this landscape. It has been shaped by settlements, farms, quarries and mines, all of which have left their imprint. Particularly evocative are the old shafts, chimneys and spoil heaps of the lead mining boom of the 18th and 19th centuries. This is still a working landscape where farming, grouse moor management, forestry, quarrying, conservation and tourism all play a part in its evolution.

Telling the story

As part of our Geopark work to make the most of the area's geological heritage, we tell the story of the North Pennines in many different ways – from leaflets, panels, displays and education resources to events, children's geology clubs and evening classes. However, we had no overarching publication to cover the geological evolution of the North Pennines from its origins to the present-day. It was part of our Geodiversity Action Plan and there was clear demand for such a publication so, with funding from the Heritage Lottery Fund, Natural England and Friends of the North Pennines, we set about producing *Reading the Rocks*.



The book is intended for the non-specialist and provides colourful reconstructions of ancient environments, nuggets of geological information and suggestions of locations to visit. It shows how, by spotting clues in the landscape and 'reading the rocks', readers can explore the North Pennines' incredible journey through time. Woven through the story are the ways in which the area's rocks and minerals have been used by local people through the ages.

Finding out more and linking to local businesses

For the reader who wants more information there is a section on farther reading and useful maps. The book also encourages readers to visit local attractions and businesses where geology, landscape and the area's mining heritage are celebrated and interpreted. For those who may wish to explore even farther afield there is a short section about Geoparks and where to find out more about other UK Geoparks and the growing number around Europe and the rest of the world.

Reading the Rocks: exploring the geology and landscape of the North Pennines. Elizabeth Pickett. 2011. 49 pages. North Pennines AONB Partnership. £8 + £1.80 postage and packing. Softback. ISBN 978-0-9565161-5-2. Available by sending a cheque for £9.80 payable to 'Friends of the North Pennines', to North Pennines AONB Partnership, Weardale Business Centre, Old Co-op Building, 1 Martin Street, Stanhope, County Durham DL13 2UY (tel: 01388 528801, email: info@northpenninesaonb.org.uk or www.northpennines.org.uk) ●

Shetland Geopark: something to Yell about

Robina Barton, Shetland Amenity Trust

Since Shetland became a Global Geopark in 2009, geological interpretation has been developed throughout the islands. Community participation is encouraged to help local residents discover Shetland's rich Earth heritage and take ownership of their Geopark.

A project celebrating the beauty and diversity of Shetland's billion-year-old Moine rocks was undertaken with residents of Burravoe on the island of Yell. The interpretation was brought to life by the imagination, enthusiasm and commitment of the local population. The project created a new tourist attraction; helped a small museum get funding, develop displays and generate income; supported a rural school to deliver parts of the Scottish Curriculum for Excellence; provided activities and events for the community; encouraged voluntary activity; and provided income for local businesses.

The Geopark management was approached by Trustees of the Burravoe Old Haa Museum who were keen to have a geological installation in the museum garden. Trustee and artist Mike McDonnell suggested a series of figures, each of a different rock type. The figures would be in the style of Inuksuit – used by the Inuit as waymarkers and aids to navigation. They would showcase the rocks and highlight Yell's geological and cultural links with North America. An interpretative display inside the museum would explain how the rocks formed when Yell was part of what is now North America. Further displays would look at Yell's relationship with North America through whaling and the Hudson's Bay Company.

Geological storyline

Robina Barton of Shetland Amenity Trust, which manages Geopark Shetland, worked with Mike to develop a project plan, source funding and co-ordinate activities. Funding was secured from Scottish Natural Heritage and Shetland's Islands Council. Allen Fraser of Shetland Geotours and Jonathan Swale of Scottish Natural Heritage are voluntary geological advisors to Geopark Shetland, ensuring the accuracy of Geopark interpretation. They worked with Robina to develop the geological storyline and identify suitable rocks for the garden figures. Tenders were invited from local stonemasons to build the figures and Alan Smiles was asked to take the project forward.

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A stone figure in the style of Inuksuit (used by the Inuit as waymarkers and aids to navigation) in Old Haa Garden, Burravoe on the island of Yell, Shetland. This and other figures showcase Yell's Moine geology and cultural links with North America.
Photo by Shetland Amenity Trust

Shetland Geopark: **Something to Yell about – 2**

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Alan and Mike sourced building stone based on geological advice and recruited volunteers to transport it. Once the first figure – mica schist – was complete, community interest was assured. Children and adults were drawn to the new inhabitant of the Old Haa Garden and were eager to meet the rest. Mica schist was joined by hornblende gneiss, quartzite, augen gneiss, blastomylonite and pegmatite, all standing at intervals in the flower border around the garden.

Robina worked with the geologists to bring the geological story to life inside the museum. Mike suggested that Burravoe school children might help and teacher Caroline Breyley agreed it would make a good school project. Robina led a hands-on geology workshop to introduce pupils to Yell's rocks and how they formed. The children wrote and recorded short soundbytes to take museum visitors on a journey back in time, and explain when and how the rocks of Yell originated. The clips were recorded at the museum with sound engineer, Dave Sinton, giving a lease of life to the long-disused Magnetic North recording studio.

Pupils were inspired to explore local beaches for pebbles to make miniature copies of the figures in the garden and Mike showed them how to make their mini Inuksuit. The little figures and the audio recordings were brought together with a series of interpretative panels to create a multi-sensory museum display.

The project was complete, but Mike secured intergenerational funding (which aims to bring people of all ages together) from Museums and Galleries Scotland to create a project booklet. The booklet (*right*), created by the children, the geologists, Old Haa Trustees and Geopark staff, is on sale at the museum, generating income to support the valuable contribution the Old Haa makes to Yell's community and its visitors.

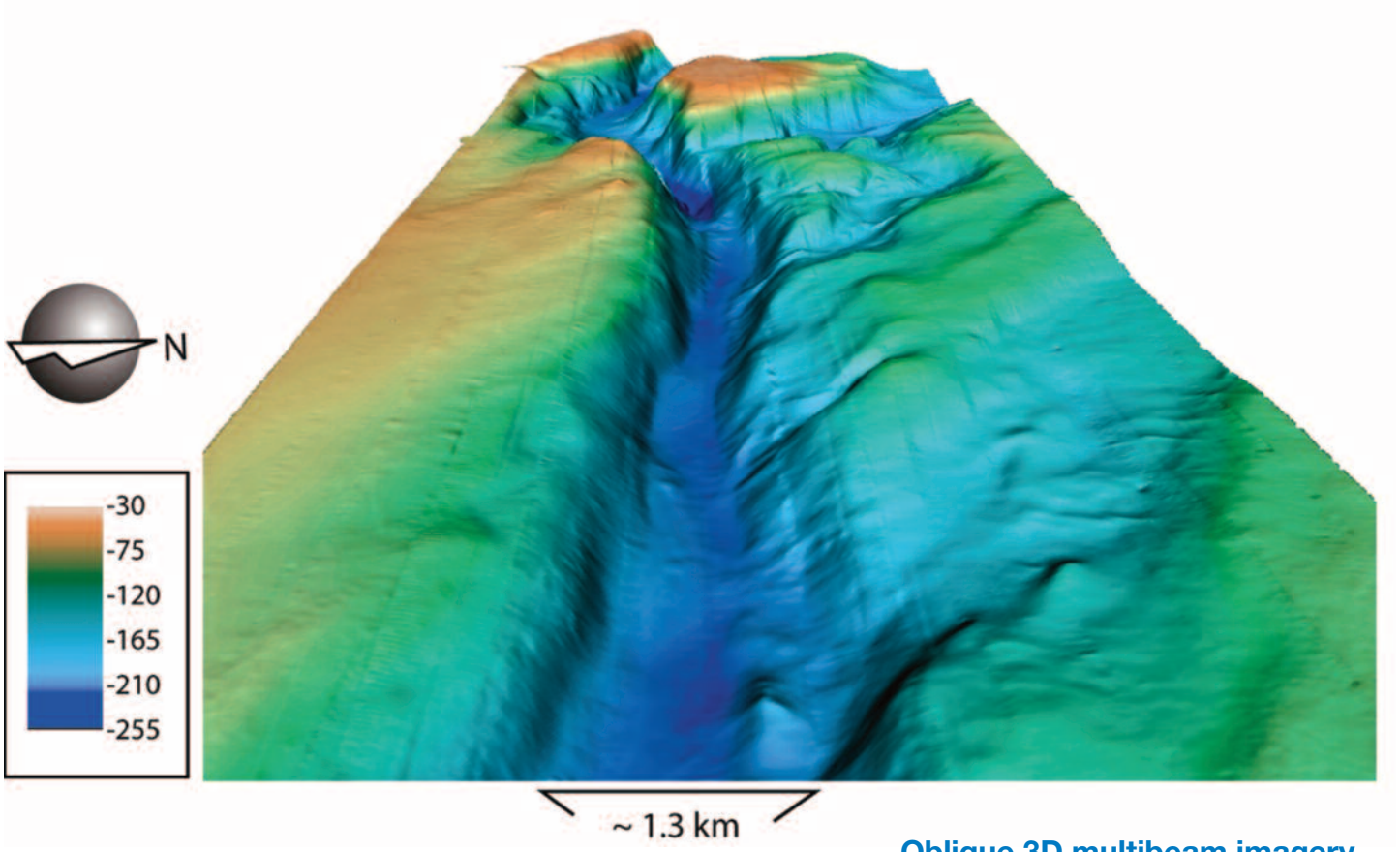
Museums and Galleries Scotland also funded a launch of the figures, exhibition and booklet. School pupils sang Inuit songs, musicians from the North Isles provided further entertainment, and the Burravoe Hall Committee laid on an enormous buffet for the 300 people who attended in June 2011. Further events are planned at the Old Haa and throughout Yell during the Shetland Nature Festival (7-15 July 2012) which is run in partnership with Geopark Shetland and European Geoparks Week. More information: www.geoparkshetland.org.uk

Cash-strapped Lochaber marches on

Lochaber Geopark, one of Scotland's three Geoparks, has been unsuccessful in raising sufficient funding, public or private, to maintain its membership of the European Geopark Network. Consequently, it has been expelled from both the European and the Global Geopark Network. While this is a very great disappointment to the volunteers who run Lochaber Geopark, the Geopark is still in business – completing a series of 20 new 'high-tech' interpretation panels this year (part-funded by Leader+ and Scottish Natural Heritage); and giving talks and guided excursions to schools, the University of the Third Age and the public. Lochaber Geopark is also actively supporting the new Scottish Geodiversity Forum.

– Jim Blair, Chairperson, Lochaber Geopark

Wonders
beneath the waves



Oblique 3D multibeam imagery, looking westwards over part of the seabed incision known as the Southern Trench. This large-scale feature lies 20 km north of Banff in the Outer Moray Firth and stretches beyond Fraserborough, extending 58km towards the north east, and in places it is up to 9 km wide and up to 250 m deep. Various theories about its formation including sub-ice fluvi-glacial erosion and / or catastrophic release of meltwater.

Alistair Rennie and John Gordon, Scottish Natural Heritage

Scotland has responsibility for 13% of Europe's seas – they are a huge environmental, economic and recreational resource but most of us have little idea of the remarkable world that lies on the seafloor beneath the waves. Now, for the first time, the range of stunning landforms hidden beneath Scotland's seas is highlighted in a new report published by Scottish Natural Heritage (SNH).

The sub-sea landforms there are every bit as impressive as anything we can see on land, and reflect the geological, glacial and marine processes that have shaped our seascapes and influenced the wildlife and habitats in our seas today.

As part of a project to identify marine habitats of high conservation value, Earth science experts have prioritised 34 key geological and geomorphological areas of national and

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Wonders beneath the waves – 2

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international interest on the Scottish seabed. The study, which was part-funded by Marine Scotland, was undertaken as part of the Scottish Marine Protected Areas Project, a joint initiative between Marine Scotland, Historic Scotland, SNH and the Joint Nature Conservation Committee.

Evocative names describe seabed features that include deep trenches extending for tens of kilometres (the Devil's Hole), extensive underwater moraines formed by the Last British Ice Sheet (the Wee Bankie), giant depressions on the sea floor (Pockmark complex) and mud volcanoes (Pilot Whale Diapirs).

Significance of underwater landscapes

Many of the areas featured in the report have the potential to deliver critical insights into important Earth processes, including climate change and future sea-level rise. However, we're increasingly aware of the significance of our underwater landscapes, not just for their intrinsic scientific value but also for their importance in supporting marine life and fisheries, and providing a diversity of wildlife habitats. Many of our key fishing grounds are associated with underwater landforms, such as the Wee Bankie, Rockall and the Southern Trench. As well as identifying the key geodiversity features in Scottish waters, the report helps to highlight what is so special about Scotland's marine environment and also the need to look after it, and the wildlife and industries it supports.

This is the first time that marine geodiversity interests have been investigated at a national level in Scotland. Together with detailed information on marine wildlife and habitats, the report will contribute to a national overview of the marine environment. The information will be used to advise Scottish Government and others on marine conservation and development, including international commitments to create a network of marine protected areas.

The report, *The identification of key geodiversity areas in Scottish waters* is available at www.snh.gov.uk/publications-data-and-research/publications/search-the-catalogue/publication-detail/?id=1837 ●

Staying power

Visitor numbers demonstrate enduring value of web-based education project

John Reynolds & Craig Slawson
GeoConservationUK and Earth Science Teachers' Association

Although active development of Earth Science On-Site (ESOS), the web-based education project from GeoConservationUK, ceased in 2008 when its Aggregates Levy Sustainability funding ran out, it continues to be a popular source of free, high-quality Earth science teaching materials.

Visitors to esos.geoconservationuk.org.uk can draw on an array of user-friendly, downloadable materials that are ready to use in the classroom or field and lock in to key stages 2, 3 and 4 of the National Curriculum, and they are doing so in their thousands.

Between 2004 and 2008, the original authors, Rick Ramsdale and John Reynolds, produced high- quality Earth science field teaching activities for schools at 16 former aggregates sites across England (*see map*) and made them available on the web. During the project, over 4,000 CDs, leaflets, and samples of teaching materials were handed out at regional geodiversity workshops and teacher conferences, including the Earth Science Teachers' Association, the Association for Science Education and the Geographical Association.

Statistics give a good indication of the sustained popularity of the ESOS website. In 2007, when the project was at its most vigorous, there were 7,416 visits, lasting an average of 1 minute 24 seconds. In 2011, the level of visits was still running at 2,972, lasting an average of 1 minute 34 seconds. This is very encouraging, particularly as we suspect that most 2011 visitors are newcomers. Minor updating, mainly of contact details, continues to keep the site topical, but the pdf downloads remain as they were in 2008.

THE ESOS SITE LOCATIONS

1 The National Stone Centre, Wirksworth, Derbyshire
2 Park Hall Country Park, Stoke on Trent, Staffordshire
3 Apes Tor / Ecton Hill, Wetton, Staffordshire
4 Black Rock, Matlock, Derbyshire
5 South Elmsall, Doncaster, West Yorkshire
6 Dryhill Nature Reserve, Sevenoaks, Kent
7 Ercall Quarries, Telford, Shropshire
8 Barrow Hill Nature Reserve, Dudley, West Midlands
9 Tedbury Camp/Vallis Vale, Frome, Somerset
10 Ryton Pools Country Park, Bubbenhall, Warwickshire
11 Mungrisdale/Mosedale, Penrith, Cumbria
12 Meldon Valley, Okehampton, Devon
13 Snableazes Quarry and Cullernose Point, Alnwick, Northumberland
14 Knowle Quarry, Much Wenlock, Shropshire
15 Boulmer foreshore, Alnwick, Northumberland
16 Barr Beacon & Pinfold Lane Quarry, Walsall

The ESOS materials have also been used beyond school groups, with adult education parties finding them very useful, especially for beginners. Using them as exemplars, several geoconservation groups have produced their own materials for other sites at this level, with one group developing A-level activities at Tedbury Camp Quarry, Somerset. ***Continued on following page***

Staying power – 2

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On-site teacher-training workshops

ESOS also had a wider dimension, involving training non-specialist teachers in the use of the 16 chosen sites and explaining how to adapt the materials for use at other geoconservation sites. This element of the project was the most difficult to deliver. There was the ever-present key constraint of short timescales imposed by the funding cycle. We could give teachers very little notice of events, making it impossible for sessions to be fitted into the professional development programmes of their schools. The option of Friday afternoon or Saturday morning sessions helped enormously, but three hours' fieldwork in winter months requires some degree of courage and endurance from non-specialists!

Student teachers learning how to use a clinometer and clipboard at the fault in Hulme Quarry, Park Hall. Photo ESTA

In the final year for both Park Hall, Stoke-on-Trent and Barrow Hill, Dudley, over 100 individual schools were invited. Personal contact with a tutor at Manchester Metropolitan University brought in eight trainee teachers from its Crewe campus. In all, 20 teachers or trainees attended a session at these sites. One managed both.

Linking information with pupil activities

Information for the teacher with little Earth science background was linked to the pupil activities in the classroom and out in the field. Each participant received an ESTA rock kit, a UK geology wall map and a CD of the project. Teachers were very positive about using the materials as exemplars in their own situations, especially the pebble-hunt and churchyard investigations. They were full of praise for the workshops.

However, when our bid for further ALSF funding was turned down in 2008, the planned development of training workshops at several sites was halted in its tracks.

Continued on following page

The number of hits recorded on the introductory pages of individual quarry sites in 2007 and 2011. This avoids double counting.

Site	2007(ranking)	2011 (ranking)
Apes Tor*	298 (6)	138 (6)
Barr Beacon**	N/A	74 (9)
Barrow Hill	182 (10)	79 (8)
Black Rock*	395 (3)	58 (10)
Boulmer Foreshore**	N/A	49 (12)
Dryhill	189 (9)	170 (2)
The Ercall	408 (2)	83 (7)
Knowle Quarry**	N/A	161 (4)
Meldon Valley	146 (11)	46 (13)
Mosedale	192 (8)	56 (11)
National Stone Centre*	340 (5)	141 (5)
Park Hall*	481 (1)	177 (1)
Ryton Pools	130 (12)	32 (16)
Snableazes**	N/A	40 (14)
South Elmsall	245 (7)	37 (15)
Tedbury Camp	388 (4)	164 (3)

* The original four pilot sites
** These four sites were completed in early 2008, hence there are no visitor figures for 2007

Staying power – 3

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Prospects

The government is planning changes to the National Curriculum for England, and these should be due in late 2012. The Earth Science Teachers' Association, the Association for Science Education, the Geography Association and others have held a joint seminar to agree to present an 'Earth Sciences voice' to the Department for Education. There is a reasonable chance that geography will be extended as a compulsory subject from Year 9 [14+] to Year 11 [16+ GCSE]. That will be good news for fieldwork!

It is hoped to develop further the ESOS online site, including more links to external information and more internal search facilities. More information: www.ukrigs.org.uk/esos/wiki/index.php5?title=Main_Page ●

Locations of ESOS user servers

2007

UK	**5,646**
London	1,383
Birmingham	316
Manchester	194
Sheffield	130
Wembley	111
Brentford	101
Stoke-on-Trent	93
Poplar	84
Bristol	71
Bath	69
Milton Keynes	69
USA	**976**
Australia	**113**
Canada	**112**
China	**31**
Germany	**29**
France	**28**
Ireland	**28**
India	**28**
Netherlands	**28**

2011

UK	**2,040**
London	249
Birmingham	78
Manchester	63
Bristol	56
Kensington	46
Leeds	35
Leicester	34
Newcastle-u-Lyme	34
Edinburgh	34
Newcastle-upon-Tyne	32
USA	**349**
Australia	**53**
Canada	**50**
India	**40**
Philippines	**27**
South Africa	**26**
France	**18**
Germany	**16**
Spain	**15**

Handbook revisions reflect changes in education

Chapter 10 of GeoConservationUK's RIGS* Handbook - RIGS and Education – has undergone major revisions to reflect changes in the rapidly moving field of education. The whole handbook is downloadable by chapter at www.gcuk.org.uk [click on Downloads].

The revisions include highlighting the work of the GCUK Education Project in both the text and an appendix. Dated and historic materials have been removed and some have been archived. A great deal of time was spent searching and testing the website links to a large number of organisations involved in life-long learning, formal education in general and fieldwork in particular. These range from government departments and examination boards to local geoconservation groups, and provide the user with a one-stop list of contacts in this important facet of LGS/RIGS work.

The revisions were undertaken by the original authors, John Reynolds, retired teacher, and Alastair Fleming, retired teacher and lecturer in Science Education at Keele University. Both continue to be actively involved in education and geoconservation.

(*RIGS – Regionally Important Geodiversity Sites)

Smart move...

The Isle of Kerrera near Oban on the west coast of Scotland. This is a classic area of Scottish geology and excellent teaching locality, ideally suited perhaps for interpretation available via smartphones. Photo by Colin MacFadyen/Scottish Natural Heritage

Making local geodiversity interpretation available to the smartphone audience

Angus Miller,
Lothian & Borders GeoConservation

Publishing information online and via smartphones seems all the rage, but it is a bit daunting for those of us still getting to grips with using a mobile phone to make calls, far less anything else. I've been experimenting with a straightforward new service for delivering maps and information to smart phones, and have been impressed at its ease of use and robustness. Best of all, it's free!

Lothian & Borders GeoConservation has been producing leaflets exploring Local Geodiversity Sites for years, and has built an excellent resource which is well regarded and does a great job. Typically we print 10,000 copies of folded A4 leaflets, and make them available free to the public through stalls, mailouts and partners. In the last few years, our designer has also produced a pdf file which can be downloaded from our website (www.edinburghgeolsoc.org/r_download.html).

Printing costs over £1,000 for each print-run of a leaflet, and we have been finding it increasingly hard

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Smart move – 2

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to raise the required cash. The general feeling we get is that paper leaflets are no longer seen as the best way to deliver information to the public. We disagree, and will continue to produce leaflets as funds permit. Having pdf files available on our website certainly ensures that publications don't disappear completely, but is there another way of getting our information out there, where people might come across it in new ways?

Robust Makkamappa

Google maps offers one solution, allowing users to upload information, draw routes and shapes on maps, and link photos and text. We experimented with the help of an Edinburgh University student, Luke Render, and you can see the result at http://g.co/maps/xjjmb. I have, however, found Google maps quite cumbersome to use, and was delighted to find Makkamappa, a simple, robust alternative which seems ready made for presenting geodiversity information at a series of linked geographical points on a map.

Makkamappa allows you to upload any map that you've got permission to use, connect it to a base map of the same area, and add points of interest. Your map might be a geology map, or a simple map showing a route for people to follow. It can be hand-drawn, and it doesn't have to be accurately to scale!

Once your map is uploaded, you then tie it into a base map for the area, in a simple process that involves selecting the same geographical point on both maps. Once that's done and your map is published, people can download it to their phone and follow your map on the ground, using the GPS in their phone. And you can add points of interest to the map very easily, including text and photos.

Mirroring Geodiversity leaflets

This solution closely mirrors our Geodiversity leaflets, which are usually based around a simple map of the area. We've experimented with our out-of-print leaflet on the Hermitage of Braid and Blackford Hill in south Edinburgh. You can see the result at http://makkamappa.com/maps/1249. It took me about two hours to upload the map and text, and it means that they are available free for anyone with an Android smartphone, iPhone, iPad or iPod touch. You start by downloading the makkamappa app, which has a free lite version that allows you to access two free maps. Or you can buy the app for a nominal amount, with unlimited map downloads. Once you've downloaded the map, you can go to the site and locate yourself on the map using GPS or your map-reading skills. Clicking on one of the points of interest brings up further information.

We're now waiting to see what sort of response and demand there is for information delivered in this way before we experiment further.

It certainly seems to be a very low-cost, efficient and robust way of making information available to a new audience, and making sure that all the hard work put into producing a leaflet doesn't disappear when the print version is no longer available. ●

Raising the profile of soils

Matthew J. Shepherd,
Natural England

If you wanted to get to know the soils in your area, would you know where to go? Or know what to look at when you got there? Soils are an intrinsic part of our Earth heritage, and form a link between geology, geomorphological processes and the living world and the atmosphere.

While soils reflect the underlying bedrock, drift or parent material, they can also tell us about how the land has been used, and how it has been changed by climate, people and other organisms. Soils are a link between ancient geological processes and today's society, yet they remain largely unrecognised in the current series of designated sites, and often play a minor role in environmental education. Soils are also a vital resource producing most of our food, and if managed properly they can also play a crucial role in mitigating climate change. While soil mapping gives a good overview of soil diversity, there's no substitute for exploring soils *in situ*. However, it can be hard to know which sites are accessible and how to interpret them when you get there. ***continued on next page***

Getting to grips with soil in the field: equipped with Munsell charts and rulers, a group digging pits on a soils training day. Photo courtesy of The Geology Trusts

Raising the profile of **soils** – 2

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A group of soils and geoconservation experts is now working together to raise the general profile of soils as a key part of Earth science. Their aim is to encourage local geoconservation groups and soil science experts jointly to identify sites that tell the story of their local soils in the context of local geological, biological, landscape and cultural features. Eventually, it is hoped, this would form a network of sites to support soils education, through universities, schools, professional training or simply for interested members of the public.

The group is supported by representatives of Natural England, GeoconservationUK, The Geology Trusts, the Association of Welsh RIGS Groups, Countryside Council for Wales (CCW), the British Society of Soil Science (BSSS), Environment Agency, Scottish Environment Protection Agency, Royal Agricultural College, National Soil Resources Institute, Institute of Professional Soil Scientists, and Scottish Natural Heritage.

Willie Towers, chair of the British Society of Soil Science education committee, said: "People often don't realise the fundamental role that soils have played in shaping our landscape and our lives. These sites will be an opportunity for local groups to celebrate the soils in their area, help others learn about them and why they are important." Soils sites will also provide opportunities for developing professional soils expertise. Chair of the Institute of Professional Soil Scientists (IPSS), Bruce Lascelles, explained: "The country has lost professional soil science expertise but many retired soil scientists wish to pass on their expertise to a new generation. A network of soils educational sites will not only inspire the next generation of soil scientists through schools and colleges, but will also provide support for the competencies developed for professional standards in soil by the IPSS." The group hopes to work with education bodies to help develop resources to aid the interpretation of the sites.

The current initiative aims to provide broad guidance during the coming year on how to select soils sites for educational networks. Local expertise is the greatest asset in identifying these sites. The aim is to put soils experts and enthusiasts in touch with their local geoconservation groups, strengthening the link between soils and Local Geological Sites or RIGS (Regionally Important Geo(morpho)logical Sites). Lesley Dunlop, of GeoconservationUK, notes: "The Local Geological Site and Regionally Important Geological Site (RIGS) systems already contain provisions for recognising the importance of soils, and John Conway of the Association of Welsh RIGS Groups has already developed educational soils trails of RIGS in Wales. What is needed now is more soil scientists getting involved to develop soils sites in their areas."

Anyone interested in getting involved or finding out more about this initiative should contact Matthew Shepherd, the Natural England soils specialist: matthew.j.shepherd@naturalengland.org.uk. ●

Making geology more fun

Katerina Braun

In Scotland over the last few years, volunteers have been working together organising geology family fun days with the aim of stimulating interest in the geological sciences amongst the younger generation.

Igniting a mini volcano.
Photo by Alistair McGowan

The first event, a Volcano Fun Day in October 2010 in Holyrood Park Visitor Centre, Edinburgh, was hosted by the Holyrood Park Rangers and funded by the Volcanic and Magmatic Studies Group of the Geological Society of London. The funding bought as much non-perishable, reusable material as possible, so that future events could be re-run at a cheaper cost. The event included displays and activities on volcanic rocks, volcanic processes and even a display on extra-terrestrial volcanoes! A guided geology walk around Arthur's Seat, Edinburgh's extinct volcano, was run every half hour, giving families the opportunity to get their boots dirty and explore the products of a real volcano. Around 70 families attended, sufficient for Holyrood Park Rangers to invite us for a re-run of the fun in 2011. This time, the event was expanded to include displays and activities on plate tectonics and Scotland's globe-trotting history, plus a longer, all-day geology trail around Arthur's Seat.

In April 2011, a 'Fossil Fun Day' was held at Fossil Grove, Victoria Park, Glasgow, hosted by Glasgow City Council and the Victoria Park Rangers to mark the re-opening of Fossil Grove. This event was funded principally by the British Sedimentary Research Group of the Geological Society of London, the Palaeontological Association and the Glasgow Natural History Society. It included a guided tour of Fossil Grove, displays on Glasgow's geology including fossils and rocks for tactile inspection supplemented with fossil-casting, fossil-excavation and jelly-coring activities. Around 250 people attended and the volunteers were run to the ground!

In January 2012, the Glasgow Science Centre invited us to attend the 'Build It' schools event to be on hand as experts in engineering geology and road building. The event ran for three days, with just under 1,850 pupils attending. There were displays of Glasgow's rocks and geology, plus displays and activities demonstrating the role of a geologist in road building, from desk study through to ground investigation, ground modelling, design and construction.

The group is now organising two family fun days per year between Spring and Autumn and hopes to organise more frequent events in future, interpreting more geodiversity themes, for example geomorphology; landslips; earthquakes; the coast; and rivers. The group intends to take events on tour across Scotland once they have been trialled and tested, although funding is required for volunteer expenses to run events Scotland-wide.

If you are interested in volunteering at future events or are interested in hosting a joint event, please email the Scottish Geodiveristy Forum membership@scottishgeodiversityforum.org and mark it for the attention of Katerina Braun.

The volunteers consist of a mix of professional, student and amateur geologists who are members of the Scottish Geodiversity Forum, Scottish geological societies, Scottish geodiversity groups plus employees of the British Geological Survey, Edinburgh University, Glasgow University, Scottish Natural Heritage and local Glasgow- and Edinburgh-based civil engineering firm URS (formerly Scott Wilson Ltd).

Mineral wealth on Sully Island

A view of the south-eastern headland of Sully Island. The near-horizontal red Triassic mudstones and calcretes for which the island is notified as an SSSI can be seen in the background. These sit unconformably on the steeply dipping Carboniferous limestone which can be seen in the foreground. Photo by Gareth Owen, CCW

Lynda Garfield and Dave Wellings, Russell Society, Wales and West Branch

Sully Island is a designated GCR site and SSSI. Now, the results of a recent study of the minerals on Sully Island by the Russell Society Wales and West branch complement the GCR citation, which states "*Sully Island preserves an excellent section of Upper Triassic marginal and intertidal rocks ... The site is critically important for understanding the ... arid playa margins in Late Triassic South Wales, a setting unique in the British Triassic*."

Sully Island becomes a small 'island' for about three hours either side of high water, otherwise accessible by foot across a causeway from Swanbridge near Sully. A knowledge of tide times is essential to access the island safely. The upper surface extends about 450m east to west and up to 110m north to south. At low water the foreshore extends the 'island' considerably.

Visitors should bear in mind Sully Island's SSSI designation and endeavour not to damage any of the site's features

The greater part of Sully Island and its extensive foreshore comprises gently dipping red beds of the Mercia Mudstone Group marginal facies. These lie unconformably on Carboniferous limestone (Friars Point Limestone) with a dip of 40° to 90° to the south-east/east.

During the late Triassic, the area lay very close to the northern margin of a large inland hypersaline lake, in an arid to semi-arid climate. Conglomerates and breccias were deposited, followed by marginal and intertidal sediments. From time to time soils developed. Eventually, the lake extended further, with the deposition of fine-grained wind-blown red muds and silts. *continued on next page*

Mineral wealth on Sully Island – 2

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Fluorite from the late Wilfred McRae's collection, collected in the 1990s

Mineral occurrences, several not previously reported, include (i) fluorite-galena and related minerals on the east and south-east of the island; (ii) quartz-celestine-calcite, particularly in nodules on the south-east of the island; (iii) galena and zinc minerals, and calcite, on the south foreshore; (iv) copper minerals in a domed area farther west on the south foreshore. Some excellent examples, especially of celestine and fluorite, have been noted. The mineralisation in the first, third and fourth areas is interpreted as Mississippi Valley Type (MVT) mineralisation, with the unique presence of fluorite, in Triassic rocks, in the first area. In the second area the nodules are of evaporitic origin in the Triassic strata.

The Carboniferous limestone on the east and south-east of the island is very disturbed. Above the main unconformity, in a pocket of 'bleached' Triassic rocks, flourite occurs with galena, baryte, calcite, quartz, goethite after pyrite, and a trace of malachite. Nearby, in a mined gully(?), seemingly below the unconformity, a few cubic metres of material now interpreted as Triassic infill are also quite rich in galena and fluorite. In the adjacent Carboniferous limestone are numerous galena-bearing veins, but no fluorite. The presence of fluorite is of particular note, because it is rare in South Wales. But why is it only in Triassic rocks?

The eastern end of the island was used for target practice from Lavernock Point in the 1870s. "Clouds of red rock dust" and "masses of stone hurled into the sea below" were described in 1874 – instant erosion! We surmise that this led to the exposure of the galena veins, in turn to small-scale mining as reported in 1901, and subsequently to the discovery of fluorite.

Celestine in a nodule, calcite lining the nodule

Photos by Garfield and Wellings

Nodules within the Triassic rocks, predominantly of quartz, are interpreted as having formed as calcretes or sulphate nodules in soil horizons. The nodules have subsequently been replaced, mainly by quartz, but on the south-east of the island also by calcite with very occasional celestine and very minor gypsum (or were these the original evaporite minerals? Mineralogical changes during diagenesis can be numerous in evaporite sequences). One especially interesting horizon is a palaeosol with large irregular nodules of up to 50cm of calcite, with, over one seven metre length, some massive blue celestine with gypsum. There is plenty of scope for further investigation to improve understanding of the hypersaline conditions that prevailed during the Triassic in this part of the world!

Triassic rocks with a layer of nodules of calcite, some of celestine.

Sully Island was recommended for RIGS designation in 2000 (*Bevins and Mason*). This recommendation has been reconfirmed by the South Wales RIGS project on account of the interesting and rare local variation of the South Wales regional MVT mineralisation, and for the nodules and minerals in the Triassic rocks, especially celestine and gypsum, which enhance the importance of Sully Island's GCR/SSSI sedimentological status. ●

Geodiversity & Climate Change

Extensive flats and slopes on inert quartzite bedrock in the Tasmanian Wilderness World Heritage Area are mantled by organic moorland soils which are similar to but much thinner than the blanket bog peats of Scotland and Ireland. Their geoheritage value lies partly in the fact they have developed so widely in a Holocene climate which has been only just wet and cool enough for them to form. Nonetheless they are an accumulated binding layer which has protected key elements of soft-sediment TWWHA geoheritage such as Pleistocene moraines and outwash terraces from erosion. Projected increasing temperatures, drier summers and a higher risk of intense bushfires could result in extensive degradation and loss of these soils, resulting in erosion of formerly protected soft-sediment landforms; major changes to landscapes, slope and fluvial geomorphic processes, vegetation communities and habitats; and the release of large quantities of sequestered carbon. Photo by Chris Sharples

Chris Sharples, University of Tasmania

Geoheritage provides our most important evidence that the Earth's climate has changed many times in the past, and gives us insights into how those changes affected past geological and geomorphic processes that produced the geodiversity we appreciate today. With renewed global climate change now increasingly apparent, the question of how those changes may affect geodiversity is no longer of only academic interest.

The Tasmanian Wilderness World Heritage Area (TWWHA) in Australia was listed on the UNESCO World Heritage List in 1989 for a range of values that included a rich heritage of geological features. These included Australia's only large area of mostly undisturbed Pleistocene glacial landforms, and also one of the most extensive remaining areas of near-pristine active fluvial, karst, coastal, soil and other geo-process systems in southern temperate latitudes. In recognition that climate change could result in changes to some of these features – not to mention consequent impacts on habitat, biodiversity and landscapes – the

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Geodiversity & Climate Change – 2

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Geodiversity Conservation and Management Section of the Tasmanian Department of Primary Industries, Parks, Water and Environment (DPIPWE) commissioned me during 2010-2011 to undertake a 'first pass' assessment of how climate change might affect the geodiversity and geoheritage of the TWWHA and what management responses (if any) might be appropriate.

This assessment followed modelling of projected future climates for Tasmania to 2100 by the Antarctic Climate and Ecosystems Co-operative Research Centre based at the University of Tasmania. This is the most detailed regional-scale climate change modelling yet completed for any part of Australia, and is based on six global climate models under the high A2 and lower B1 emission scenarios of the Intergovernmental Panel on Climate Change (IPCC). My method first considered how active geomorphic and soil processes in the present landscape may change, and then assessed how changed active processes may affect relict or 'fossil' geoheritage such as hard (bedrock) or soft (sediment) landforms and geological exposures, for instance from increased erosion or sedimentation. The active geoprocesses were grouped into themes such as fluvial, karst, coastal, alpine and soil processes, each of which are governed by a characteristic set of 'system controls' or environmental forcings such as bedrock type, topography, antecedent geomorphic history, precipitation, temperature, and vegetation cover. I assessed how each projected climate change might modify each system control, and then identified the implications for each theme.

Climate change will have little or no effect on some system controls (for example bedrock type and antecedent geomorphic history). However, it directly affects others such as precipitation (and consequent processes including runoff and fluvial discharge), while indirectly affecting important controls such as sea level (which controls coastal geomorphology), vegetation cover and dynamics (which may strongly control fluvial catchment processes, karst chemistry and soil development) and fire (which strongly controls vegetation dynamics and erosion processes in the Australian landscape). The full analysis and findings are in a report available for download at www.dpipwe.tas.gov.au/inter.nsf/WebPages/CART-8PB2HU?open .

Many of the most notable projected changes to geodiversity in the TWWHA stem from much more seasonal, increased precipitation in winter and less in summer. Intense downpours are expected to become more common, with longer dry periods in between. Together with the increased risk of catchment fires that this also implies, resulting in more frequent vegetation cover damage, a trend towards increased catchment erosion and landslides, more flash-flooding and river-channel erosion, along with increased deposition of mobilised sediments, can be expected. Episodes of major flooding and transport of landslide-derived sediment into karst caves in the northern part of the TWWHA have been notable in recent years and may be an incipient effect of climate change. Other notable impacts include active shoreline recession and dune erosion, which are already almost ubiquitous on soft TWWHA coastlines. These are likely to respond earlier to global sea-level rise than most Australian shores because the TWWHA coast has Australia's most energetic and stormy wave climate.

Similarities with Scotland and Ireland

However, one of the most pervasive impacts of climate change expected in the TWWHA is the loss of organic moorland soils which continuously mantle over 400,000 hectares of the TWWHA. Although similar to the blanket bogs of Scotland and Ireland, these soils are much thinner in Tasmania (typically 30 cm) because the Holocene TWWHA climate has been only just cool and wet enough for them to develop. They are valued as geoheritage in part because their very existence in such an environment is unusual. Their accumulation over

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Geodiversity & Climate Change – 3

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soft-sediment landforms such as Pleistocene glacial moraines and ancient river terraces has been responsible for protecting important relict landform geoheritage in the TWWHA from erosion through the Holocene. With warmer drier summers and increased fire risks expected over the next century, large areas of these already-marginal soils are likely to be destroyed, resulting in dramatic changes to catchment runoff and fluvial processes, exposing important soft-sediment landform geoheritage to erosion, and resulting in significant changes to TWWHA landscapes. In addition, it could lead to the release of large quantities of previously sequestered carbon into the atmosphere.

The risk to soft-sediment heritage

Active geomorphic and soil processes in the TWWHA will respond to climate change by evolving towards a new state (as they have done many times before during Earth's geological history); however in the process, coastal, fluvial and other erosion (and deposition) processes will become more active as the systems adjust. As a general rule there is likely to be only minimal loss of geoheritage embodied in hard rock. Instead, losses of geodiversity and geoheritage will be most significant where ancient soft-sediment landforms and deposits are exposed to increased coastal and terrestrial erosion processes. This unfortunately includes significant geoheritage features such as Pleistocene glacial moraines, ancient alluvial fans and river terraces, and coastal dune systems containing detailed palaeo-environmental and prehistoric cultural information embodied in palaeosol sequences and Aboriginal middens.

How should management of the TWWHA respond to such changes? Whereas efforts to intervene directly and artificially protect significant geoheritage features from accelerated erosion might be appropriate in environments already intensively modified by human activities, this will rarely be the case for the TWWHA. Here, the overarching objective is to maintain natural process systems in as undisturbed a state as possible.

Continued on next page

Slopes in some parts of the TWWHA have already been denuded of their thin mantle of moorland organic soils by intense fires during the 20th Century, as seen here in the Hardwood River valley. These soils are particularly sensitive to fire since they formed in a climate that was already marginal for them. As a result, projected impacts of climate change to 2100 including increased fire hazards and increased summer drying and desiccation of these soils, are likely to accelerate their loss.

Photo by Mike Comfort

Geodiversity & Climate Change – 4

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The most appropriate response to climate change

In general, the most appropriate response to climate change in the TWWHA will be simply to allow its natural processes (including its geodiversity) to evolve towards a new state, and to manage the consequences of change rather than to attempt to stop it happening. The most realistic response to impending loss of key elements may be to record thoroughly such features and take samples for archiving and future research. DPIPWE has commenced such a programme for the dune systems of the TWWHA coast that are being rapidly eroded. The scale and huge expense of any artificial interventions there would be unachievable, and would have an unacceptable impact on other natural processes for which the TWWHA is valued.

A further response will be increasingly to monitor and research the changes in TWWHA geomorphic systems. Given that we cannot fully foresee how natural processes will respond to climate change, ongoing research and monitoring in areas such as the TWWHA, where artificial disturbances other than climate change are minimal, may provide insights that are beneficial to climate change adaptation efforts elsewhere. ●

Further Reading

Prosser, C.D., Burek, C.V., Evans, D.H., Gordon, J.E., Kirkbride, V.B., Rennie, A.F. & Walmsley, C.A. 2010. Conserving Geodiversity Sites in a Changing Climate: management Challenges and Responses. ***Geoheritage, 2, 123-136***.

Left: Stephens Bay. Nearly all sandy beaches and dunes on the TWWHA coast have been continually eroded since at least the 1980s. The TWWHA coast is exposed to the most energetic and stormy wave climate of any Australian coast, which makes these beaches sensitive to even small changes in sea-level and has caused them to begin receding in response to global sea-level rise earlier than most others in the region. The ongoing erosion is destroying a rich coastal geoheritage comprising a record of Pleistocene and Holocene environmental change and Aboriginal occupation contained in dune palaeosol sequences and middens, such as the extensive midden visible here.

Right: Climate change may cause increased erosion to expose previously hidden geological materials. At Hannant Inlet in the TWWHA, recent shoreline erosion probably related to sea-level rise has exposed an unusual Pleistocene deposit of aligned woody fragments in coarse sediment. This exposure, which may be a landslide or alluvial fan deposit recording the destruction of a forested slope, has been listed on the Tasmanian Geoconservation Database and is likely to yield insights into Pleistocene landscape processes. However, it is a small site which could be entirely destroyed by continuing shoreline erosion by 2100.

Left: This ice-abraded highland surface provides evidence of a small ice cap which existed in the TWWHA highlands during the last of the Pleistocene glaciations. The form and geoheritage value of this hard bedrock feature are likely to be negligibly affected by climate change to 2100, and indeed increasing average temperatures are likely to slow the natural erosion of this landform since the freeze-thaw erosion processes that occur in this area are expected to become less severe with climate change. All photos on this page by Chris Sharples

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The glacial valley of High Cup Gill is one of the most spectacular and memorable landscapes in the North Pennines. A new book explains simply how the landforms were created.
See article on page 10.

Photo by Steve Westwood / Natural England